Feasibility Study Report

National Grid
Schenectady, New York

December 2006

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Certification Statement

I, Margaret A. Carrillo-Sheridan, P.E. as a Professional Engineer registered in the State of New York, to the best of my knowledge, and based on my inquiry of the persons involved in preparing this document under my direction, certify that the Feasibility Study for the National Grid Schenectady (Broadway) Service Center was completed in general accordance with an Order on Consent (Index No. A4-0473-0000) between National Grid and the New York State Department of Environmental Conservation (NYSDEC). The FS Report identifies and evaluates potential remedial alternatives to address environmental concerns at the site.

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Executive Summary

This Feasibility Study (FS) Report presents the results of an evaluation of remedial alternatives to address environmental impacts at the National Grid Schenectady (Broadway) Service Center (the site) located in the City of Schenectady, Schenectady County, New York. This FS Report was prepared by BBL, an ARCADIS company (BBL) on behalf of National Grid in accordance with an Order on Consent between National Grid and the New York State Department of Environmental Conservation (NYSDEC) (Order on Consent Index No. A4-0473-0000, effective November 17, 2003).

The FS identifies remedial action objectives (RAOs), develops general response actions (GRAs) for each impacted site medium, identifies and screens potential remedial technologies, and presents a comparative analysis of potential remedial alternatives to address site-related impacts.

The FS was prepared based on information presented in the following reports previously submitted to the NYSDEC:

- *Draft Preliminary Site Assessment/Interim Remedial Measure Study* (PSA/IRM Study), January 1993, Atlantic Environmental Services, Inc. (Atlantic);

- *Remedial Investigation Report for the Schenectady (Broadway) Site* (RI Report), January 1999, Parsons Engineering Science, Inc. (Parsons) (approved by the NYSDEC in January 199); and

- *Site Remedial Investigation Report* (SRI Report), November 2005, BBL (approved by the NYSDEC in December 2005).

In addition, this document was prepared in a manner that is consistent with the Order on Consent and the following documents:

- The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, 42 U.S.C. Sections 9601 et seq., as amended;

- Applicable provisions of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) regulations contained in Part 300 of Title 40 of the Code of Federal Regulations (40 CFR 300);

- The United States Environmental Protection Agency (USEPA) guidance document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (CERCLA Interim Final 1988);

- NYSDEC Technical and Administrative Guidance Memorandum (TAGM) 4025 entitled, "Guidelines for Remedial Investigations/Feasibility Studies," dated March 31, 1989; and

- NYSDEC TAGM 4030 entitled "Selection of Remedial Actions at Inactive Hazardous Waste Sites," revised May 15, 1990 (TAGM 4030).

The purpose of this FS is to identify, evaluate, and select remedial alternatives that are appropriate for site-specific conditions; protective of human health and the environment; and consistent with relevant sections of the New York State Environmental Conservation Law, the NCP, and CERCLA regulations.

I. Background

The site is currently utilized as a service center and covers an area of approximately 9 acres. The property is located at the corner of Broadway and Weaver Street in the City of Schenectady, Schenectady County, New York, approximately three-quarters of a mile southwest of downtown Schenectady. The area surrounding the site primarily consists of a mixture of industrial and commercial properties. The site is bounded to the north by a Delaware & Hudson (D&H) railroad line, to the south by Broadway, to the east by Weaver Street, and to the west by a CSX Transportation, Inc. (CSX) railroad line.

Based on National Grid records and information obtained from site investigation reports, the site formerly operated as a manufactured gas plant (MGP) and produced manufactured gas from 1903 to the mid-1940s using the coal carbonization and carbureted water gas processes. The original MGP was constructed in 1903 and used the coal carbonization process for the production of manufactured gas. Based on available information, coal gas production continued until sometime in the 1940s. By 1956, manufactured gas production had ceased and the site was, and currently still is used for natural gas distribution. The gas holders were reportedly removed from the site in 1961.

II. Environmental Impacts

Environmental impacts at the site were identified during site investigation activities that included, a PSA/IRM Study conducted by Atlantic, an RI completed by Parsons, and additional RI activities (a historical subsurface structure investigation, groundwater investigations, and a till investigation) completed by BBL.

Environmental impacts identified based on the results of the above-listed investigations included the presence of visually impacted soil containing light non-aqueous phase liquids (LNAPL) and dense non-aqueous phase liquids (DNAPL), from both MGP- and petroleum-related operations at the site. Constituents of concern (COCs) in subsurface soil at the site consist of benzene, toluene, ethylbenzene, and xylene (BTEX) and polynuclear aromatic hydrocarbons (PAHs). COCs in groundwater consist of BTEX, and in sediment consist of polychlorinated biphenyls (PCBs) and PAHs.

Based on current groundwater conditions, and the current and foreseeable future uses of off-site properties surrounding the site, soil vapor intrusion (SVI) on off-site properties is not identified as an environmental concern. To address potential SVI issues on-site, a SVI work plan detailing proposed on-site soil vapor investigation activities will be prepared and submitted to NYSDEC.

III. Standards, Criteria, and Guidelines

Standards, Criteria, and Guidelines (SCGs) were used to develop remedial action limits necessary to protect human health and the environment. Under NYSDEC guidelines for conducting an RI/FS, SCGs are defined as follows:

- Standards and Criteria – Those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances; and

- Guidelines – Non-promulgated criteria that are not legal requirements; however, remedial programs should be designed with consideration given to guidelines that, based on professional judgment, are determined to be applicable to the site.

The SCGs considered for the remedial alternatives identified in this FS have been categorized as Chemical-Specific, Action-Specific, or Location-Specific and are described in Tables 2-1 through 2-3, respectively.

IV. Remedial Action Objectives

RAOs are identified as medium-specific goals for protecting human health and the environment. These objectives are, in general, developed by considering the results of risk assessments and/or the SCGs identified for the site. The overall objectives of any remedial activities are to minimize potential human health risks to current and future site workers, reduce the quantity and extent of environmental impacts, and minimize the potential future migration of impacts to offsite areas. To support these objectives, RAOs have been established for onsite surface and subsurface soil, onsite and offsite groundwater, and onsite sediments. The RAOs for the media to be addressed as part of the remedial activities are presented in the following table.

Environmental Media	Constituents of Concern	RAOs
Onsite Subsurface Soil	BTEX and Total PAHs	1. Minimize potential risks to current and future onsite workers. 2. Minimize potential future offsite migration of NAPL to the extent possible. 3. Prevent migration of NAPL to Schermerhorn Creek to the extent possible.
Onsite Surface Soil	Total PAHs	
Onsite and Offsite Groundwater	BTEX and Total PAHs	1. Minimize future impacts to groundwater and reduce concentrations of COCs in groundwater to the extent practicable. 2. Prevent future discharge of impacted groundwater to surface water in Schermerhorn Creek to the extent practicable. 3. Minimize contact with or ingestion of impacted groundwater to the extent practicable.

Environmental Media	Constituents of Concern	RAOs
Onsite Sediments	PCBs and Total PAHs	1. Minimize potential risks to current and future onsite workers from direct contact with impacted sediments to the extent practicable. 2. Minimize potential dissolution of COCs from sediment to groundwater that may result in surface water impacts greater than ambient water quality criteria to the extent practicable. 3. Prevent impacts to biota from impacted sediments from bioaccumulation through the aquatic food chain to the extent practicable. 4. Eliminate exposure of downstream biota to site related impacts.

Notes:
1. Note that bioaccumulation does not apply to PAHs.
2. Total PAHs include the following: 2-methylnaphthalene; acenaphthene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene, benzo(k)fluoranthene; chrysene; dibenzo(a,h) anthracene; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; naphthalene; phenanthrene; and pyrene.

V. Remedial Technology Screening and Development of Remedial Alternatives

General Response Actions (GRAs) were identified to address impacted soil, groundwater, and sediment at the site. GRAs describe those actions that may satisfy the RAOs, and could include no action, institutional controls, containment, treatment (i.e., reduction of toxicity, mobility, and/or volume), removal, or a combination of various actions. Each GRA is associated with one or more potentially applicable remedial technology. Each remedial technology was evaluated against preliminary and secondary screening criteria to determine whether the technology was potentially applicable for the remediation of impacted soil, groundwater, and/or sediment. Preliminary screening was used to reduce the number of potentially applicable technologies based on technical implementability. Technical implementability is determined by referring to site characteristics and site characterization results to screen out technologies that cannot feasibly be implemented at the site. Secondary screening was then used to further simplify the development and evaluation of the remedial alternatives by comparing the effectiveness and implementability of each remedial technology relative to other potential technologies. Preliminary and secondary screenings of the remedial technologies are presented in Sections 4.3.1 and 4.3.2. The screening results are summarized in Tables 4-1 through 4-6.

The remedial technologies that were retained following the preliminary and secondary screening were developed into media-specific remedial alternatives to meet the RAOs for impacted media at the site.

Consistent with the NCP (40 CFR 300.430), the range of remedial alternatives capable of addressing the presence of chemical constituents in impacted environmental media includes the following:

- The "No-Action" alternative;

- Containment-based alternatives that involve little or no treatment, but are protective of human health and the environment by preventing or minimizing exposure to chemical constituents through the use of containment options and/or institutional controls;

- Treatment-based alternatives that treat COCs, but vary in the degree of treatment employed and long-term management required; and

- Removal-based alternatives that remove COCs to the extent possible and eliminate or minimize the need for long-term management.

The retained remedial technologies that were assembled into media-specific remedial alternatives are presented in Sections 4.5.1 through 4.5.3 and summarized in Section 4.6.

VI. Detailed Evaluation of Remedial Alternatives

Following preliminary and secondary screening, and the development of the media-specific remedial alternatives, a detailed description of each remedial alternative was prepared and each alternative was evaluated with respect to the following seven criteria specified in NYSDEC TAGM 4030 (NYSDEC, 1990) and the USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (USEPA, 1988):

- Compliance with SCGs;
- Long-Term Effectiveness and Permanence;
- Reduction of Toxicity, Mobility, and Volume;
- Short-Term Effectiveness;
- Overall Protection of Human Health and the Environment;
- Implementability; and
- Cost.

These evaluation criteria encompass statutory requirements and include other gauges such as overall feasibility and public acceptance. The detailed evaluation of each media-specific remedial alternative is presented in Sections 5.4, 5.5, and 5.6 for soil, groundwater, and sediment, respectively. Estimated costs for each media-specific remedial alternative are presented in Tables 5-1 through 5-13 and Table 6-1.

VII. Assembly of Site Wide Remedial Alternatives

Following the detailed evaluation of the media-specific remedial alternatives, site-wide remedial alternatives were assembled to address impacted media at the site. Descriptions of the site-wide remedial alternatives are presented in Sections 6.2.1 through 6.2.8. A comparative analysis (presented in Section 6.3) was also prepared to identify the relative advantages and disadvantages of each site-wide remedial alternative.

VIII. Recommended Remedial Alternative

Based on the results of the detailed analysis of the individual remedial technology processes (presented in Section 5) and the assembled site-wide remedial alternatives (presented in Section 6), a site-wide alternative has been selected as the recommended remedy (Site-Wide Alternative No. 2). Site-Wide Alternative No. 2 involves construction of a containment barrier wall; construction of an asphalt cap over the site; excavation of NAPL-impacted soil adjacent to select subsurface utilities; excavation of potentially NAPL-impacted soil south of Schermerhorn Creek; implementation of administrative controls and continued groundwater monitoring; passive NAPL recovery; and sediment removal and installation of closed culvert. The containment wall would surround NAPL-impacted soil with a relatively impermeable cement-bentonite wall (permeability at minimum on the order of 10^{-7} cm/sec) to minimize the potential migration of NAPL and impacted groundwater within the limits of the containment wall. This alternative is implementable and would be effective in meeting the site-wide RAOs. The barrier system and limited soil removal outside the barrier wall and adjacent to select subsurface utilities, in concert with the asphaltic concrete cap, would minimize the potential for human exposure to NAPL-impacted soils and soils containing BTEX and PAHs at concentrations greater than 10 and greater than 500 ppm, respectively. Implementation of administrative controls would further protect future site workers from exposure to the COCs in the soil and groundwater. In addition, groundwater monitoring would be conducted to document that site-related, impacted groundwater is not migrating offsite and to demonstrate that COCs in groundwater outside the containment area are attenuating via natural processes. Installation of a closed culvert would isolate the on-site portion of the Schermerhorn Creek from potentially-impacted groundwater and potentially NAPL-impacted soils from areas not addressed by the containment barrier wall.

Based on the detailed analysis, Alternative No. 2 is the selected site-wide alternative.

Site-Wide Alternative No. 2

Soil	Groundwater	Sediment
- Asphalt Cap - Containment Barrier Wall - Soil Removal – NAPL-Impacted Soil Adjacent to Subsurface Utilities - Soil Removal – Potentially NAPL-Impacted Soil South of Schermerhorn Creek and Offsite Treatment/ Disposal	- Administrative Controls with Continued Monitoring - Passive NAPL Recovery	- Sediment Removal and Installation of Closed Culvert

Alternative No. 2 effectively meets the RAOs established for the site and possesses the following comparative advantages for addressing environmental concerns identified at the site:

- The asphaltic concrete cap would be effective at reducing infiltration of precipitation into impacted soils.

- The containment barrier wall would be effective at minimizing future offsite migration of NAPL and impacted groundwater while limiting disruption to the site and the surrounding community that would be associated with soil removal alternatives.

- The containment barrier wall and excavation of NAPL-impacted soil adjacent to select subsurface utilities would be effective at addressing onsite NAPL-impacted soil, and impacted groundwater within its boundary, while excavation south of Schermerhorn Creek would address potentially impacted areas outside the containment barrier wall.

- Installing a closed culvert following sediment removal would provide an effective method to isolating the Schermerhorn Creek surface water from potentially impacted groundwater and potentially NAPL-impacted soils located outside the containment barrier wall regardless of potential future changes in the water table elevation and/or groundwater flow patterns.

- The containment barrier wall could be constructed in phases and could be coordinated with the facility to allow minimal disruption to daily operations at the site.

- Administrative controls would further limit potential exposure to impacted soils and groundwater (e.g., restricting groundwater usage, restricting excavation activities)

The total estimated cost for the recommended site-wide alternative is $19,900,000 and this alternative is estimated to require approximately two years to complete.

Acronyms and Abbreviations

The following acronyms and abbreviations listed alphabetically are applicable to this FS.

AMSL	above mean sea level
BBL	BBL, an ARCADIS company
BFS	blast furnace slag
BOD	biological oxygen demand
bgs	below grade surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CAMP	Community Air Monitoring Plan
CB	cement-bentonite
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	cubic-foot
CFR	Code of Federal Regulations
COC	constituent of concern
COD	chemical oxygen demand
CRS	cultural resources survey
CSX	CSX Transportation, Inc.
CWA	Clean Water Act
CY	cubic-yard
D&H	Delaware & Hudson Railroad
DNAPL	dense non-aqueous phase liquid
DPH	dissolved-phase hydrocarbons
DUS/HPO	dynamic underground stripping and hydrous pyrolysis/oxidation
ELUR	environmental land use restriction
EM	electromagnetic
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
FWIA	Fish and Wildlife Impact Assessment
GRA	general response action
GRP	ground penetrating radar
HASP	Health and Safety Plan
HC	hydrocarbon
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
HWR	hazardous waste remediation
ID	inside diameter
IRM	interim remedial measure
ISS	in-situ soil stabilization
LDR	land disposal restrictions
LNAPL	light non-aqueous phase liquid
LTTD	low-temperature thermal desorption
MGP	manufactured gas plant
MNA	monitored natural attenuation
MVS	Mining Visualization Software
NAPL	non-aqueous phase liquid
NCP	National Contingency Plan

NPDES	National Pollution Discharge Elimination System
NYCRR	New York Conservation Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	operation and maintenance
OM&M	operation, maintenance, and monitoring
OSHA	Occupational Safety and Health Act
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyls
PID	photoionization detector
POTW	publicly-owned treatment works
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
PRAP	proposed remedial action plan
PRB	permeable reactive barrier
PRG	preliminary remediation goal
PSA	Preliminary Site Assessment
RAO	remedial action objective
RCRA	Resource Control and Recovery Act
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation
SB	soil-bentonite
SCDOH	Schenectady County Department of Health
SCG	standards, criteria, and guidelines
SPDES	State Pollution Discharge Elimination System
SPLP	synthetic precipitation leaching potential
SPT	standard penetration testing
SRI	Site Remedial Investigation
SVE	soil vapor extraction
SVI	soil vapor intrusion
SVOC	semi-volatile organic compound
TAGM	Technical and Administrative Guidance Memorandum
TAL	target analyte list
TBC	to-be-considered
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TOC	total organic carbon
TOGS	Technical and Operation Guidance Series
UCS	unconfined compressive strength
USAF	United States Air Force
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UTS	universal treatment standard
UV	ultra-violet
VOC	volatile organic compound

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Appendices

1. Introduction

1.1 General

This Feasibility Study (FS) Report presents the results of an evaluation of remedial alternatives to address environmental impacts identified at the National Grid Schenectady (Broadway) Service Center (the site) located in the City of Schenectady, Schenectady County, New York. This FS Report was prepared on behalf of National Grid by BBL, an ARCADIS company (BBL), in accordance with an Order on Consent between National Grid and the New York State Department of Environmental Conservation (NYSDEC) (Order on Consent Index No. A4-0473-0000, effective November 17, 2003).

The FS was prepared based on information presented in the following reports that were submitted to the NYSDEC:

- *Draft Preliminary Site Assessment/Interim Remedial Measure Study* (PSA/IRM Study), January 1993, Atlantic Environmental Services, Inc. (Atlantic);

- *Remedial Investigation Report for the Schenectady (Broadway) Site* (RI Report), January 1999, Parsons Engineering Science, Inc. (Parsons); and

- *Site Remedial Investigation Report* (SRI Report), November 2005, BBL.

The FS has been prepared to evaluate remedial alternatives to address environmental impacts at the site in a manner consistent with the Order on Consent and with the following documents:

- The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, 42 U.S.C. Sections 9601 et seq., as amended;

- Applicable provisions of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) regulations contained in Part 300 of Title 40 of the Code of Federal Regulations (40 CFR 300);

- The United States Environmental Protection Agency (USEPA) guidance document titled "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (CERCLA Interim Final 1988);

- NYSDEC Technical and Administrative Guidance Memorandum (TAGM) 4025 titled, "Guidelines for Remedial Investigations/Feasibility Studies," dated March 31, 1989;

- NYSDEC TAGM 4030 titled "Selection of Remedial Actions at Inactive Hazardous Waste Sites," revised May 15, 1990 (TAGM 4030); and

In addition, NYSDEC "Draft DER-10 Technical Guidance for Site Investigation and Remediation," dated December 2002 was considered in the preparation of this FS.

1.2 Purpose and Report Organization

The purpose of this FS Report is to identify and evaluate remedial alternatives that are appropriate for site-specific conditions, protective of human health and the environment, and consistent with relevant sections of NYSDEC guidance, the NCP, and CERCLA regulations. The overall objective of the FS is to recommend a cost-effective remedial alternative that satisfies the remedial action objectives (RAOs) established for the site.

The organization of this FS Report is presented in the following table:

Section	Purpose
Section 1 – Introduction	Presents the purpose and objective of the FS. Provides a description of the physical site characteristics, site history, and an overall site characterization summary based on the results of investigations conducted at the site.
Section 2 – Identification of Potential Standards, Criteria, and Guidelines	Identifies the standards, criteria, and guidelines (SCGs) that govern the development and selection of remedial alternatives.
Section 3 – Development of Remedial Action Objectives	Summarizes the results of the Risk Assessment conducted for the site, develops site-specific RAOs that are protective of human health and the environment, and identifies media to be addressed through implementation of the remedial alternatives.
Section 4 – Identification and Screening of Technologies and Development of Remedial Alternatives	Identifies and presents screening results for General Response Actions (GRAs) and remedial technology types and processes. An assembled list of potential remedial alternatives for meeting the RAOs for the site are presented in this section based on the results of the screening.
Section 5 – Detailed Evaluation of Remedial Alternatives	Presents a detailed description and analysis of each potential remedial alternative. This section presents the results of the evaluation that has been conducted for each remedial alternative using the criteria presented in the referenced FS guidance documents.
Section 6 – Assembly and Selection of Site-Wide Remedial Alternatives	Presents a comparative analysis of each of the remedial alternatives and identifies the recommended remedial alternative.
Section 7 – Recommended Remedial Alternative	Identifies the recommended site-wide remedial alternative for the site.
Section 8 – References	Presents a list of the references cited in the FS Report.

1.3 Background Information

This section summarizes site background information relevant to the development and evaluation of the remedial alternatives discussed in this FS Report, including site location and physical setting, historical operation and land use, a summary of previous investigation activities, and an overall site characterization that includes a discussion of the nature and extent of impacts.

1.3.1 Location and Physical Setting

The site is located at the corner of Broadway and Weaver Street in the City of Schenectady, Schenectady County, New York (Figure 1-1) and covers an area of approximately 9 acres. The site is approximately three-quarters of a mile southwest of downtown Schenectady and the area surrounding the site primarily consists of a mixture of industrial and commercial properties. National Grid currently utilizes the site as a service center. The principal structure at the site is an office building with an attached garage and repair shop located near the southeastern portion of the property. Additional existing above-ground structures at the site include a small garage located in the western portion of the site, an open garage used for truck and equipment storage in the central portion of the site, and a storage building along the northern property boundary. Schermerhorn Creek transects the site flowing from southwest to northeast. A natural gas regulation and distribution station is located west of the office building near the center of the site. Parking areas are located to the north of the natural gas regulator and distribution station and west of the main entrance to the site along Broadway. A National Grid electrical substation (Weaver Street Substation) is located on the eastern portion of the site. Current site features are shown on Figure 1-2. Extensive subsurface utilities are located at the site, including underground natural gas piping and electrical conduit.

The perimeter of the site is fenced and access to the site is provided via two gated entrances, the main entrance on Broadway and a secondary entrance on Weaver Street. The site is bounded to the north by a Delaware & Hudson (D&H) railroad line, to the south by Broadway, to the east by Weaver Street, and to the west by a CSX Transportation, Inc. (CSX) railroad line.

Schenectady County lies almost entirely within the Mohawk lowland area bounded by the Adirondack Mountains to the north and by the Helderberg Escarpment of the Allegheny Plateau Province to the south.

The Mohawk lowland was deeply eroded during Pleistocene glacial advances, as well as by more recent drainage systems. During glacial retreat, the lowland was covered by pro-glacial Lake Albany (Woodworth, 1905). Glaciolacustrine deposits including sands, silts, and clays were deposited in Lake Albany. Eventually, a barrier in the lower valley of the Hudson River was eroded, causing the water level of Lake Albany to decline. This drainage left most of the Mohawk River Valley exposed, and the Mohawk River began to erode the pre-existing lake deposits and even bedrock, leaving coarse-grained sediments or channel fill deposits along the river channel. During Mohawk River flooding events, overbank floodplain deposits (interbedded clay, silt, and sand layers) were also formed. According to Stoller (1911), the Mohawk River followed several different courses before the current course was established.

The ground surface at the property, on either side of the Schermerhorn Creek, generally slopes towards the creek, which flows from southwest to northeast across the site. Schermerhorn Creek daylights in the southwestern portion of the site from an approximately 90-inch diameter concrete culvert and re-enters an approximately 72-inch diameter culvert at the northeastern property boundary on Weaver Street. The open section of creek at the site is approximately 1,100 feet long. Sediment has accumulated within the creek and the culverts to thicknesses of up to approximately 6.5 feet. The accumulation of sediment in the onsite portion of Schermerhorn Creek causes the creek to overflow its banks during heavy rainfall/snow melt events leading to flooding in the eastern-third of the National Grid property as well as Weaver Street several times a year. Accumulated sediment within the creek has also blocked discharge to the creek from City-owned storm drains originating at catch basins along Broadway, causing the street to flood during the heavy rainfall/snow melt events.

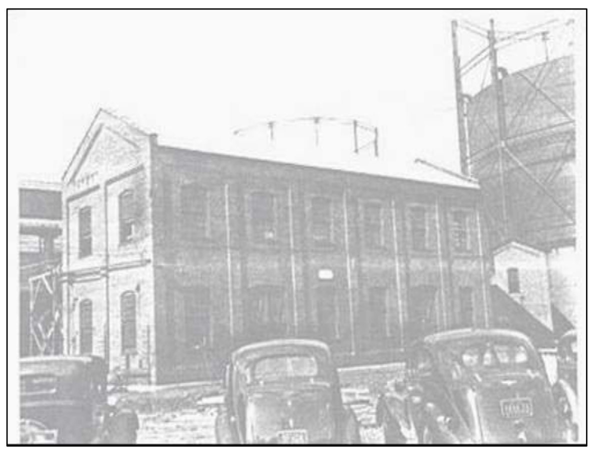
Schermerhorn Creek eventually discharges to the Mohawk River, which is located approximately 4,000 feet north of the site. The Mohawk River flows in a generally southeastward direction across Schenectady County, discharging to the Hudson River approximately 15 miles east of the site, near Cohoes, New York. From Hoffmans, New York where the Mohawk River enters Schenectady County to approximately 5 miles beyond the site, the river occupies a relatively wide floodplain (approximately 1 to 2 miles across). The surface elevation of the floodplain is generally between 220 and 240 feet above mean sea level (AMSL) in the site vicinity. From the floodplain to the highland area south of the site, the ground surface elevation increases rapidly to more than

350 feet AMSL. The site is located within the 500-year floodplain of the Mohawk River, but outside of the 100-year floodplain (FEMA, 1983).

1.3.2 Historical Operation and Land Use

Based on National Grid records and information obtained from site investigation reports, manufactured gas was produced at the site from 1903 to the mid-1940s using the coal carbonization and carbureted water gas processes. The original manufactured gas plant (MGP) was constructed in 1903 and used the coal carbonization process for production of manufactured gas. The gas was stored in an 800,000 cubic-foot (CF) above-grade steel gas holder located in the northern portion of the site near the northeast corner of the existing storage building. At that time, the east side of the site was occupied by a small trolley car yard operated by the Schenectady Railway Company. The trolley yard covered the area now occupied by the National Grid office building, garage, and the open area north of the garage.

Manufactured gas production switched to the carbureted water gas process beginning in 1907 following construction of a water gas house, a brick purifier house, a boiler house, and a 150,000 CF above-grade steel gas holder that was located in the northern portion of the site near the southeast corner of the existing storage building. A 2 million CF above-grade gas holder was then constructed east of the 800,000 CF gas holder in 1913 to increase gas storage capacity. In 1914, the principal structures at the site included the three gas holders; a retort house; a central manufacturing building containing an engine room, boiler room, generator house, and condenser house; and a purifier house. Smaller structures included a governor house, a concrete oil tank, an ammonia concentrator, a tar separator, and a tar tank. By 1930, a second purifier house and second boiler room were present at the site (Atlantic, 1993). The approximate locations of the historical MGP site features are indicated on Figure 1-2.



Circa 1938

Gas production at the site increased between 1914 and 1927, until gas generated at a regional plant in Troy, New York became the primary source of manufactured gas to the City of Schenectady. By 1930, several of the water gas manufacturing structures (one of the purifier houses, the generator house, and the condenser house) had been converted to other uses, indicating that water gas production had ceased. Based on available information, coal gas production continued until sometime in the 1940s and weekly testing of gas production equipment was conducted during the 1950s. By 1956, manufactured gas production had ceased and the site was used for natural gas distribution. The gas holders were reportedly removed from the site in 1961.

A predecessor of National Grid assumed ownership of the site in 1950. Previous property owners included the Mohawk Gas Company (1903 to 1919), the Schenectady Illuminating Company (1919 to 1921), the Adirondack Power and Light Company (1921 to 1927), and the New York Power and Light Company (1927 to 1950).

1.3.3 Summary of Previous Investigations

Previous investigations conducted at the site include the following:

- Preliminary Site Assessment/Interim Remedial Measure (PSA/IRM) Study conducted by Atlantic Environmental Services, Inc. (Atlantic) in 1992;
- Remedial Investigations (RI) conducted by Parsons Engineering Science (Parsons) in 1994, 1996, and 1997;
- Non-aqueous phase liquid (NAPL) and groundwater investigation activities conducted by BBL in 2001 and 2002;
- Historical subsurface structure investigation conducted by BBL in 2004;
- Additional subsurface investigations initiated by BBL in 2004 and 2005; and
- Till investigation conducted by BBL in 2005.

The investigation activities and the results obtained from the investigations were presented in the following reports:

- *Preliminary Site Assessment/Interim Remedial Measure Study* (PSA/IRM Study), Atlantic, January 1993;
- *Remedial Investigation Report for the Schenectady (Broadway) Site* (RI Report), Parsons, January 1999. The RI Report was approved by the NYSDEC in January 1999; and
- *Site Remedial Investigation Report* (SRI Report), BBL, November 2005. The SRI Report was approved by the NYSDEC in December 2005.

Summaries of the objectives and activities conducted during each of the previous investigation activities are presented below. The site characterization described in Section 1.4 is based on the results of the previous investigation activities described below.

Preliminary Site Assessment/Interim Remedial Measure Study

Atlantic conducted the PSA/IRM Study field activities during the spring and summer of 1992. The objective of the PSA/IRM Study was to identify potential sources of MGP residual material at the site and obtain sufficient data to develop an IRM to address potential source area(s). The PSA/IRM Study consisted of the following investigations:

- Soil gas survey;
- Subsurface soil investigation;
- Groundwater investigation; and
- Sediment investigation.

Soil gas survey activities were conducted to obtain a preliminary assessment of the horizontal extent and relative concentration of volatile organic compounds (VOCs) in soil and groundwater at the site. Soil investigation activities were then conducted to focus on areas at the site that indicated potentially elevated VOC concentrations based on the soil gas survey results. A total of 73 soil samples were collected from 15 test pits (test pits BT-1 through BT-15) and 26 soil borings (soil borings BB-1 through BB-26) completed during the PSA to facilitate the characterization of subsurface soil conditions. Each of the soil samples was screened in the field for volatile organic vapors using a photoionization detector (PID) and for separate phase liquids using a centrifuge, and the soil samples were subsequently submitted for laboratory analysis for VOCs and polynuclear aromatic hydrocarbons (PAHs).

One groundwater monitoring well (BMW-1, which was later renamed monitoring well MW-2) was installed to facilitate the collection of a sample to characterize groundwater in order to identify potential handling and disposal requirements in the event that groundwater management was required during potential remedial activities to be conducted at the site.

Atlantic also collected two sediment samples (sediment samples BSD-1 and BSD-2) from Schermerhorn Creek using a hand auger. Each sediment sample was field screened for the presence of separate phase liquids using a centrifuge and submitted for laboratory analysis for VOCs and PAHs.

Soil, groundwater, and sediment sampling locations are shown on Figure 1-3.

Remedial Investigation

Parsons conducted the RI field activities during the summer and fall of 1994, the spring and summer of 1996, and the winter of 1997. The objectives of the RI were as follows:

- Evaluate the nature and extent of impacted soil, including the delineation and characterization of source materials, residuals, and potential migration pathways;
- Evaluate potential human health and environmental risks and preliminary remediation goals (PRGs);
- Obtain data to support an FS; and
- Investigate potential offsite sources.

The RI consisted of the following investigations:

- Surface soil investigation;
- Subsurface soil investigation;
- Groundwater investigation;
- Surface water investigation;
- Sediment investigation; and
- Human Health Risk Assessment (HHRA) and Fish and Wildlife Impact Analysis (FWIA).

The surface soil investigation consisted of collecting 25 surface soil samples for field screening for PAHs and polychlorinated biphenyls (PCBs) using EnSys field test kits. Based on the results of the field screening, a total of 18 surface soil samples collected from nine onsite and nine offsite sampling locations were submitted for laboratory analysis. Each of the surface soil samples (with the exception of soil samples BSS-17 and BB-84) was submitted for laboratory analysis for target compound list (TCL) VOCs, TCL SVOCs, pesticides/PCBs, target analyte list (TAL) inorganics, cyanide, and total organic carbon (TOC). Surface soil samples BSS-17 and BB-84 were submitted for laboratory analysis for benzene, toluene, ethylbenzene, and xylenes (BTEX); PAHs; and cyanide.

Parsons collected a total of 135 discrete subsurface soil samples from 58 additional onsite and offsite soil borings (soil borings BB-27 through BB-84, and BB-41R). Boring locations were selected to further delineate impacted material based on the results of the PSA/IRM Study and to focus on areas at the site that were not sampled as part of the PSA/IRM Study. Soil boring locations are shown on Figure 1-3. Of the 135 samples, 110 were submitted for laboratory analysis for BTEX, PAHs, and cyanide and 19 were submitted for laboratory analysis for TCL VOCs, TCL SVOCs, pesticides, TAL inorganics, and cyanide. The remaining subsurface soil samples were submitted for waste characterization analysis or geotechnical testing.

Parson's drilling subcontractor installed a total of 29 groundwater monitoring wells at and in the vicinity of the site during the summer of 1994 and spring of 1996 to facilitate monitoring of onsite and downgradient groundwater quality and evaluate onsite hydrogeological characteristics. Monitoring wells installed during previous investigation activities were renamed MW-1 (for the monitoring well installed prior to the PSA/IRM Study) and MW-2 (monitoring well BMW-1, installed during the PSA/IRM Study).

The RI monitoring wells consisted of 10 single wells (monitoring wells MW-3 through MW-5, MW-7, MW-10, MW-11, MW-12, MW-16, MW-17, and MW-18), two well pairs (monitoring well clusters MW-6 and MW-15), and five well triplets (monitoring well clusters MW-8, MW-9, MW-13, MW-14, and MW-19). Well construction details and well construction logs are presented in the RI Report (Parsons, 1999).

Parsons conducted two groundwater sampling events at the site between June and August 1996. Groundwater samples collected during both of the sampling events were submitted to Nytest for laboratory analysis for TCL VOCs, TCL SVOCs, pesticides, PCBs, TAL inorganics, and cyanide. In addition, during the initial round of sampling, 12 of the groundwater samples (collected from monitoring wells MW-6S, MW-7, MW-8I, MW-9S, MW-9I, MW-9D, MW-12, MW-13I, MW-16, MW-17, MW-18, and MW-19D) were also analyzed for biological oxygen demand (BOD), chemical oxygen demand (COD), chloride, hardness, nitrate, nitrite, oil and grease, sulfate, sulfide, total dissolved solids (TDS), pH, and alkalinity.

Additional investigation activities conducted as part of the RI consisted of a sediment and surface water investigation for Schermerhorn Creek. Four surface water samples (BSW-1, BSW-2, BSW-4, and BSW-5) and 34 sediment samples (collected from 20 sediment sampling locations) were collected within Schermerhorn Creek. Surface water samples were submitted for laboratory analysis for TCL VOCs, TCL SVOCs, pesticides, PCBs, TAL inorganics, and cyanide. Parsons submitted 14 of the 34 sediment samples to Nytest for laboratory analysis for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL inorganics, cyanide, and TOC. The remaining 20 sediment samples were analyzed for BTEX, PAHs, PCBs, cyanide, and TOC.

A summary of the two-component baseline risk assessment (which consisted of an HHRA and an FWIA) prepared based on the results of the RI is presented in Section 3.

NAPL and Groundwater Investigation Activities

The objectives of the NAPL and groundwater monitoring activities were to monitor the presence and extent of NAPL in existing monitoring wells at the site, passively recover NAPL (to the extent practicable), further delineate the extent of NAPL at the site, and further characterize groundwater quality at the site. Following NYSDEC approval of Parsons RI Report, BBL conducted the following NAPL and groundwater investigation activities between June 2001 and June 2002:

- Monthly NAPL monitoring (from June 2001 through December 2001);
- Additional NAPL delineation sampling (December 2001); and
- NAPL monitoring and groundwater sampling activities (June 2002).

BBL conducted monthly NAPL monitoring from June 2001 through December 2001 to monitor the presence/absence and thickness of NAPL in existing monitoring wells at and in the vicinity of the site and to passively recover NAPL (to the extent possible) using manual bailing techniques. Field personnel utilized an oil/water interface probe to identify the presence/absence of NAPL in each of the existing monitoring wells. Where identified based on the gauging activities, NAPL was removed to the extent practicable using stainless steel bailers and containerized in 55-gallon drums for offsite disposal and the amount of NAPL recovered was recorded.

Additional NAPL delineation sampling activities were conducted during the week of December 17, 2001 to further delineate the horizontal extent of NAPL at the site. Initially, four soil borings (BB-85, BB-86, BB-88, and BB-89) were completed along the northern and western property boundaries (i.e., the hydraulically downgradient property boundaries). An additional soil boring (BB-87) was completed east of the open garage to facilitate installation of monitoring well MW-20.

NAPL monitoring conducted during June 2002 consisted of gauging each existing monitoring well using an oil/water interface probe to identify the potential presence/thickness of light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL). Where identified based on the gauging activities, NAPL was removed to the extent practicable using stainless steel bailers and containerized in 55-gallon drums for offsite disposal and the amount of recovered NAPL was recorded.

BBL also conducted groundwater sampling activities during the week of June 10, 2002 to further characterize groundwater quality at the site. Monitoring wells MW-16 and MW-17 were not able to be located during the June 2002 monitoring event due to the presence of gravel over the well covers. Prior to collecting the groundwater samples, BBL's field personnel purged approximately three well volumes of groundwater from each monitoring well using disposable polyethylene bailers. Groundwater samples were then collected from 26 existing monitoring wells at and in the vicinity of the site. Groundwater samples were not collected at monitoring wells MW-3, MW-4, and MW-5 due to the presence of NAPL. Each groundwater sample was submitted for laboratory analysis for VOCs, SVOCs, and cyanide.

Historical Subsurface Structure Investigation

BBL conducted a historical subsurface structure investigation in May, June, and September 2004 to further evaluate the potential presence and extent of NAPL in the immediate vicinity (i.e., above, below, within, and immediately adjacent to) of historical subsurface structures associated with former MGP operations at the site. The objectives of the investigation were as follows:

- Verify the presence (or confirm the absence) of historical subsurface structures and document the location of these structures;
- Identify the approximate depth and size of historical subsurface structures;
- Develop survey data and mapping of historical subsurface structures; and
- Complete soil borings penetrating historical subsurface structure foundations and collect soil samples to assess the presence/absence and extent of NAPL-impacted soil underlying the subsurface structures.

Historical structures associated with MGP operations at the site (which contained a subsurface component) include the following:

- 2 million CF above-grade gas holder;
- 800,000 CF above-grade gas holder;
- 150,000 CF above-grade gas holder;
- retort building;
- generator/condenser house (including boiler and engine rooms);
- two purifier houses;
- ammonia concentrator;
- coke bin;
- pit;
- oil tank;
- tar tank;
- tar separator;
- water gas condenser;
- scrubber tank; and
- separator.

The approximate locations of historical subsurface structures based on a review of historical site maps and previous site investigation activities are shown on Figure 1-2.

The historical subsurface structure investigation included a non-intrusive subsurface investigation (consisting of a geophysical survey) and an intrusive subsurface investigation (consisting of the completion of test borings and soil borings).

Prior to implementing drilling activities, BBL completed a non-intrusive geophysical investigation to assist in locating and delineating historical subsurface structure foundations and other subsurface features. The non-intrusive geophysical investigation consisted of conducting electromagnetic (EM) and ground-penetrating radar (GPR) surveys in an attempt to identify the general location of subsurface structures across the site.

Following completion of the non-invasive geophysical survey activities, BBL completed the test borings using an AMS PowerProbe™ equipped with a 2-inch diameter, 4-foot long macrocore sampling tube. In general, a series of test borings were completed at each probing location along transects oriented perpendicular to the estimated edge of the subsurface structure foundations in order to identify the approximate physical limits of the structures. BBL field personnel completed a total of 83 test borings along 27 transects.

Field personnel visually characterized the soil samples collected during the completion of the test borings for soil type, staining, obvious odors, and the presence of NAPL. In addition, a PID was utilized to screen each soil sample for the presence of volatile organic vapors.

Following evaluation of the information obtained from the test boring activities described above, a total of 43 soil borings were completed using a combination of the AMS PowerProbe™ and a truck-mounted hollow-stem auger (HAS) drill rig. The soil borings were completed to facilitate evaluating conditions and collecting soil samples below historical subsurface structures. The HSA drill rig was utilized at locations where the subsurface structure could not be drilled through using a hand-held core saw (due to depth or thickness of the subsurface structure). In addition, where NAPL was encountered above or on top of a subsurface structure, the structure was not penetrated. Instead, the boring location was relocated immediately adjacent to the subsurface structure and completed to a depth below the subsurface structure to facilitate sample collection and visual characterization of the subsurface soil conditions.

During completion of the boring activities, BBL's onsite geologist visually characterized each soil sample for soil type, staining, obvious odors, and the presence of potential MGP-related materials (e.g., NAPL, coal tar-like materials, wood chips).

Eight subsurface soil samples, BB-92 (0-2'), BB-102 (3-5'), BB-107 (2-4'), BB-111 (4-6.5'), BB-112B (2.5-5.6'), BB-124 (6-8'), BB-127 (6-8'), and BB-128 (2-4'), were collected and submitted for laboratory analysis for BTEX, PAHs, and cyanide. Soil samples submitted for laboratory analysis were selected based on the presence of visually impacted soil (i.e., NAPL or staining) and noticeable MGP- or petroleum-type odors.

Additional Subsurface Investigations

The overall objective of the additional subsurface investigations was to further evaluate the extent of NAPL in soil and associated dissolved-phase hydrocarbons (DPH) in groundwater at the site. The additional subsurface investigations, conducted from July 2004 through January 2005, consisted of the following:

- Preliminary groundwater screening at monitoring wells MW-8S and MW-8D;
- Additional NAPL-related soil boring activities;
- Downgradient monitoring well installation activities;
- Silt and clay unit additional investigation activities;
- Monitoring well abandonment/replacement activities;
- Monitoring well repair/replacement and redevelopment activities; and
- Groundwater sampling activities.

Preliminary Groundwater Screening

BBL collected groundwater samples at monitoring wells MW-8I and MW-8D to complete preliminary screening of the groundwater in this area to evaluate the need for an additional groundwater monitoring well cluster downgradient from the site.

Additional NAPL-Related Soil Borings

BBL completed 16 additional soil borings (soil borings BB-134 through BB-148 and BB-142R) to further characterize subsurface soil conditions and evaluate the presence and extent of NAPL along the western fence line (i.e., the hydraulically downgradient site boundary) and in the vicinity of PSA/IRM and RI borings where field personnel indicated the presence of visible NAPL in soil below the silt and clay unit at the site.

BBL's drilling subcontractor, Parratt-Wolff, completed soil borings BB-134 and BB-135 using a 4¼-inch inside diameter (ID) hollow-stem auger. Continuous soil samples were collected during the soil boring activities by advancing a 2-inch outside diameter, 2-foot long split-barrel sampling device ahead of the auger. The remaining soil borings were completed using an AMS PowerProbe™ equipped with a 2-inch diameter, 4-foot long macrocore sampling tube. BBL's onsite geologist visually characterized each soil sample for soil type and the presence of staining, obvious odors, and potential MGP-residual materials.

Downgradient Monitoring Well Installation Activities

In order to provide an additional monitoring point to further assess the horizontal and vertical extent of DPH in groundwater hydraulically downgradient from the site, groundwater monitoring well cluster MW-27 (consisting of shallow and deep monitoring wells MW-27S and MW-27D, respectively) was installed on August 2, 2004.

Monitoring well cluster MW-27 was installed in an area hydraulically downgradient of monitoring well MW-3 between monitoring well MW-7 and monitoring well MW-8 cluster west of the property boundary.

Silt and Clay Unit Additional Investigation Activities

During 2004, BBL conducted additional investigation activities to evaluate the potential for the silt and clay unit located beneath the site to act as a confining unit for the vertical migration of NAPL. The investigation activities consisted of installing two monitoring wells with the well screens set entirely within the silt and clay unit and collecting undisturbed soil samples of the silt and clay material using Shelby Tube samplers. The undisturbed soil samples were submitted for laboratory analysis for grain size analysis, vertical hydraulic conductivity, Atterberg limits, and bulk density.

Monitoring Well Abandonment and Replacement Activities

Based on a review of the site geology and construction details for monitoring wells MW-4, MW-5, MW-16, and MW-18 (installed during the RI), BBL determined that the well screens at these locations extended from above the low-permeability silt and clay unit to below this unit in areas potentially containing NAPL. Each of these monitoring wells was abandoned by overdrilling and grouting the borehole to the ground surface. Monitoring wells MW-4, MW-5, MW-16, and MW-18 were replaced with monitoring wells MW-22, MW-21, MW-26, and MW-23, respectively. Each of these new monitoring wells was constructed with the bottom of the well screens set slightly below the top of the low-permeability silt and clay unit and were equipped with a 2-foot long sump at the bottom of the well casing for collecting DNAPL (if present).

Monitoring Well Repair/Replacement and Redevelopment Activities

BBL identified and gauged existing monitoring wells installed as part of the investigation activities conducted at the site in order to identify obvious damage to the wells and to evaluate the depth to the bottom of the well relative to well completion depth at the time of original construction. Based on the assessment, field personnel noted the presence of accumulated sediment within each existing monitoring wells, at thicknesses ranging up to approximately 10.76 feet in monitoring well MW-6S.

Based on the results of the inspection and gauging activities, a total of 15 monitoring wells (monitoring wells MW-6S, MW-8S, MW-8I, MW-8D, MW-11, MW-12, MW-13I, MW-13P, MW-14S, MW-14P, MW-14I, MW-17, MW-19S, MW-19I, and MW-19D) were redeveloped as part of these activities to remove accumulated sediment from the wells. Each monitoring well was redeveloped so that the measured depth to the bottom of the well was within 1 foot of the original monitoring well installation depth.

During January 2005, a manually-driven macrocore sampler was used in an attempt to collect a sample of the material that had accumulated in the bottom of monitoring well MW-20. Based on the location of MW-20, there was the potential that the material at the bottom of the well may have consisted of DNAPL that was too dense to recover using a bailer. While attempting to retrieve the sampler after it was driven into the material at the bottom of the well, the monitoring well casing was lifted several inches out of the borehole. Since this could have caused damage to the integrity of the well, National Grid elected to abandon and replace monitoring well MW-20. Well abandonment activities consisted of overdrilling and removing monitoring well MW-20 intact. Following removal, the materials accumulated in the bottom of the well were visually characterized. Based on the visual characterization, accumulated materials consisted of sediment with trace NAPL. A new monitoring well (monitoring well MW-20R) was then installed to replace damaged monitoring well MW-20.

Groundwater Sampling Activities

A site-wide groundwater sampling event was conducted during November 2004 and January 2005 to further characterize groundwater at and in the vicinity of the site. Static groundwater level measurements were obtained from each accessible onsite and offsite monitoring well on November 11, 2004 and January 12, 2005. Monitoring wells located on CSX property (including monitoring wells MW-9S, MW-9I, MW-9D, and MW-10) were not able to be monitored during the November 2004 groundwater sampling event due to delays in obtaining a right-of-entry agreement between National Grid and CSX. These wells were sampled on January 12, 2005 following execution of the right-of-entry agreement.

Groundwater samples were submitted for laboratory analysis for BTEX and PAHs using USEPA SW-846 Methods 8260 and 8270, respectively.

Till Investigation

BBL conducted a till investigation to evaluate the presence and hydrogeologic properties of the till beneath the property and further evaluate property stratigraphy. In general, till investigation activities consisted of the following:

- Soil boring and monitoring well installation activities; and
- Geotechnical testing of till unit.

Monitoring Well Installation Activities

Thirteen new monitoring wells (MW-13T, MW-19T, MW-28S, MW-28I, MW-28D, MW-28T, MW-29S, MW-29I, MW-29T, MW-30S, MW-30I, MW-30D, MW-30T) at five well clusters were installed, with five monitoring wells (MW-13T, MW-19T, MW-28T, MW-29T, and MW-30T) screened entirely within the till unit. The monitoring well locations were selected to provide additional data in strategic areas of the property. In addition to the till wells, monitoring wells screened within the shallow, intermediate, and deep hydrostratigraphic zones were installed (as appropriate) at monitoring well cluster locations MW-28, MW-29, and MW-30 to facilitate collection of additional site hydraulic data.

Geotechnical Testing of Till Unit

Standard penetration testing (SPT) was conducted at each of the till unit monitoring well soil borings. During completion of the drilling activities, soil samples recovered from the split-spoon samplers were placed in jars, labeled, and archived in boxes. Select samples were submitted for triaxial permeability testing to determine the permeability of the till. Select samples were also submitted for geotechnical testing for grain size (sieve and hydrometer) and Atterberg limits to further evaluate geotechnical characteristics of the subsurface geology at the site.

1.4 Site Characterization/Nature and Extent of Impacts

This section presents an overall site characterization based on the results obtained for the site investigation activities conducted to date (as described above under Section 1.3.3). The site characterization consists of a summary of the following:

- Site Geology and Hydrogeology;

- NAPL Extent and Soil Quality;
- Groundwater Quality;
- Creek Sediment Quality; and
- Soil Vapor Quality

1.4.1 Site Geology and Hydrogeology

Site geology consists of three primary geologic units: fill material; an interbedded fine, medium, and coarse sand, silt, and clay alluvial/lacustrine unit; and a till unit.

As described above, focused additional investigation activities were completed during 2004 to investigate a silt and clay deposit located in the lacustrine unit to determine the nature of this deposit and assess whether this deposit provides a hydraulic barrier at the site. Ultimately, BBL concluded that although the silt and clay material is present across much of the site, it does not appear to constitute a continuous confining layer due to the variable and interbedded nature of the alluvial/lacustrine unit.

An additional focused investigation was conducted during March and April 2005 to confirm the presence and confining nature of the till unit and assess the vertical hydraulic gradients at the site. Based on the findings of this investigation, the till unit appears to be present and continuous across the site. Typically, the top of till across the site is encountered at a depth between 56 and 70 feet below grade surface (bgs), although an apparent trough in the upper surface of the till exists across the northern portion of the site oriented in a general northeastern direction. The depth of the top of till within the area of the trough is approximately 75 to 80 feet bgs.

Site hydrogeology was characterized using information obtained from regional hydrogeologic references as well as information obtained during site investigations. Based on a review of this information, the following five hydrostratigraphic zones (including the silt and clay subunit) were defined:

- A shallow zone, comprised of saturated fill and the upper fine sand unit, located above the silt and clay unit;
- A silt and clay subunit that includes seams of interbedded fine sands – classified as a "leaky" semi-confining unit;
- An intermediate zone, comprised of the upper portion of the lower fine sand subunit below the silt and clay subunit;
- A deep zone, comprised of the lower portion of the lacustrine lower fine sand subunit, below the silt and clay subunit; and
- A till zone located below the glaciolacustrine deposits.

Generalized Geologic Column

Approximate Upper Contact Elev.(ft. AMSL)	Thickness Range (ft)	Stratigraphic Unit
Ground surface - 228	2 to 13	**Fill –** silt, sand, gravel, ash, cinders, slag. Also includes demolition debris, foundation remnants, and buried utilities.
Upper Fine Sand – Silt and Clay – 215 Lower Fine Sand – 205	26 to 66	**Lacustrine Fine Sand, Silt and Clay** – interbedded and laminated fine-grained deposits of varying grain size.
174	>45	**Till** – dense basal till consisting of poorly-sorted silt, sand, clay, and gravel.

Note: elevations from approximate center of site

Groundwater levels at the site range between approximately 3 and 10 feet bgs and on average the depth to groundwater is approximately 6 feet bgs. Shallow groundwater flow direction is generally toward the northwest (toward the Mohawk River) with local northern and northeastern flow components. In addition, based on the water levels measured at the site, Schermerhorn creek appears to be a losing stream in the vicinity of the site. This means that surface water in the creek is discharging to groundwater and that locally, groundwater flow is away from the creek. A water table elevation contour map reflecting the water levels measured during the May 2005 groundwater monitoring event is included on Figure 1-4.

Hydrostratigraphic Zone	Geometric Mean Horizontal Hydraulic Conductivity (cm/sec)
Shallow (15 Wells)	9.70×10^{-4}
Intermediate (12 Wells)	8.59×10^{-4}
Deep (nine Wells)	2.50×10^{-3}
Till (six Wells)	4.15×10^{-7}

Specific capacity test data collected from 46 monitoring wells during the November 2004 groundwater sampling event, and the April 2005 till investigation were used to evaluate the horizontal hydraulic conductivity of the formation surrounding the monitoring wells. Hydraulic conductivity values calculated from specific capacity and well recovery tests range from 2.10×10^{-8} cm/sec (MW-30T) to 1.14×10^{-1} cm/sec (MW-6I). The geometric mean calculated for the four hydrostratigraphic zones identified at the property are summarized in the adjacent table.

Several undisturbed subsurface soil samples were collected from the silt and clay subunit and the till units during the site investigation activities. Each of the undisturbed soil samples was submitted for laboratory testing for vertical hydraulic conductivity using a triaxial permeameter.

Although the vertical conductivities for both the silt and clay subunit and till unit appear to indicate potentially confining conditions, the silt and clay unit (due to its interbedded and discontinuous nature across the site) does not effectively prevent vertical migration of fluids. Based on information obtained from more than 30 soil borings completed during site investigate activities, the till unit appears to be present and continuous across the site.

Sample ID	Vertical Hydraulic Conductivity (cm/sec)
Silt and Clay Unit	
BB-28H (14-16’)	3.3×10^{-7}
BB-83 (12-14’)	4.1×10^{-8}
MW-24 (12-13.6’)	4.5×10^{-6}
MW-25 (10-12’)	7.3×10^{-8}
Geometric Mean	2.6×10^{-7}
Till Unit	
MW-13T (68-70’)	7.3×10^{-8}
MW-19T (64-66’)	1.2×10^{-6}
MW-28T (50-54’)	3.2×10^{-8}
MW-30T (48-50’)	5.8×10^{-7}
MW-30T (56-58’)	9.6×10^{-8}
Geometric Mean	1.7×10^{-7}

1.4.2 NAPL Extent and Soil Quality

Analytical soil sample results were compared to the NYSDEC Division of Hazardous Waste Remediation *“Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels”* HWR 94-4046 (TAGM 4046), dated January 24, 1994, recommended soil cleanup objectives. The approximate distribution of soil containing chemical constituents greater than the TAGM 4046 NYSDEC-recommended soil cleanup objectives is shown on Figure 1-5. The delineation of soil containing chemical constituents at concentrations greater than recommended soil cleanup objectives was determined based on computer modeling using mining visualization software (MVS). The MVS model interpolated the extent of impacted soils from analytical data obtained for the analysis of soil samples collected during site investigations.

In addition, the analytical soil sampling results were compared to recommended soil cleanup objectives for total VOCs and SVOCs presented in NYSDEC’s TAGM 4046 and a follow-up NYSDEC memorandum from Michael J. O’Toole, Jr. dated December 20, 2000. The guidance values establish limits for total detected VOCs and SVOCs as less than or equal to (≤) 10 parts per million (ppm) and ≤ 500 ppm, respectively. Based on the analyses performed and the chemical constituents of concern (COCs) found in MGP-impacted soil, the summary below compares BTEX to the ≤ 10 ppm and total PAHs to the ≤ 500 ppm guidance values.

A summary of soil quality is presented below in conjunction with a discussion of the extent of NAPL since a large portion of the identified impacts to the site soil is associated with NAPL (primarily coal tar DNAPL). Principal components of coal tar that are typically analyzed for at MGP sites are BTEX and PAHs. Since coal tar contains elevated concentrations of these compounds, soil samples that contained visual indications of coal tar were not always analyzed; instead, BTEX and PAHs were assumed to be present in the visibly NAPL-impacted soil at concentrations greater than the regulatory guidance values described above. This relationship between NAPL-impacted soils and BTEX and PAH concentrations was generally confirmed based on the analytical results for soil samples collected during the Historical Subsurface Structure Investigation and Additional Subsurface Investigation conducted during 2004.

NAPL-impacted soil distribution is depicted on Figure 1-6. The distribution of NAPL shown on Figure 1-6 was developed based on two approaches; one approach resulting in the areas shown on Figure 1-6 designated as approximate extent of NAPL-impacted soil and the other designated as the interpreted areas of potential NAPL-impacted soil. The areas designated as "approximate extent…" includes NAPL-impacted soils delineated based on computer modeling using MVS. The MVS model was used to interpolate the extent of NAPL-impacted soil from a database formed from visual observations of NAPL in soil samples collected beneath the site. "Interpreted areas of potential NAPL-impacted soil" depicted on Figure 1-6 include areas where test borings, test pits, and subsurface excavations were completed and where NAPL-impacted soils were noted but not included in the MVS database (e.g., test pits, test borings, previous excavations). In addition, areas where no soil data were available indicating visually clean soil between NAPL-impacted soil sampling locations were included as areas of potentially NAPL-impacted soil on Figure 1-6. The majority of NAPL-impacted soil was encountered below the water table, which would make any soil removal alternative difficult.

A sufficient volume of DNAPL was not able to be collected during the recent investigation activities to assess its physical characteristics that influence its migration potential. However, conclusions can be made regarding NAPL migration based on indications of where NAPL has been identified in the subsurface strata.

- the majority of NAPL- and MGP residual-impacted soil is located near former MGP structures;
- NAPL was observed at several locations across the property immediately above the silt and clay unit;
- coal tar-type odors, blebs, and coal tar-saturated rootlets were also observed throughout the silt and clay unit with greater degrees of NAPL saturation within coarser-grained interbedded fine sand seams within the silt and clay unit;
- at some locations NAPL was observed in the upper portion of the lower fine sand unit, below the silt and clay unit (primarily in the western and central portions of the site);
- no NAPL was observed in the lower portion of the lower fine sand unit near the upper surface of the till unit, or within the till unit itself;
- vertical migration of historic NAPL releases has apparently ceased based on the absence of NAPL observations in the lower fine sand unit and underlying till;
- NAPL was not observed in offsite monitoring wells;
- NAPL does not appear to be migrating horizontally; and
- the majority of NAPL-impacted soils were encountered below the water table.

Presented below is a discussion of NAPL distribution of the site in the surface soils, subsurface soils, and in soils beneath historical subsurface structures.

Surface Soil

A total of 19 surface soil samples were collected during the RI and additional soil investigation activities. Results obtained for the analysis of the surface soil samples indicated the following:

- Soil sample BB-92 (0-2') (located near the former coal bin) was the only sample that indicated the presence of total BTEX at concentrations greater than the 10 ppm guidance value (48.2 ppm).

- Two soil samples [BSS-4 (0-0.5'), located along the former railroad siding in the western portion of the site, and BB-84 (0-2'), located east of Schermerhorn Creek near a former gasoline distribution area] contained total PAHs at concentrations greater than (>) the 500 ppm guidance value (554.5 and 3,158 ppm, respectively).

Subsurface Soil

During the site investigation activities, a total of 234 soil samples were submitted for laboratory analysis for BTEX and 261 soil samples were submitted for laboratory analysis for PAHs, as summarized in the Soil Sample Summary table below.

The extent of NAPL-impacted soil (from Figure 1-6) and soil containing PAHs at concentrations >500 ppm is shown on Figure 1-7. The interpreted extent of NAPL-impacted soil and soil containing total PAHs at concentrations greater than the recommended soil cleanup objectives indicates the following:

- NAPL was generally observed in the northern portion of the site in the fill, upper fine sand units, and uppermost portion of the silt and clay at soil borings BB-9, BB-51, BB-55, and BB-88; in the central portion of the site beneath the former 150,000 CF holder at soil boring locations BB-8 and BB-118, above the subsurface slab at soil boring BB-112B, and at several soil borings in the vicinity of the ammonia concentrator, tar tank, and tar separator; and in the western portion of the site near the ground surface along the western fence line, in the upper fine sand above the silt and clay unit, within rootlets through the silt and clay unit, throughout the fine sand seams in the silt and clay unit, into the upper portion of the lower fine sand unit. NAPL has never been observed in the creek or the creek sediment.

- Similar to NAPL distribution, soil containing PAHs at concentrations greater than the guidance value is concentrated in the northern portion of the site near the 800,000 CF holder (soil borings BB-9 and BB-128); in the central portion of the site near the former condenser house, oil tank, tar tank, and tar separator (soil borings BB-11, BB-41R, BB-81, BB-111, and BB-112B); and along the western fence line near the former railroad siding and former coal stock pile area (soil borings BB-13, BB-14, BB-29, BB-30, BB-32, BB-86, and BB-135).

- PAH-impacted soils are also present south of Schermerhorn Creek in the vicinity of a former UST previously located west of the existing Garage/Office Building. The soil impacts in this area are believed to primarily be due to a petroleum source formerly located west of the Garage/Office Building.

Analysis	Number of Samples/Investigation					Totals
	PSA/ IRM	RI	NAPL Investigation	HSSI	ASI	
BTEX*	73	152	0	8	1	234
PAHs*	73	152	27	8	1	261

Notes:
1. * - For some investigations, samples were analyzed for an expanded list of VOCs and SVOCs.
2. HSSI = Historical Subsurface Structure Investigation.
3. ASI = Additional Subsurface Investigations.
4. Number of samples does not include QA/QC or waste characterization samples.

Soil Beneath Historical Subsurface Structures

A Historical Subsurface Structure Investigation was conducted during 2004 with the overall objective of identifying the potential presence and extent of NAPL beneath historical subsurface structures associated with former MGP operations at the site. The results of this investigation indicated that although coal tar NAPL was identified in the vicinity of several of the historical subsurface structures, NAPL was not identified at other than trace amounts directly below any of the historical subsurface structures. Specifically, soil boring BB-58 was completed beneath the 2 million CF holder concrete foundation by Parsons as part of the RI. The BB-58 soil boring log indicates the presence of "strong HC (hydrocarbon) odor, sheen, free phase" and "wood, black-stained fill, free-phase wet" at 4 feet and 7 feet bgs, respectively. Five borings (soil borings BB-95 through BB-99), completed as part of this investigation, were advanced to depths between 7.4 and 8.6 feet bgs. None of the borings encountered the "free phase" material that was indicated in the BB-58 soil boring log. Test pits (to confirm the absence of NAPL) were not installed in the former holder area due to surface/subsurface obstructions. The 2 million CF gas holder is believed (based on historical drawings obtained for the 150,000 CF holder showing foundation construction) to be supported by numerous wood piers. Therefore, the presence of NAPL or NAPL-impacted soil beneath the 2 million CF holder is not confirmed, but has been included on Figure 1-6 as an "interpreted area of potential NAPL-impacted soil."

1.4.3 Groundwater Quality

This section summarizes groundwater characteristics at and near the site based on the results of groundwater sampling conducted since 1992. A summary of the groundwater quality at and in the immediate vicinity of the site is discussed below respective to site hydrostratigraphic zones (i.e., shallow, intermediate, deep, and till zones). NAPL has never been encountered in offsite groundwater monitoring wells. Results obtained for the analysis of natural attenuation parameters are discussed in detail in the Natural Attenuation Evaluation Report included as Appendix A.

1.4.3.1 Shallow Groundwater Monitoring Results

A total of 19 monitoring wells are currently screened in the shallow hydrostratigraphic zone. This unit is generally defined as the saturated zone above the silt and clay unit and in most cases the well screen straddles the water table. As presented in the SRI Report, during 2004, BBL abandoned and replaced monitoring wells MW-4, MW-5, MW-16, and MW-18 with monitoring wells MW-22, MW-21, MW-26, and MW-25, respectively, because the original monitoring wells were constructed with their well screens straddling the low-permeability silt and clay unit. For the purposes of this summary, the results obtained for the analysis of the groundwater samples collected from the abandoned monitoring wells are discussed under this section.

BTEX

BTEX compounds were detected at concentrations greater than the Class GA NYSDEC groundwater standards/guidance values presented in Technical Operational Guidance Series (TOGS) 1.1.1 - *Ambient Water Quality Standards and Guidance Values,* June, 1998 (TOGS 1.1.1) (NYSDEC, 1998) in groundwater samples collected from nine of the 15 shallow monitoring wells (monitoring wells MW-3, MW-9S, MW-13SR, MW-20, MW-21, MW-22, MW-23, MW-24, and MW-26) that were sampled during the November 2004/January 2005 sampling event.

Generally, the monitoring wells where BTEX compounds were detected at concentrations greater than TOGS 1.1.1 standards and guidance values correspond to the locations where NAPL was observed (i.e., the northern, central, and western areas described above). Elevated BTEX concentrations (212 parts per billion [ppb] and 1,780 ppb) were also detected in the groundwater samples collected from monitoring wells MW-24 (located on the south side on Schermerhorn Creek) and MW-26 (located hydraulically downgradient from the former oil tank), respectively. The time series data presented in the adjacent table do not indicate identifiable trends toward greater or lesser BTEX concentrations.

PAHs

PAHs were detected at concentrations greater than the NYSDEC groundwater standards/guidance values presented in TOGS 1.1.1 (NYSDEC, 1998) in groundwater samples collected from eight of the 15 shallow monitoring wells (monitoring wells MW-3, MW-9S, MW-20, MW-21, MW-22, MW-23, MW-24, and MW-26) sampled during the November 2004/January 2005 sampling event. With the exception of monitoring well MW-13SR, PAHs were detected at concentrations greater than NYSDEC standard/guidance values in groundwater samples collected from the same wells where analytical results indicated elevated concentrations of BTEX.

Time Series Groundwater BTEX and PAH Concentrations in Shallow Overburden Wells

Well ID	Total BTEX (ppb)			
	6/96	7/96	6/02	11/04-1/05
MW-2/MW-20	1,500	1,417	4,299	NS
MW-9S	1,166	326	3,828	387
MW-16/MW-26	993	758	NS	1,780
MW-18/MW-23	20,700	17,400	7,160	13,530
	Total PAHs (ppb)			
MW-2/MW-20	1,804	197	3,254	NS
MW-9S	140	130	452	100
MW-16/MW-26	4,476	5,890	NS	6,280
MW-18/MW-23	2,224	968	596	531

Notes:
1. Monitoring well MW-20 installed during January 2002 to replace MW-2.
2. MW-23 installed in August 2004 to replace MW-18. MW-18 screened within both shallow and intermediate hydrostratigraphic units.
3. MW-26 installed in August 2004 to replace MW-16. MW-16 screened within both shallow and intermediate hydrostratigraphic units.
4. NS = Not sampled.

As indicated in the shallow groundwater time series table above, PAH concentrations appear to have generally been decreasing in monitoring well MW-18 and replacement well MW-23 located to the east of the storage building in the central portion of the site. PAH concentrations appear to have generally increased in groundwater samples collected from monitoring well MW-16 and replacement well MW-26 located to the south of the open garage hydraulically downgradient from the former oil storage tank. The remaining time series data do not indicate identifiable trends in PAH concentrations.

1.4.3.2 Intermediate Groundwater Monitoring Results

A total of 13 monitoring wells are currently screened within the intermediate hydrostratigraphic zone. This unit is generally defined as the fine sand unit below the silt and clay unit. However, some of the wells included in the discussion of this hydrostratigraphic zone were included because their hydraulic properties (e.g., hydraulic head, hydraulic conductivity) are more consistent with the intermediate zone. Results obtained for the laboratory analysis of groundwater samples collected from the intermediate groundwater zone are summarized below.

BTEX

BTEX was detected at concentrations greater than the Class GA NYSDEC groundwater standards/guidance values presented in TOGS 1.1.1 in groundwater samples collected from four of the 12 intermediate monitoring wells (monitoring wells MW-8I, MW-9I, MW-17, and MW-25) sampled during the November 2004/January 2005 sampling event.

Time Series Groundwater BTEX and PAH Concentrations in Intermediate Overburden Wells

Well ID	Total BTEX (ppb)			
	6/96	7/96	6/02	11/04-1/05
MW-8I	1,435	113	28	589
MW-9I	739	274	712	581
MW-17	626	124	NS	475
	Total PAHs (ppb)			
MW-8I	<10	2	28.3	61
MW-9I	79	<37	110	52
MW-17	116	28	NS	86

Note:
1. NS = Not sampled

Generally, the monitoring wells where BTEX was detected at concentrations greater than TOGS 1.1.1 standards and guidance values correspond to the locations where NAPL was observed (i.e., the Northern, Central, and Western areas described above). However, groundwater monitoring wells MW-8I and MW-9I are located offsite, hydraulically downgradient of the western and northern portions of the site (respectively). The time series evaluation of intermediate hydrostratigraphic groundwater BTEX concentrations presented in the adjacent table does not indicate consistent trends toward increasing or decreasing BTEX concentrations.

PAHs

PAHs were detected at concentrations greater than the NYSDEC groundwater standards/guidance values presented in TOGS 1.1.1 in four of the 12 intermediate monitoring wells (MW-8I, MW-9I, MW-17, and MW-25) sampled during the November 2004/January 2005 sampling event. Note that these are the same wells where BTEX concentrations were detected at concentrations greater than groundwater standards and guidance values.

As indicated in the intermediate groundwater time series table above, a general increasing trend in groundwater PAH concentrations is evident in groundwater samples collected from monitoring well MW-8I (from non-detect in 1992 to 61 ppb in 2004). Monitoring well MW-8I is located offsite west of the CSX railroad right-of-way. Results obtained for the analysis of groundwater samples collected from the other intermediate monitoring wells did not indicate a distinguishable trend toward increasing or decreasing PAH concentrations over time.

1.4.3.3 Deep Groundwater Monitoring Results

A total of seven monitoring wells are currently screened within the deep hydrostratigraphic zone. The deep zone is generally defined as the lower portion of the lower fine sand unit below the silt and clay unit at the site. Results obtained for the laboratory analysis of groundwater samples collected from the deep aquifer zone are summarized below.

BTEX

Based on the results obtained for the analysis of groundwater samples collected from the deep monitoring wells during the November 2004/January 2005 sampling event, groundwater sample MW-9D (19 ppb total BTEX) was the only groundwater sample that indicated the presence of BTEX compounds at concentrations greater than Class GA groundwater standards/guidance values. Monitoring well MW-9D is located offsite, northwest of the Service Center property on the west side of the D&H railroad right-of-way

PAHs

Based on the results obtained for the laboratory analysis of the groundwater samples, none of the groundwater samples collected from the deep monitoring wells during the November 2004/January 2005 groundwater sampling event contained PAHs at concentrations greater than Class GA groundwater standards/guidance values.

1.4.3.4 Till Groundwater Monitoring Results

A total of six monitoring wells are screened within the till unit beneath the site. However, with the exception of monitoring well MW-27D, each of the till wells was installed following the November 2004/January 2005 groundwater sampling event and were installed to assess hydraulic gradients in the till.

The results obtained for the analysis of the groundwater sample collected as part of the November 2004 sampling event from monitoring well MW-27D did not indicate the presence of BTEX or PAHs at concentrations greater than laboratory detection limits.

1.4.4 Creek Sediment and Surface Water Quality

Sediment and surface water investigations were conducted during the PSA/IRM and RI activities between 1994 and 1997. Two sediment samples were collected during PSA/IRM activities and a total of 34 sediment samples were collected at 20 sampling locations during RI activities. A total of four surface water samples were also collected during the RI to characterize surface water quality within Schermerhorn Creek.

Results for the sediment samples were compared to NYSDEC's "*Technical Guidance for Screening Contaminated Sediments,"* sediment screening criteria for the protection of benthic aquatic life (chronic toxicity).

VOCs and inorganics were not detected at concentrations greater than the sediment screening criteria for the protection of benthic aquatic life (chronic toxicity). SVOCs [including acenaphthene, anthracene, benzo(a)anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, phenol, and pyrene] were detected in sediment samples collected at several sampling locations at concentrations greater than the sediment screening criteria for the protection of benthic aquatic life (chronic toxicity). The maximum concentration of total PAHs were detected in sediment samples collected from the following sampling locations:

- Sample BSD-2, collected from a depth interval of 0 to 0.11 foot contained total PAHs at a concentration of 617.26 ppm (PSA/IRM Study); and

- Sample BSD-14, collected from a depth interval of 0 to 4 feet contained total PAHs at a concentration of 278.29 ppm (RI).

PCBs were also detected at concentrations greater than the sediment screening criteria for the protection of benthic aquatic life (chronic toxicity) in four of the 34 samples analyzed at concentrations up to 15 ppm [sediment sample BSD-13 (0-4')]. Based on the above-described sampling events, four areas encompassing several individual sediment sampling locations were identified along the creek where SVOCs and PCBs were detected in sediment samples at elevated concentrations. These areas are indicated on Figure 1-8 are consistent with the data presented in the NYSDEC-approved RI (Parsons, January 1999) and are summarized in the adjacent table.

Impacted Sediment Areas

Area	Sediment Sampling Locations
Area 1	BSD-1 (PSA), BSD-14
Area 2	BSD-12, BSD-13
Area 3	BSD-2 (PSA), BSD-11
Area 4	BSD-9

None of the surface water samples contained chemical constituents at concentrations exceeding Class D Ambient Water Quality Standards and Guidance Values for fresh water fish survival presented in TOGS 1.1.1.

1.4.5 Soil Vapor Quality

A soil gas survey was conducted by Atlantic as part of the PSA/IRM Study to estimate the lateral extent and relative concentration of VOCs in soil and shallow, unconfined groundwater across the site. Detailed results of the investigation are presented in the PSA/IRM Study Report (Atlantic ES, 1993) and were summarized in the SRI Report (BBL, 2005). As indicated in the PSA/IRM Study Report, soil gas samples producing chromatograms indicative of coal tar impacts were generally located north and west of the open garage and near the 800,000 CF gas holder. Soil gas samples producing chromatograms indicative of petroleum impacts were generally located in the central portion of the site near the former storage building.

Based on current groundwater conditions, there is little to no potential for the presence of MGP-related soil vapors on offsite parcels. As documented in the SRI Report, BTEX compounds and PAHs were detected in groundwater samples collected at offsite monitoring well clusters MW-8 and MW-9. Results obtained for groundwater monitoring at the MW-8 monitoring well cluster indicated that COCs were present in groundwater collected from the monitoring well screened within the intermediate hydrostratigraphic zone, but not within the overlying shallow hydrostratigraphic zone. BTEX has been observed in the intermediate monitoring well (MW-8I, screened 25 to 35 feet below grade surface) located west of the site, but there are no detections of BTEX in the shallow monitoring well (MW-8S, screened 6 to 16 feet below grade surface). As indicated in the November 2002 USEPA *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (USEPA, 2002), only volatile contaminants in the uppermost portions of a given aquifer are likely to volatilize into the vadose zone and subsequently have the potential to migrate into indoor air spaces. Furthermore, as indicated in the October 2006 NYSDOH document entitled "*Guidance for Evaluating Soil Vapor Intrusion in the State of New York*" (NYSDOH, 2006), vapor phase migration or partitioning of volatile chemicals in impacted groundwater is unlikely if the impacted groundwater is overlain by non-impacted groundwater. Therefore, based on previous water level measurements (presented in the SRI Report [BBL, 2005]), a minimum of 8 feet of non-impacted shallow groundwater is overlying the impacted intermediate groundwater unit and serves as an effective barrier to potential soil vapor intrusion (SVI) concerns. Furthermore, monitoring well cluster MW-9 is located in an undeveloped property that is landlocked by a convergence of railroad right-of-ways and it is unlikely that this property will be developed in the future. Therefore, SVI investigation activities at offsite locations are not required.

Current onsite structures include an open garage, a garage/shed, a storage building, and the office building. Currently, only the office building is an occupied building and National Grid does not plan to occupy the garage/shed or the storage building for the foreseeable future. Therefore, a majority of the site buildings do not have potential vapor exposure/intrusion issues. To address the potential for vapor intrusion into the sole occupied building and at the request of the NYSDEC, an SVI work plan detailing proposed onsite soil vapor investigation activities will be prepared and submitted to the NYSDEC under separate cover. The SVI work plan will follow the protocols set forth in National Grid's September 2006 Standard Operating Procedure (SOP): *Soil Vapor Intrusion Evaluation at National Grid Manufactured Gas Plant* (MGP) *Sites in New York State* prepared by O'Brien & Gere (OBG) (OBG, 2006).

2. Identification of Potential Standards, Criteria, and Guidelines

2.1 General

This FS was prepared in general conformance with the applicable SCGs set forth in TAGM 4025 (NYSDEC, 1989) and TAGM 4030 (NYSDEC, 1990), and the NCP. Although this section discusses the potential SCGs associated with these documents, these potential SCGs do not dictate required remedial actions or remediation cleanup levels. However, potential SCGs specifically identified for the Schenectady (Broadway) site are presented below.

2.1.1 Definition of SCGs

"Standards and criteria" are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that are generally applicable, consistently applied, and officially promulgated under federal or state law that are either directly applicable or relevant and appropriate to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances.

"Guidelines" are non-promulgated criteria that are not legal requirements and do not have the same status as "standards and criteria;" however, remedial programs should be designed with consideration given to guidelines that, based on professional judgment, are determined to be applicable to the project [Part 375-1.10(c)(1)(ii)of Title 6 of the New York Compilation of Codes, Rules, and Regulations (6 NYCRR 375-1.10(c)(1)(ii))].

2.1.2 Types of SCGs

NYSDEC has provided guidance on applying the SCG concept to the RI/FS process. In accordance with NYSDEC guidance, SCGs are to be progressively identified and applied on a site-specific basis as the RI/FS proceeds. The SCGs considered for the potential remedial alternatives identified in this FS Report were categorized into the following NYSDEC-recommended classifications:

- ***Chemical-Specific SCGs*** - These SCGs are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values for each constituent of concern (COC). These values establish the acceptable amount or concentration of chemical constituents that may be found in, or discharged to, the ambient environment;

- ***Action-Specific SCGs*** - These SCGs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste management and site cleanup; and

- ***Location-Specific SCGs*** - These SCGs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in specific locations.

The SCGs identified for the site are presented below.

2.2 SCGs

The identification of federal and state SCGs for the evaluation of remedial alternatives at the site was a multi-step process that included a review of the HHRA and FWIA completed as part of the RI. Site-specific SCGs are presented below.

2.2.1 Chemical-Specific SCGs

Potential chemical-specific SCGs for this site are summarized in Table 2-1. One set of chemical-specific SCGs that potentially apply to the impacted site soil are the Resource Conservation and Recovery Act- (RCRA-) regulated (RCRA-regulated) levels for Toxicity Characteristic Leaching Procedure (TCLP) constituents, as outlined in 40 CFR 261 and in 6 NYCRR Part 371. The TCLP constituent levels are a set of numerical criteria at which solid waste is considered a hazardous waste by the characteristic of toxicity. In addition, the hazardous characteristics of ignitability, reactivity, and corrosivity also may apply depending on the results of waste characterization activities. Additionally, the NYSDEC-recommended soil cleanup objectives presented in TAGM 4046 are applicable for chemical constituents in soil at the site.

According to the RI, the groundwater beneath the site is classified as Class GA and, as such, the New York State (NYS) Groundwater Quality Standards (6 NYCRR Parts 700-705) are potentially applicable chemical-specific standards, as are the Class GA groundwater standards and guidance values presented in TOGS 1.1.1 (NYSDEC, 1998). These standards identify acceptable levels of constituents in groundwater based on potable use.

The NYSDEC Division of Fish, Wildlife, and Marine Resources document titled, "*Technical Guidance for Screening Contaminated Sediments,"* dated January 1999, is a technical guidance document that presents guidance for identifying the concentration of specific constituents in sediments that may impact aquatic ecosystems.

2.2.2 Action-Specific SCGs

The potential action-specific SCGs for this site are summarized in Table 2-2. Action-specific SCGs include general health and safety requirements and general requirements regarding handling and disposing of hazardous waste (including transportation and disposal, permitting, manifesting, disposal and treatment facilities). The action-specific SCGs have been divided into the following two categories:

- Action-specific SCGs potentially common to all remedial alternatives; and
- Action-specific SCGs potentially applicable to specific remedial alternatives.

The first category includes general health and safety requirements and general requirements regarding RCRA hazardous waste facilities (including transportation and disposal facilities). The second category includes the SCGs that apply to individual remedial alternatives.

One set of potential action-specific SCGs for the site consists of the land disposal restrictions (LDRs), which regulate land disposal of hazardous wastes. The LDRs are applicable to alternatives involving the disposal of hazardous waste (if any). Because MGP wastes resulted from historical operations that ended before the passage of RCRA, MGP-impacted material is only considered a hazardous waste in New York if it is removed (generated) and it exhibits a characteristic of a hazardous waste. However, if the MGP-impacted material only exhibits the hazardous characteristic of toxicity for benzene (D018), it is conditionally exempt from the hazardous waste management requirements (6 NYCRR Parts 370-374 and 376) when destined for thermal treatment in accordance with the requirements set forth in NYSDEC's TAGM HWR-4061, *Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from Former Manufactured Gas Plants* (NYSDEC, 2002a). If MGP-related hazardous wastes are destined for land disposal in New York, the state hazardous waste regulations apply, including LDRs and alternative LDR treatment standards for hazardous waste soil.

The LDR for hazardous waste soils is a 90% reduction in constituent concentration capped at 10 times the Universal Treatment Standards (10xUTS). This means that if concentrations of constituents in excavated soil exceed 10xUTS, the soil would have to be treated to reduce constituent concentrations to below 10xUTS prior to land disposal. Under the Phase IV, Part 2 regulations, characteristically hazardous MGP-impacted soil may be rendered non-hazardous after generation at the remediation site by mixing the soil with clean materials to render the impacted soil amenable to treatment and to reduce concentrations of the chemical constituents in soil to less than the hazardous characteristic(s). Following mixing, the soil would no longer be considered a hazardous waste, but would still have to meet the LDR requirements.

The United States Department of Transportation (USDOT) and New York State rules for the transport of hazardous materials are provided under 49 CFR Parts 107 and 171.1 through 172.558 and 6 NYCRR 372.3. These rules include procedures for packaging, labeling, manifesting, and transporting of hazardous materials and would potentially be applicable to the transport of hazardous materials under any remedial alternative. New York State requirements for waste transporter permits are included in 6 NYCRR Part 364, along with standards for the collection, transport, and delivery of regulated wastes within New York. Contractors transporting waste materials offsite during the selected remedial alternative would need to be properly permitted.

Section 401 (State Water Quality Certification) of the Clean Water Act (CWA) is administered by the NYSDEC. Any remedial alternatives that result in a discharge into Schermerhorn Creek would need to comply with the substantive provisions of a State Water Quality Certification from the NYSDEC.

The National Pollutant Discharge Elimination System (NPDES) program also is administered in New York by the NYSDEC as a State Pollutant Discharge Elimination System (SPDES). If the selected remedial alternative for the site results in discharges to surface water (due to dewatering or other activities), discharge limits would need to be established for individual constituents in accordance with the NYSDEC SPDES (6 NYCRR 750-758).

A remedial alternative conducted within the site would need to comply with applicable requirements outlined under the Occupational Safety and Health Act (OSHA). General industry standards are outlined under OSHA (29 CFR 1910) that specify time-weighted average concentrations for worker exposure to various compounds and training requirements for workers involved with hazardous waste operations. The types of safety equipment and procedures to be followed during site remediation are specified under 29 CFR 1926, and recordkeeping and reporting-related regulations are outlined under 29 CFR 1904.

In addition to the requirements outlined under OSHA, the preparedness and prevention procedures, contingency plan, and emergency procedures outlined under RCRA (40 CFR 264) are potentially relevant and appropriate to those remedial alternatives that include the generation, treatment, or storing hazardous wastes.

2.2.3 Location-Specific SCGs

The potential location-specific SCGs for this site are summarized in Table 2-3. Examples of potential location-specific SCGs include floodplain and wetland regulations, restrictions promulgated under the National Historic

Preservation Act, Endangered Species Act, and other federal acts. Location-specific SCGs also include local building permit conditions for facilities constructed or relocated (e.g., service garage to potentially be removed and reconstructed following remedial activities) on site.

As part of their RI activities, Parsons reviewed the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map, Community Panel No. 360741 0001, dated September 1983, and determined that the site was not located within the 100-year floodplain for the Mohawk River. In addition, the NYS Natural Heritage Program files indicated that there are no known occurrences of threatened or endangered species or significant habitats within a 2-mile radius of the site.

Hartgen Associates (Hartgen), conducted a Cultural Resources Survey (CRS) for the site. The results of the CRS (Appendix B) concluded that there are no historic archeological sites near the Service Center.

3. Development of Remedial Action Objectives

3.1 General

This section presents the RAOs for the impacted media that have been identified within the site. These RAOs represent medium-specific goals that are protective of human health and the environment (USEPA, 1988a; NYSDEC, 2002a). These objectives are, in general, developed by considering the results of the HHRA and FWIA (conducted as part of the RI, as described above under Section 1.3.3) and with reference to potential SCGs identified for the project area. The purposes for developing RAOs are to specify the constituents of concern (COCs) at the project area and to assist in developing quantitative goals for cleanup of the COCs in each medium that may require remediation.

The following sections briefly summarize the results from the HHRA and FWIA and identify the RAOs for impacted media in the project area.

3.2 Exposure Evaluation Summary

As indicated above, a two-component baseline risk assessment (consisting of an HHRA and an FWIA) was conducted as part of the NYSDEC-approved RI (Parsons, January 1999). The HHRA was conducted to assess the potential risk to human health resulting from chemical constituents within environmental media at and in the vicinity of the site. A Phase I FWIA was conducted to develop a site description to address existing environmental conditions and characterize local ecological resources. The objectives of the FWIA were to identify the fish and wildlife resources that exist on and in the vicinity of the site, and to evaluate the potential for exposure of these resources to site-related constituents in environmental media. The results of the FWIA are used to aid in remedial decision-making and to determine if further ecological impact evaluation is warranted. The FWIA was conducted in accordance with the requirements outlined as Step I and Step IIA of the NYSDEC Division of Fish and Wildlife document titled “Impact Analysis for Inactive Hazardous Waste Sites” (NYSDEC, October 1994). The results obtained for each component of the baseline risk assessment are summarized below.

3.2.1 Human Health Risk Assessment

As part of the HHRA, information regarding current and foreseeable land use and available data for the site were evaluated to identify COCs and assess potential exposure to human receptors. The HHRA defined COCs as constituents detected at concentrations greater than applicable screening criteria in one or more samples of soil, groundwater, or sediment regardless of whether they were site-derived. Applicable screening criteria included TAGM 4046 (NYSDEC, 1994) for soils and TOGS 1.1.1 (NYSDEC, 1998) for groundwater. Since there are no applicable human health-based screening criteria for sediments, site background concentrations of hydrocarbons were used for comparison. The results of the HHRA indicated a potential health threat, both carcinogenic and non-carcinogenic, to current and future onsite workers at the site, as well as to current and future residents who rely on downgradient groundwater for domestic purposes. The assessment is based on a number of highly conservative (health-protective) assumptions, which may overstate the calculated potential health threat. The actual health threat to receptors is likely substantially lower than calculated. The greatest potential health threats identified in the HHRA was to onsite workers exposed to surface and subsurface soil onsite and individuals who utilize groundwater immediately downgradient of the site for domestic purposes.

Note the majority of the site is currently covered with asphalt limiting exposure to soils and there are no known downgradient users of groundwater for potable purposes.

3.2.2 Fish and Wildlife Impact Analysis

The results of the FWIA indicated the absence of ecological resources associated with the site. The FWIA also indicated that potential impacts to fish and wildlife were considered to be minimal. Therefore, the derivation of site-specific ecology-based remedial objectives was not considered appropriate for the site.

3.3 Remedial Action Objectives

This section presents the RAOs for environmental media at the site. RAOs are medium-specific goals that result in the protection of human health and the environment. The RAOs were used to evaluate potential remedial options relative to their capacity to protect human health and the environment considering exposure pathways and applicable SCGs.

The RAOs for the site, in consideration of COCs, exposure pathways, and receptors, are presented in the following table:

Environmental Media	COCs	RAOs
Onsite Subsurface Soil	BTEX and Total PAHs	1. Minimize potential risks to current and future onsite workers. 2. Minimize potential future offsite migration of NAPL to the extent possible. 3. Prevent migration of NAPL to Schermerhorn Creek to the extent possible.
Onsite Surface Soil	Total PAHs	
Onsite and Offsite Groundwater	BTEX and Total PAHs	1. Minimize future impacts to groundwater and reduce concentrations of COCs in groundwater to the extent practicable. 2. Prevent future discharge of impacted groundwater to surface water in Schermerhorn Creek to the extent practicable. 3. Minimize contact with or ingestion of impacted groundwater to the extent practicable.
Onsite Sediments	PCBs and Total PAHs	1. Minimize potential risks to current and future onsite workers from direct contact with impacted sediments to the extent practicable. 2. Minimize potential dissolution of COCs from sediment to surface water that may result in surface water impacts greater

Environmental Media	COCs	RAOs
		than ambient water quality criteria to the extent practicable. 3. Prevent impacts to biota from impacted sediments from bioaccumulation through the aquatic food chain to the extent practicable. 4. Eliminate exposure of downstream biota to site related impacts.
Note: 1. Note that bioaccumulation does not apply to PAHs. 2. Total PAHs include the following: 2-methylnaphthalene; acenaphthene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene, benzo(k)fluoranthene; chrysene; dibenzo(a,h) anthracene; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; naphthalene; phenanthrene; and pyrene.		

Rationale supporting the development of each RAO is presented in the following sections.

3.3.1 Soil

The RAOs for onsite soil were developed to be protective of human health and the environment, to the extent practicable, and to assist with identifying potential remedial technologies. These RAOs are targeted at reducing the potential for human exposure to onsite soil impacted by MGP- and petroleum-related COCs and protecting the environment.

The following remediation goals have been developed for onsite soil relative to soil RAO #1:

- Minimize the potential for exposure of current and future onsite workers to onsite soil containing total BTEX compounds at concentrations >10 ppm. Total BTEX is determined by the sum of the detected concentrations of benzene, toluene, ethylbenzene, and xylene in a soil sample. The 10 ppm value was selected based on the recommended soil cleanup objectives presented in NYSDEC TAGM 4046. TAGM 4046 establishes a recommended soil cleanup objective of ≤ 10 ppm for total VOCs. As indicated above, the VOCs of interest at MGP sites are BTEX because they occur in abundance. Therefore the soil evaluation uses BTEX ≤ 10 ppm as the guidance value.

- Minimize the potential for exposure of current and future onsite workers to onsite soil containing total PAHs at concentrations >500 ppm. Total PAHs are determined by the sum of the detected concentrations for the following COCs: 2-methylnaphthalene; acenaphthene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene, benzo(k)fluoranthene; chrysene; dibenzo(a,h) anthracene; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; naphthalene; phenanthrene; and pyrene. The 500 ppm value was selected based on the recommended soil cleanup objectives presented in NYSDEC TAGM 4046 (USEPA, 1994). TAGM 4046 establishes a recommended soil cleanup objective of ≤ 500 ppm for total SVOCs. As indicated above, the SVOCs of interest at MGP sites are PAHs because they occur in abundance. Therefore, the soil evaluation uses PAHs ≤ 500 ppm as the guidance value.

The estimated areal extent of onsite NAPL-impacted soil and soil containing PAHs at concentrations >500 ppm is presented on Figure 1-7. Areas with soil containing BTEX at concentrations >10 ppm, lie within those with NAPL-impacted soil and soil containing PAHs at concentrations >500 ppm.

Soil RAO #2 was developed to further protect human health and the environment by minimizing the potential for future offsite migration of NAPL.

Soil RAO #3 was developed to minimize potential future impacts to Schermerhorn Creek by minimizing the potential migration of NAPL to creek sediment or surface water.

3.3.2 Groundwater

Based on the evaluation of the site hydrogeologic characteristics, four hydrostratigraphic units (shallow, intermediate, deep, and till) have been identified for groundwater beneath the site. Results obtained for groundwater sampling activities completed during the previous site investigations indicate that impacted groundwater at the site is primarily located in the shallow and intermediate hydrostratigraphic units.

The groundwater beneath the site is classified as Class GA and, as such, NYS Groundwater Quality Standards (6 NYCRR Parts 700-705) are applicable.

Groundwater at the site is not used for drinking purpose. As presented in the SRI Report (BBL, 2005), the NYSDEC Division of Environmental Remediation's *Proposed Remedial Action Plan* (PRAP) for the General Electric (GE) Main Plant (Site No. 447004) (NYSDEC, 2004) states: *"There is a well established hydrogeologic divide west of the western boundary of the* (GE) *site that separates groundwater beneath the site from the groundwater west of the* (GE) *site. The groundwater beneath the* (GE) *site and east of the divide migrates towards the Mohawk River. The groundwater west of the hydrogeologic divide migrates toward the Mohawk River or the Schenectady-Rotterdam municipal well field."* The GE Main Plant is located immediately west of the Schenectady (Broadway) site on the west side of the D&H and CSX right-of-ways. Because the Schenectady (Broadway) site is east of the hydrogeologic divide, groundwater beneath the National Grid property flows toward the Mohawk River and not to the municipal well field. This is further supported by water level measurements collected from onsite and offsite monitoring wells that indicate a general groundwater flow direction to the northwest toward the Mohawk River.

Therefore, the greatest potential for exposure to impacted groundwater is via direct contact that may be encountered during construction/excavation work. The potential exposure to impacted groundwater could be minimized by using properly trained personnel and personal protective equipment (PPE). Based on the FWIA, groundwater does not represent a complete ecological exposure pathway since wildlife would generally not be exposed to site-related groundwater during foraging, nesting, or burrowing activities.

The RAOs for groundwater were developed to be protective of both human health and the environment. Human health will be protected by preventing, to the extent practicable, exposure to site-related COCs. Protection to the environment will be accomplished by eliminating the further migration of dissolved-phase, site-related COCs; improving the groundwater quality, to the extent practicable; and preventing migration (to the extent practical) of impacted groundwater to surface water in Schermerhorn Creek (see subsections 1.4.1 and 5.6.2, and Appendix G for further details regarding groundwater/surface water interaction).

3.3.3 Creek Sediment

COCs consisting of PCBs and PAHs were detected in sediment within the onsite portion of Schermerhorn Creek. Concentrations of these COCs detected in sediment samples collected both upstream and downstream from the site were similar to the sediment samples collected onsite. As presented in Section 1.4.4, four areas encompassing multiple individual sediment sampling locations were identified during the RI along the onsite portion of the creek where SVOCs and PCBs were detected in sediment samples at elevated concentrations (relative to the concentrations detected in other sediment samples onsite, upstream, and downstream from the site). The identified areas are based on RI data for PCBs and PAHs detected at concentrations greater than sediment screening criteria as presented in the NYSDEC-approved RI Report (Parsons, 1999). Although no significant risks associated with the creek sediment were identified in the baseline risk assessment, the RAOs developed for the creek sediment address the impacted sediment.

The sediment RAOs were developed to be protective of human health, minimize potential contact with impacted sediment, and prevent COCs from entering the surface water at concentrations greater than ambient water quality criteria. Sediment RAOs #2 and #3 are protective of the environment by preventing impacts (to the extent practical) to surface water and aquatic biota.

4. Identification and Screening of Technologies and Development of Remedial Alternatives

4.1 General

This section identifies potential remedial alternatives to address impacted soil, groundwater, and creek sediment at the site. As an initial step, GRAs were identified to address impacted soil, groundwater, and creek sediment. GRAs are media-specific and describe actions that will satisfy the RAOs. GRAs may include various actions such as treatment, containment, institutional controls, excavation, or any combination of such actions. Based on the GRAs, potential remedial technology types and processes were identified and screened to determine the technologies that were the most appropriate for the site. Technologies/process options that were retained following the screening were used to develop potential remedial alternatives. Detailed evaluations of these alternatives are presented in Section 5.

According to the USEPA's "*Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA"* (USEPA, 1988a), the term "technology type" refers to general categories of technologies. The term "technology process options" refers to specific processes within each technology type. For each GRA identified, a series of technology types and associated process options has been assembled. In accordance with the USEPA's guidance document, each technology type and associated processes are briefly described and evaluated against preliminary and secondary screening criteria. This approach was used to determine if the application of a particular technology type and process option is applicable given the site-specific conditions for remediation of the impacted media. Based on this screening, remedial technology types and process options were eliminated or retained and subsequently combined into potential remedial alternatives for further, more detailed evaluation.

This approach is consistent with the screening and selection process provided in TAGM 4030 (NYSDEC, 1990).

Remedial technology types that are potentially applicable for addressing the impacted media at the site were identified through a variety of sources including review of scientific journals, vendor information, engineering experience, and review of the following documents:

- NYSDEC TAGM #4030 - Selection of Remedial Actions at Inactive Hazardous Waste Sites, (NYSDEC, 1990);
- Draft DER-10 (NYSDEC, 2002b);
- *"Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA"* (USEPA, 1988a);
- "*Remediation Technologies Screening Matrix and Reference Guide*" (USEPA and USAF, 1993);
- "*Management of Manufactured Gas Plant Sites*" (Gas Research Institute, 1996);
- "*A Resource for MGP Site Characterization and Remediation*" (USEPA, 1999).

According to USEPA guidance (USEPA, 1988b), technology types and process options can be identified by drawing on a variety of sources, including regulatory references and standard engineering texts not specifically directed toward impacted sites. Although each former MGP site offers its own unique site characteristics, the evaluation of remedial technology types and process options that are applicable to MGP-related impacts, or have been implemented at other MGP sites, is well documented. Therefore, this collective knowledge and experience, and regulatory acceptance of previous feasibility studies performed on MGP-related sites with similar impacts, were used to reduce the universe of potentially applicable process options for the site to those with documented success in achieving similar RAOs. The identified remedial technologies for addressing impacted soil, groundwater, and sediment are presented in the following sections.

4.2 General Response Actions

Based on the RAOs identified in Section 3.3, the following site-specific GRAs have been established:

Onsite Soil

- No Action;
- Institutional Controls;
- In-Situ Containment/Control;
- In-Situ Treatment;
- Removal;
- Ex-Situ Onsite Treatment; and
- Offsite Treatment and/or Disposal.

Soil GRAs would be applied to the onsite surface and subsurface soils that contain COCs at concentrations greater than remediation goals identified in Section 3.3.1.

Groundwater

- No Action;
- Institutional Controls;
- In-Situ Containment/Control;
- In-Situ Treatment;
- Removal;
- Ex-Situ Onsite Treatment; and
- Offsite Treatment and/or Disposal.

Groundwater GRAs would be applied to the groundwater underlying the site, as well as impacted groundwater offsite (and downgradient of the site).

Sediment

- No Action;
- Institutional Controls;
- In-Situ Containment;
- In-Situ Treatment;
- Removal;
- Ex-Situ Onsite Treatment; and
- Offsite Treatment and/or Disposal.

Sediment GRAs would be applied to the sediment within the approximate 1,100-foot onsite portion of Schermerhorn Creek.

Within each of these GRAs, remedial technology types were identified for each impacted medium as described below.

4.3 Remedial Technology Screening

The potentially applicable remedial technology types and technology process options associated with each of the GRAs were subjected to preliminary and secondary screening to retain the technologies that would most effectively achieve the RAOs identified for the site. Remedial technology refers to a general category of technologies, such as capping or immobilization, while the technology process is a specific process within each remedial technology type. A "No Action" GRA has been included and retained through the screening evaluation as required by USEPA's *"Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (*USEPA, 1988a) and the NCP regulations.

The following sections present a summary of the preliminary and secondary screening evaluations.

4.3.1 Preliminary Screening

Preliminary screening was performed to reduce the number of potentially applicable technologies on the basis of technical implementability. Technical implementability was determined using site characterization information to screen out technology types and process options that could not effectively be implemented at the site. The results of the preliminary screening are presented in Table 4-1 (soil), Table 4-2 (groundwater), and Table 4-3 (sediment). These tables identify and briefly describe each technology process and present screening comments relative to the technical implementability of the technology process. The technology processes that were not retained have been shaded on the tables.

4.3.1.1 Soil

As presented in Table 4-1, the following remedial technologies were identified under the GRAs to address impacted onsite surface and subsurface soil:

1. *No Action* - No activities would be implemented to address impacted onsite surface and subsurface soil.

2. *Institutional Controls* – The remedial technologies identified under this GRA consist of non-intrusive administrative controls focused on minimizing potential contact with impacted onsite surface and subsurface soil. The technology process screened under the administrative controls remedial technology consists of environmental easements to limit future use of the site as well as subsurface activities that are permitted at the site. This technology process was retained for secondary screening.

3. *In-Situ Containment/Control* – Remedial technologies associated with this GRA consist of measures to address the impacted onsite soil without removal or treatment. Remedial technologies evaluated under the preliminary screening process consisted of capping and containment to minimize potential future migration of NAPL. Technology processes screened under these remedial technologies consisted of clay/soil capping,

asphaltic concrete capping, and multi-media capping (capping); and steel sheetpiling and slurry wall (containment). Based on the results of the preliminary screening, asphaltic concrete capping and containment via steel sheetpiling and slurry wall were retained for secondary evaluation. Planned continued use of the site following completion of remedial activities lead to the dismissal of clay/soil capping and multi-media cap technology processes because these types are not suitable for high-traffic areas.

4. *In-Situ Treatment* – Remedial technologies associated with this GRA consisted of measures to treat or stabilize impacted onsite soil in-situ (i.e., without removal). These technologies would treat the soil to remove or otherwise alter the COCs to achieve the RAOs established for site soil. The remedial technologies evaluated under this GRA consisted of immobilization, extraction, and biodegradation. Technology processes screened under these remedial technologies include:

   - solidification/stabilization and vitrification (immobilization);
   - steam stripping, soil vapor extraction (SVE), six-phase soil heating, dynamic underground stripping and hydrous pyrolysis/oxidation (DUS/HPO), and soil flushing (extraction); and
   - enhanced bioremediation and in-situ anaerobic biodegradation (biodegradation).

   Based on the results of preliminary screening, solidification/stabilization was retained for secondary screening. The remaining technology processes were not retained due to potential concerns and restrictions associated with the extensive subsurface natural gas distribution piping and the ineffectiveness of these technology processes in treating SVOCs and NAPL.

5. *Removal* – Remedial technologies associated with this GRA consist of measures to remove impacted surface and subsurface soil. The remedial technology (and the technology process) identified and screened consisted of excavation. Based on the results of preliminary screening, excavation was retained for secondary evaluation.

6. *Ex-Situ Onsite Treatment and/or Disposal* – Remedial technologies associated with this GRA consist of measures to treat impacted surface and subsurface soil onsite after they have been excavated. The remedial technologies evaluated under this GRA consisted of recycle/reuse, extraction, thermal destruction, biodegradation, chemical treatment, and onsite disposal. Technology processes screened under these remedial technologies include:

   - onsite asphalt batching (recycle/reuse);
   - solvent extraction, low-temperature thermal desorption (LTTD), and steam stripping (extraction); onsite incineration (thermal destruction);
   - bioreactor, biopile, land farming, and composting (biodegradation);
   - chemical oxidation (chemical treatment); and
   - onsite RCRA or solid waste landfill (onsite disposal).

   Based on the results of preliminary screening, onsite asphalt batching, LTTD, and onsite incineration were retained for secondary screening. Due to limited site space, anticipated treatment duration, and ineffectiveness of treating COCs, the remaining technology processes were not retained.

7. *Offsite Treatment and/or Disposal* – Remedial technologies associated with this GRA consist of measures to treat impacted surface and subsurface soil offsite after they have been removed from the ground. The remedial technologies evaluated for this GRA consisted of: recycle/reuse, extraction, thermal destruction, and offsite disposal. Technology processes screened under these remedial technologies include:

   - offsite asphalt batching, brick/concrete manufacturer, and fuel blending/co-burn in utility boiler (recycle/reuse);
   - LTTD (extraction);
   - incineration (thermal destruction); and
   - RCRA landfill or solid waste landfill (offsite disposal).

   Based on the results of preliminary screening, LTTD and offsite disposal at a RCRA or solid waste landfill were retained for secondary evaluation. The remaining processes were not retained due to the limited number of facilities capable of implementing the remedial technology processes.

The results of the preliminary screening for the potential remedial technologies to address impacted onsite soil are presented in Table 4-1.

4.3.1.2 Groundwater

As presented in Table 4-2, the following remedial technologies were identified to address the GRAs previously identified for impacted groundwater:

1. *No Action* – No activities would be implemented to address impacted groundwater at and downgradient from the site.

2. *Institutional Controls* – The remedial technologies associated with this GRA consist of non-intrusive administrative controls focused on minimizing potential contact with or use of impacted groundwater at and immediately downgradient of the site. The technology processes screened under the administrative controls remedial technology consists of environmental easements/groundwater use restrictions to restrict groundwater use at the site and limit permitted subsurface activities that could facilitate contact with impacted groundwater. This technology process was retained for secondary screening.

3. *In-Situ Containment/Control* – The remedial technologies associated with this GRA consist of measures to address impacted groundwater without removal or treatment. The remedial technology evaluated for this GRA consisted of capping/infiltration control and hydraulic containment. The technology processes evaluated under these remedial technologies include:

   - clay/soil cap, asphaltic concrete cap, and multi-media cap (capping/infiltration control); and
   - steel sheetpiles and slurry walls (hydraulic containment).

   Based on the results of the preliminary screening, asphaltic concrete capping and containment via steel sheetpiling and slurry wall were retained for secondary evaluation. Planned continued use of the site following completion of remedial activities lead to the dismissal of clay/soil capping and multi-media cap technology processes because these types are not suitable for high-traffic areas. Hydraulic containment could also be achieved using groundwater extraction techniques (vertical extraction wells, horizontal extraction wells, collection trenches) as discussed under the removal GRA.

4. *In-Situ Treatment* – The remedial technologies associated with this GRA consist of measures to treat impacted groundwater in-situ (i.e., without extracting the groundwater). These technologies would treat the groundwater to remove or otherwise alter the COCs to achieve the RAOs established for groundwater. Remedial technologies evaluated for this GRA included biological treatment, chemical treatment, and extraction. The technology processes evaluated under these technologies include:

   - groundwater monitoring, enhanced aerobic biodegradation, anaerobic biodegradation, and biosparging (biological treatment);
   - chemical oxidation and permeable reactive barrier (PRB) (chemical treatment); and
   - dynamic underground stripping and DUS/HPO (extraction).

   Based on the results of the preliminary screening, groundwater monitoring, enhanced aerobic biodegradation, biosparging, chemical oxidation, and PRB were retained for secondary evaluation. Due to the general ineffectiveness and/or potential to facilitate uncontrolled NAPL migration, the remaining processes were not retained.

5. *Removal* – The remedial technologies associated with this GRA consist of measures to remove impacted groundwater and NAPL for onsite treatment or disposal. The technology processes selected for groundwater removal include:

   - vertical extraction wells;
   - horizontal extraction wells; and
   - collection trenches.

   The technology processes selected for NAPL removal include the following;

   - active removal;
   - passive removal;
   - collection trenches; and
   - hot water/steam injection.

   Based on the results of preliminary screening, vertical extraction wells, horizontal extraction wells, and collection trenches were retained for secondary evaluation of groundwater removal and active removal, passive removal, and collection trenches were retained for secondary evaluation of NAPL removal. Hot water/steam injection was not retained because the process could facilitate uncontrolled migration of NAPL.

6. *Ex-Situ Onsite Treatment* – The remedial technologies associated with this GRA consist of measures to extract and treat impacted groundwater onsite. Ex-situ onsite remedial treatment technologies evaluated to address the COCs in the extracted groundwater under the preliminary screening evaluation consisted of chemical treatment and physical separation. The technology processes screened under these technologies include:

   - ion exchange, ultra-violet (UV) oxidation, and chemical oxidation (chemical treatment); and

- carbon adsorption, filtration, air stripping, precipitation/coagulation/flocculation, and oil/water separation (physical separation).

Based on the results of the preliminary screening, ion exchange was the only remedial process not retained for secondary evaluation because the process is not proven to effectively treat organics.

7. *Offsite Treatment and/or Disposal* – The remedial technologies associated with this GRA consist of measures to discharge groundwater at an offsite location after extraction. Groundwater technology processes include:

    - discharge at a publicly owned treatment works (POTW);
    - discharge to surface water via storm sewer;
    - discharge at a privately owned treatment/disposal facility; and
    - reinjection via injection wells (could be onsite or offsite).

    Based on the results of the preliminary screening, reinjection was the only remedial process not retained for secondary evaluation due to the difficulty in obtaining agency approval and required more stringent treatment requirements.

The results of the preliminary screening for the potential remedial technologies to address impacted groundwater are presented in Table 4-2.

4.3.1.3 Creek Sediment

As presented in Table 4-3, the following remedial technologies were identified to address the GRAs identified for impacted sediment within the onsite portion of the Schermerhorn Creek:

1. *No Action* – No activities would be implemented to address impacted sediment within the onsite portion of Schermerhorn Creek.

2. *Institutional Controls* – The remedial technologies associated with this GRA consist of non-intrusive administrative controls focused on minimizing potential contact with impacted sediment within the onsite portion of Schermerhorn Creek. The technology process screened under this GRA consists of posting signage that would warn of the presence of impacted sediment and deter actions that may increase the potential for exposure to the impacted sediment or disturb/mobilize the impacted sediment. This technology was retained for secondary screening.

3. *In-Situ Containment* – The remedial technologies associated with this GRA consist of measures to treat the impacted sediment within the onsite portion of Schermerhorn Creek without removal. The remedial technologies evaluated under this GRA consisted of containment, engineered barrier, and sediment covering. The technology processes screened under these include:

    - sheetpile (containment);
    - engineered coverings (engineered barrier); and
    - sediment covering (rip-rap).

    Based on the results of the preliminary screening, sheetpiling was retained for secondary screening. Engineered barriers and rip-rap were not retained for further evaluation due to the increased potential of flooding as a result of the additional volume of materials placed in this creek.

4. *In-Situ Treatment* – The remedial technologies associated with this GRA consist of measures to treat the impacted sediment within the onsite portion of Schermerhorn Creek without removal. The remedial technologies evaluated under this GRA consisted of natural recovery and immobilization. The technology processes screened under these consisted of enhanced biodegradation (natural recovery) and solidification/stabilization (immobilization). Based on the results of the preliminary screening, no in-situ treatment technologies were retained for further evaluation because the time frame needed for enhanced biodegradation of NAPL would be prohibitive and solidification/stabilization could increase the volume of material in the creek and potentially increase the occurrence of flooding.

5. *Removal* – The remedial technology associated with this GRA consists of measures to remove impacted sediment from the onsite portion of Schermerhorn Creek. The remedial technology evaluated under this GRA consisted of dredging, which included the technology processes of mechanical dredging and hydraulic dredging. Based on the results of the preliminary screening, mechanical dredging was retained for secondary evaluation. Hydraulic dredging was not retained because the process is not appropriate for the small volume and coarse nature of impacted sediments.

6. *Ex-Situ Onsite Treatment* – The remedial technology associated with this GRA consists of measures to treat impacted sediment onsite following removal from Schermerhorn Creek. The remedial technologies evaluated under this GRA consisted of extraction, recycle/reuse, and thermal destruction. Technology processes screened under these remedial technologies include:

    - LTTD, steam stripping, and solvent extraction (extraction);
    - onsite asphalt batching (recycle/reuse); and
    - incineration (thermal destruction).

    Based on the results of the preliminary screening, LTTD, onsite asphalt batching, and incineration were retained for secondary screening. Due to the ineffectiveness in treating the COCs, steam stripping and solvent extraction were not retained.

7. *Offsite Treatment and/or Disposal* – The remedial technologies associated with this GRA consist of measures to treat impacted sediment offsite following removal from Schermerhorn Creek. The remedial technologies evaluated under this GRA consisted of recycling/reuse, extraction, thermal destruction, and disposal. Technology processes screened under these remedial technologies include:

    - shipping to an asphaltic concrete batch plant, brick/concrete manufacturer, or co-burn in a utility boiler (recycling/reuse);
    - LTTD (extraction);
    - incineration (thermal destruction); and
    - disposal in a RCRA landfill or solid waste landfill (disposal).

    Based on the results of preliminary screening, LTTD and offsite disposal at a RCRA or solid waste landfill were retained for secondary evaluation. The remaining processes were not retained due the limited number of facilities capable of implementing the remedial technology processes.

The results of the preliminary screening for the potential remedial technologies to address impacted sediment are presented in Table 4-3.

4.3.2 Secondary Screening

As indicated above, a number of potentially applicable technologies and technology processes were retained through the preliminary screening for soil, groundwater, and sediment. Consistent with NCP guidance and to further refine the technology processes to be assembled into remedial alternatives, the technology processes retained through preliminary screening were subjected to a secondary screening. The object of the secondary screening was to choose, when possible, one representative remedial technology category for each environmental medium to simplify the subsequent development and evaluation of the remedial alternatives. The results of the secondary screening of soil, groundwater, and sediment technologies and technology processes are presented in Tables 4-4 (soil), 4-5 (groundwater), and 4-6 (sediment). The technology processes that were not retained have been shaded on the tables. In general, technologies are presented and discussed in relative terms as they relate to other remedial technologies of the same type. A description of the secondary screening criteria is listed below:

- Effectiveness – This criterion identifies the effectiveness of the remedial alternatives at meeting the RAOs established for the environmental media at the site.

- Implementability – This criterion evaluates the ability to construct, reliably operate, and meet technical specifications or criteria with each technology and the availability of specific equipment and technical specialists to operate the equipment. This evaluation also includes consideration of the operation and maintenance (O&M) required after completion of remedial construction.

- Relative Cost – This criterion evaluates the overall cost required to implement the remedial technology. As a screening tool, relative capital and O&M costs are considered in place of detailed cost estimates. For each remedial technology and associated technology process, relative costs are presented as low, moderate, or high.

Based on the results of the secondary screening, the following remedial technologies and technology processes were retained for further analysis and evaluation.

4.3.2.1 Soil

The basis for retaining each soil remedial technology and technology process during the secondary screening is described below.

1. *No Action* – The "No Action" alternative does not achieve the RAOs for soil; however, the alternative was retained to serve as a baseline against which other remedial options may be compared.

2. *Institutional Controls* – For this GRA, the access and use restrictions (in the form of environmental easements) were retained for further evaluation. Institutional controls will not achieve RAOs as a stand-alone process, but were retained because institutional controls can easily be implemented in conjunction with other remedial technologies to potentially reduce exposure of current and future onsite workers to impacted soils. The relative cost of implementing institutional controls is low.

3. *In-Situ Containment/Control* – In-situ containment/control technologies were identified as being potentially suitable to address site soils and include capping and physical containment. Asphaltic concrete capping is an effective measure for reducing stormwater infiltration through impacted media. A cap would also limit direct contact between onsite personnel and impacted soil (i.e., soil RAO #1) and was therefore retained for further evaluation. Containment barrier walls were retained for further evaluation because the technology would limit potential future offsite migration of NAPL and impacted groundwater (soil RAO #2 and #3 and

groundwater RAO #2). The relative cost of installing an asphaltic concrete cap is moderate and the relative cost of constructing a containment barrier is moderate to high.

4. *In-Situ Treatment* – For this GRA, in-situ stabilization/solidification was retained for further evaluation. In-situ stabilization/solidification is an effective means to reduce leaching/mobility, eliminate free liquids, and reduce hydraulic conductivity in NAPL-impacted soils at the site. This technology would minimize potential future offsite migration of NAPL and potential migration of NAPL to Schermerhorn Creek (soil RAOs #2 and #3, respectively). Additionally, the mixing of virgin stabilization materials, as well as the homogenization of soils, would ultimately lead to a reduction in soil toxicity on a per unit volume basis. Equipment, materials, and contractors capable of implementing in-situ soil stabilization are available. The relative cost of in-situ soil stabilization is moderate to high.

5. *Removal* – Excavation was the only removal technology process screened. This technology could be implemented (i.e., equipment and contractors needed to complete the soil removal are readily available). However, there are several factors that would make soil removal difficult. Primarily, the volume of water to be managed/treated, relocating existing infrastructure primarily in the form of natural gas utilities, and potentially relocating Service Center operations. Removal is a proven technology to address impacted material and would achieve soil RAO #1 of minimizing potential risks to current and future onsite works. In addition, when combined with proper handling of the excavated material, this technology process would be effective at minimizing potential future migration of NAPL offsite and to Schermerhorn Creek as NAPL-Impacted soils would no longer be present (soil RAOs #2 and #3). Additionally, removal of impacted soil combined with the treatment of water pumped from the excavation would serve to minimize future impacts to groundwater, prevent migration of impacted groundwater to Schermerhorn Creek, and prevent contact with impacted groundwater (groundwater RAOs #1, #2, and #3). Until the excavated soil is transported offsite, it may still possess potential risk to onsite personnel. The relative cost of removal is high.

6. *Ex-Situ Onsite Treatment* – Based on the secondary screening, no ex-situ onsite remedial technologies or technology processes were retained for further evaluation. Ex-situ onsite treatment technology processes retained for further evaluation following preliminary screening (i.e., onsite asphalt batching and extraction via LTTD) were not retained due to implementability (i.e., insufficient space available at the site).

7. *Offsite Treatment and/or Disposal* – Offsite treatment and/or disposal remedial technologies and technology processes retained for further evaluation included: offsite extraction via LTTD and offsite disposal via a RCRA landfill or solid waste landfill. LTTD could potentially be implemented by mobilizing LTTD equipment to a local offsite location to reduce costs and other potential hazards associated with the transportation of impacted soils. Treatment via both LTTD and offsite disposal are feasible as the equipment, personnel, and facilities to implement these activities are available. The relative cost for offsite treatment/disposal is moderate to high.

4.3.2.2 Groundwater

The basis for retaining each groundwater remedial technology and technology process during the secondary screening is described below.

1. *No Action* – The “No Action” alternative does not achieve the RAOs established for groundwater; however, the alternative was retained to serve as a baseline against which other remedial options may be compared.

2. *Institutional Controls* – For this GRA, use restrictions (in the form of environmental easements and groundwater use restrictions) were retained for further evaluation. Institutional controls will not achieve RAOs as a stand-alone process, but were retained because institutional controls can be easily implemented in conjunction with other remedial technologies to potentially reduce exposure of current and future onsite workers to impacted groundwater (groundwater RAO #3). The relative cost associated with this technology process is low.

3. *In-Situ Containment/Control* – The in-situ containment/control technology was retained for further evaluation and consists of hydraulic containment via barrier wall (e.g., water-tight sheetpiling, slurry wall). This technology process could potentially provide an effective means to limit future offsite migration of impacted groundwater and would achieve the RAO of mitigating future impacts to groundwater by containing the NAPL-impacted soils. This GRA would indirectly facilitate the reduction of COC concentrations in offsite groundwater as NAPL-impacted soils would be contained within the limits of the barrier wall and would no longer serve as a potential source of dissolved-phase COCs to groundwater. However, this technology would not meet the RAO of reducing concentrations of COCs in onsite groundwater within the containment area. This technology process also was retained for further evaluation as an alternative to address impacted soil at the site. The relative cost of this GRA is moderate to high.

4. *In-Situ Treatment* – In-situ treatment technology processes retained for further evaluation consisted of continued groundwater monitoring and chemical oxidation. Continued groundwater monitoring would be used to document the reduction of COC concentrations via natural processes (e.g., advection, adsorption, dispersion, decay). Chemical oxidation is an innovative technology with limited full-scale implementation to treat dissolved-phase VOCs via oxidation. Both of these technology processes are implementable at the site and have the potential of reducing concentrations of COCs in groundwater (groundwater RAO #1). Biosparging was considered for the northeastern portion of the property as the primary impacts in this area appeared to be from petroleum-related impacts and therefore coal tar NAPL-impacted soils may not be present. Although the overall impact of the biosparging cannot be determined without a pilot study or installing a system and monitoring the effects, it is anticipated that without removal of NAPL-impacted soils, the impact of the biosparging would be short term, and therefore the system would have to be operated for a very long time to have a permanent effect on the system. Therefore, biosparging was not retained for further evaluation. Enhanced biodegradation was also not retained through secondary screening since the process would require a large addition of air/amendments to create and sustain aerobic environment. Permeable reactive barriers were also not retained due to the presence of NAPL along the downgradient property boundary, which could potentially inhibit the effectiveness of the wall. The relative costs for the retained in-situ treatment alternatives range from low to moderate.

5. *Removal* – Removal technology processes retained for further evaluation under this GRA consisted of groundwater removal via vertical extraction wells and collection trenches and NAPL recovery via passive methods is a feasible technology process that could potentially provide effective means of removing impacted groundwater and NAPL. Horizontal extraction wells for groundwater removal were not retained based on the inappropriateness for the site (i.e., horizontal wells may be used for a special application where impacted water could be more effectively recovered for treatment). These technology processes may be effective at preventing the migration of impacted groundwater and NAPL offsite and to Schermerhorn Creek (soil RAOs #2 and #3 and groundwater RAO #2). Removal technologies are proven and the equipment, materials, and contractors to construct extraction wells and/or collection trenches are readily available. Relative costs for removal options range from low to moderate.

6. *Ex-Situ Onsite Treatment* – Ex-situ onsite treatment remedial technologies retained for further evaluation include physical separation through: carbon adsorption, filtration, precipitation/coagulation/flocculation,

oil/water separation, and air stripping. Carbon adsorption is an implementable technology process that targets hydrocarbons and SVOCs. Filtration is an easily implemented process that would remove suspended solids and could be used as part of a groundwater treatment train. Precipitation/coagulation/flocculation is a feasible technology process that could be used as a pre-treatment method to transform dissolved constituents into insoluble solids which would subsequently be removed. Oil/water separation is an easily implemented and effective means of separating insoluble oil from groundwater and could be used as part of a groundwater treatment train, if needed. Air stripping is used to effectively separate VOCs, such as BTEX compounds, and is somewhat effective at separating SVOCs from impacted groundwater. All of these are proven technology processes that are readily implementable and would reduce concentrations of COCs in the extracted groundwater (portion of groundwater RAO #1); however, the technologies would not meet the portion of groundwater RAO #1 to mitigating future impacts to groundwater because NAPL-impacted soil (the source of ongoing dissolved-phase impacts to groundwater) is not addressed by this alternative. Relative costs associated with the individual treatment processes range from low to high; however, the capital and O&M costs associated with ex-situ treatment of extracted groundwater would be high.

7. *Offsite Treatment and/or Disposal* – Groundwater discharge to a local POTW was retained for further evaluation because it can effectively dispose of groundwater; however, the impacted groundwater would require treatment to achieve water quality criteria established by the POTW before discharge could occur and therefore does not meet the RAOs established from onsite and offsite groundwater.

4.3.2.3 Creek Sediment

The basis of retaining each sediment remedial technology and technology process during the secondary screening is described below.

1. *No Action* – The "No Action" alternative does not achieve the RAOs for sediment; however, the alternative was retained to serve as a baseline against which other remedial options may be compared.

2. *Institutional Controls* – For this GRA, use restrictions (in the form of governmental controls, proprietary controls, enforcement and permit controls, and information devices) were retained for further evaluation. Institutional controls will not achieve RAOs as a stand-alone process, but were retained because institutional controls can be easily implemented in conjunction with other remedial technologies to potentially reduce exposure of current and future onsite workers to impacted sediment.

3. *In-Situ Containment/Control* – The in-situ containment/control technology process of containment through the use of sheetpiles was not retained for further evaluation., Containment alone would not prevent potential downstream migration of impacted sediments.

4. *Removal* – For this GRA, mechanical dredging is an effective technology process that could remove impacted sediments from the onsite portion of Schermerhorn Creek and was therefore retained for further evaluation.

5. *Ex-Situ Onsite Treatment* – Based on the secondary screening, no ex-situ onsite remedial technologies or technology processes were retained for further evaluation. Ex-situ onsite treatment technology processes retained for further evaluation following preliminary screening (i.e., onsite asphalt batching and extraction via LTTD) were not retained due to implementability (i.e., insufficient space available at the site).

6. *Offsite Treatment/Disposal* – Offsite disposal at a RCRA or solid waste landfills are both feasible remedial options and therefore retained for further evaluation as offsite treatment/disposal remedial options.

4.4 Summary of Retained Remedial Technologies

To summarize, the following remedial technologies were retained through secondary screening:

Soil

- No Action;
- Administrative Controls;
- Capping;
- Containment;
- Immobilization;
- Excavation
- Extraction; and
- Offsite Disposal.

Groundwater

- No Action;
- Use Restrictions;
- Hydraulic Containment;
- Biological Treatment;
- Chemical Treatment;
- Groundwater Removal;
- NAPL Removal;
- Physical Separation; and
- Groundwater Discharge.

Sediment

- No Action;
- Institutional Controls;
- Dredging; and
- Disposal.

4.5 Development of Remedial Alternatives

Using the screened technologies listed above, this section develops remedial alternatives capable of addressing the impacted environmental media at the site. Consistent with the NCP (40 CFR 300.430), the following range of alternatives was developed:

- The "No-Action" alternative;

- Alternatives that involve little or no treatment, but provide protection of human health and the environment by preventing or minimizing exposure to the COCs through the use of containment options and/or institutional controls;

- Alternatives that remove COCs to the extent possible, thereby minimizing the need for long-term management; and

- Alternatives that treat the COCs but vary in the degree of treatment employed and long-term management needed.

Presented below are summaries of the assembled soil remedial alternatives, assembled groundwater remedial alternatives, and assembled sediment remedial alternatives.

4.5.1 Soil Remedial Alternatives

Remedial alternatives that have been developed for addressing the impacted soils at the site are presented below. Detailed technical descriptions of the remedial alternatives are presented in Section 5 as part of the detailed remedial alternative evaluations.

Soil Alternative 1 - No Action

Under this alternative, no remedial activities would be conducted.

Soil Alternative 2 – Asphaltic Concrete Cap

This alternative involves the installation of a low-permeability asphaltic concrete cap over the site areas containing NAPL-impacted soil. The asphaltic concrete cap would be sealed and maintained annually to minimize infiltration of stormwater. The approximate extent of the asphaltic cap is shown on Figure 4-1.

Soil Alternative 3 – Containment Barrier Wall

This alternative involves installing a low-permeability containment wall to contain or isolate NAPL-impacted soil and limit migration of impacted groundwater. Potential materials to form a containment barrier wall include water-tight sheetpiling and low-permeability slurry walls. The slurry wall consists of a vertical trench filled with a low-permeability mixture (e.g., cement and bentonite). In areas where the installation of a containment barrier wall would be inhibited by subsurface utilities, high-pressure jet-grouting or other methods would be used to complete the barrier wall. The approximate extent of the containment barrier is shown on Figure 4-2.

Soil Alternative 4 – In-Situ Soil Stabilization of NAPL-Impacted and Potentially NAPL-Impacted Soil

This alternative involves the mixing of Portland cement or other pozzolanic materials with soil to solidify the material to reduce leaching and mobility of COCs and decrease the hydraulic conductivity of the soil. In-situ soil stabilization (ISS) is performed by mixing a fluid cement grout into a column of soil without excavating or removing the soil. ISS mixing typically involves using a large crane or excavator-mounted large-diameter augers in the soil while grout is pumped through the augers into the soil. The resulting mixed material is generally a homogeneous mixture of soil and grout that hardens to become a weakly-cemented material. For relatively shallow applications (up to approximately 35 feet bgs), the mixing tool may be 6 to 12 feet in diameter. In order to create continuous zones of treatment, the columns of mixed soil and cement are overlapped to provide continuity.

This application of ISS would be focused on the areas of NAPL-impacted and potentially NAPL-impacted soil. In areas not suitable for ISS (such as areas in close proximity to subsurface utilities), high-pressure jet-grouting could be used to complete the soil stabilization. The approximate extent of ISS under this alternative is shown on Figure 4-3.

<u>Soil Alternative 5 – In-Situ Soil Stabilization of NAPL-Impacted Soil and Soil Containing PAHs > 500 ppm</u>

Similar to soil alternative 4, this alternative involves the mixing of Portland cement or other pozzolanic materials with soil to solidify the material to reduce leaching and mobility of COCs and decrease the hydraulic conductivity of the soil. This application of ISS would be focused on the areas of NAPL-impacted soil and soil containing PAHs > 500 ppm. Due to the extent of subsurface natural gas utilities in the impacted soil areas, relocation of Service Center personnel and operations, as well as the existing natural gas regulator station and associated subsurface piping, would be necessary. The approximate extent of ISS under this alternative is shown on Figure 4-4.

<u>Soil Alternative 6 – Soil Removal – NAPL-Impacted Soil Adjacent to Subsurface Utilities</u>

This alternative involves excavating NAPL-impacted soil adjacent to and immediately beneath subsurface utilities to create a corridor of non-impacted soil surrounding the utilities and transporting the excavated material for offsite treatment or disposal. The anticipated limits of the soil to be removed under this alternative are shown on Figure 4-5. NAPL-impacted soil would be excavated to a depth of approximately 1 foot below the subsurface utilities (assumed to be 5 foot below grade). Excavation activities would include the removal of soil via hand-digging to minimize the potential to cause damage to the utilities. Following the removal of the NAPL-impacted soil, the bottom 2 feet of the excavation would be backfilled with a controlled low-strength material (i.e., low-strength concrete). The remaining portion of the excavation would be completed with an appropriate backfill.

<u>Soil Alternative 7 – Soil Removal - NAPL-Impacted Soil and Soil Containing PAHs at Concentrations > 500 ppm and Offsite Treatment/Disposal</u>

This alternative involves excavating NAPL-impacted soil and soil containing total PAHs at concentrations >500 ppm and transporting the excavated material for offsite treatment or disposal. As previously indicated, soils containing BTEX at concentrations >10 ppm are located within the area of NAPL-impacted soil and/or soil containing PAHs at concentrations >500 ppm.

Under this alternative, the soil excavation limits would be based on the visual limits of NAPL-impacted soil and soil containing total PAHs at concentrations >500 ppm based on the laboratory analysis of soil samples collected during site investigation activities. The anticipated limits of the soil to be removed under this option are shown on Figure 4-6. As previously indicated, the majority of NAPL-impacted soils are below the water table. Additionally, several subsurface natural gas utilities associated with an onsite gas regulation station are located within the limits of the impacted soil area. This would make any soil removal at the site difficult and would limit the effectiveness and benefit of only removing impacted soil above the water table.

The anticipated maximum depth of the soil removal activities is approximately 35 feet bgs, resulting in a soil removal volume of approximately 144,000 cubic-yards (CY). Excavation would generally be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. Due to the extent of subsurface natural gas utilities in the impacted soil areas, relocation of Service Center personnel and operations, as well as the existing natural gas regulator station and associated subsurface piping, would be necessary.

Excavated soils would require dewatering/stabilization prior to being transported for offsite treatment/disposal. Materials that are determined to be hazardous would be transported to a permitted hazardous waste management facility for disposal in accordance with applicable rules and regulations.

A temporary water treatment facility would be designed and constructed onsite to provide treatment of groundwater collected during any excavation efforts and treatment of water generated from dewatering of the excavated soil. Treated water would be discharged for offsite disposal at a POTW.

Soil Alternative 8 – Soil Removal – Soil Containing Constituents Greater than TAGM 4046 Recommended Soil Cleanup Objectives

This alternative is similar to Soil Alternative 7. Under this alternative, remedial activities would consist of removing soil containing chemical constituents greater than TAGM 4046 NYSDEC recommended soil cleanup objectives. The anticipated limits of the soil to be removed under this option (based on previous soil investigation activities) are shown on Figure 4-7. As indicated above, the majority of NAPL-impacted soils are below the water table. Additionally, several subsurface natural gas utilities associated with an onsite gas regulation station are located within the limits of the impacted soil area. This would make any soil removal at the site difficult and would limit the effectiveness and benefit of only removing impacted soil above the water table.

The anticipated maximum depth of the soil removal activities is approximately 40 feet bgs, resulting in a soil removal volume of approximately 360,000 CY. Excavation would generally be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. Due to the extent of subsurface natural gas utilities in the impacted soil areas, relocation of Service Center personnel and operations, as well as the existing natural gas regulator station and associated subsurface piping, would be necessary.

Similar to Soil Alternative 7, excavated soils would require dewatering/stabilization prior to being transported for offsite treatment/disposal. Materials that are determined to be hazardous would be transported to a permitted hazardous waste management facility for disposal in accordance with applicable rules and regulations.

A temporary water treatment facility would be designed and constructed onsite to provide treatment of groundwater collected during any excavation efforts and treatment of water generated from dewatering of the excavated soil. Treated water would be discharged for offsite disposal at a POTW.

4.5.2 Groundwater Remedial Alternatives

Remedial alternatives that have been developed for addressing impacted groundwater at the site are presented below. Detailed technical descriptions of the groundwater remedial alternatives are presented in Section 5 as part of the detailed remedial alternative evaluations.

Groundwater Alternative 2 – Administrative Controls with Continued Groundwater Monitoring

Under this remedial alternative, institutional controls, such as environmental easements, would be implemented by National Grid to prevent future onsite use of groundwater. These environmental easements, or other institutional controls, would prohibit residential use of the property so that site groundwater would not be used.

Existing monitoring wells located along the northern and western perimeter of the site near the existing fence line contain COCs at concentrations greater than TOGS 1.1.1 Class GA groundwater standards and guidance values. As a result, it is probable that some potentially limited quantity of dissolved-phase site constituents have migrated downgradient of the fence line beneath the adjoining CSX and D&H properties, which immediately abut the National Grid property. These adjoining CSX and D&H properties would also be subject to environmental easements under this alternative.

As part of the proposed remedy for the GE Schenectady Main Plant property (presented in the GE Main Plant PRAP), administrative controls were to be implemented to prevent the use of groundwater as a source of potable or process water without necessary water quality treatment, as determined by the Schenectady County Department of Health (SCDOH). The administrative controls for the GE property reportedly include access controls and restrictions on the future use of the site property. Similar administrative controls (as were established at the GE property) would be established for the site. Future property owners would be required to complete and submit annual certification to the NYSDEC that administrative and engineering controls were put in place as part of the site remedy, are still place, have not been altered, and are still effective.

Groundwater Alternative 3 – Passive NAPL Recovery

This alternative involves passively recovering NAPL from beneath the property. Passive NAPL recovery would be accomplished by conducting periodic manual bailing from a number of wells installed in areas containing NAPL-impacted soil. The wells would be screened across subsurface zones where NAPL-impacted soils have been identified. Recovered NAPL would be transferred to containers for future transportation and offsite treatment/disposal.

Groundwater Alternative 4 - In-Situ Chemical Oxidation

Under this alternative, in-situ chemical oxidation would be implemented to reduce the mass of chemical constituents (i.e., BTEX and PAHs) in the subsurface of the site. In-situ chemical oxidation is an innovative technology that involves the addition of oxidizing agents (e.g., hydrogen peroxide, ozone) to degrade organic constituents to less-toxic byproducts.

Groundwater Alternative 5 – Groundwater Extraction and Treatment

This alternative involves installing groundwater extraction wells to remove impacted groundwater, contain/control the migration of dissolved phase constituents in groundwater, and treating the groundwater through a permanent groundwater treatment facility to be constructed at the site. Groundwater treatment could employ a number of pre-treatment and treatment technologies to remove chemical constituents from the groundwater. Following treatment, the groundwater would be discharged to the POTW for further treatment (as necessary) and disposal. Under this remedial alternative, groundwater monitoring activities would be conducted every 6 months for a period of at least 3 years to document the reduction of concentrations of the COCs within the groundwater beneath the site. Monitoring activities would consist of the collection of groundwater field data (i.e., pH, turbidity, temperature, etc.) and the collection of groundwater samples for laboratory analysis from appropriate monitoring wells within the existing monitoring well network currently in place at the site. Additional activities would include hydraulic monitoring (water-level monitoring and potentiometric surface mapping) to evaluate hydraulic control.

4.5.3 Sediment Remedial Alternatives

Remedial alternatives that have been developed for addressing the impacted sediment within the onsite portion of Schermerhorn Creek are presented below. Detailed technical descriptions of the sediment remedial alternatives are presented in Section 5 as part of the detailed remedial alternative evaluations.

Sediment Alternative 2 – Impacted Sediment Removal

Under this remedial alternative, approximately 630 CY of impacted sediment within the onsite portion of Schermerhorn Creek would be excavated to address environmental impacts that currently exist for the creek. As needed, sheetpiling would be used during excavation for side-slope stability of the creek banks during excavation of the sediments. During the excavation effort, stream flow would be diverted around the portion of the creek undergoing excavation. It is likely that this diversion effort would occur through the use of pumping and the stormwater flow control structure located approximately ¼ mile upstream from the site. Appropriate downstream erosion control measures, such as silt fencing/curtains, would also be installed. Following excavation, the creek would be backfilled with appropriate imported material.

Sediment Alternative 3 – Sediment Removal and Installation of Closed Culvert

Under this remedial alternative, sediment within the onsite portion of Schermerhorn Creek would be excavated to facilitate installation of a closed culvert that would be used to convey flow within the portion of Schermerhorn Creek located within National Grid's property. Excavation would be accomplished using standard excavation equipment (e.g., excavators) and during the excavation efforts, stream flow would be diverted around the portion of the creek undergoing excavation. The stream diversion effort would occur through a combination of pumping and utilizing the stormwater flow control structure located approximately ¼ mile upstream from the site. As needed, sheetpiling would be used to stabilize the creek banks during excavation of the creek sediments.

Based on preliminary calculations, approximately 5,900 CY of sediment and soil would be removed to facilitate installation of the closed culvert for the entire length of the onsite portion of Schermerhorn Creek (approximately 1,100 feet). Appropriate downstream erosion control measures, such as silt fencing/curtains would be installed and maintained during the excavation and construction efforts. Following excavation and culvert placement, the area above the culvert would be backfilled and covered with asphalt pavement. As necessary, stormwater control structures (e.g., stormwater grates, stormwater diversion ditches) would be installed along the path of the culvert. The proposed location of the closed culvert is shown on Figure 4-8.

4.6 Remedial Alternatives

Media-specific alternatives that were retained after preliminary and secondary screening are evaluated in detail in Section 5 and include the following:

Soil Remedial Alternatives

1. No Action
2. Asphaltic Concrete Cap with Institutional Controls
3. Containment Barrier Wall
4. In-Situ Soil Stabilization of NAPL-Impacted and Potentially NAPL-Impacted Soils
5. In-Situ Soil Stabilization of NAPL-Impacted Soil and Soil Containing PAHs > 500 ppm
6. Soil Removal - NAPL-Impacted Soil Adjacent to Subsurface Utilities

7. Soil Removal - NAPL-Impacted Soil and Soil Containing PAHs at Concentrations >500 ppm and Offsite Treatment/Disposal
8. Soil Removal - Soil Containing Constituents Greater Than TAGM 4046 Recommended Soil Cleanup Objectives and Offsite Treatment/Disposal

Groundwater

1. No Action
2. Administrative Controls with Continued Groundwater Monitoring
3. Passive NAPL Recovery
4. In-Situ Chemical Oxidation
5. Groundwater Extraction and Treatment

Sediment

1. No Action
2. Impacted Sediment Removal
3. Sediment Removal and Installation of Closed Culvert

5. Detailed Evaluation of Remedial Alternatives

5.1 General

This section presents detailed descriptions of the remedial alternatives developed to achieve the RAOs for soil, groundwater, and creek sediment at the National Grid Schenectady (Broadway) Service Center. Each of the retained remedial alternatives are described and evaluated with respect to the criteria presented in the NYSDEC guidance for Feasibility Studies in TAGM 4030 (NYSDEC, 1990) and - "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (USEPA, 1988a). The results of the detailed evaluation of remedial alternatives will be used to aid in the recommendation of appropriate alternatives for implementation at the site.

5.2 Description of Evaluation Criteria

The detailed evaluation of remedial alternatives presented in this section consists of an assessment of each assembled alternative (presented in Section 4.6) against the following seven evaluation criteria:

- Compliance with SCGs;
- Long-Term Effectiveness and Permanence;
- Reduction of Toxicity, Mobility, or Volume;
- Short-Term Effectiveness;
- Overall Protection of Human Health and the Environment;
- Implementability; and
- Cost.

These evaluation criteria encompass statutory requirements and include other gauges such as overall feasibility. Additional criteria, including public and state acceptance, will be addressed following submittal of this revised FS Report.

A description of the evaluation criteria is presented in the following sections.

5.2.1 Compliance with SCGs

This criterion evaluates the remedial alternative's ability to comply with SCGs. The following items are considered during evaluation of the remedial alternative:

- Compliance with chemical-specific SCGs;
- Compliance with action-specific SCGs; and
- Compliance with location-specific SCGs.

This evaluation criterion also addresses whether the remedial alternative would be in compliance with other appropriate federal and state criteria, advisories, and guidance. Applicable chemical-, action-, and location-specific SCGs are presented in Tables 2-1 through 2-3, respectively.

5.2.2 Long-Term Effectiveness and Permanence

The evaluation of each remedial alternative relative to its long-term effectiveness and permanence is made by considering the risks that may remain following completion of the remedial alternative. The following factors will be assessed in the evaluation of the alternative's long-term effectiveness and permanence:

- Potential environmental impacts from untreated waste or treatment residuals remaining at the completion of the remedial alternative;
- The adequacy and reliability of controls (if any) that will be used to manage treatment residuals or remaining untreated waste; and
- The remedial alternative's ability to meet RAOs established for the site.

5.2.3 Reduction of Toxicity, Mobility, and Volume

This evaluation criterion addresses the degree to which the remedial alternative will permanently and significantly reduce the toxicity, mobility, or volume of the constituents present in the site media. The evaluation focuses on the following factors:

- The treatment process and the amount of materials to be treated;
- The anticipated ability of the treatment process to reduce the toxicity, mobility, or volume;
- The nature and quantity of treatment residuals that will remain after treatment;
- The relative amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled; and
- The degree to which the treatment is irreversible.

5.2.4 Short-Term Effectiveness

The short-term effectiveness of the remedial alternative is evaluated relative to its effect on human health and the environment during implementation of this alternative. The evaluation of each alternative with respect to its short-term effectiveness will consider the following:

- Short-term impacts to which the community may be exposed during implementation of the alternative;
- Potential impacts to workers during implementation of the remedial actions and the effectiveness and reliability of protective measures;
- Potential environmental impacts of the remedial action and the effectiveness of mitigative measures to be used during implementation; and
- Amount of time until protection is achieved.

Additional items to be considered when evaluating the remedial alternative relative to its short-term effectiveness are identified as specific considerations in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA, 1988a).

5.2.5 Overall Protection of Human Health and the Environment

This evaluation of the remedial alternative addresses considers if alternative provides adequate protection of human health and the environment. This evaluation relies on the assessments conducted for other evaluation criteria, including long-term and short-term effectiveness and compliance with SCGs.

5.2.6 Implementability

This criterion addresses the technical and administrative feasibility of implementing the remedial alternative, including the availability of the various services and materials required for implementation. The following factors are considered during the implementability evaluation:

- ***Technical Feasibility*** - This factor refers to the relative ease of implementing or completing the remedial alternative based on site-specific constraints. In addition, the remedial alternative's constructability and operational reliability are considered, as well as the ability to monitor the effectiveness of the remedial alternative.

- ***Administrative Feasibility*** - This factor refers to the feasibility of acquiring and the time required to obtain any necessary approvals and permits.

5.2.7 Cost

This criterion refers to the total cost to implement the remedial alternative. The total cost of each alternative represents the sum of the direct capital costs (materials, equipment, and labor), indirect capital costs (engineering, licenses, or permits, and the contingency allowances), and O&M costs. O&M costs may include operating labor, energy, chemicals, sampling, and analysis. These costs, which are developed to allow the comparison of the remedial alternatives, are estimated with expected accuracies of -30 to +50%, in accordance with USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA, 1988a). A 20% contingency factor is included to cover unforeseen costs incurred during implementation. Present worth costs are calculated for alternatives expected to last more than 2 years. In accordance with USEPA guidance, a 7% discount rate (before taxes and after inflation) is used to determine the present worth factor.

5.3 No Action Alternative

The "No Action" alternative was retained for evaluation for each of the environmental media to be addressed at the site as required by USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA, 1988a) and NCP regulations. Because the "No Action" alternative applies to each medium, this alternative is evaluated in detail once below and applies to each of the environmental media.

Technical Description

The "No Action" alternative serves as the baseline for comparison of the overall effectiveness of the other remedial alternatives. The "No Action" alternative would not involve implementation of any remedial activities to address the COCs in the environmental media at the site. The site would be allowed to remain in its current condition and no effort would be made to change the current site conditions.

Compliance with SCGs

- *Chemical-Specific SCGs*: The chemical-specific SCGs identified for this alternative are presented in Table 2-1. Because removal or treatment is not included as part of this alternative, the chemical-specific SCGs would not be met with this alternative.

- *Action-Specific SCGs*: This alternative does not involve implementation of any remedial activities; therefore, the action-specific SCGs are not applicable.

- *Location-Specific SCGs*: Because no remedial activities would be conducted under this alternative, the location-specific SCGs are not applicable.

Long-Term Effectiveness and Permanence

Under the "No Action" alternative, the COCs in the soil would not be addressed. As a result, this alternative would not meet the RAOs identified for the site.

Reduction of Toxicity, Mobility, and Volume

Under the "No Action" alternative, environmental media would not be treated (other than by natural processes), recycled, or destroyed. Therefore, the toxicity, mobility, and volume of the COCs in the impacted environmental media at the site would not be reduced through treatment.

Short-Term Effectiveness

No remedial action would be implemented for the impacted environmental media at the site; therefore, there would be no short-term environmental impacts or risks posed to the community.

Overall Protection of Human Health and the Environment

The "No Action" alternative does not address the impacted environmental media. Therefore, the "No Action" alternative would be ineffective and would not meet the RAOs established for environmental media at the site.

Implementability

The "No Action" alternative does not require implementation of any remedial activities.

Cost

The "No Action" alternative does not involve implementation of any remedial activities; therefore, there are no costs associated with this alternative.

5.4 Detailed Evaluation of Soil Remedial Alternatives

This section presents the detailed analysis of each of the following soil remedial alternatives (previously identified in Section 4.6):

- Soil Alternative 1 – No Action;
- Soil Alternative 2 – Asphaltic Concrete Cap with Institutional Controls;
- Soil Alternative 3 – Containment Barrier Wall;
- Soil Alternative 4 – In-Situ Soil Stabilization of NAPL-Impacted and Potentially NAPL-Impacted Soil;
- Soil Alternative 5 – In-Situ Soil Stabilization of NAPL-Impacted Soil and Soil Containing PAHs > 500 ppm;
- Soil Alternative 6 – Soil Removal - NAPL-Impacted Soil Adjacent to Subsurface Utilities;
- Soil Alternative 7 – Soil Removal/Offsite Treatment/Disposal - NAPL-Impacted Soil and Soil Containing PAHs > 500 ppm and; and
- Soil Alternative 8 – Soil Removal/Offsite Treatment/Disposal - Soil Containing Chemical Constituents Greater than TAGM 4046 Recommended Soil Cleanup Objectives.

Each alternative is evaluated against the seven NCP (as discussed prior, public acceptance will be addressed following completion of the FS) evaluation criteria described in Section 5.2. The "No Action" alternative (Soil Alternative 1) was previously discussed in Section 5.3.

5.4.1 Soil Alternative 2 – Asphaltic Concrete Cap with Institutional Controls

Technical Description

This alternative would involve the construction of a low-permeability asphaltic concrete cap over the site areas containing NAPL-impacted soils to minimize potential exposure to impacted soil and minimize the amount of surface water infiltration through impacted soils. Prior to placement of the asphalt cap, the existing asphalt paving and a 6-inch gravel layer located in areas of impacted soils would be removed and disposed offsite. As necessary, limited soil removal (or filling) may be conducted to facilitate appropriate grade and elevation to promote drainage. The approximate extent of the asphalt cap is shown on Figure 4-1. The asphalt cap would consist of the following components:

- Geotextile to provide a visual separation layer;

- A 6-inch-thick select fill layer placed, compacted, and graded above the impacted soils (where the gravel layer was removed);

- A 4-inch-thick base course bituminous asphalt layer; and

- A 2-inch-thick wearing course bituminous asphalt layer.

Construction of the asphalt cap would not require removal of aboveground structures, nor would subsurface utilities be disturbed during cap installation. Site-related traffic would be allowed to drive over the cap and use the capped surface as a parking area. Following installation of the asphalt cap, a maintenance and monitoring plan would be implemented to monitor the cap for cracking and to repair the cap, as needed, to maintain the cap integrity.

This alternative would also include institutional controls in the form of environmental easements (e.g., environmental land use restrictions [ELURs]) to limit future use of the property. Environmental easements would prohibit the use of onsite groundwater and limit future development of the property to commercial/industrial use. Note, because these easements would apply to both soil and groundwater, a discussion of environmental easements within the groundwater alternatives analysis is not repeated.

Compliance with SCGs

- *Chemical-Specific SCGs:* The chemical-specific SCGs for this alternative are presented in Table 2-1. Because no NAPL-impacted soil removal or treatment is included as part of this alternative, the chemical-specific SCGs for soils would not be met by this alternative.

  Chemical-specific SCGs that may apply to site groundwater include the NYS Groundwater Quality Standards (6 NYCRR Parts 700-705), which identify acceptable chemical constituent concentrations in groundwater. As this alternative does not include treatment, removal, or containment of NAPL-impacted soil, this alternative would not directly improve the groundwater quality beneath or downgradient from the site. However, by limiting infiltration of surface water to the subsurface, some improvements in groundwater quality may occur through natural processes.

- *Action-Specific SCGs:* The action-specific SCGs identified for this alternative are presented in Table 2-2. Action-specific SCGs that apply to this alternative include health and safety requirements associated with the excavation and grading of impacted surface soil.

  Workers and worker activities that occur during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. NYS regulations pertaining to identifying, listing, and managing hazardous wastes (6 NYCRR Parts 370 and 371) may be applicable if it is determined through soil sampling and laboratory analysis that the asphalt and gravel materials removed under this alternative exhibit the characteristics of a hazardous waste.

  Compliance with action-specific SCGs would be accomplished by following a NYSDEC-approved Remedial Design/Remedial Action (RD/RA) Work Plan and a site-specific health and safety plan (HASP).

- *Location-Specific SCGs:* The location-specific SCGs are presented in Table 2-3. There are several location-specific SCGs that may pertain to this option, most of which apply to the improvements associated with Schermerhorn Creek. In general, these location-specific SCGs are associated with construction within the potential floodplain of Schermerhorn Creek.

Long-Term Effectiveness and Permanence

Implementing this alternative would minimize the potential for human and/or biota exposure to these materials (by providing a physical barrier between the impacted soils and humans/biota). This alternative does not involve the removal or treatment of the impacted soils other than to facilitate cap installation. However, a physical barrier will be installed to minimize contact with NAPL-impacted soils. In the event the cap is breached due to the need to perform subsurface excavation activities (i.e., utility installation, new building foundation), PPE, as specified in a site-specific HASP, would be used to minimize potential risks.

Long-term cap monitoring and maintenance, along with use restrictions of the capped area, would be required for this option to remain effective and reliable. A review of the cap integrity and effectiveness would be conducted on a regular basis with yearly cap maintenance. Maintenance functions would consist of sealing and/or patching of any cracked cap area, if present. Because the cap will be constructed of readily available materials, repair and replacement of the cap, if necessary, would easily be accomplished.

Reduction of Toxicity, Mobility, and Volume

This alternative does not involve any form of treatment of impacted soil to reduce the toxicity or volume of the COCs present in the impacted soils. However, implementing this alternative would reduce the mobility of the COCs present in site soil by minimizing infiltration of precipitation.

Short-Term Effectiveness

Implementation of this alternative may result in exposure of onsite workers to the COCs present in the soil by the following mechanisms:

- Ingestion or dermal contact with impacted soil; and
- Inhalation of dust impacted by the COCs and/or inhalation of volatilized organic vapors.

Potential exposure of onsite workers to COCs would be minimized by the use of PPE, as specified in a site-specific HASP that would be developed during the remedial design (RD). Air monitoring would be performed during implementation of this alternative to determine the need for additional engineering controls (e.g., use of water sprays to suppress dust, modify the rate of construction activities, etc.) to assess whether dust or volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community will not have access to the site during the remedial activities since the site is currently and will continue to be fenced. Risks to the community also would be minimized by providing manned security of the site and implementation of a Community Air Monitoring Plan (CAMP) to minimize the potential for volatile organic vapors or impacted dust to migrate from the site.

This remedial alternative could be completed within 2 months of alternative initiation.

Overall Protection of Human Health and the Environment

The installation of an asphalt cap would reduce the mobility of the COCs, as well as limit potential human contact with these materials. Capping of the impacted soils, along with implementing the associated institutional controls, would meet the site-specific RAO of minimizing the potential for exposure to surface and subsurface soil by current and future onsite workers. This alternative would effectively isolate the impacted soils and significantly reduce the potential for human exposure. In addition, this option would provide protection of the environment and contribute to meeting the RAO of mitigating future impacts to groundwater by reducing the volume of water (in the form of precipitation or surface water run-on) which is transported vertically through the impacted soils to the water table. COCs from the NAPL-impacted soil would continue to enter into the dissolved-phase.

Implementability

The construction of an asphalt cap is technically feasible and could be implemented in less than one construction season. Equipment and materials necessary to construct the cap are readily available for use, as are remediation contractors capable of installing the cap. Technologies used to install the asphalt cap are proven and developed and are not anticipated to require further development before actual implementation.

Difficulties and uncertainties associated with the implementation of this alternative consist of activities to be conducted within an active service center and the associated high-traffic areas. Coordination of the cap installation with ongoing daily site activities would be required to address these potential difficulties. Schedule delays associated with material availability should not be an issue during implementation of this alternative due to the availability of asphalt providers.

Cost

The capital cost associated with this alternative includes site preparation and cap construction. Future site maintenance activities would include cap maintenance. The present worth cost has been calculated assuming that cap maintenance activities are continued for a period of 30 years. The estimated present worth cost of this alternative is approximately $1.4 million (M). A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-1.

5.4.2 Soil Alternative 3 – Containment Barrier Wall

Technical Description

This alternative would limit potential future offsite migration of NAPL (which is not currently known to be mobile) and impacted groundwater through installation of a low-permeability vertical containment barrier wall. The anticipated location of the containment barrier wall is indicated on Figure 4-2. The location of the containment barrier wall as shown on Figure 4-2 surrounds the delineated extent of onsite NAPL-impacted soil as determined based on previous soil investigation activities. Note, the containment barrier wall would be installed to surround the majority of known and inferred NAPL-impacted onsite soils. However, potential NAPL-impacted soils offsite and under the railroad, as well as isolated inferred onsite NAPL-impacted soils are not encompassed by the containment barrier wall. As indicated in Section 1.4.2, the presence of NAPL-impacted soils beneath the 2 million CF holder foundation and south of Schermerhorn Creek has not been confirmed. As previously discussed, the 2 million CF concrete gas holder foundation is believed (based on historical drawings) to be supported by numerous wooden piers that would make excavation/pre-trenching through and beneath the holder difficult. In addition, the containment barrier wall alignment does not encompass NAPL-impacted soils located in the vicinity of the former purifier house due to the extensive subsurface natural gas transmission line network in this portion of the site as part of the Gas Regulator Station (GRS).

The low-permeability containment wall would extend from above the upper elevation of the seasonal high groundwater table fluctuation zone and would be keyed into the underlying till unit. A pre-design investigation would be conducted to assess the depth to till unit at regular intervals along the path of the wall. Several technologies are available for constructing vertical containment barriers, including slurry walls and water-tight sheetpiling.

Groundwater levels within the containment barrier wall would be expected to equilibrate to the approximate groundwater potentiometric surface elevation of the till unit (which is at or slightly below the current water elevation). Infiltration through the sealed asphaltic concrete cap is expected to be minimal (approximately 1 inch per year or 0.1 gpm for the entire capped area). Therefore, no groundwater management is anticipated to be necessary in order to maintain an inward gradient from the area outside the containment barrier wall to the area within the containment barrier wall. Maintaining an inward hydraulic gradient would minimize the potential for impacted groundwater contained within the barrier wall to migrate. Calculations supporting this approach are presented in Appendix C.

For purposes of providing a cost for this alternative, cement-bentonite (CB) slurry walls were evaluated as the technology for installing the vertical containment barrier; however, other technologies including soil bentonite barriers, steel interlocking-sheetpiles or high-density polyethylene (HDPE) sheeting could also be effective. The containment barrier could also be constructed of a combination of one or more technologies.

A CB slurry wall would be constructed at the site by trenching (using a long-stick excavator) and adding CB slurry to the trench to act as a low-permeability barrier to groundwater and NAPL movement. Trenching of soils during installation of the wall is not intended as a soil removal method for purposes other than installing the vertical containment barrier. Excavated trench soils would be staged onsite prior to transportation for offsite disposal in accordance with applicable rules and regulations. In addition to serving as the stabilizing fluid to maintain the stability of the trench, the CB slurry would be left in the trench to set up and form the containment barrier wall.

The presence of the subsurface utilities would be an obstruction for installing a CB slurry wall. At locations of the site where utilities cross the proposed path of the barrier wall, jet-grouting or other engineering methods could be used to construct the slurry wall. The exact depth of the subsurface utilities is not known, however, the assumed depth of subsurface natural gas utilities based on conversations with onsite personnel is less than eight feet bgs. For the purposes of providing a cost for this FS, jet-grouting was assumed to be utilized to complete the containment barrier wall in the vicinity of subsurface utilities. Jet-grouting consists of injecting a fluid CB grout (similar to the mix used for the CB slurry wall) into a column of soil using high pressure without excavating or removing the soil. The grout breaks the structure of the soil and mixes the soil and grout in-situ creating a generally homogenous mixture, which in-turn solidifies into a weakly-cemented material in order to create a continuous low-permeability barrier. Jet-grouting is generally considered a replacement technology and would require management of spoils. Spoil volume for the jet-grouting is estimated as approximately 100% of the treated soil volume. Jet-grouting has been used in this application on many other sites.

CB slurry used to form the wall would consist of a mixture of blast furnace slag cement (BFS), Portland cement, bentonite, and water, which can achieve the strength and permeability (on the order of 10^{-7} cm/sec) of compacted clay. During the installation process, cement is added to a bentonite-water slurry just prior to introduction into the trench. Containment barrier wall is a proven technology that has been used for years at numerous sites to limit migration or contain impacted soils and groundwater. There have been a number of applications of CB slurry walls at MGP sites for the containment of impacted media, including sites in Wisconsin, New York, and Pennsylvania.

As part of the FS process, bench-scale testing of containment barrier walls was conducted. Initial bench-scale testing consisted of an evaluation of the soil-bentonite (SB) slurry wall construction. Geo-Solutions, Inc. (Geo-Solutions) conducted a bench-scale study to evaluate the slurry wall technology using NAPL-impacted soil. Specifically, various types and amounts of bentonite were added to NAPL-impacted soil to test the permeability of the mixtures for potential use as a SB slurry wall. A three-phase laboratory testing program was completed to assess the potential attainable permeability and compatibility of a SB mixture with impacted site groundwater. The three phases of laboratory testing consisted of:

1. Developing bentonite slurries and testing for gross compatibility with impacted site groundwater.
2. Developing SB mixtures and testing for water permeability.
3. Assessing the long-term permeability of mixtures with impacted site groundwater.

The SB mixtures evaluated during the bench-scale permeability testing did not meet the typical hydraulic conductivity (k) limit of k less than 1 x 10^{-7} cm/sec. Geo-Solutions indicated that suitable SB mixtures could be obtained by incorporating additional soil or bentonite into the soil mixture; however, these additions would be cost-prohibitive.

A summary report for the bench-scale testing activities and results for the slurry wall technology are presented in Appendix D.

The CB slurry provides several important advantages to SB slurry walls including:

- The backfill is not dependent on the suitability of the site soils.

- The CB slurry construction method provides superior trench stability compared with SB due to CB's higher density and self-hardening properties.

- A smaller area is needed for mixing the CB, which makes the CB method more applicable to sites with limited working room. The CB is mixed in a grout plant and pumped to the trench. Excavated trench soils are transported offsite for disposal.

- CB slurry wall installation provides more flexibility during installation (i.e., wall can be constructed in sections, from both directions, can started and stopped, etc.), where a SB slurry wall needs to be constructed continuously in one direction.

As indicated above, the barrier wall would be anchored into the till unit beneath the site. Based on the findings of onsite investigation activities, till is generally located between 50 and 65 feet below grade and is continuous across the site. As indicated above, a pre-design investigation would be conducted to assess the depth to till at regular intervals along the path of the wall. Bench-scale testing of the CB slurry wall technology would also be conducted as part of the pre-design phase to confirm the anticipated effectiveness of the barrier wall.

Long-term O&M of a vertical containment barrier would be conducted to assess the continued effectiveness of the containment barrier wall. O&M activities would generally consist of monitoring hydraulic properties upgradient, within, and downgradient of the containment wall and periodically monitoring groundwater quality downgradient of the barrier wall.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. Subsurface soil beneath the property contains chemical constituents at concentrations greater than the recommended soil cleanup objectives presented in NYSDEC TAGM 4046 (USEPA, 1994). This alternative does not actively remove or treat impacted soils at the site other than potentially impacted soil removed during installation of the barrier wall. As such, this alternative would not achieve the chemical-specific SCGs presented in NYSDEC

TAGM 4046. However, installation of the physical containment barrier would minimize potential downgradient offsite migration of NAPL and/or chemical constituents present in the onsite soil.

Chemical-specific SCGs that may apply to site groundwater are the NYS Groundwater Quality Standards (6 NYCRR Parts 700-705), which identify acceptable chemical constituent concentrations in groundwater. This alternative does not provide a means to improve onsite groundwater quality. However, by containing NAPL-impacted soil; the future flux of dissolved phase constituents in groundwater to offsite areas would be reduced, and the concentrations in the offsite groundwater downgradient of the site would be reduced overtime via natural processes.

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are associated with the construction of the containment barrier wall, disposal of MGP waste material (TAGM 4061), monitoring requirements, and OSHA health and safety requirements. Workers present and work activities conducted during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following a NYSDEC-approved RD/RA Work Plan and site-specific HASP.

  Process residuals generated during implementation of this alternative (e.g., excavated material during installation of the barrier wall) would be characterized to determine appropriate offsite disposal requirements. Disposal of MGP-impacted materials would be in accordance with NYSDEC MGP disposal regulations presented in TAGM 4061 (NYSDEC, 2002a), as indicated above. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs,/LDRs and USDOT requirements for packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to construction within a potential floodplain of Schermerhorn Creek.

Long-Term Effectiveness and Permanence

The installation of a physical containment barrier would meet the RAOs of minimizing potential future offsite migration of NAPL, preventing migration of NAPL to Schermerhorn Creek, and mitigating future impacts to offsite groundwater by isolating NAPL-impacted soils, thereby minimizing future contributions of dissolved-phase impacts. Although residual concentrations of PAHs and BTEX would remain in site soils, this remedial alternative would in large part attain the RAO of mitigating future impacts to groundwater by isolating the majority of NAPL- or potentially NAPL-impacted soils that contribute to ongoing dissolved-phase impacts to groundwater. This alternative alone would not meet the RAO of minimizing potential risks (i.e., exposure) of onsite workers to impacted soils and groundwater beneath the site.

The containment wall should have good long-term effectiveness as the NAPL-soils and impacted groundwater contained within the wall will continue to be prevented from migrating offsite. A long-term O&M plan would be implemented to verify the continued effectiveness of the remedy. O&M activities would consist of periodic monitoring of the hydraulic conditions upgradient and downgradient of the containment barrier wall, and periodically collecting groundwater samples downgradient from the barrier wall to monitor groundwater quality.

Reduction of Toxicity, Mobility, and Volume

Installation of a vertical containment barrier wall would minimize the potential for future downgradient migration of onsite NAPL and impacted groundwater. In addition, the toxicity and volume of chemical constituents in offsite groundwater downgradient of the site would be expected to be reduced because onsite NAPL-impacted soils would be physically isolated and would not continue to contribute COCs to downgradient groundwater via dilution, dispersion, or dissolution. Toxicity, mobility, and volume of chemical constituents in groundwater outside the containment wall would be permanently reduced under this alternative. NAPL-impacted soil will not be treated under this alternative; rather it will be contained and prevented from migrating offsite. Limited amounts of NAPL-impacted soil may be removed during the trenching activities to construct the containment barrier wall. The containment barrier wall would also be relatively impermeable to groundwater, which would inhibit migration of impacted groundwater within the barrier wall. Concentrations of the chemical constituents in saturated subsurface soils may be reduced by this alternative over time via natural processes.

A portion of potentially NAPL-impacted soils would not be addressed under this alternative; specifically potentially NAPL-impacted soil beneath the 2 million CF holder foundation, potentially NAPL-impacted soil in the area of the gas regulator station (in the vicinity of the former purifier house), and potentially NAPL-impacted soil south of Schermerhorn Creek. As indicated in Section 1.4.2, the presence of NAPL-impacted soil beneath the 2 million CF holder foundation has not been confirmed. The potentially NAPL-impacted soil south of Schermerhorn Creek is in an isolated location and can be addressed via targeted removal.

Short-Term Effectiveness

During the implementation of this alternative, onsite workers may be exposed to chemical constituents in soil, groundwater, and NAPL by ingestion, dermal contact, and/or inhalation. Potential exposure of onsite workers to chemical constituents would be minimized by the use of PPE, as specified in a site-specific HASP that would be developed during the RD phase. Air monitoring would be performed during implementation of this alternative to determine the need for additional engineering controls (e.g., use of water sprays and/or foam to suppress dust and vapors during containment barrier installation, modifying the rate of construction activities, etc.) and to confirm that dust or volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community would not have access to the site during the implementation of the remedial activities as the site is currently and would continue to be fenced. Risks to the community also would be minimized by providing security at the site and implementing site-specific CAMP to minimize the potential migration of volatile organic vapors, impacted dust, or nuisance odors from the site. The containment barrier wall construction may require approximately 10 months.

Overall Protection of Human Health and the Environment

The installation of a physical containment barrier alone would not meet the soil RAOs of minimizing potential risks to current and future workers. As indicated above, a portion of potentially NAPL-impacted soils would not be addressed under this alternative: potentially NAPL-impacted soil beneath the 2 million CF holder foundation; in the vicinity of the gas regulator station; and south of Schermerhorn Creek. This remedial alternative would meet the soil RAOs of minimizing potential future offsite migration of NAPL and preventing migration of NAPL to Schermerhorn Creek. In addition, this alternative would also meet the groundwater RAO of mitigating future impacts to groundwater by minimizing the potential for onsite NAPL-impacted soil to continue to contribute dissolved-phase COCs to offsite groundwater.

Implementability

Installation of a containment barrier wall is technically feasible. This technology is proven and remedial contractors, materials, and equipment for constructing a barrier wall are readily available.

Difficulties associated with the implementation of this remedial alternative would consist of performing activities at an active service center where operations need to be maintained during remedy construction. The existing bridge crossing over the Schermerhorn Creek may not support the heavy equipment (such as the long-stick excavator) that will be necessary to install this remedy. To address this issue, the bridge crossings may need to be upgraded, unless the Schermerhorn Creek is culverted as part of the site-wide remedy and as discussed in Section 5.6.2. Existing above- and underground utilities primarily associated with the onsite natural gas distribution system, and historic subsurface structures or debris from the former MGP operations, would also provide challenges in implementing/constructing this alternative. Implementation issues related to the remedial alternative include installation of a containment barrier adjacent to an active railroad spur and around active underground natural gas mains. In addition, operating heavy equipment (such as a long-stick excavator) adjacent to the Schermerhorn Creek could be problematic due to side slope stability issues within the creek (unless the creek is culverted prior to CB slurry wall installation).

Use of alternative CB slurry wall installation methods (such as jet-grouting) would address concerns associated with construction of a barrier wall in the area of underground utilities. Conducting pre-design alignment borings and installing a shallow "pre-trench" along the alignment would identify unknown utilities and near surface obstructions. Engineering support measures may be required to protect the integrity of the active railroad and the active underground natural gas utilities. The creek side slopes could be addressed by culverting the creek, relocating the CB slurry wall away from the creek, or installing steel sheet pile in the creek adjacent to the CB slurry wall. Technical problems could result in schedule delays (e.g., equipment failure, treatment difficulties, traffic issues, coordination issues, etc.), but can be minimized with proper advanced planning and coordination of the remedial activities.

The anticipated time associated with implementation of this remedial alternative would be approximately 10 months (excluding pre-design investigation), and the long-term monitoring and maintenance could last 30 years or more.

Cost

The capital costs associated with this alternative include site preparation and containment barrier wall installation. Future site monitoring/maintenance activities would include: periodic monitoring of the containment wall and groundwater monitoring downgradient of the containment barrier. The present worth cost has been calculated assuming that monitoring/maintenance activities are continued for a period of 30 years. As stated above, CB slurry wall is the primary containment barrier technology under this remedial alternative and the technology considered during the development of remedial alternative cost estimates. The estimated present worth cost of this alternative is approximately $8.8 M. If water-tight steel sheet piling was used in place of a CB slurry wall the total cost would increase to approximately $12.5 M. A detailed breakdown of the estimated costs to install a CB containment barrier wall is presented in Table 5-2.

5.4.3 Soil Alternative 4 – In-Situ Soil Stabilization of NAPL-Impacted and Potentially NAPL-Impacted Soils

Technical Description

Under this alternative, NAPL-impacted and potentially NAPL-impacted soils would be treated via immobilization using ISS. ISS involves the mixing of Portland cement or other pozzolanic material with soil and waste to provide a material with improved physical characteristics. The anticipated location of the ISS under this alternative is indicated on Figure 4-3. The primary physical properties typically attributed to ISS treated materials that are desired in NAPL-impacted soils at the Schenectady (Broadway) site consist of the following:

- Reduced leaching/mobility;
- Minimizing free liquids; and
- Reduced hydraulic conductivity.

ISS is performed by mixing a fluid cement grout into a column of soil without excavating or removing the soil. The ISS treatment would reduce the volume (via reducing the pore space) and potential mobility of pore-filling liquids (e.g., water, NAPL) in the treated area. There are several methods for implementing ISS. One method (as described in Section 5.4.2), consists of jet-grouting. Jet-grouting consists of injecting a fluid CB into a column of soil using high pressure and is usually used to form a panel of solidified soil as part of a grout cutoff wall or in the vicinity of subsurface obstructions (e.g., foundations, utilities) to obtain immobilization without the need for excavating the soil. Another method involves using a large crane or excavator-mounted drill to turn a special mixing tool into the soil while CB grout is pumped through the tool into the soil. The resulting material is generally a homogeneous mixture of soil and grout that hardens to become a weakly-cemented material. The mixing tool for an application such as the Schenectady (Broadway) site may be 6 to 12 feet in diameter (depending on the required depth for ISS application). In order to create continuous zones of treatment, the columns of mixed soil and cement are overlapped to provide continuity.

Prior to conducting the ISS activities, the areas of soil to be stabilized would be pre-excavated to a depth of approximately 5 feet to facilitate removal of subsurface foundations associated with former MGP structures, to manage excess materials generated by the ISS activities, and to facilitate backfilling above the frost line with imported sand and gravel fill material to minimize potential issues associated with the solidified material undergoing freeze-thaw cycles. Based on the anticipated areas to be stabilized, the open garage located in the control portion of the site would be demolished/disassembled.

The ISS process would stabilize NAPL-impacted soil and NAPL by both solidifying the soil into a solid mass (microencapsulation) and by solidifying the soil around the NAPL-impacted soil (macroencapsulation) forming a containment barrier to prevent migration of the NAPL outside of the solidified shell. Additionally, the curing process is an exothermic reaction and the heat from the reaction could serve to volatilize a portion of the COCs associated with the impacted media. The mixing equipment could be fitted with a hood to collect and treat off-gases.

Geo-Solutions conducted a bench-scale study to evaluate the effectiveness of various CB mixtures (i.e., soil stabilization mixtures) at reducing the leachability and permeability of the NAPL-impacted soil at the site. The bench-scale testing activities consisted of testing various mixtures of BFS, Portland cement, bentonite, and water for compatibility with the COCs and NAPL in the soil and groundwater at the site. Solidification mixtures were tested for density, permeability, strength, and leachability of VOCs and SVOCs (using the synthetic precipitation leaching procedure). The results of bench-scale testing indicated that a combination of

BFS, Portland cement, bentonite, and water mixed with the NAPL-impacted soil would provide the optimal mixture for solidification/stabilization of the onsite soil. A summary of the bench-scale testing activities and results is presented in Appendix E.

Under this alternative, ISS would be conducted on visibly NAPL-impacted and potentially NAPL-impacted soils as identified during the previous site investigations (i.e., primarily east of the Open Garage, along the western fence line, and in the northern portion of the site near the former 800,000 CF gas holder). For application with the large diameter mixing tool, removal of buried foundations, utilities and obstacles in the path of the proposed treatment would be necessary. To address concerns regarding the integrity of solidified soils during/following freeze-thaw cycles, the areas to be treated using ISS would first be excavated to a depth of approximately 5 feet bgs. The excavated soil would be characterized and transported for offsite disposal at an appropriate facility. This would allow room for "fluff" (i.e., expansion of stabilized soils) during the ISS treatment as well as area to place clean imported sand and gravel backfill above the frost line. Specific design details would be addressed as part of the RD phase.

During the ISS process, excess materials (i.e., spoils consisting of a mixture of soil, groundwater, NAPL, and grout) is estimated as approximately 25% of the soil volume with the mixing tool method and approximately 100% for the jet-grouting method. The spoils would be managed (as necessary) prior to transportation for offsite treatment and/or disposal.

Post-ISS quality control sampling would consist of sampling the stabilized soil columns to verify that performance criteria (i.e., unconfined compressive strength [UCS], permeability, and PAH concentrations following synthetic precipitation leaching potential [SPLP] extractions) are met. For the purposes of providing a cost for this alternative, QA/QC activities were assumed to include: sampling approximately 20% of the solidified columns, testing each of the samples for UCS and 10% of the samples for permeability and SPLP PAHs. Long-term O&M will consist of monitoring constituent concentrations in the groundwater downgradient of ISS treatment areas and periodically collecting cores from the solidified material to assess the integrity of the material. If performance criteria are not specifically met in some locations, columns can be over bored and additional stabilizing agents can be added.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. The ISS alternative would not meet the recommended soil cleanup objectives presented in NYSDEC TAGM 4046. ISS alone would also not be expected to meet applicable SCGs for site groundwater (including the NYS Groundwater Quality Standards). However, the potential for dissolution of COCs associated with the solidified material would be greatly reduced. Also, free liquids (e.g., impacted groundwater) within the stabilized material would be reduced.

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are associated with ISS monitoring, disposal of MGP-impacted soils (TAGM 4061), and OSHA health and safety requirements. Workers present and work activities conducted during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following an NYSDEC-approved RD/RA Work Plan and site-specific HASP. Measures would be taken (as appropriate) to control levels of airborne particulate matter during soil excavation activities, in accordance with 40 CFR 50 National Ambient Air Quality Standards.

Waste materials generated during implementation of this alternative (i.e., excavated soil and spoils from soil mixing and grouting) would be characterized to determine appropriate offsite disposal requirements. Disposal of MGP-impacted materials would be in accordance with NYSDEC MGP disposal regulations presented in TAGM 4061, as indicated above. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs/LDRs and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to potentially reducing flood storage within the potential floodplain of Schermerhorn Creek during the ISS activities.

Long-Term Effectiveness and Permanence

Implementing this alternative alone would reduce risks to onsite personnel of mitigating future impacts to groundwater by minimizing future contributions of dissolved-phase impacts to onsite and offsite groundwater. ISS would also meet the RAO for soil of minimizing future offsite migration of NAPL and migration of NAPL to Schermerhorn Creek. Following solidification, NAPL, NAPL-impacted soil, and associated COCs would be stabilized. The potential for offsite migration of NAPL would also be reduced since NAPL would either be solidified within the homogenized mixture or encapsulated within stabilized soil. Although residual concentrations of PAHs and BTEX may be left in site soils, this remedial alternative would in large part attain the RAO of mitigating future impacts to groundwater by isolating the majority of NAPL- or potentially NAPL-impacted soils contributing to ongoing dissolved-phase impacts to groundwater.

A long-term O&M program would be implemented to confirm the ongoing effectiveness of the ISS at addressing the NAPL-impacted soil at the site. O&M activities would consist of monitoring constituent concentrations in the groundwater downgradient of the ISS treatment areas and periodically collecting cores from the solidified material to assess the integrity of the material.

Reduction of Toxicity, Mobility, and Volume

ISS treatment would minimize the potential for future downgradient migration of onsite NAPL and impacted groundwater. In addition, the toxicity and volume of chemical constituents in onsite and offsite groundwater would be expected to be reduced because NAPL-impacted soils would be stabilized, effectively minimizing the dissolution of COCs from the impacted soils into the dissolved phase. Also, during ISS, the heat of the reaction would drive off certain volatile COCs from the impacted soil, thus reducing the volume of COCs. Potential volatile organic vapors generated during ISS would be captured by the ISS apparatus through an attachment on the drill rig and treated onsite. Additionally, COCs associated with stabilized material within the solidified mixture would no longer be able to volatilize; thus minimizing potential vapor issues at the ground surface.

Short-Term Effectiveness

During implementation of this alternative, onsite workers potentially may be exposed to chemical constituents in soil, groundwater, and NAPL by ingestion, dermal contact, and/or inhalation.

Potential exposure of onsite workers to chemical constituents would be minimized by the use of PPE, as specified in a site-specific HASP that would be developed during the RD phase. Air monitoring would be performed during implementation of this alternative to determine the need for additional engineering controls (e.g., use of water sprays and/or foam to suppress dust and vapors during containment barrier installation, modifying the rate of construction activities, etc.) and to confirm that dust or volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community would not have access to the site during implementation of the remedial activities as the site is currently and would continue to be fenced. Risks to the community also would be minimized by providing security at the site and implementing a CAMP to minimize the potential migration of volatile organic vapors or impacted dust from the site. The ISS treatment activities may require approximately 12 months to complete.

Overall Protection of Human Health and the Environment

The implementation of ISS treatment would meet the soil RAOs of minimizing potential risks to current and future onsite workers and minimizing potential future offsite migration of NAPL. The potential migration of NAPL to the Schermerhorn Creek would be significantly controlled as the majority of NAPL-impacted soils would be immobilized. Potentially NAPL-impacted soils in the vicinity of the gas regulator station would not be immobilized and could discharge to the Schermerhorn Creek. ISS treatment would minimize future impacts to groundwater and minimize potential contact with or ingestion of impacted groundwater since the most impacted groundwater would be contained (and/or completely bound) within the solidified/stabilized material. ISS would have a limited impact on directly reducing the concentrations of COCs in groundwater. The primary reduction in COC concentrations would likely be through volatilization during the mixing and curing processes and through natural processes over time. ISS would also not address the RAO of mitigating potential impacts from COCs in the onsite Schermerhorn Creek sediments.

Implementability

Implementation of the ISS process is technically feasible. Remedial contractors for implementing this technology are available. There have been a number of applications of ISS on MGP sites including sites in Georgia, Wisconsin, New Hampshire, Massachusetts, and Pennsylvania. A case study for ISS of MGP-impacted soils at a site in Columbus, GA is presented as Appendix F. As indicated in Appendix F, based on the full-scale implementation of this technology at a former MGP site, the applicability of ISS depends on the nature of the COCs and the intended future use of the property. The study concluded that ISS is an available and effective cleanup alternative for MGP sites.

Difficulties associated with the implementation of this remedial alternative would consist of performing activities at an active service center. The presence of the subsurface utilities would be an obstruction for implementation of ISS. At portions of the site where utilities cross through treatment zones, high-pressure jet-grouting (or alternative immobilization methods) would be used to stabilize the soil. High-pressure jet-grouting is generally considered a replacement technology and would require management of spoils (estimated up to 100% of treated soil volume).

Other difficulties associated with ISS include the presence of subsurface debris and aboveground and underground structures, such as the remaining foundations from historical structures. These obstacles could prohibit the advancement of and potentially damage the drilling/injecting equipment used for ISS. The open garage and historical foundations located east of and beneath the Open Garage would have to be excavated and disposed to facilitate completion of ISS treatment. Conducting ISS immediately adjacent to Schermerhorn Creek could be problematic due to potential side slope stability issues on the creek bank. Steel sheet pile or other engineered methods may be required to support the creek bank during ISS (unless the creek is culverted prior to ISS implementation). Technical problems could result in schedule delays (e.g., equipment failure, treatment difficulties, traffic issues, coordination issues, etc.), but can be minimized with proper advanced planning and coordination of the remedial activities.

The time associated with successful implementation of this technology would be approximately 12 months (excluding pilot and treatability studies), and the long-term monitoring and maintenance could last 30 years or more.

Cost

The capital costs associated with this alternative include site preparation and completion of the ISS treatment. Future site monitoring/maintenance activities would include groundwater monitoring. The present worth cost has been calculated assuming that monitoring/maintenance activities are continued for a period of 30 years. The estimated present worth cost of this alternative is approximately \$21.6 M. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-3.

5.4.4 Soil Alternative 5 – In-Situ Soil Stabilization of NAPL-Impacted and Soil Containing PAHs > 500 ppm

Technical Description

Under this alternative, NAPL-impacted soil and soil containing PAHs at concentrations > 500 ppm would be treated via immobilization using ISS. As described in Section 5.4.3, ISS involves the mixing of Portland cement or other pozzolanic material with soil and waste to provide a material with improved physical characteristics. The anticipated location of the ISS under this alternative is indicated on Figure 4-4. The primary physical properties typically attributed to ISS treated materials that are desired in NAPL-impacted soils at the Schenectady (Broadway) site consist of the following:

- Reduced leaching/mobility;
- Minimizing free liquids; and
- Reduced hydraulic conductivity.

As previously discussed, ISS is performed by mixing a fluid cement grout into a column of soil without excavating or removing the soil. The ISS treatment would reduce the volume and potential mobility of pore-filling liquids (e.g., water, NAPL) in the treated area. There are several methods for implementing ISS. One method (as described in Section 5.4.2), consists of jet-grouting. Jet-grouting consists of injecting a fluid CB into a column of soil using high pressure and is usually used to form a panel of solidified soil as part of a grout cutoff wall or in the vicinity of subsurface obstructions (e.g., foundations, utilities) to obtain immobilization without the need for excavating the soil. Another method involves using a large crane or excavator-mounted drill to turn a special mixing tool into the soil while CB grout is pumped through the tool into the soil. The resulting material is generally a homogeneous mixture of soil and grout that hardens to become a weakly-cemented material. The mixing tool for an application such as the Schenectady (Broadway) site may be 6 to 12 feet in diameter (depending on the required depth for ISS application). In order to create continuous zones of treatment, the columns of mixed soil and cement are overlapped to provide continuity.

Prior to conducting the ISS activities, the areas of soil to be stabilized would be pre-excavated to a depth of approximately 5 feet to facilitate removal of subsurface foundations associated with former MGP structures, to manage excess materials generated by the ISS activities, and to facilitate backfilling above the frost line with imported sand and gravel fill material to minimize potential issues associated with the solidified material undergoing freeze-thaw cycles. Based on the anticipated areas to be stabilized, all onsite above-ground structures would be demolished/disassembled. In addition, a majority of the subsurface utilities would be removed.

The ISS process would stabilize NAPL, NAPL-impacted soil and soil containing PAHs > 500 ppm by both solidifying the soil into a solid mass (microencapsulation) and by solidifying the soil around the NAPL-impacted soil (macroencapsulation) forming a containment barrier to prevent migration of the NAPL outside of the solidified shell. Additionally, the curing process is an exothermic reaction and the heat from the reaction could serve to volatilize a portion of the COCs associated with the impacted media. The mixing equipment could be fitted with a hood to collect and treat off-gases.

As indicated in Section 5.4.3, Geo-Solutions conducted a bench-scale study to evaluate the effectiveness of various CB mixtures (i.e., soil stabilization mixtures) at reducing the leachability and permeability of the NAPL-impacted soil at the site. The bench-scale testing activities consisted of testing various mixtures of BFS, Portland cement, bentonite, and water for compatibility with the COCs and NAPL in the soil and groundwater at the site. Solidification mixtures were tested for density, permeability, strength, and leachability of VOCs and SVOCs (using the synthetic precipitation leaching procedure). The results of bench-scale testing indicated that a combination of BFS, Portland cement, bentonite, and water mixed with the NAPL-impacted soil would provide the optimal mixture for solidification/stabilization of the onsite soil. A summary of the bench-scale testing activities and results is presented in Appendix E.

Under this alternative, ISS would be conducted on visibly NAPL-impacted soil and soil containing PAHs at concentrations > 500 ppm as identified during the previous site investigations (i.e., a majority of the site north of Schermerhorn Creek and select areas south of Schermerhorn Creek). For application with the large diameter mixing tool, removal of buried foundations, utilities and obstacles in the path of the proposed treatment would be necessary. To address concerns regarding the integrity of solidified soils during/following freeze-thaw cycles, the areas to be treated using ISS would first be excavated to a depth of approximately 5 feet bgs. The excavated soil would be characterized and transported for offsite disposal at an appropriate facility. This would allow room for "fluff" (i.e., expansion of stabilized soils) during the ISS treatment as well as area to place clean imported sand and gravel backfill above the frost line. Specific design details would be addressed as part of the RD phase.

During the ISS process, excess materials (i.e., spoils consisting of a mixture of soil, groundwater, NAPL, and grout) is estimated as approximately 25% of the soil volume with the mixing tool method. The spoils would be managed (as necessary) prior to transportation for offsite treatment and/or disposal.

Post-ISS quality control sampling would consist of sampling the stabilized soil columns to verify that performance criteria (i.e., UCS, permeability, and PAH concentrations following SPLP extractions) are met. For the purposes of providing a cost for this alternative QA/QC activities were assumed to include: sampling approximately 20% of the solidified columns, testing each of the samples for UCS and 10% of the samples for permeability and SPLP PAHs. Long-term O&M will consist of monitoring constituent concentrations in the groundwater downgradient of ISS treatment areas and periodically collecting cores from the solidified material to assess the integrity of the material. If performance criteria are not specifically met in some locations, columns can be over bored and additional stabilizing agents can be added.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. The ISS alternative would not meet the recommended soil cleanup objectives presented in NYSDEC TAGM 4046. ISS alone would also not be expected to meet applicable SCGs for site groundwater (including the NYS Groundwater Quality Standards). However, the potential for dissolution of COCs associated with the solidified material would be greatly reduced. Also, free liquids (e.g., impacted groundwater) within the stabilized material would be reduced.

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are associated with ISS monitoring, disposal of MGP-impacted soils (TAGM 4061), and OSHA health and safety requirements. Work activities conducted during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following an NYSDEC-approved RD/RA Work Plan and site-specific HASP. Measures would be taken (as appropriate) to control levels of airborne particulate matter during soil excavation activities, in accordance with 40 CFR 50 National Ambient Air Quality Standards.

  Waste materials generated during implementation of this alternative (i.e., excavated soil and spoils from soil mixing and grouting) would be characterized to determine appropriate offsite disposal requirements. Disposal of MGP-impacted materials would be in accordance with NYSDEC MGP disposal regulations presented in TAGM 4061, as indicated above. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs/LDRs and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to potentially reducing flood storage within the potential floodplain of Schermerhorn Creek during the ISS activities.

<u>Long-Term Effectiveness and Permanence</u>

Implementing this alternative alone would reduce risks to onsite personnel of mitigating future impacts to groundwater by minimizing future contributions of dissolved-phase impacts to onsite and offsite groundwater. ISS would also meet the RAO for soil of minimizing future offsite migration of NAPL and migration of NAPL to Schermerhorn Creek. Following solidification, NAPL, NAPL-impacted soil, and associated COCs would be stabilized. The potential for offsite migration of NAPL would also be reduced since NAPL would either be solidified within the homogenized mixture or encapsulated within stabilized soil. Although residual concentrations of PAHs and BTEX may be left in site soils, this remedial alternative would in large part attain the RAO of mitigating future impacts to groundwater by isolating NAPL-impacted soils contributing to ongoing dissolved-phase impacts to groundwater.

A long-term O&M program would be implemented to confirm the ongoing effectiveness of the ISS at addressing the NAPL-impacted soil and soil containing PAHs > 500 ppm at the site. O&M activities would consist of monitoring constituent concentrations in the groundwater downgradient of the ISS treatment areas and periodically collecting cores from the solidified material to assess the integrity of the material.

<u>Reduction of Toxicity, Mobility, and Volume</u>

ISS treatment would minimize the potential for future downgradient migration of onsite NAPL and impacted groundwater. In addition, the toxicity and volume of chemical constituents in onsite and offsite groundwater would be expected to be reduced because NAPL-impacted soils would be stabilized, effectively minimizing the dissolution of COCs from the impacted soils into the dissolved phase. Also, during ISS, the heat of the reaction would drive off certain volatile COCs from the impacted soil, thus reducing the volume of COCs. Potential volatile organic vapors generated during ISS would be captured by the ISS apparatus through an attachment on the drill rig and treated onsite. Additionally, COCs associated with stabilized material within the solidified mixture would no longer be able to volatilize; thus minimizing potential vapor issues at the ground surface.

Short-Term Effectiveness

During implementation of this alternative, onsite workers potentially may be exposed to chemical constituents in soil, groundwater, and NAPL by ingestion, dermal contact, and/or inhalation.

Potential exposure of onsite workers to chemical constituents would be minimized by the use of PPE, as specified in a site-specific HASP that would be developed during the RD phase. Air monitoring would be performed during implementation of this alternative to determine the need for additional engineering controls (e.g., use of water sprays and/or foam to suppress dust and vapors during containment barrier installation, modifying the rate of construction activities, etc.) and to confirm that dust or volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community would not have access to the site during implementation of the remedial activities as the site is currently and would continue to be fenced. Risks to the community also would be minimized by providing security at the site and implementing a CAMP to minimize the potential migration of volatile organic vapors or impacted dust from the site. The ISS treatment activities would require approximately 24 months to complete.

Overall Protection of Human Health and the Environment

The implementation of ISS treatment would meet the soil RAOs of minimizing potential risks to current and future onsite workers and minimizing potential future offsite migration of NAPL, and the potential migration of NAPL to the Schermerhorn Creek by immobilizing NAPL-impacted soils. ISS treatment would minimize future impacts to groundwater and minimize potential contact with or ingestion of impacted groundwater since the most impacted groundwater would be stabilized within the solidified/stabilized material. ISS would have a limited impact on directly reducing the concentrations of COCs in groundwater. The primary reduction in COC concentrations would likely be through volatilization during the mixing and curing processes and through natural processes over time. ISS would also not address the RAO of mitigating potential impacts from COCs in the onsite Schermerhorn Creek sediments.

Implementability

Implementation of the ISS process is technically feasible. Remedial contractors for implementing this technology are available. There have been a number of applications of ISS on MGP sites including sites in Georgia, Wisconsin, New Hampshire, Massachusetts, and Pennsylvania. A case study for ISS of MGP-impacted soils at a site in Columbus, GA is presented as Appendix F. As indicated in Appendix F, based on the full-scale implementation of this technology at a former MGP site, the applicability of ISS depends on the nature of the COCs and the intended future use of the property. The study concluded that ISS is an available and effective cleanup alternative for MGP sites.

Difficulties associated with the implementation of this remedial alternative would consist of performing activities at an active service center. All above-ground structures in the area of soils to be stabilized would be dismantled/demolished as part of this alternative. The presence of the subsurface utilities would be an obstruction for implementation of ISS, especially the presence of the extensive subsurface gas utility network located in the vicinity of the former purifier house. A majority of the subsurface utilities at the site would be relocated as part of this soil alternative.

Other difficulties associated with ISS include the presence of subsurface debris and aboveground and underground structures, such as the remaining foundations from historical structures. These obstacles could prohibit the advancement of and potentially damage the drilling/injecting equipment used for ISS. All existing aboveground structures within the main portion of the site and all historical foundations would have to be demolished/excavated and disposed to facilitate completion of ISS treatment. Technical problems could result in schedule delays (e.g., equipment failure, treatment difficulties, traffic issues, coordination issues, etc.), but can be minimized with proper advanced planning and coordination of the remedial activities. Conducting ISS immediately adjacent to Schermerhorn Creek could be problematic due to potential side slope stability issues on the creek bank. Steel sheet pile or other engineered methods may be required to support the creek bank during ISS (unless the creek is culverted prior to ISS implementation).

The time associated with successful implementation of this technology would be approximately 24 months (excluding pilot and treatability studies, and relocation of existing utilities), and the long-term monitoring and maintenance could last 30 years or more.

Cost

The capital costs associated with this alternative include site preparation and completion of the ISS treatment. Future site monitoring/maintenance activities would include groundwater monitoring. The present worth cost has been calculated assuming that monitoring/maintenance activities are continued for a period of 30 years. The estimated present worth cost of this alternative is approximately $37.0 M. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-4.

5.4.5 Soil Alternative 6 – Soil Removal – NAPL-Impacted Soil Adjacent to Subsurface Utilities

Technical Description

This alternative would address NAPL-impacted soils adjacent to subsurface gas utilities. Under this alternative, NAPL-impacted soils in the immediate vicinity (within 1-foot in any direction) would be removed. The anticipated limits of the soil to be removed under this alternative are shown on Figure 4-5. Note that the majority of observed, modeled or otherwise inferred NAPL at the site is located below the groundwater table and therefore below subsurface utilities at the site. As such, a limited area of utilities on the site would require excavation of surrounding, NAPL-impacted soils. NAPL-impacted soil would be excavated to a depth of approximately 1 foot below the subsurface utilities (assumed to be 5 foot below grade). Excavation activities would include the removal of soil via controlled methods (such as hand-digging) to minimize the potential to cause damage to the utilities.

Under this alternative, approximately 150 CY of soil would be removed. The excavated soil would be stockpiled onsite to facilitate characterization of the material prior to transportation and offsite treatment or disposal. Soil stabilization/dewatering would not be required as part of this alternative as excavation activities would only take place above the water table. Excavated soil would be presumed to be NAPL-impacted and would be managed in accordance with NYSDEC MGP disposal regulations presented in TAGM 4061 (NYSDEC, 2002a). For the purpose of providing a cost, it was assumed that the impacted soil would be transported to a permitted hazardous waste management facility for treatment (LTTD) in compliance with LDRs. Additional treatment/disposal alternatives would be reviewed as part of the RD.

Following the removal of the NAPL-impacted soil, a demarcation barrier would be installed on the utility trench side walls and the bottom two feet of the excavation would be backfilled with a controlled low-strength material (i.e., low-strength concrete). The remaining portion of the excavation would be completed with an appropriate a demarcation barrier installed over the top of the trench and backfill.

This alternative would also include the implementation of a long-term O&M plan (i.e., site management plan) to be prepared following remedial activities. The O&M plan would include requirements for conducting intrusive activities (i.e., PPE requirements and excavation procedures) and would provide procedures for properly handling and disposing of potentially impacted materials that may be encountered during future subsurface activities. No long-term monitoring or maintenance activities have been identified with this alternative.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. This alternative would not meet the recommended soil cleanup objectives presented in NYSDEC TAGM 4046: only select NAPL-impacted soils would be removed. Removal of NAPL-impacted soils adjacent to subsurface utilities alone would not be expected to meet applicable SCGs for site groundwater (including the NYS Groundwater Quality Standards).

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are associated with the excavation and treatment/disposal of the impacted soils, monitoring requirements, and OSHA health and safety requirements. Workers present and work activities conducted during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following an NYSDEC-approved RD/RA Work Plan and site-specific HASP. Measures would be taken (as appropriate) to control levels of airborne particulate matter during soil excavation activities, in accordance with 40 CFR 50 National Ambient Air Quality Standards.

  Waste materials generated during implementation of this alternative (i.e., excavated soil and spoils from soil mixing and grouting) would be characterized to determine appropriate offsite disposal requirements. Disposal of MGP-impacted materials would be in accordance with NYSDEC MGP disposal regulations presented in TAGM 4061, as indicated above. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs/LDRs and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

- Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to construction within a potential floodplain of Schermerhorn Creek.

Long-Term Effectiveness and Permanence

Implementing this alternative would minimize the potential for future human exposure to NAPL-impacted soils by removing these materials from areas most likely to require subsurface work by future onsite workers. This alternative alone would not achieve the RAOs of minimizing offsite NAPL migration and preventing NAPL migration to Schermerhorn Creek and would have to be implemented in conjunction with additional remedial alternatives to achieve all soil RAOs.

In addition to the removal of NAPL-impacted soils adjacent to subsurface utilities, the potential for future worker exposure to impacts would be further reduced via the implementation of a long-term O&M plan (i.e., site management plan) that would be prepared following remedial activities. As indicated above, the O&M plan would include requirements for conducting intrusive activities (i.e., PPE requirements and excavation procedures) and would provide procedures for properly handling and disposing of potentially impacted materials. Long-term monitoring or maintenance would not be required as part of this alternative.

Reduction of Toxicity, Mobility, and Volume

This alternative involves the removal of NAPL-impacted soils adjacent to subsurface utilities thereby reducing the toxicity and volume in select areas. The reduction of toxicity, mobility, and volume of impacted soil on a side-wide basis, would not be achieved by the implementation of this alternative alone.

Short-Term Effectiveness

During implementation of this alternative, onsite workers potentially may be exposed to chemical constituents in soil and NAPL by ingestion, dermal contact, and/or inhalation. Potential exposure of onsite workers to chemical constituents would be minimized by the use of PPE, as specified in a site-specific HASP that would be developed during the RD phase. Air monitoring would be performed during implementation of this alternative to determine the need for additional engineering controls (e.g., use of water sprays and/or foam to suppress dust and vapors during excavation activities, modifying the rate of construction activities, etc.) and to confirm that dust or volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community would not have access to the site during implementation of the remedial activities as the site is currently and would continue to be fenced. Risks to the community also would be minimized by providing security at the site and implementing a CAMP to minimize the potential migration of volatile organic vapors or impacted dust from the site. The soil excavation activities would require approximately 1 month to complete.

Overall Protection of Human Health and the Environment

The excavation of NAPL-impacted soil adjacent to subsurface structures would not meet the soil RAOs of minimizing the potential for offsite migration of NAPL or prevent migration of NAPL to Schermerhorn Creek. In addition, this alternative would not meet the groundwater RAOs of minimizing future impacts to groundwater and reduction concentrations of COCs in the groundwater or preventing future discharge of impacted groundwater to the surface water in Schermerhorn Creek. However, by removing NAPL-impacted soils adjacent to subsurface utilities, this alternative would meet, in part, the soil RAO of minimizing potential risks to current and future onsite workers by removing NAPL-impacted soil from areas most likely to require subsurface work (i.e., minimizing potential exposure to impacted soils).

Implementability

Impacted soil removal and backfilling is technically feasible. Remedial contractors for this alternative are readily available.

Difficulties and uncertainties associated with the implementation of this alternative consist of activities to be conducted within an active service center and the associated high-traffic areas. Coordination of the excavation activities with ongoing daily site activities would be required to address these potential difficulties. Other difficulties associated with this alternative include working in close proximity to subsurface utilities (i.e., deactivating and supporting the utility lines), but could be minimized with proper advanced planning and coordination. The anticipated time to complete the activities associated with this alternative is approximately 1 month.

Cost

The capital costs associated with this alternative include site preparation, soil excavation, and backfilling with select fill materials. No direct O&M costs have been identified for this alternative. The estimated present worth cost of this alternative is $140,000. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-5.

5.4.6 Soil Alternative 7 – Soil Removal - NAPL-Impacted Soil and Soil Containing PAHs >500 ppm and Offsite Treatment/Disposal

Technical Description

This alternative would address impacted soil at the site through soil removal. Soil excavation activities would include the removal of unsaturated and saturated NAPL-impacted soil (based on visual characterization during site investigation activities) and soil containing total PAHs at concentrations >500 ppm (based on analytical results obtained for the laboratory analysis of soil samples collected during site investigation activities). Following removal, the excavated soil would be transported for offsite treatment and/or disposal at an appropriate permitted facility(ies). The anticipated extent of the soil removal under this alternative is indicated on Figure 4-6.

Soil removal activities would be conducted to depths ranging from 15 feet bgs up to 40 feet bgs depending on the depth of NAPL-impacted soil and soil containing PAHs at concentrations >500 ppm. For the purposes of delineating the anticipated soil removal area, the approximate extent of NAPL-impacted soil and soil containing total PAHs at concentrations >500 ppm was determined based on MVS computer modeling that utilized a database of field observations recorded on soil boring logs as part of previous investigation activities. Based on the results of the MVS modeling, this alternative would include the removal of approximately 144,000 CY of soil and the subsequent backfilling with imported clean fill materials.

Excavation of impacted soil would generally be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. The following additional activities would be required under this alternative due to the extent of the proposed soil removal:

- Closure/relocation of the Service Center facility;
- Relocation/rerouting of the natural gas regulating station; and
- Demolition of onsite aboveground structures.

In addition, based on the proximity of the excavation to the adjacent railroad, special permitting and stabilization measures may be necessary. Due to the depth and location of the soil excavation, steel sheetpiling and shoring measures would be necessary to maintain the stability of the excavation sidewalls. Soil removal activities would likely include:

- Installing sheetpiles and shoring (smaller areas maybe isolated to facilitate excavation);
- Dewatering the excavation area;
- Excavating soil to the target depth; and
- Backfilling the excavation area with clean-imported fill material.

For the purposes of estimating a cost for this alternative, it was assumed that a foam spray (or other vapor control measures, such as a spray structure) would be used (as necessary) to suppress odors and volatile organic vapors in portions of the excavation and on the excavated soil. A CAMP would be followed throughout the completion of these activities to document airborne particulate and volatile organic vapor concentrations surrounding the excavation area.

BBL estimated the groundwater removal rates and volumes that would be required to conduct soil removal activities "in the dry." In support of estimating the water removal rates and volumes, BBL assumed the following:

- Excavation would be divided into four smaller excavation areas each measuring 40,000 square-feet (SF);
- An average excavation depth of 22 feet; and
- An average groundwater level of 6 feet bgs.

Additional variables used in the calculations included the hydraulic conductivity and vertical hydraulic gradients in the soil units and the hydraulic conductivity of the sheetpiling.

The volume and rate of water removal was initially calculated assuming no precipitation (i.e., the only water that infiltrated the excavation was through the bottom of the excavation or the sheetpiling). To account for precipitation entering the excavation area, the average annual precipitation was obtained from the National Oceanic and Atmospheric Administration (NOAA). Based on calculations, the dry weather pumping rate would be approximately 8.9 gallons per minute (gpm) and the total estimated volume of water to be pumped/treated over the 4-year duration of the excavation (i.e., infiltration plus precipitation) was approximately 16.5 million gallons. Calculations supporting these results are presented in Appendix C.

The excavated soil would be stockpiled in onsite staging areas to facilitate handling, stabilization (via gravity dewatering or mixing with dryer soils or stabilizing agents), consolidation, and characterization for offsite treatment/disposal purposes. Disposal of MGP-impacted materials would be conducted in accordance with NYSDEC MGP disposal regulations presented in TAGM 4061 (NYSDEC, 2002a). For the purposes of providing a cost for this option, it was assumed that NAPL-impacted soil and soil containing total PAHs at concentrations >500 ppm that are deemed hazardous in accordance with USEPA or NYSDEC regulations and/or guidance would be transported to a permitted hazardous waste management facility for treatment (LTTD) in compliance with LDRs. Additionally, NAPL-impacted soil and soil containing total PAHs at concentrations >500 ppm that are determined to be non-hazardous will be consolidated and transported for offsite treatment/disposal at an approved facility (i.e., a solid waste landfill). Additional disposal/treatment alternatives would be reviewed as part of the RD.

Also for costing purposes, it was assumed that water generated during excavation and soil dewatering activities would be treated onsite using a temporary water treatment system that would likely consist of oil-water separation, filtration, air stripping, and vapor-phase carbon adsorption prior to being discharged to onsite sanitary sewers for subsequent treatment at the local POTW. Details related to water treatment, handling, and discharge would need to be addressed as part of the RD phase.

Although the majority of impacted soils and groundwater would be permanently removed and treated/disposed, groundwater monitoring may be required for a period of time following completion of this alternative.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. NAPL-impacted soil and soil containing total PAHs at concentrations >500 ppm would be removed under this remedial alternative. However, chemical constituents would remain in site soils at concentrations greater than TAGM 4046 recommended cleanup objectives.

  Chemical-specific SCGs that may apply to site groundwater include the NYS Groundwater Quality Standards (6 NYCRR Parts 700-705), which identify acceptable chemical constituent concentrations in groundwater. Because this alternative includes the removal of NAPL-impacted soils and removal and treatment of groundwater that collects within the excavation area (i.e., likely the most impacted groundwater at the site), future impacts to groundwater by site soils should be significantly reduced, and this alternative would likely achieve this SCG.

  Another chemical-specific SCG that may apply for this alternative is associated with discharging treated groundwater to a POTW (and/or to surface water, if necessary). A discharge permit would need to be obtained from the local POTW and the treated water would need to meet influent requirements.

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are associated with the excavation and treatment/disposal of the impacted soils, removal and treatment of groundwater from the excavations, monitoring requirements, and OSHA health and safety requirements. Workers and worker activities that occur during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Measures would be taken (as appropriate) to control levels of airborne particulate mater during soil excavation activities, in accordance with 40 CFR 50 National Ambient Air Quality Standards.

  Additional SCGs applicable to this alternative are associated with the transportation and treatment/disposal of the excavated materials. Transportation of the excavated materials would be completed in accordance with procedures identified in 6 NYCRR 364 and 372, 49 CFR 107, and 40 CFR 262, 263, 171, and 172. Disposal activities would be completed in accordance with 6 NYCRR 372 and 373 and 40 CFR 262, 263, 170-179, and 270.

  National Ambient Air Quality Standards (including particulate levels) would be applicable and adhered to during excavation activities. The implementation of this option would result in the generation of air emissions from the operation of a temporary groundwater treatment system. The SCGs applicable to air emissions include the prevention of significant deterioration (PSD) air emission provisions contained in 40 CFR 51 and all relevant requirements under the Clean Air Act contained in 40 CFR 1-99. In addition, New York State regulations regarding air emissions would apply. To comply with these SCGs, a temporary groundwater treatment system would be designed and operated such that PSD limits would not be exceeded and the system would comply with all state and federal air emission requirements.

  Process residuals generated during the implementation of this remedial alternative and not reused (e.g., activated carbon used in the temporary groundwater treatment system) would be characterized to determine the appropriate offsite disposal requirements. If any of the materials are characterized as a hazardous waste, then the RCRA, UTS/LDR, and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable to this unit. Compliance with these requirements would be achieved by utilizing a licensed waste transporter and properly permitted disposal facilities.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. There are several location-specific SCGs that may pertain to this option, most of which apply to the improvements associated with the Schermerhorn Creek. In general, these location-specific SCGs are associated with reducing the floodplain for the Schermerhorn Creek.

Long-Term Effectiveness and Permanence

The implementation of this alternative would permanently remove the most heavily impacted soil from the site. However, soil containing total PAHs and BTEX at concentrations ≤500 ppm and ≤10 ppm (respectively) would remain. Soil removal under this option would minimize the potential for future offsite migration of NAPL and migration of NAPL to Schermerhorn Creek since NAPL-impacted soil would be permanently removed and disposed offsite.

This remedial alternative would in large part attain the RAO of mitigating future impacts to groundwater and reducing concentrations of COCs in groundwater as NAPL-impacted soils that contribute to ongoing dissolved-phase impacts to groundwater and impacted groundwater/NAPL at the site would be permanently removed.

While short-term groundwater monitoring may be required, no long-term monitoring or maintenance would be related to the soil excavation remedial alternative since the soil would be permanently removed as part of this remedy.

Reduction of Toxicity, Mobility, and Volume

Implementation of this alternative would reduce the toxicity, mobility, and volume of impacted soil and groundwater as well as LNAPL and DNAPL beneath the property. This remedial alternative is an irreversible process as the impacted soil and NAPL would be excavated and transported for offsite treatment/disposal. In addition, impacted groundwater would be removed from the excavation area to facilitate soil removal and groundwater would be treated and disposed offsite. The chemical constituents remaining in subsurface soil and groundwater following excavation may likely be reduced via natural attenuation over time, as constituents within subsurface soil dissolve/disperse into groundwater.

Short-Term Effectiveness

During the implementation of this alternative, onsite remedial workers may be exposed to chemical constituents in soil, groundwater, and NAPL by ingestion, dermal contact, and/or inhalation. Potential exposure of onsite workers to chemical constituents would be minimized by the use of PPE, as specified in a site-specific HASP. Air monitoring would be performed during implementation of this alternative to determine the need for additional engineering controls (e.g., use of water sprays/foam suppressants to suppress dust/vapors/odors during soil excavation, performing excavation work within temporary enclosures, modifying the rate of construction activities, etc.) and to confirm that dust or volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community would not have access to the site during the implementation of the remedial activities as the site is currently and would continue to be fenced. Risks to the community also would be minimized by providing security at the site and implementing a CAMP to minimize the potential migration of volatile organic vapors or impacted dust from the site. The excavated soil would pose a risk while onsite and during transportation from the site to the treatment/disposal facility since it would be more assessable to human exposure. Under this alternative, traffic resulting from the transportation of approximately 144,000 CY of impacted soil for offsite treatment/disposal (approximately 19,000 one-way truckloads for soil removal and importing clean fill materials) would pose a potential nuisance to the community and increase the risk for accidents and spills. Based on the extent of remedial activities described herein, soil removal activities under this remedial alternative may require approximately 48 months to complete.

Overall Protection of Human Health and the Environment

The excavation and offsite treatment/disposal of NAPL-impacted soil and soil containing total PAHs at concentrations >500 ppm, followed by placement of clean backfill material would meet the soil RAOs of minimizing potential risk to current and future onsite workers and minimizing potential future offsite migration of NAPL. Potential human and environmental exposure to the impacted soil would be minimized following remedial activities because the majority of impacted soils would be physically removed from the site and treated/disposed of at permitted facilities. All soils within the limits of the soil removal area would be removed to a depth of at least 10 feet (bgs) as part of this alternative and therefore not readily accessible to site workers or personnel. In addition, NAPL-impacted soils would be removed minimizing future dissolved-phase impacts to groundwater.

Implementability

Impacted soil removal and treatment is technically feasible. Remedial contractors for the removal of the impacted soil are readily available.

As indicated above, based on the extent of the soil removal anticipated under this alternative, the Service Center personnel, equipment, and materials would likely have to be relocated and the existing Service Center would be decommissioned. Difficulties with implementation of this remedial alternative would consist of the following:

- Excavating in the close proximity of the railroads located north and west of the property;
- Managing the anticipated volume of soil;
- Obtaining and transporting to the site approximately 144,000 CY of clean fill materials;
- Managing and disposing the anticipated volume of groundwater and precipitation that would accumulate in the excavation area and through dewatering (anticipated to be greater than 16.5 million gallons over the period of the excavation activities);
- Relocating the existing onsite natural gas distribution system;
- Coordinating the removal and disposal efforts due to limited space to stage disposal trucks.

The current bridge crossing onsite would not likely support the size or volume of truck traffic necessary to support this alternative. The bridge crossing(s) would likely need to be upgraded/replaced, unless the Schermerhorn Creek is culverted in the area of the remedy.

Uncertainties related to the soil removal and construction activities are associated with soil handling and treatment and interference with above/below ground infrastructure. In addition, the need to lower the water table to facilitate the excavation activities may limit the rate of soil removal. The installation of shoring or sheeting would require a test boring program prior to installation to confirm that excavation reinforcements (e.g., sheetpiling) can be driven into the subgrade at the required depths. The likelihood exists that technical problems will lead to schedule delays (i.e., equipment failure, treatment difficulties, traffic issues, etc.) but can be minimized with proper advance planning and coordination of the remedial activities.

Based on the nature of the materials to be excavated (i.e., MGP-impacted soils), pre-mixing with less impacted soils may be necessary to meet the treatment requirements for thermal treatment (as necessary). Adequate treatment/disposal facility capacity should be available; however, coordination to balance the removal, transportation, and treatment/disposal activities would be required due to limited space at the site and due to the limited capacity of the thermal treatment and/or disposal facilities. The necessary equipment and personnel capable of implementing the soil removal alternatives are available. The anticipated time necessary to complete the activities associated with this alternative is approximately 4 years, not including the pre-design soil boring program or time to obtain necessary permits to conduct these activities.

Cost

The capital costs associated with this alternative include site preparation, groundwater dewatering well construction, temporary groundwater treatment system construction and operation costs through excavation activities, soil excavation, soil stabilization, transportation, and treatment/disposal. As indicated above, the need for a long-term O&M program following completion of these soil removal activities is not deemed necessary because the large majority of impacted soil and groundwater would be permanently removed and treated/disposed. Therefore, no direct O&M costs have been identified for this alternative. The estimated present worth cost of this alternative is $77.0 M. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-6.

5.4.7 Soil Alternative 8 – Soil Removal – Soil Containing Chemical Constituents Greater Than TAGM 4046 Cleanup Objectives and Offsite Treatment/Disposal

Technical Description

This alternative would address impacted soil at the site though soil removal. Soil excavation activities would include the removal of soil containing BTEX compounds and PAHs [e.g., benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a)anthracene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, and pyrene] at concentrations greater than NYSDEC TAGM 4046 guidance values. Under this alternative, soils would be excavated and staged and transported for offsite treatment/disposal. Soil excavation activities would include the removal of unsaturated and saturated soil to a maximum depth of approximately 40 feet bgs. Based on the results of the MVS computer modeling, this alternative would include the removal of approximately 360,000 CY of soil and the subsequent backfilling of approximately the same soil volume. Following removal, the excavated soil would be transported for offsite treatment and/or disposal at an appropriate permitted facility(ies). The anticipated extent of the soil removal under this alternative is shown on Figure 4-7.

Similar to the soil removal option presented under Section 5.4.6, excavation of impacted soil would generally be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. The following additional activities would be required under this alternative due to the extent of the proposed soil removal:

- Closure/relocation of the Service Center facility;
- Relocation/rerouting of the natural gas regulating station piping and equipment; and
- Demolition of onsite aboveground structures.

In addition, based on the proximity of the excavation to the adjacent railroad, special permitting and stabilization measures may be necessary. Due to the depth and location of the soil excavation, steel sheetpiling and shoring measures would be necessary to maintain the stability of the excavation sidewalls. Soil removal activities would include:

- Installing sheetpiles and shoring (smaller areas maybe isolated to facilitate excavation);
- Dewatering the excavation area
- Excavating soil to the target depth; and
- Backfilling the excavation area with clean-imported fill material.

For the purposes of estimating a cost for this alternative, it was assumed that a foam spray (or other vapor control measures, such as a spray structure) would be used (as necessary) to suppress odors and volatile organic vapors in portions of the excavation and on the excavated soil. A CAMP would be followed throughout the completion of these activities to document airborne particulate and volatile organic vapor concentrations surrounding the excavation area.

Similar to the soil removal described above under Soil Alternative No. 7, BBL estimated the groundwater removal rates and volumes that would be required to conduct soil removal activities "in the dry." In support of estimating the water removal rates and volumes, BBL assumed the following:

- Excavation would be divided into nine smaller excavation areas each measuring 36,000 SF;
- An average excavation depth of 22 feet;
- An average groundwater level of 6 feet bgs;

Additional variables used in the calculations included the hydraulic conductivity and vertical hydraulic gradients in the soil units and the hydraulic conductivity of the sheetpiling.

The volume and rate of water removal was initially calculated assuming no precipitation (i.e., the only water that infiltrated the excavation was through the bottom of the excavation or the sheetpiling). To account for precipitation entering the excavation area, the average annual precipitation was obtained from the NOAA. Based on calculations, the dry weather pumping rate would be approximately 10.4 gpm and the total estimated volume of water to be pumped/treated over the 9-year duration of the excavation (i.e., infiltration plus precipitation) was approximately 41.2 million gallons. Calculations supporting these results are presented in Appendix C.

The excavated soil would be stockpiled in onsite staging areas to facilitate handling, stabilization (via gravity dewatering or mixing with dryer soils or stabilizing agents), consolidation, and characterization for offsite treatment/disposal purposes. Disposal of MGP-impacted materials would be conducted in accordance with NYSDEC MGP disposal regulations presented in TAGM 4061. For costing purposes, it was assumed that excavated soils that are deemed hazardous in accordance with USEPA or NYSDEC regulations and/or guidance will be transported to a permitted hazardous waste management facility for treatment (LTTD) in compliance with LDRs. Excavated materials that are determined to be non-hazardous will be consolidated and transported for offsite treatment/disposal at an approved facility (i.e., a solid waste landfill). Additional treatment/disposal alternatives would be reviewed as part of the RD.

It was also assumed that water generated during excavation and soil dewatering activities would be treated onsite using a temporary water treatment system that would likely consist of oil-water separation, filtration, air stripping, and vapor-phase carbon adsorption prior to being discharged to onsite sanitary sewers for subsequent treatment at the local POTW. Details related to water treatment, handling, and discharge would need to be addressed as part of the RD phase.

The need for a long-term O&M program would not be required following completion of this alternative because the large majority of impacted soils and groundwater would be permanently removed and treated/disposed.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. Surface and subsurface soil at the site containing COCs at concentrations greater than individual TAGM 4046 guidance values would be removed under this remedial alternative.

  Chemical-specific SCGs that may apply to site groundwater include the NYS Groundwater Quality Standards (6 NYCRR Parts 700-705), which identify acceptable chemical constituent concentrations in groundwater. Because this alternative includes the removal of NAPL-impacts soils and removal and treatment of groundwater that collects within the excavation area (i.e., likely the most impacted groundwater at the site), future impacts to groundwater by site soils should be significantly reduced, and this alternative would likely achieve this SCG.

  Another chemical-specific SCG that may apply for this alternative is associated with discharging treated groundwater generated by excavation/soil dewatering activities to a POTW. A discharge permit would need to be obtained from the local POTW and the treated water would need to meet influent requirements.

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are associated with the excavation and disposal of the impacted soils, removal and treatment of groundwater, monitoring requirements, and OSHA health and safety requirements. Workers and worker activities that occur during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Measures would be taken (as appropriate) to control levels of airborne particulate mater during soil excavation activities, in accordance with 40 CFR 50 National Ambient Air Quality Standards.

  Additional SCGs applicable to this alternative are associated with the transportation and disposal of the excavated materials. Transportation of the excavated materials would be completed in accordance with procedures identified in 6 NYCRR 364 and 372, 49 CFR 107, and 40 CFR 262, 263, 171, and 172. Disposal activities would be completed in accordance with 6 NYCRR 372 and 373 and 40 CFR 262, 263, 170-179, and 270.

  The implementation of this option would result in the generation of air emissions from the operation of a temporary groundwater treatment system. The SCGs applicable to air emissions include the PSD air emission provisions contained in 40 CFR 51 and all relevant requirements under the Clean Air Act contained in 40 CFR 1-99. In addition, New York State regulations regarding air emissions would apply. To comply with these SCGs, a temporary groundwater treatment system would be designed and operated such that PSD limits would not be exceeded and the system would comply with all state and federal air emission requirements.

Process residuals generated during the implementation of this remedial alternative and not reused (e.g., activated carbon used in the temporary groundwater treatment system) would be characterized to determine the appropriate offsite disposal requirements. If any of the materials are characterized as a hazardous waste, then the RCRA, UTS/LDR, and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable to this unit. Compliance with these requirements would be achieved by utilizing a licensed waste transporter and properly permitted disposal facilities.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. There are several location-specific SCGs that may pertain to this option, most of which apply to the improvements associated with the Schermerhorn Creek. In general, these location-specific SCGs are associated with reducing the floodplain for the Schermerhorn Creek.

Long-Term Effectiveness and Permanence

The implementation of this alternative would permanently remove soil containing individual BTEX and PAH concentrations greater than NYSDEC TAGM 4046 guidance values. Soil removal under this option would minimize the potential for future offsite migration of NAPL and migration of NAPL to Schermerhorn Creek since NAPL-impacted soil would be permanently removed and disposed offsite.

This remedial alternative would attain the RAO of mitigating future impacts to groundwater and reducing concentrations of COCs in groundwater since NAPL-impacted soils would be removed and impacted groundwater would be pumped and treated during excavation dewatering activities.

No long-term monitoring or maintenance would be directly related to the soil excavation remedial alternative since the soil would be permanently removed as part of this remedy.

Reduction of Toxicity, Mobility, and Volume

Implementation of this alternative would reduce the toxicity, mobility, and volume of impacted soil and groundwater as well as LNAPL and DNAPL beneath the property. This remedial alternative is an irreversible process as the impacted soil and NAPL would be excavated and transported for offsite treatment/disposal. In addition, impacted groundwater would be removed from the excavation area to facilitate soil removal and groundwater would be treated and disposed offsite.

Short-Term Effectiveness

During the implementation of this alternative, onsite remedial workers may be exposed to chemical constituents in soil, groundwater, and NAPL by ingestion, dermal contact, and/or inhalation. Potential exposure of onsite workers to chemical constituents would be minimized by the use of PPE, as specified in a site-specific HASP. Air monitoring would be performed during implementation of this alternative to determine the need for additional engineering controls (e.g., use of water sprays/foam suppressants to suppress dust/vapors/odors during soil excavation, performing excavation work within temporary enclosures, modifying the rate of construction activities, etc.) and to confirm that dust or volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community would not have access to the site during the implementation of the remedial activities as the site is currently and would continue to be fenced. Risks to the community also would be minimized by providing security at the site and implementing a CAMP to minimize the potential migration of volatile organic vapors or impacted dust from the site. Under this alternative, traffic resulting from the transportation of approximately 360,000 CY of impacted soil for offsite treatment/disposal (approximately 50,000 one-way truckloads for soil removal and importing clean fill materials) would pose a potential nuisance to the community and increase the risk for accidents and spills. Based on the extent of remedial activities described herein, this remedial alternative may require approximately 8 to 10 years to complete.

Overall Protection of Human Health and the Environment

The excavation and offsite treatment/disposal of soil containing individual BTEX and PAH concentrations greater than NYSDEC TAGM 4046 guidance values, followed by placement of clean backfill material would meet the soil RAOs of minimizing potential risk to current and future onsite workers and minimizing potential future offsite migration of NAPL. Potential human and environmental exposure to the impacted soil would be minimized following remedial activities because the impacted soils would be physically removed from the site and treated/disposed of at permitted facilities.

Implementability

Impacted soil removal and treatment is technically feasible. Remedial contractors for the removal of the impacted soil are readily available.

As indicated above, based on the extent of the soil removal anticipated under this alternative, the Service Center personnel, equipment, and materials would likely have to be relocated and the existing Service Center would be decommissioned. Difficulties with implementation of this remedial alternative would consist of the following:

- Excavating in the close proximity of the railroads located north and west of the property;
- Managing the anticipated volume of soil (estimated as 360,000 CY);
- Obtaining and transporting approximately of 360,000 CY of clean fill materials;
- Managing and disposing the anticipated volume of groundwater and precipitation that would accumulate in the excavation area and through dewatering (anticipated to be greater than 41.2 million gallons over the period of the excavation activities);
- Relocating the existing onsite natural gas distribution system; and
- Coordinating the removal and disposal efforts due to limited space to stage disposal trucks; difficult access to the site due to the presence of Schermerhorn Creek; and limited space to stage excavated materials.

The current bridge crossing onsite would not likely support the size or volume of truck traffic necessary to support this alternative. The bridge crossing(s) would likely need to be upgraded/replaced, unless the Schermerhorn Creek is culverted in the area of the remedy.

Uncertainties related to the soil removal and construction activities are associated with soil handling and treatment and interference with above/below ground infrastructure. In addition, the need to lower the water table to facilitate the excavation activities may limit the rate of soil removal. The installation of shoring or sheeting would require a test boring program prior to installation to confirm that excavation reinforcements (e.g., sheetpiling) can be driven into the subgrade at the required depths. The likelihood exists that technical problems will lead to schedule delays (i.e., equipment failure, treatment difficulties, traffic issues, etc.) but can be minimized with proper advance planning and coordination of the remedial activities.

Based on the nature of the materials to be excavated (i.e., MGP-impacted soils), pre-mixing with less impacted soils may be necessary to meet the treatment requirements for thermal treatment (as necessary). Based on the large volume of soil, adequate treatment/disposal facility capacity may be difficult to obtain, coordination to balance the removal and treatment disposal activities would be required due to limited space at the site and due to the capacity of the thermal treatment facilities. The necessary equipment and personnel capable of implementing the soil removal alternatives are available. The anticipated time necessary to complete the activities associated with this alternative is approximately 8 to 10 years not including the pre-design soil boring program or time to obtain necessary permits to conduct these activities.

Cost

The capital costs associated with this alternative include site preparation, groundwater dewatering well construction, temporary groundwater treatment system construction and operation costs through excavation activities, soil excavation, soil stabilization, transportation, and treatment/disposal. No direct operation or maintenance costs have been identified for this alternative. The estimated present worth cost of this alternative is $155.7 M. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-7.

5.5 Detailed Evaluation of Groundwater Remedial Alternatives

This section presents the detailed analysis of each of the following groundwater remedial alternatives (previously identified in Section 4.6):

- Groundwater Alternative 1 – No Action;
- Groundwater Alternative 2 – Administrative Controls with Continued Groundwater Monitoring;
- Groundwater Alternative 3 – Passive NAPL Recovery;
- Groundwater Alternative 4 – In-Situ Chemical Oxidation; and
- Groundwater Alternative 5 – Groundwater Extraction and Treatment.

Each alternative is evaluated against the seven NCP (as discussed prior, public acceptance will be addressed following completion of the FS) criteria described in Section 5.2. The "No Action" alternative (Groundwater Alternative 1) was previously discussed in Section 5.3.

5.5.1 Groundwater Alternative 2 – Administrative Controls with Continued Groundwater Monitoring

Technical Description

The administrative controls with continued groundwater monitoring would use environmental easements to prevent (to the extent possible) future use of onsite groundwater as well as maintain existing asphalt pavement to minimize potential exposure to surface soils and infiltration through impacted soils. Groundwater is currently not used for potable purposes at or downgradient of the site. Environmental easements may also be required at the adjacent CSX and D&H properties, because groundwater data at some locations on and downgradient from the railroad property indicated the presence of COCs exceeding applicable SCGs. As a result, National Grid would have to enter into an agreement with CSX and D&H to provide environmental easements on these properties to restrict potential future use of groundwater on these properties.

A natural attenuation evaluation was conducted as part of the remedial investigation activities completed at the site. The natural attenuation evaluation consisted of an analysis of the nature and extent of dissolved-phase COCs at the site; the advective and diffusive transport of the COCs; and the intrinsic biodegradation of the COCs in groundwater. Based on the results of the evaluation, the geochemical characteristics of the groundwater at the site are favorable to anaerobic biodegradation of COCs. In addition, there is a relatively healthy and diverse anaerobic community structure currently in place at the site that is capable of inducing enzymes that degrade the BTEX and PAHs to less toxic byproducts (i.e., carbon dioxide and water). The subsurface conditions at the site appear to be favorable for natural microbial degradation of BTEX and PAHs at the site. A Natural Attenuation Evaluation Report is presented as Appendix A. This alternative would be more effective if NAPL-impacted soils were removed, isolated/contained, or immobilized such that they no longer contribute to the dissolved-phase impacts associated with site groundwater.

As part of the proposed remedy for the GE property (as outlined in the previously mentioned PRAP [NYSDEC, 2004]), administrative controls downgradient are to be implemented to prevent the use of groundwater as a source of potable or process water without necessary water quality treatment as determined by the SCDOH. The administrative controls for the GE property, as presented in the PRAP (NYSDEC, 2004), include access controls and restrictions on the future use of the site property. Future property owners would be required complete and submit annual certification to the NYSDEC that administrative and engineering controls, put in place as part of the site remedy, are still place, have not been altered, and are still effective.

The City of Schenectady City Clerk's Office and the SCDOH were contacted during July 2005 to determine if codes or regulations existed preventing the construction of private wells for potable use within the City of Schenectady. As indicated in conversations with the Schenectady Code Enforcement Office and the SCDOH, no laws or regulations are in place to prevent private residents from constructing and utilizing groundwater extraction wells for potable water; however, according the SCDOH private water supplies may not be tied into, and must be isolated from, public water supplies.

Under this alternative, groundwater monitoring activities would be conducted quarterly for a period of 1 year and semi-annually thereafter to document groundwater quality beneath and near the site. Monitoring activities would consist of the collection of groundwater field data (i.e., pH, turbidity, temperature, etc.); collecting groundwater samples for laboratory analysis from select monitoring wells within the network currently in place as well as additional monitoring wells to be installed to facilitate monitoring (as appropriate); and bailing and monitoring of NAPL (if present) in the monitoring wells.

The results of the groundwater monitoring would be summarized and presented to the NYSDEC in annual reports. Based on the analytical results of the monitoring and trends in groundwater COC concentrations, National Grid may request from the NYSDEC permission to modify the monitoring program and/or to monitor groundwater less frequently or cease monitoring altogether at the site.

Compliance with SCGs

- *Chemical-Specific SCGs*: The chemical-specific SCGs identified for this alternative are presented in Table 2-1. Chemical-specific SCGs that may apply to site groundwater are the NYS Groundwater Quality Standards (6 NYCRR Parts 700-705)), which identify acceptable concentrations of chemical constituents in groundwater. Depending on the reduction of COC concentrations in groundwater as a result of natural processes, this alternative potentially could meet this SCG over time (likely hundreds of years if this was the only remedy for addressing groundwater).

- The action-specific SCGs identified for this alternative are presented in Table 22. Action-specific SCGs that may apply to this alternative include the OSHA 29 CFR 1910 and 1926 regulations.

- *Location-Specific SCGs*: This alternative does not involve the implementation of any remedial activities; therefore, the location-specific SCGs are not applicable.

Long-Term Effectiveness and Permanence

Under this alternative, the COCs present in the groundwater would not be addressed through treatment. However, if COC concentrations are reduced via natural processes, the process is permanent and the RAO of reducing COC concentrations in groundwater to the extent practicable could be met over an extended period of time. Used in combination with a remedial alternative that would remove or treat NAPL-impacted soils, this alternative could be effective at assessing the potential attenuation of the dissolved-phase COCs. Long-term monitoring hydraulically downgradient of the site would be required to evaluate any potential offsite migration of COCs in groundwater.

As presented in the technical description for this alternative, subsurface conditions at the site appear to be favorable for natural attenuation of COCs at the site.

Reduction of Toxicity, Mobility, and Volume

Under this alternative, the COCs associated with impacted groundwater would not be directly treated, recycled, or destroyed. However, monitoring may indicate that concentrations of COCs (and therefore toxicity and volume) are being reduced via natural processes (which would be monitored directly by this alternative).

Short-Term Effectiveness

Implementation of this alternative may result in the exposure of onsite workers to impacted groundwater during groundwater monitoring activities via ingestion or dermal contact with the impacted groundwater; NAPL (if present); and inhalation of volatile organic vapors. Potential exposure of onsite workers to COCs would be minimized by the use of PPE, as specified in a site-specific HASP that would be developed during the RD. Air monitoring would be performed during implementation of this alternative to confirm that volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

Under this alternative, there would be no contact with impacted groundwater with the exception of the groundwater sampling activities associated with periodic monitoring. Soils would not be disturbed during the groundwater monitoring; therefore, there would be no short-term environmental impacts or risks posed to the community. The site is currently fenced, restricting access to onsite monitoring wells. Offsite monitoring wells are equipped with locks to restrict access to the wells.

This alternative could be implemented immediately. However, if the alternative is implemented as a stand-alone remedy, monitoring could be required for more than 100 years before SCGs are met.

Overall Protection of Human Health and the Environment

This alternative does not actively address impacted site media. However, the groundwater monitoring activities associated with this alternative could document the reduction of COC concentrations in groundwater via natural processes (e.g., biodegradation; dispersion; dilution; sorption; volatilization; chemical or biological stabilization; transformation; and destruction of COCs). The administrative controls with annual monitoring alternative addresses the impacted groundwater beneath the site through the use of environmental easements that would deter potential human exposure to groundwater. Potential offsite migration of impacted groundwater would be monitored via annual sampling to protect potential offsite groundwater users. This alternative does not address the groundwater RAO of mitigating future impacts to groundwater and reducing concentrations of COCs in groundwater to the extent possible. This alternative does not address the RAOs for onsite surface and subsurface soils and onsite Schermerhorn Creek sediments.

Soil RAOs of minimizing potential risks to current and future onsite workers and minimizing potential future offsite migration of NAPL would not be addressed by this alternative. However, as indicated above, the potential for dissolved-phase COCs in groundwater to naturally attenuate to a level that would achieve applicable SCGs would be improved by the removal, containment/isolation, and/or immobilization of potential NAPL-impacted soils.

Implementability

The administrative controls with continued groundwater monitoring alternative does not require the implementation of any remedial activities. Equipment and personnel qualified to conduct groundwater monitoring activities are readily available as are analytical laboratories to perform the analyses for the groundwater samples.

Cost

The capital costs associated with this alternative include: attaining environmental easement to prohibit use of onsite groundwater; installing up to three (3) new monitoring well clusters (up to nine wells total); conducting periodic groundwater monitoring; and conducting laboratory analysis of the groundwater samples. The present worth cost has been calculated assuming that annual groundwater monitoring activities are continued for a period of 30 years. The estimated present worth cost of this alternative is approximately $1.0 M. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-8.

5.5.2 Groundwater Alternative 3 – Passive NAPL Recovery

Technical Description

Passive DNAPL recovery efforts would be implemented to remove DNAPL that accumulates within collection wells. Collection wells would be constructed to target areas where measurable thicknesses of DNAPL have been previously encountered. DNAPL recovery would be performed periodically using manual recovery methods (i.e., dedicated bailers) as DNAPL accumulates within the wells. Periodic monitoring of the collection wells would be conducted to evaluate the presence/absence of DNAPL and to recover accumulated DNAPL, to the extent practical. Recovered DNAPL would be placed into appropriate containers for offsite treatment/disposal.

LNAPL recovery efforts would be conducted to recover LNAPL using recovery wells. LNAPL recovery would be performed manually. Existing monitoring wells would be utilized to monitor for the presence of and recovery of accumulated NAPL, where present. Recovered LNAPL would be placed into appropriate containers for offsite treatment/disposal.

It is expected that some groundwater will be removed during DNAPL and LNAPL recovery; however, large volumes of groundwater are not expected to be removed during these activities. Groundwater that is recovered would be characterized prior to offsite transportation for treatment/disposal.

NAPL recovery would be conducted in conformance with a site-specific OM&M Plan (to be prepared) at regular intervals until NAPL is no longer recoverable.

Compliance with SCGs

- *Chemical-Specific SCGs*: The chemical-specific SCGs identified for this alternative are presented in Table 2-1. Chemical-specific SCGs that may apply to site groundwater the NYS Groundwater Quality Standards (6 NYCRR Parts 700-705), which identify acceptable chemical constituent concentrations in groundwater. Although this alternative involves removing NAPL, this SCG would not likely be met without removal, treatment, isolation/containment, or immobilization of NAPL-impacted soils.

- *Action-Specific SCGs*: Action-specific SCGs that apply to this alternative are associated with installation of NAPL collection trenches and wells; disposal of recovered NAPL; monitoring requirements; and OSHA health and safety requirements. Workers and worker activities that occur during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following an NYSDEC-approved RD/RA Work Plan and site-specific HASP.

  Process residuals generated during the implementation of the alternative (e.g., drilling waste from well installation) would be characterized to determine appropriate offsite disposal requirements. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs/LDRs and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to the improvements associated with the Schermerhorn Creek and potential construction in the Schermerhorn Creek floodplain.

Long-Term Effectiveness and Permanence

As indicated above, this alternative is not anticipated to remove a substantial percentage of the NAPL present at the site. However, NAPL most likely to have the potential to migrate would have the greatest potential to be collected and therefore, this alternative may be effective at meeting the soil RAO of preventing the future offsite migration of NAPL and migration of NAPL to Schermerhorn Creek. Under this alternative, the COCs present in the groundwater would not be addressed through direct treatment of the groundwater. Impacted soil is not addressed under this alternative and therefore would continue to serve as a source of dissolved-phase impacts to groundwater. NAPL recovery activities would reduce the volume of NAPL present in the subsurface, potentially reducing the mass flux of dissolution of COCs from impacted soil and NAPL to groundwater. Used in conjunction with a soil remedial alternative, discussed in the prior section, passive NAPL recovery could reduce the future impacts to groundwater in addition to removing NAPL mass. Groundwater and NAPL monitoring would be required to evaluate the effectiveness of the NAPL recovery activities.

Reduction of Toxicity, Mobility, and Volume

Passive NAPL recovery would reduce the potential for future downgradient migration of NAPL and the volume of NAPL present at the site would be reduced. In addition, the concentrations of COCs in the onsite groundwater would likely be reduced (by reducing the mass of NAPL and thereby the mass flux of dissolution of COCs from NAPL to the groundwater); however, this alternative does not address the impacted soils and is not anticipated to remove a large percentage of the NAPL present at the site, which would continue to serve as a source of dissolved-phase impacts to groundwater. Mobility of the NAPL would be reduced as the NAPL that is most likely to be to migrate would be recovered by passive recovery methods.

Short-Term Effectiveness

During the implementation of this alternative, onsite workers may be exposed to chemical constituents in soil, groundwater, and NAPL by ingestion, dermal contact, and/or inhalation. Potential exposure of onsite workers to chemical constituents would be minimized by the use of PPE, as specified in a site-specific HASP that would be developed during the RD phase. Air monitoring would be performed during implementation of this alternative to confirm volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community would not have access to the site during the implementation of the remedial activities as the site is currently and would continue to be fenced. Risks to the community would also be minimized by providing security at the site and implementing a CAMP to minimize the potential migration of volatile organic vapors or impacted dust from the site. This remedial alternative may require approximately 2 months to construct. Ongoing NAPL recovery may be conducted for years based on the success of the NAPL recovery efforts.

Overall Protection of Human Health and the Environment

The groundwater remedial alternative of passive NAPL recovery would generally address the RAO of mitigating future impacts to groundwater by removing NAPL from the subsurface. However, these activities would not likely remove the bulk of the NAPL from the site. Based on the site-specific nature of NAPL (i.e., very viscous, semi-solid tar like material), passive recovery has a limit to the potential volume of NAPL able to be physically recovered. Therefore, ongoing dissolution of COCs from NAPL would continue following implementation of this alternative. The soil RAOs of minimizing potential risks to current and future onsite workers and minimizing potential offsite migration of NAPL would not be fully addressed by this alternative alone (i.e., offsite migration of NAPL may be somewhat minimized by these activities). Subsequently, the groundwater RAOs of mitigating future impacts to groundwater and reducing concentrations of COCs in the groundwater to the extent possible would not be achieved. This alternative does not address onsite impacted sediments associated with Schermerhorn Creek, and therefore does not achieve the onsite Schermerhorn Creek sediments RAO.

Implementability

This alternative is technically feasible and easily implemented. Recovery wells are proven remedial technologies that are commonly used for passive recovery of NAPL. Based on the findings of previous investigations/monitoring activities, highly viscous NAPL was encountered beneath the site, and NAPL recovery attempts to date have shown limited recovery rates. Special considerations specific to this site are the constraints involved in performing remedial activities within an active service center. Large diameter recovery wells with a larger slot-size well screen would be utilized to facilitate NAPL recovery. Equipment and remedial contractors capable of installing NAPL recovery wells are readily available. Construction of this alternative could be completed within a few months.

Cost

The capital costs associated with this alternative include construction of the NAPL recovery wells. O&M costs associated with this alternative include NAPL monitoring and recovery activities. The present worth cost has been calculated assuming that monitoring/maintenance activities are continued for a period of 30 years. The estimated present worth cost of this alternative is approximately $680,000. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-9.

5.5.3 Groundwater Alternative 4 – In-Situ Chemical Oxidation

Technical Description

This alternative would address impacted groundwater and NAPL at the site using in-situ chemical oxidation. In-situ chemical oxidation is an innovative technology with limited full-scale data available to confirm its effectiveness at addressing MGP-derived NAPL. Recent pilot studies conducted by National Grid have shown that in-situ chemical oxidation is only partially effective in the treatment of MGP-derived NAPL, in that the technology treats the dissolved-phase portion of the residual MGP-derived NAPL. The primary purpose of in-situ chemical oxidation would be to reduce the concentration of COCs in the groundwater and potentially reduce the mass flux of COCs from NAPL to the dissolved phase in groundwater. In the case of NAPL serving as an ongoing source of dissolved phase impacts to groundwater, mass flux would be defined as the rate at which the COCs would dissolute from the NAPL to the dissolved phase. Insitu chemical oxidation would be effective at reducing this rate of transfer or mass flux as the COCs, when they enter the dissolved phase, would readily be oxidized. However, chemical oxidation has limited effectiveness on treating NAPL directly.

In-situ chemical oxidation involves the introduction of oxidizing agents into the subsurface to degrade BTEX and PAHs to less-toxic byproducts. For the purposes of this alternative, it has been assumed that ozone, persulfate, peroxide, or a combination of these would be used as the oxidizing agent(s) to address subsurface impacts.

Prior to full-scale implementation of in-situ chemical oxidation, a pilot-scale study would be conducted to evaluate the feasibility, effectiveness, and appropriate design parameters for full-scale implementation. The pilot-scale testing would likely include pre-injection baseline monitoring, installing a series of oxidant injection wells, injecting oxidizing agents (i.e., ozone) into the subsurface, and performing post-injection monitoring to evaluate the effectiveness of the remedial technology. Multiple oxidant injections may be performed as part of the pilot-scale study to monitor the effectiveness and determine appropriate operating conditions. If the findings of the pilot-scale testing indicate that in-situ oxidation may be effective, the RD for the full-scale system would be prepared and/or modified (if necessary) and implementation of in-situ chemical oxidation would proceed on a full-scale application.

During full-scale implementation, a network of injection and/or sparging wells (for soil vapor extraction) would be installed in select areas of the site. In order for in-situ oxidation to be effective, it is necessary to deliver the oxidizing agents in a manner that promotes contact with the chemical constituents. The radius of influence surrounding an individual injection location is uncertain and may be dependant upon site-specific conditions, including subsurface stratigraphy, oxidant concentration, injection pressure, etc. Information collected during implementation of the pilot-scale study would be evaluated to properly design the oxidant delivery parameters (e.g., oxidant concentration, injection pressure, etc.) and the spacing of oxidant injection locations.

In conjunction with oxidant injection, an SVE system may be required to recover off-gas generated during treatment and excess ozone that does not degrade/react. The SVE system also may be utilized to promote flow and increase oxidant delivery through vadose zone soils. If necessary, the SVE system would include an off-gas vapor treatment system to remove chemical constituents and residual ozone in the extracted vapor stream. The need for an SVE system as part of full-scale implementation would be determined as part of the RD following completion of a pilot-scale study.

A monitoring program would be conducted to evaluate treatment effectiveness as part of both the pilot-scale and full-scale implementation. Pre-injection monitoring would be conducted prior to full-scale implementation to determine baseline concentrations of chemical constituents in subsurface soil and groundwater within the treatment areas. During full-scale implementation, the monitoring program would consist of collecting periodic subsurface soil and groundwater samples on a monthly basis for laboratory analysis to determine if the treatment efforts are reducing concentrations of COCs in subsurface media. Long-term groundwater monitoring activities would be continued following completion of the in-situ oxidation treatment activities. Field parameters also would be monitored to determine the effectiveness of treatment, protect the health and safety of onsite workers and the community, and evaluate system operations by monitoring for indicator parameters (including temperature, pH, dissolved ozone, dissolved oxygen, and oxidation-reduction potential [ORP] at groundwater monitoring locations, and carbon dioxide, oxygen, ozone, VOCs, and induced pressures at soil-vapor monitoring points). In addition, monitoring of the influent and effluent to the SVE off-gas treatment system (if required) would be conducted to determine the effectiveness of vapor treatment.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. Chemical-specific SCGs that may apply to site groundwater include the NYS Groundwater Quality Standards (6 NYCRR Parts 700-705), which identify acceptable concentrations of chemical constituents in groundwater. Onsite groundwater quality would be addressed via in-situ chemical oxidation. Future impacts to offsite groundwater quality downgradient of the site may be reduced as the mass flux (i.e., transfer of COCs) from NAPL-impacted soils would be reduced by the chemical oxidation. However because the chemical oxidation process will have limited effectiveness in treating NAPL, onsite NAPL may continue to provide a source of offsite dissolved-phase groundwater contamination.

  Subsurface soil at the site contains chemical constituents at concentrations greater than the recommended soil cleanup objectives presented in NYSDEC TAGM 4046. In-situ treatment may not achieve the chemical-specific SCGs presented in NYSDEC TAGM 4046.

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are associated with installation and operation of the oxidant injection system, monitoring requirements, and OSHA health and safety requirements. Workers and worker activities that occur during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following an NYSDEC-approved RD/RA Work Plan and site-specific HASP.

The implementation of this alternative would result in the generation of air emissions. The SCGs applicable to air emissions include the PSD air emission provisions contained in 40 CFR 51 and all relevant requirements under the Clean Air Act contained in 40 CFR 1-99. In addition, New York State regulations regarding air emissions would apply. To comply with these SCGs, the treatment system would need to be designed and operated such that PSD limits would not be exceeded and the system would comply with all state and federal air emission requirements.

Process residuals generated during the implementation of the alternative (e.g., drilling waste from well installation) would be characterized to determine appropriate offsite disposal requirements. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs/LDRs and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to the improvements associated with the Schermerhorn Creek. In general, these location-specific SCGs are associated with the removal of sediments and construction of the remedy within the potential floodplain of the Schermerhorn Creek.

Long-Term Effectiveness and Permanence

Implementation of this alternative would be expected to treat (via chemical oxidation) BTEX- and PAH-impacted groundwater in the vicinity of the treatment areas. In-situ chemical oxidation would primarily address dissolved-phase impacts and is not demonstrated to be very effective or efficient at directly treating/oxidizing NAPL. During treatment, this remedial alternative would be effective at addressing the RAO of mitigating impacts to groundwater by reducing the mass flux of COCs from the NAPL to the dissolved phase and by oxidizing dissolved-phase COCs in groundwater.

A long-term O&M plan would be developed that would include monitoring the in-situ chemical oxidation system performance, adjusting system operations for optimal performance, and performing routine maintenance. Long-term groundwater monitoring would also be conducted using existing monitoring wells to monitor the concentrations of COCs in groundwater and assess the effectiveness of the in-situ chemical oxidation. If NAPL and NAPL-impacted soils remain following completion of the in-situ chemical oxidation treatment, COCs will continue to dissolute and enter the groundwater in the dissolved phase.

Reduction of Toxicity, Mobility, and Volume

Implementation of this alternative would reduce the toxicity, mobility, and volume of the chemical constituents in the groundwater. In-situ chemical oxidation can also decrease the rate of mass transfer (i.e., mass flux) of COCs from NAPL and impacted soil to the dissolved phase.

Oxidation is a permanent process; therefore, the COCs that are oxidized by this process would be permanently treated. However, if NAPL and/or impacted soils remain following treatment, groundwater can become re-impacted as COCs dissolute from NAPL and/or impacted soil into groundwater.

Short-Term Effectiveness

Implementation of this alternative may result in the exposure of onsite workers to chemical constituents in soil, groundwater, and NAPL by ingestion, dermal contact, and/or inhalation. Implementation of this alternative may also result in the potential exposure of onsite workers to highly reactive oxidizing agents injected under pressure.

Potential exposure of onsite workers to chemical constituents and operational hazards would be minimized by the use of PPE and through equipment and material handling procedures, as specified in a site-specific HASP that would be developed during the RD phase. Air monitoring would be performed during implementation of this alternative to determine the need for additional engineering controls (e.g., use of water sprays to suppress dust/vapors/odors, modifying the rate of construction activities, etc.) and to confirm that dust or volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP. In addition, in-situ monitoring would be conducted under this alternative during application of oxidizing agents to confirm that subsurface conditions do not become reactive or potentially explosive.

The community would not have access to the site during the remedial activities because the site is currently and would continue to be fenced. Risks to the community would also be minimized by providing security at the site and implementing a CAMP to minimize potential migration of volatile organic vapors or fugitive dust from the site.

Overall Protection of Human Health and the Environment

In-situ chemical oxidation would not meet the RAO of mitigating future impacts to groundwater; however, in the short term, it could reduce concentrations of COCs in groundwater. As indicated above, in-situ chemical oxidation would not be effective at treating or removing NAPL and COCs associated with the NAPL-impacted soil that would continue to serve as a source of dissolved-phase impacts to groundwater after oxidant injection is stopped. Soil RAOs including: minimizing potential risks to current and future onsite workers; minimizing potential future offsite migration of NAPL to the extent possible; and mitigating impacts from COCs in the onsite Schermerhorn Creek sediment would not be achieved through the implementation of in-situ chemical oxidation. In-situ chemical oxidation would also not be effective at addressing onsite impacted sediments.

Implementability

In-situ chemical oxidation is an innovative technology. Information obtained from pilot tests that would be conducted at the site as well as information from chemical oxidation pilot tests and full-scale implementation conducted at other MGP sites would provide valuable information regarding the implementability and effectiveness of this technology process.

Delivery of the oxidizing agents to the impacted areas is critical to effectively and efficiently implement in-situ oxidation technologies. Ozone could be generated onsite using commercially available mobile ozone-generating units and delivered to the subsurface via typical injection wells and/or air sparging wells. Equipment and materials associated with the implementation of in-situ oxidation are available. Installation of ozone injection points, vapor extraction wells, and a vapor treatment system are technically feasible. However, relatively few remedial vendors have experience implementing full-scale in-situ chemical oxidation using ozone. An SVE system may also be required in conjunction with in-situ chemical oxidation to recover and treat off-gas and residual ozone. SVE is technically feasible and implementable. Equipment and materials for an SVE system are readily available.

Several uncertainties exist for full-scale implementation of in-situ oxidation. The radius of influence surrounding individual injection locations is uncertain and may be dependant upon site-specific conditions, including subsurface stratigraphy, ozone concentration, injection pressure, etc. There is also the uncertainty of short circuiting where a leaky seal at an injection point may allow oxidant to move directly up the well annulus to the unsaturated zone instead of being forced into the impacted groundwater zone. In addition, soil oxygen demand could result in a low estimation of the amount of oxidant required to address the impacted media due to the oxygen demand of natural organic material in site soils. Uncertainties also exist for other system design parameters (e.g., ozone concentrations, injection rates, injection pressures, etc.). As indicated above, a pilot-scale study would be necessary to evaluate the feasibility, effectiveness, and appropriate design parameters for full-scale implementation.

Difficulties associated with implementation of this alternative consist of performing remedial activities within an active service center. Uncertainties related to the remedial activities include implementing in-situ oxidation activities within high-traffic areas and areas containing underground utilities and above-grade structures. The likelihood exists that technical problems will lead to schedule delays (due to equipment failure, treatment difficulties, traffic issues, coordination issues, etc.), but may be minimized with proper advance planning and coordination.

The time associated with successful implementation of this remedial alternative would be approximately 3 to 5 years (excluding pilot and treatability studies), and the long-term monitoring of groundwater at and in the vicinity of the site could last 30 years or more.

Cost

The capital costs associated with this alternative include in-situ chemical oxidation pilot study and the construction of the full-scale in-situ chemical oxidation remedial system. Future site monitoring/maintenance activities would consist of periodic groundwater monitoring. The present worth cost has been calculated assuming that monitoring/maintenance activities will be conducted for a period of 30 years. The estimated present worth cost of this alternative is approximately $5.7 M. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-10.

5.5.4 Groundwater Alternative 5 – Groundwater Extraction and Treatment

Technical Description

Under this alternative, groundwater would be extracted utilizing existing and/or newly installed wells and treated aboveground in an onsite treatment facility. The objective of this alternative is to capture, remove, and treat impacted groundwater before it migrates offsite. The treatment facility would consist of an oil/water separator, equalization tank, filtration, an air stripper (with off-gas treatment), and vapor-phase carbon adsorption. The treated groundwater would be discharged to the sanitary sewer system and conveyed to the Schenectady Water Pollution Control Plant for disposal.

The treatment process would be designed to meet the influent requirements of the Schenectady Water Pollution Control Plant. Sludge generated as a result of the groundwater treatment operations would need to be characterized and disposed of at a permitted facility.

Based on the results of previous investigation activities (as presented in the SRI report), a total of six groundwater extraction wells would be installed to capture and remove the impacted onsite groundwater plume (estimated to be approximately 800 feet wide at the downgradient end of the site, based on the results obtained from previous investigation activities). The groundwater extraction wells would intercept impacted groundwater (up to 40 feet below the groundwater table). Based on preliminary calculations, groundwater would be extracted at a rate of 7 gpm per well to recover groundwater to a depth of 40 feet below the groundwater table. However, as indicated in the SRI Report (BBL, 2005), additional data may be required to refine this estimate for the purposes of design. Costs have been included under this alternative for collecting additional data and completing a site groundwater flow model to support this alternative (as necessary).

The groundwater would continue to be removed and treated until the groundwater no longer contains site-related chemical constituents at concentrations greater than the TOGS 1.1.1 NYSDEC groundwater quality criteria and guidelines or no discernable change in the groundwater (as compared with upgradient groundwater) is noted during three consecutive sampling events (conducted once every 6 months).

A long-term O&M program would be established to monitor the effectiveness of migration control, the treatment as well as the groundwater quality within the limits of the impacted groundwater plume over time. O&M will consist of monitoring treatment system effluent as well as periodically monitoring groundwater quality to determine the effectiveness of the groundwater treatment. For the purposes of evaluating this alternative, long-term O&M for this system is anticipated to be conducted over a 30-year period.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. Chemical-specific SCGs that may apply to site groundwater include the NYS Groundwater Quality Standards (6 NYCRR Parts 700-705), which identify acceptable concentrations of chemical constituents in groundwater. Onsite groundwater quality would be addressed via groundwater extraction and onsite treatment. Future impacts to offsite groundwater quality downgradient of the site would be addressed by preventing offsite migration of impacted groundwater by pumping. Without removal or treatment of NAPL-impacted soil, this SCG would not likely be met in onsite groundwater due to the ongoing dissolution of COCs from the NAPL-impacted soil to groundwater.

  Subsurface soil at the site contains chemical constituents at concentrations greater than the recommended soil cleanup objectives presented in NYSDEC TAGM 4046. Groundwater extraction and onsite treatment would not achieve the chemical-specific SCGs for soil (i.e., NYSDEC recommended soil cleanup objectives) presented in NYSDEC TAGM 4046.

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are associated with installation and operation of the extraction wells and groundwater treatment system, monitoring requirements, and OSHA health and safety requirements. Workers and worker activities that occur during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following an NYSDEC-approved RD/RA Work Plan and site-specific HASP.

  The implementation of this alternative would result in the generation of air emissions based on the anticipated treatment train. However, these emissions would be treated to meet applicable SCGs. The SCGs applicable to air emissions include the PSD air emission provisions contained in 40 CFR 51 and all relevant requirements under the Clean Air Act contained in 40 CFR 1-99. In addition, New York State regulations regarding air emissions would apply. To comply with these SCGs, the treatment system would need to be designed and operated such that PSD limits would not be exceeded and the system would comply with all state and federal air emission requirements.

Process residuals generated during the implementation of the alternative (e.g., drilling waste from well installation and sludge generated from groundwater treatment) would be characterized to determine appropriate offsite disposal requirements. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs/LDRs and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to the improvements associated with the Schermerhorn Creek. In general, these location-specific SCGs are associated with construction of a treatment system building within the potential floodplain of Schermerhorn Creek.

Long-Term Effectiveness and Permanence

Groundwater extraction and treatment would result in the permanent removal of COCs from extracted groundwater. However, this alternative alone would not directly address NAPL and impacted soils. The remaining NAPL and impacted soils would continue to serve as a source of dissolved-phase impacts to groundwater and therefore would not meet the RAO of minimizing future impacts to groundwater. During operation of the extraction and treatment activities, this alternative should prevent migration of impacted groundwater to Schermerhorn Creek and prevent contact to site workers with the impacted groundwater. It is anticipated that without addressing the NAPL-impacted soils, extraction and treatment of groundwater would have to be conducted for an indeterminate amount of time in order to maintain the impacted groundwater plume.

This alternative alone does not meet the soil RAOs of minimizing potential risks to current and future onsite workers or minimizing offsite migration of NAPL or migration of NAPL to Schermerhorn Creek.

Reduction of Toxicity, Mobility, and Volume

Implementation of this alternative would reduce the toxicity, mobility, and volume of the COCs in the groundwater through treatment by physically removing and treating the groundwater, and discharging the treated groundwater to the sanitary sewer for further treatment at the Schenectady Water Pollution Control Plant. Removal of the impacted groundwater would also minimize the offsite migration (and thus the mobility) of impacted groundwater.

This alternative is an irreversible process as the PAHs and VOCs in extracted groundwater would be permanently removed. However, the NAPL present in the subsurface and NAPL-impacted soils would not be addressed by the remedial alternative and would be a continuing source of dissolved-phase COCs to the groundwater.

Short-Term Effectiveness

Implementation of this alternative may result in the exposure of onsite workers to chemical constituents in soil, groundwater, and NAPL by ingestion, dermal contact, and/or inhalation.

Potential exposure of onsite workers to chemical constituents and operational hazards would be minimized by the use of PPE and through equipment and material handling procedures, as specified in a site-specific HASP that would be developed during RD phase. Air monitoring would be performed during implementation of this alternative to confirm that volatilized organic vapors are within acceptable levels, as specified in the site-specific HASP.

The community would not have access to the site during the remedial activities because the site is currently and would continue to be fenced. Under this alternative, there would be limited generation of dust or volatile organic vapors (as the treatment system would be enclosed in a permanent structure); therefore there would be little or no short-term environmental impacts or risks posed to the community. If an apparent risk from vapor emissions was identified, a site-specific CAMP would be prepared and followed during implementation of this alternative. Construction of the groundwater extraction and treatment systems would take approximately 6 months to complete and extraction and treatment operations could last 30 years or more.

Overall Protection of Human Health and the Environment

The implementation of groundwater removal and treatment would meet the RAO of mitigating future impacts to groundwater by extracting and treating the impacted groundwater before it leaves the site. The concentrations of COCs in the groundwater would also be reduced. However, without removing or addressing NAPL-impacted soils, active extraction and treatment of groundwater may be required for an indeterminate amount of time (as a result of dissolution of COCs from NAPL-impacted soils to the groundwater).

This alternative would not address the NAPL-impacted soils present at the site and would not meet the RAO of minimizing potential risks to current and future onsite works by eliminating the potential for exposure to the soils. In addition, in the event that impacted groundwater is located at lateral locations or vertical depths greater than the capture zone, then this groundwater would not be treated. In addition, unless the Schermerhorn Creek is culverted, impacted groundwater and/or NAPL could discharge to the creek as a result of modified groundwater flow patterns (due to groundwater extraction).

Implementability

Groundwater extraction and treatment is technically feasible and readily implementable. Remedial contractors are available that are capable of installing extraction wells (or modifying existing wells) and constructing the treatment system. In addition, the equipment necessary for the groundwater treatment facility are readily available from vendors.

Long-term approval for discharge to the Schenectady Water Pollution Control Plant would need to be obtained to ensure the plant's ability to accept the discharge for several years. Pilot studies may be needed to confirm the treatment system can be designed to meet Schenectady Water Pollution Control Plant's influent requirements. Pump tests would be required to confirm the groundwater extraction rate necessary to obtain hydraulic containment of the impacted groundwater.

The time associated with construction of a groundwater extraction and treatment system would be approximately 6 months (excluding a potential pilot study) and the groundwater removal and treatment operations could last 30 years or more.

Cost

The capital costs associated with this alternative include the construction of the permanent groundwater extraction and onsite treatment systems. Future site monitoring/maintenance activities would include: periodic groundwater treatment and monitoring. The present worth cost has been calculated assuming that monitoring/maintenance activities are continued for a period of 30 years. The estimated present worth cost of this alternative is approximately $5.0 M. A detailed breakdown of the estimated costs associated with this alternative is presented in Table 5-11.

5.6 Detailed Evaluation of Sediment Remedial Alternatives

This section presents the detailed analysis of each of the following groundwater remedial alternatives (previously identified in Section 4.6):

- Sediment Alternative 1 – No Action;
- Sediment Alternative 2 – Impacted Sediment Removal; and
- Sediment Alternative 3 –Sediment Removal and Installation of Closed Culvert.

Each alternative is evaluated against the seven NCP (as discussed prior, public acceptance will be addressed following completion of the FS) criteria described in Section 5.2. The "No Action" alternative (Sediment Alternative 1) was previously discussed in Section 5.3.

5.6.1 Sediment Alternative 2 – Impacted Sediment Removal

Technical Description

Under this remedial alternative, impacted sediment within the onsite portion of Schermerhorn Creek would be excavated. As needed, sheetpiling would be used to stabilize the creek banks during excavation of the sediments. Excavation would be accomplished using standard excavation equipment (i.e., excavators) and during the excavation efforts, stream flow would be diverted around the portion of the creek undergoing excavation. It is likely that this diversion effort would occur through a combination of pumping and utilizing the stormwater flow control structure located approximately ¼ mile upstream from the site. Appropriate downstream erosion control measures, such as silt fencing/curtains would also be installed. Following excavation, the creek would be restored to existing grades. The anticipated extent of the sediment removal under this alternative is indicated on Figure 1-8 and summarized in the adjacent table.

Impacted Sediment Areas

Area	Depth (ft)	Volume (CY)
Area 1	5	250
Area 2	4	270
Area 3	2	70
Area 4	2	40
	Total Volume	**630**

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. Chemical-specific guidelines that are to be considered under this alternative are the sediment screening levels (NYSDEC, 1999). The document states that sediment with concentrations of COCs greater than listed criteria are to be considered impacted, but the listed criteria do not necessarily represent a final concentration that must be achieved through remediation (i.e., they are not cleanup criteria).

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are monitoring requirements and OSHA health and safety requirements. Workers and worker activities that occur during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following an NYSDEC-approved RD/RA Work Plan and site-specific HASP.

  Excavated sediment generated during implementation of the alternative would be characterized to determine appropriate offsite disposal requirements. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs/LDRs and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

  Permitting/approvals with the Army Corps of Engineers and the NYSDEC will be required for conducting construction activities within a waterway of the United States.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to the improvements associated with the Schermerhorn Creek. In general, these location-specific SCGs are associated with the removal of sediments and other modifications to the waterway.

<u>Long-Term Effectiveness and Permanence</u>

Under this alternative, impacted sediment would be removed from Schermerhorn Creek. Removal of the impacted sediment would minimize the impacts of COCs in creek sediments. This alternative is irreversible since the COCs associated with the existing sediment will be permanently removed and disposed offsite. Potential site-wide remedial activities to be implemented at the property (summarized in Section 6) could promote changes to the groundwater table elevation and groundwater flow direction. The effects of these changes are difficult to predict and could cause the creek to become a gaining stream, thus releasing impacted groundwater and/or NAPL to surface water in the creek.

<u>Reduction in Toxicity, Mobility, and Volume</u>

Implementation of this alternative would reduce the potential mobility and volume of impacted sediments and the associated COCs through their physical removal from the stream bed. Once removed, these sediments would be handled and disposed at a permitted facility.

<u>Short-Term Effectiveness</u>

Implementation of this alternative may result in exposure of onsite workers to the COCs present in the sediments and groundwater by inhalation, ingestion, or dermal contact of the impacted sediments. The potential exists for flooding during the rerouting of the stream and removal of impacted sediment. Potential flooding would be addressed with additional pumping and storage/disposal options to be further identified as part of the RD phase. Air monitoring would be performed in accordance with a site-specific CAMP during the implementation of this alternative to determine the need for additional engineering controls to confirm that volatilized organic vapors are within acceptable levels, as would be specified in a site-specific HASP. Under this alternative, there would be limited generation of dust or volatized organic vapor; therefore there would be little or no short-term environmental impacts or risk posed to the community. In addition, access to the site would be limited to site-related personnel as the site is currently and will continue to be fenced.

Overall Protection of Human Health and the Environment

This impacted sediment removal alternative would address the RAOs of minimizing risks to current and future onsite workers from direct contact with impacted sediments, preventing dissolution of COCs from sediment to groundwater, and preventing impacts to biota, to the extent possible. This alternative would not address the sediment RAO of eliminating exposure of downstream biota to site related contamination if potential changes in site hydraulics release impacted groundwater and/or NAPL to surface water in the creek. RAOs for onsite soils of minimizing potential risks to current and future onsite works and minimizing the potential for offsite migration and the RAO for groundwater of mitigating future impacts to groundwater and reducing the concentrations of COCs in the groundwater would not be addressed by this remedial alternative.

Implementability

The excavation of creek sediments is technically feasible and readily implementable. Contractors capable of performing the sediment excavation are readily available.

Difficulties in implementation would be associated with the remedial construction activities to be conducted within the active service center. Natural gas pipe lines are known to cross the creek in at least three locations, and are believed to be positioned within the sediment in the bottom of the creek. Uncertainties related to the sediment excavation activities are associated with above/below ground infrastructure. The installation of shoring or sheeting would require a test boring program prior to installation to confirm that excavation reinforcements (e.g., sheetpiling) can be driven into the subgrade at the required depths. The likelihood exists that technical problems will lead to schedule delays (i.e., equipment failure, treatment difficulties, traffic issues, weather/flooding, etc.) but can be minimized with proper advance planning and coordination of the remedial activities.

The time associated with the implementation of this alternative would be 3 to 6 months.

Cost

The capital costs associated with this alternative include sheetpiling, sediment excavation, and the handling and disposal of impacted sediments. The estimated present worth cost of this alternative is approximately $2.0 M. A detailed breakdown of the estimated cost associated with this alternative is presented in Table 5-12.

5.6.2 Sediment Alternative 3 –Sediment Removal and Installation of Closed Culvert

Technical Description

As described in Section 1.4.1, historic groundwater level information indicates that surface water within the onsite portion of Schermerhorn Creek is currently discharging to groundwater. This is a favorable condition, as potentially impacted groundwater in the vicinity of the creek is not currently discharging to surface water. Furthermore, over the course of the previous site investigation activities, visual observations of NAPLs and/or sheens have not been noted within Schermerhorn Creek. However, potential site-wide remedial activities to be implemented at the property (presented in Section 6) could promote changes to the groundwater table and groundwater flow direction. Due to the complex hydrostratigraphy beneath and surrounding the site (e.g., strong vertical gradients between hydrostratigraphic units, numerous regional hydraulic influences), fully understanding current groundwater flow conditions or predicting the effect of implementing the selected site-wide remedial alternative cannot be achieved with an acceptable degree of certainty. The effects of the selected site-wide remedial alternative could cause the creek to become a gaining stream, thus releasing impacted groundwater and/or NAPL to surface water in the creek. The potential for the creek to become a gaining stream must be addressed (in order to meet groundwater RAO #2) via installation of a water-tight barrier to prevent groundwater/surface water interaction.

The water-tight barrier proposed to limit the potential for groundwater intrusion into the Schermerhorn Creek is installation of a concrete culvert. Culverting the onsite portion of the creek is a practicable and feasible means to prevent groundwater and/or NAPL from discharging to the creek regardless of potential future changes in the water table elevation and/or groundwater flow patterns caused by site-wide remedial activities. The selection of a concrete culvert is based on an analysis of potential isolation options, which is presented in Appendix G.

Under this remedial alternative, sediment within the onsite portion of Schermerhorn Creek would be excavated to facilitate installation of a concrete box culvert that would be used to convey flow within the portion of Schermerhorn Creek located within National Grid's property. The box culvert would be designed to provide a flow capacity similar to the existing 90-inch diameter culvert that discharges creek flow to the open channel section of the creek that currently exists on site. Additionally, the culvert would be water-tight to eliminate groundwater (or NAPL) infiltration into the culvert. Sediment excavation would be accomplished using standard excavation equipment (e.g., excavators) and during the excavation efforts, stream flow would be diverted around the portion of the creek undergoing excavation. The stream diversion effort would occur through a combination of pumping and utilizing the stormwater flow control structure located approximately ¼ mile upstream from the site. As needed, sheetpiling would be used to stabilize the creek banks during excavation of the creek sediments.

Based on preliminary calculations, approximately 5,900 CY of sediment and soil would be removed to facilitate installation of the box culvert to a depth that would maintain an appropriate slope to facilitate drainage (anticipated to be approximately 12 feet bgs) and a minimum width of 12 feet for the entire length of the onsite portion of Schermerhorn Creek (approximately 1,100 feet). Appropriate downstream erosion control measures, such as silt fencing/curtains would be installed and maintained during the excavation and construction efforts.

The excavated material would be stored onsite for dewatering and waste characterization prior to offsite disposal at an appropriate facility. Following excavation and culvert placement, the area above the culvert would be backfilled and covered with asphalt pavement. As necessary, stormwater control structures (e.g., stormwater catch basin/grates) would be installed along the path of the culvert. The proposed approximate location of the box culvert is shown on Figure 4-8.

Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 2-1. Chemical-specific guidelines that are to be considered under this alternative are the sediment screening levels (NYSDEC, 1999). The document states that sediment with concentrations of COCs greater than listed criteria are to be considered impacted, but the listed criteria do not necessarily represent a final concentration that must be achieved through remediation (i.e., they are not cleanup criteria). Removal of the impacted sediment would meet this criteria.

- *Action-Specific SCGs*: Action-specific SCGs are presented in Table 2-2. Action-specific SCGs that apply to this alternative are monitoring requirements and OSHA health and safety requirements. Workers and worker activities that occur during implementation of this alternative must comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904. Compliance with action-specific SCGs would be accomplished by following an NYSDEC-approved RD/RA Work Plan and site-specific HASP.

  Excavated soil/sediment generated during implementation of the alternative would be characterized to determine appropriate offsite disposal requirements. If any of the materials are characterized as a hazardous waste, then the RCRA UTSs/LDRs and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials may be applicable. Compliance with these requirements would be achieved by utilizing licensed waste transporters and properly permitted disposal facilities.

  Permitting/approvals with the Army Corps of Engineers will be required for conducting construction activities within a waterway of the United States.

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 2-3. Remedial activities at the site would be conducted in accordance with local building/construction codes and ordinances. There are several location-specific SCGs that may pertain to this option, most of which apply to the improvements associated with the Schermerhorn Creek. In general, these location-specific SCGs are associated with the removal of sediments and other modifications to the waterway.

Long-Term Effectiveness and Permanence

The accumulation of sediment in the onsite portion of Schermerhorn Creek has caused the creek to overflow its banks during heavy rainfall/snow melt events leading to flooding in the eastern-third of the National Grid property as well as Weaver Street several times a year. The accumulated sediment has also blocked City-owned storm drains originating at catch basins along Broadway causing the street to flood during the heavy rainfall/snow melt events.

Under this alternative, impacted sediment would be removed from Schermerhorn Creek. Removal of the impacted sediment would address the sediment RAOs as removal of the sediment for offsite disposal would: eliminate direct contact to current and future onsite workers with impacted sediments (sediment RAO #1); eliminate the potential for dissolution of COCs from sediment to groundwater (sediment RAO #2); and eliminate the potential for impacts to biota from impacted sediments through bioaccumulation (sediment RAO #3).

As indicated above, potential site-wide remedial activities to be implemented at the property could promote changes to the groundwater table and groundwater flow direction. The effects of these changes are difficult to predict and could cause the creek to become a gaining stream, thus releasing impacted groundwater and/or NAPL to surface water in the creek. Culverting the onsite portion of the creek would mitigate the potential for groundwater and NAPL from discharging to the creek regardless of potential future changes in the water table elevation and/or groundwater flow patterns (groundwater RAO #2 and soil RAO #3, respectively).

This alternative is irreversible since the COCs associated with the sediment would be permanently removed and disposed offsite thereby addressing each of the sediment RAOs and eliminating the potential for future erosion, scouring, migration, and transport of sediment.

Reduction in Toxicity, Mobility, and Volume

Implementation of this alternative would reduce the potential mobility and volume of impacted sediments and the associated COCs through their physical removal from the stream bed. Once removed, these sediments would be handled and disposed at a permitted facility. In addition, culverting the creek would limit the mobility of NAPL in site soils and groundwater in the vicinity of the creek, as NAPL could not be mobilized to the creek under this alternative.

Short-Term Effectiveness

Implementation of this alternative may result in exposure of onsite workers to the COCs present in the sediments and groundwater by inhalation, ingestion, or dermal contact of the impacted sediments and/or impacted groundwater. The potential exists for flooding during the rerouting of the stream and removal of impacted sediment. Potential flooding would be addressed with additional pumping and storage/disposal options to be further identified as part of the RD phase. Air monitoring would be performed in accordance with a site-specific CAMP during the implementation of this alternative to determine the need for additional engineering controls to confirm that volatilized organic vapors are within acceptable levels, as would be specified in a site-specific HASP. Under this alternative, there would be limited generation of dust or volatized organic vapor; therefore there would be little or no short-term environmental impacts or risk posed to the community. In addition, access to the site would be limited to site-related personnel as the site is currently and will continue to be fenced.

Overall Protection of Human Health and the Environment

This sediment alternative would address each of the sediment RAOs presented in Section 3 by physically removing the impacted sediments (and therefore the associated risks) as well as preventing groundwater and NAPL from discharging to the creek (groundwater RAO #2 and soil RAO #3, respectively).

Implementability

The excavation of creek sediments and installation of a concrete box culvert are technically feasible and readily implementable. Contractors capable of performing the sediment excavation and installation of a concrete box culvert are readily available.

Difficulties in implementation would be associated with the remedial construction activities to be conducted within the active service center. Natural gas pipe lines are known to cross the creek in at least three locations, and are believed to be positioned within the sediment in the bottom of the creek. Additionally, a high-voltage electric utility line crosses the creek near the Weaver Street Substation. Uncertainties related to the sediment excavation activities include temporarily relocating the above-mentioned utility lines. Additional difficulties consist of design considerations for replacing onsite steel-deck bridges if the culvert could not support the weight of service center vehicle traffic.

Onsite stormwater runoff and storm sewer drain(s) from Broadway currently discharges to Schermerhorn Creek. The closed culvert system design would need to include a stormwater management plan consisting of means to receive these additional flows and would potentially include inlet(s), manhole(s), storm sewer grate(s), and onsite drainage swales to convey stormwater runoff to the culvert.

Additional hydraulic calculations would be required to assess potential buoyant forces on the closed culvert (because the culvert would be water-tight to eliminate infiltration of groundwater) and the culvert would be designed to withstand the associated buoyant forces. The culverted section of the creek may require periodic maintenance to remove accumulated sediment. This would be more difficult within the closed culvert as compared to open channel.

The installation of shoring or sheeting would require a test boring program prior to installation to confirm that excavation reinforcements (e.g., sheetpiling) can be driven into the subgrade at the required depths. The likelihood exists that technical problems will lead to schedule delays (i.e., equipment failure, treatment difficulties, traffic issues, weather/flooding, etc.) but can be minimized with proper advance planning and coordination of the remedial activities.

The time associated with the implementation of this alternative would be 12 to 18 months.

Cost

The capital costs associated with this alternative include sheetpiling, sediment excavation, concrete box culvert installation, and the handling and disposal of impacted sediments. The estimated present worth cost of this alternative is approximately $6.6 M. A detailed breakdown of the estimated cost associated with this alternative is presented in Table 5-13.

6. Assembly and Selection of Site Wide Remedial Alternatives

6.1 General

This section assembles the individual, media-specific remedial alternatives evaluated in detail in Section 5 into a number of site-wide remedial alternatives and presents the recommended site-wide remedy.

6.2 Analysis of Assembled Site-Wide Remedial Alternatives

As discussed in Section 5, none of the individual remedial alternatives alone will address all of the RAOs established for the site. Therefore, several combinations of the remedial alternatives are evaluated in this section. Site-wide remedies that have been assembled from the remedial alternatives that address specific site media are summarized in the following table:

	SOIL								GROUNDWATER					SEDIMENT	
Site-Wide Remedial Alternative	No Action	Asphaltic Concrete Cap	Containment Barrier Wall	In-Situ Soil Stabilization - NAPL Impacted and Potentially NAPL-Impacted Soil	In-Situ Soil Stabilization - NAPL Impacted Soil and Soil Containing PAHs > 500 ppm	Soil Removal - NAPL-Impacted Soil Adjacent to Subsurface Utilities	Soil Removal - NAPL-Impacted Soil and Soil Containing PAHs > 500 ppm	Soil Removal - Soil Containing Constituents Greater Than NYSDEC TAGM 4046 Recommended Soil Cleanup Objectives	No Action	Administrative Controls with Continued Groundwater Monitoring	Passive NAPL Recovery	In-Situ Chemical Oxidation	Groundwater Extraction and Treatment	No Action	Impacted Sediment Removal and Installation of Closed Culvert
No. 1	X								X					X	
No. 2		X	X			X				X	X				X
No. 3		X		X						X					X
No. 4		X			X					X					X
No. 5		X	X			X				X		X			X
No. 6							X			X					X
No. 7								X		X					X
No. 8		X											X		X

The advantages and disadvantages for each of the above site-wide alternatives are presented in the following sections.

6.2.1 Site-Wide Alternative No. 1

Site-Wide Alternative No. 1 consists of the following:

Soil	Groundwater	Sediment
- No Action	- No Action	- No Action

This alternative would consist of conducting no action to address the environmental impacts identified at the site. Existing site conditions that support the No Action alternative include the following:

- NAPL does not appear to be migrating at this time;
- NAPL migration over time appears to have primarily been vertical and not horizontal. Vertical migration appears to have stopped based on the lack of visual NAPL in the lower portion of the lower fine sand unit;
- There are no users of onsite or downgradient groundwater for potable purposes;
- A large portion of the site is currently covered in asphalt pavement limiting direct contact with site soils; and
- The onsite portion of Schermerhorn Creek is a losing stream thereby limiting the potential for discharge of NAPL or impacted site groundwater to the creek.

There is no cost for implementing this alternative.

6.2.2 Site-Wide Alternative No. 2

Site-Wide Alternative No. 2 consists of the following:

Soil	Groundwater	Sediment
- Asphaltic Concrete Cap - Containment Barrier Wall - Soil Removal – NAPL-Impacted Soil Adjacent to Subsurface Utilities - Soil Removal – Potentially NAPL-Impacted Soil South of Schermerhorn Creek and Offsite Treatment/ Disposal	- Administrative Controls with Continued Groundwater Monitoring - Passive NAPL Recovery	- Sediment Removal and Closed Culvert Installation

As indicated in the detailed evaluations presented in Section 5, each of these individual technology processes is implementable at the site and equipment, materials, and contractors necessary to construct these remedies are readily available.

Because the proposed containment barrier wall does not cross Schermerhorn Creek, potentially NAPL-impacted soil south of the creek is not addressed by this remedy. Therefore, Site-Wide Alternative No. 2 also includes targeted excavation to address potentially NAPL-impacted soil south of Schermerhorn Creek. Excavation activities would include: removal of existing asphalt; installation of temporary sheetpiling; excavation and handling of 1,200 CY of potentially NAPL-impacted soil; importation and placement of backfill; asphalt restoration; and transportation and offsite disposal of excavated material. The cost associated with the removal of the potentially NAPL-impacted soil south of Schermerhorn Creek is provided in Table 6-1.

The combination of these individual alternatives provides a comprehensive remedial approach for addressing the site. Other than potentially NAPL-impacted soils in the vicinity of the GRS, a containment barrier wall would surround the majority of NAPL-impacted soils and be keyed into the hydraulically confining till unit, thus meeting the RAO of minimizing potential future offsite migration of NAPL to the extent practicable. The barrier wall would also isolate NAPL-impacted soils that serve as an ongoing source of dissolved-phase impacts to groundwater and this would meet groundwater RAO of mitigating future impacts to groundwater.

Groundwater outside of the containment barrier would continue to be monitored periodically to document decreasing groundwater COC concentrations over time. Additional monitoring points could be installed as appropriate and as possible based on access agreements and space limitations. Administrative controls, at minimum, consisting of environmental easements in the form of ELURs would be placed on the site to limit future use of groundwater or completion of subsurface excavation/construction activities. Additional administrative controls would consist of maintaining existing asphalt paving (outside of the proposed asphaltic concrete cap) to minimize the potential for direct contact with impacted surface soils and infiltration through impacted soils. The asphalt cap, removal of soil adjacent to select subsurface gas utilities, and removal of potentially NAPL-impacted soil south of Schermerhorn Creek, in combination with the administrative controls, would meet the RAO of minimizing potential risks to current and future onsite workers by limiting potential exposure through contact with impacted media.

Passive NAPL recovery would also be conducted as part of this alternative to remove NAPL to the extent practicable using manual bailing. This would accomplish a level of contaminant mass reduction in addition to the containment provided by the barrier wall.

Sediment within the onsite portion of Schermerhorn Creek would be removed to facilitate installation of a closed culvert. This would directly address each of the sediment RAOs to protect human health and biota from COCs in the portion of Schermerhorn Creek within the site, as well as downgradient of the site. In addition, installation of a closed culvert would isolate the Schermerhorn Creek surface water from potentially-impacted groundwater and NAPL located outside the containment barrier (in the vicinity of the gas regulator station) regardless of potential future changes in the water table elevation and/or groundwater flow patterns and meet groundwater RAO #2.

The total estimated cost for Site-Wide Alternative No. 2 is $19,900,000 and this alternative would require approximately 2 years to complete.

6.2.3 Site-Wide Alternative No. 3

Site-Wide Alternative No. 3 consists of the following:

Soil	Groundwater	Sediment
- Asphaltic Concrete Cap - In-Situ Soil Stabilization – NAPL-Impacted and Potentially NAPL-Impacted Soil	- Administrative Controls with Continued Groundwater Monitoring	- Sediment Removal and Closed Culvert Installation

As indicated in the detailed evaluations presented in Section 5, each of these individual technology processes is implementable at the site and equipment, materials, and contractors necessary to construct these remedies are readily available.

The combination of these individual alternatives provides a comprehensive remedial approach for addressing the site. In-situ soil stabilization would treat the majority of NAPL-impacted soils identified at the site through immobilization. Following treatment, the NAPL-impacted soils would be part of a homogeneous mixture along with stabilizing materials to form a low-permeability soil-crete monolith. The stabilized material would reduce leaching/dissolution of COCs to groundwater and would immobilize NAPL. The average and maximum concentrations of total PAHs and total BTEX in the solidified mixture would also be lowered due to the homogenization of the material and the addition of non-impacted media. BTEX and some PAHs may also be volatilized during the curing process due to increased temperatures. Off-gases potentially generated during ISS mixing would be captured and treated. This method provides treatment of soils in-situ, which greatly reduces the potential for exposure to onsite personnel constructing the remedy.

ISS bench-scale studies (Appendix E) have been conducted and indicated an achievable permeability of 5.8×10^{-7} cm/sec using a mixture of BFS/cement, bentonite, and water in percentages of 10, 0.35, and 10, respectively.

Groundwater outside of the stabilized area would continue to be monitored periodically to document decreasing groundwater COC concentrations over time. Additional monitoring points could be installed as appropriate and as possible based on access agreements and space limitations. Administrative controls, at minimum, consisting of environmental easements in the form of ELURs would be placed on the site to limit future use of groundwater or completion of subsurface excavation/construction activities. Additional administrative controls would consist of maintaining existing asphalt (outside of the proposed asphaltic concrete cap) to minimize the potential for direct contact with impacted surface soils and infiltration through impacted soils. The asphalt cap, in combination with the administrative controls, would meet the RAO of minimizing potential risks to current and future onsite workers by limiting potential exposure through contact with impacted media.

Sediment within the onsite portion of Schermerhorn Creek would be removed to facilitate installation of a closed culvert. This would directly address each of the sediment RAOs to protect human health and biota from COCs in the portion of Schermerhorn Creek within the site, as well as downgradient of the site. In addition, installation of a closed culvert would prevent potentially impacted groundwater and NAPL (from areas outside the stabilized soils) from discharging to the creek (groundwater RAO #2 and soil RAO #3, respectively) regardless of potential future changes in the water table elevation and/or groundwater flow patterns.

The ISS of visually impacted material should serve to prevent future migration of NAPL to the creek through micro- and macro-encapsulation. As indicated in the technology description, pre-excavation will be conducted in the upper portion of the ISS areas to allow for material bulking and to maintain the top of the stabilized material below the frost line to minimize the effect of the freeze-thaw cycle on the stabilized mass. If, during pre-excavation, indications of NAPL are identified outside of the ISS area, the ISS area will be adjusted to include the visually impacted material. Measures would also be in place to minimize potential migration of the NAPL to the creek where ISS was not feasible.

The total estimated cost for Site-Wide Alternative No. 3 is $30,500,000 and this alternative would require approximately 2 years to complete.

6.2.4 Site-Wide Alternative No. 4

Site-Wide Alternative No. 4 consists of the following:

Soil	Groundwater	Sediment
- Asphaltic Concrete Cap - In-Situ Soil Stabilization – NAPL-Impacted Soil and Soil Containing PAHs > 500 ppm	- Administrative Controls with Continued Groundwater Monitoring	- Sediment Removal and Closed Culvert Installation

As indicated in the detailed evaluations presented in Section 5, each of these individual technology processes is implementable at the site and equipment, materials, and contractors necessary to construct these remedies are readily available.

The combination of these individual alternatives provides a comprehensive remedial approach for addressing the site. In-situ soil stabilization would treat the majority of NAPL-impacted soils and soils containing PAHs > 500 ppm identified at the site through immobilization. Following treatment, the NAPL-impacted soils would be part of a homogeneous mixture along with stabilizing materials to form a low-permeability soil-crete monolith. The stabilized material would reduce leaching/dissolution of COCs to groundwater and would immobilize NAPL. The average and maximum concentrations of total PAHs and total BTEX in the solidified mixture would also be lowered due to the homogenization of the material and the addition of non-impacted media. BTEX and some PAHs may also be volatilized during the curing process due to increased temperatures. Off-gases potentially generated during ISS mixing would be captured and treated. This method provides treatment of soils in-situ, which greatly reduces the potential for exposure to onsite personnel constructing the remedy.

As indicated previously, ISS bench-scale studies (Appendix E) have been conducted and indicated an achievable permeability of 5.8×10^{-7} cm/sec using a mixture of BFS/cement, bentonite, and water in percentages of 10, 0.35, and 10, respectively.

Similar to Site-Wide Alternative No. 3, groundwater outside of the stabilized area would continue to be monitored periodically to document decreasing groundwater COC concentrations over time. Additional monitoring points could be installed as appropriate and as possible based on access agreements and space limitations. Administrative controls, at minimum, consisting of environmental easements in the form of ELURs would be placed on the site to limit future use of groundwater or completion of subsurface excavation/construction activities. Additional administrative controls would consist of maintaining existing asphalt (outside of the proposed asphaltic concrete cap) to minimize the potential for direct contact with impacted surface soils and infiltration through impacted soils. The asphalt cap, in combination with the administrative controls, would meet the RAO of minimizing potential risks to current and future onsite workers by limiting potential exposure through contact with impacted media.

Sediment within the onsite portion of Schermerhorn Creek would be removed to facilitate installation of a closed culvert. This would directly address each of the sediment RAOs to protect human health and biota from COCs in the portion of Schermerhorn Creek within the site, as well as downgradient of the site. In addition, installation of a closed culvert would prevent groundwater and NAPL from discharging to the creek (groundwater RAO #2 and soil RAO #3, respectively) regardless of potential future changes in the water table elevation and/or groundwater flow patterns.

The ISS of impacted material should serve to prevent future migration of NAPL to the creek through micro- and macro-encapsulation. As indicated in the technology description, pre-excavation will be conducted in the upper portion of the ISS areas to allow for material bulking and to maintain the top of the stabilized material below the frost line to minimize the effect of the freeze-thaw cycle on the stabilized mass. If, during pre-excavation, indications of NAPL are identified outside of the ISS area, the ISS area will be adjusted to include the visually impacted material. Measures would also be in place to minimize potential migration of the NAPL to the creek where ISS was not feasible.

The total estimated cost for Site-Wide Alternative No. 4 is $46,000,000 and this alternative would require approximately 3 years to complete.

6.2.5 Site-Wide Alternative No. 5

Site-Wide Alternative No. 5 consist of the following:

Soil	Groundwater	Sediment
- Asphaltic Concrete Cap - Containment Barrier Wall - Soil Removal – NAPL-Impacted Soil Adjacent to Subsurface Utilities	- Administrative Controls with Continued Groundwater Monitoring - In-Situ Chemical Oxidation	- Sediment Removal and Closed Culvert Installation

As indicated in the detailed evaluations presented in Section 5, each of these individual technology processes is implementable at the site and equipment, materials, and contractors necessary to construct these remedies are readily available.

The combination of these individual alternatives provides a comprehensive remedial approach for addressing the site. Other than potentially NAPL-impacted soils in the vicinity of the GRS, a containment barrier wall would surround the majority of NAPL-impacted soils and be keyed into the hydraulically confining till unit, thus meeting the RAO of minimizing potential future offsite migration of NAPL to the extent practicable. The barrier wall would also isolate NAPL-impacted soils that serve as an ongoing source of dissolved-phase impacts to groundwater outside of the containment barrier and thus would meet the groundwater RAO of mitigating future impacts to groundwater.

Groundwater outside of the containment barrier would continue to be monitored periodically to document decreasing groundwater COC concentrations over time. Additional monitoring points would be installed as appropriate and as possible based on access agreements and space limitations. Administrative controls, at minimum, consisting of environmental easements in the form of ELURs would be placed on the site to limit future use of groundwater or completion of subsurface excavation/construction activities. Additional administrative controls would consist of maintaining existing asphalt (outside of the proposed asphaltic concrete cap) to minimize the potential for direct contact with impacted surface soils and infiltration through impacted soils. The asphalt cap, in combination with the administrative controls, would meet the RAO of minimizing potential risks to current and future onsite workers by limiting potential exposure through contact with impacted media.

In-situ chemical oxidation is an innovative technology, but its effectiveness and implementability has been documented at other sites with similar COCs in site media. Under this site-wide alternative, in-situ chemical oxidation would be used on the inside of the containment barrier wall to reduce the mass flux of COCs from NAPL and impacted soils to the dissolved-phase groundwater. In-situ oxidation would target areas within the former MGP area with the most heavily impacted saturated and unsaturated soils (as determined based on previous investigation/monitoring activities). Insitu chemical oxidation is effective on dissolved phase constituents and has limited effectiveness in directly treating NAPL. After cessation of oxidant injection, impacts to groundwater could return due to continued dissolution of COCs from NAPL. Prior to full-scale implementation of in-situ chemical oxidation, a pilot-scale study would be required to evaluate the feasibility, effectiveness, and appropriate design parameters for full-scale application. Information developed by the pilot-scale study would be used to design the oxidant delivery parameters (e.g., oxidant concentration, injection pressure, etc.) and the spacing of oxidant injection locations. In-situ oxidation may not achieve regulatory cleanup standards/guidance values throughout the site.

Sediment within the onsite portion of Schermerhorn Creek would be removed to facilitate installation of a closed culvert. This would directly address each of the sediment RAOs to protect human health and biota from COCs in the portion of Schermerhorn Creek within the site, as well as downgradient of the site. In addition, installation of a closed culvert would prevent potentially impacted groundwater and NAPL (from areas outside the containment barrier) from discharging to the creek (groundwater RAO #2 and soil RAO #3, respectively) regardless of potential future changes in the water table elevation and/or groundwater flow patterns.

The containment barrier wall should also serve to prevent future migration of NAPL to the creek. If, during installation of the containment barrier wall, indications of NAPL are encountered along the creek-side of the trench, measures would be ready to minimize potential migration of NAPL to the creek.

The total estimated cost for Site-Wide Alternative No. 5 is $23,500,000 and this alternative would require approximately 7 years to complete.

6.2.6 Site-Wide Alternative No. 6

Site-Wide Alternative No. 6 consist of the following:

Soil	Groundwater	Sediment
- Soil Removal - NAPL-Impacted Soil and Soil Containing PAHs >500 ppm and Offsite Treatment/Disposal	- Administrative Controls with Continued Groundwater Monitoring	- Sediment Removal and Closed Culvert Installation

As indicated in the detailed evaluations presented in Section 5, each of these individual technology processes is implementable at the site and equipment, materials, and contractors necessary to construct these remedies are readily available.

Excavation and disposal of soil containing visual indications of NAPL and total PAHs at concentrations >500 ppm would generally address the soil and groundwater RAOs established for the site. This alternative would involve excavation of an average of 22 feet of soil across the majority of the site, with a maximum depth of approximately 40 feet bgs. Based on the visual characterization and soil sample analytical results, maximum excavation depth is anticipated to be approximately 40 feet bgs (east of the Open Garage). The majority of the impacted soil under this alternative is located below the water table. Soil removal would be extremely difficult and would require handling and treatment of large volumes of water in order to facilitate excavation of the impacted material. Based on the extent of the subsurface utilities and the limits and depth of the soil that would be removed by these activities, the existing gas regulating station and associated piping and the personnel, equipment, and materials associated with the Service Center would need to be relocated. This alternative would be extremely disruptive to the general area, including potential supply disruption of utilities. In addition to essentially requiring the shutdown and relocation of the facility, the increased truck traffic and management and transportation of impacted materials over public roads would cause a significant risk for accidents and potential spills.

Although potentially feasible, this alternative would also require additional evaluation to assess the stability of the excavation bottom under the strong upward hydraulic gradients at depth and hydraulic forces that would be generated on the bottom of the excavation under the soil removal conditions. Excavation in the wet is not feasible due to the shallow nature of the groundwater and depth of the impacted material.

By removing NAPL-impacted soil and soil containing the highest concentrations of COCs, ongoing dissolved-phase impacts to groundwater would be reduced. Based on space and property limitations, removal of the entire extent of NAPL- and PAH-impacted soil may not be feasible. Administrative controls, at minimum, consisting of environmental easements in the form of ELURs would be placed on the site to limit future use of groundwater at the site. Additional measures may be required to obtain groundwater use restrictions for properties downgradient from the site. Groundwater at the downgradient property boundary and at existing offsite wells would continue to be monitored periodically to document groundwater COC concentrations over time. New monitoring points would be required following soil excavation.

Sediment within the onsite portion of Schermerhorn Creek would be removed to facilitate installation of a closed culvert. This would directly address each of the sediment RAOs to protect human health and biota from COCs in the portion of Schermerhorn Creek within the site, as well as downgradient of the site. In addition, installation of a closed culvert would prevent groundwater and NAPL from discharging to the creek (groundwater RAO #2 and soil RAO #3, respectively) regardless of potential future changes in the water table elevation and/or groundwater flow patterns.

The total estimates cost for Site-Wide Alternative No. 6 is $84,600,000 and this alternative would require approximately 5 years to complete.

6.2.7 Site-Wide Alternative No. 7

Site-Wide Alternative No. 7 consist of the following:

Soil	Groundwater	Sediment
- Soil Removal - Soil Containing Constituents at Concentrations Greater than TAGM 4046 Recommended Soil Cleanup Objectives and Offsite Treatment/ Disposal	- No Action	- Sediment Removal and Closed Culvert Installation

As indicated in the detailed evaluations presented in Section 5, each of these individual technology processes is implementable at the site and equipment, materials, and contractors necessary to construct these remedies are readily available.

Excavation and disposal of soil containing chemical constituents at concentrations exceeding NYSDEC recommended soil cleanup objectives presented in TAGM 4046 would address the soil and groundwater RAOs established for the site. This alternative would involve the excavation of an average of 30 feet of soil across the majority of the site as well as some offsite soil. The majority of the soil to be excavated under this alternative is located below the water table. The maximum depth of soil removal under this alternative is assumed to be approximately 40 feet in the area east of the Open Garage. Soil removal would be extremely difficult and would require handling and treatment of large volumes of water in order to facilitate excavation of the impacted material. Based on the extent of the subsurface utilities and the limits and depth of the soil that would be removed by these activities, the existing gas regulating station and associated piping, as well as personnel, equipment, and materials associated with the Service Center operations, would need to be relocated. This alternative would be extremely disruptive to the general area. In addition to essentially requiring the shutdown and relocation of the facility, increased truck traffic, management, and transportation of impacted materials over public roads would cause a significant risk for accidents and potential spills.

Sediment within the onsite portion of Schermerhorn Creek would be removed to facilitate installation of a closed culvert. This would directly address each of the sediment RAOs to protect human health and biota from COCs in the portion of Schermerhorn Creek within the site, as well as downgradient of the site. In addition, installation of a closed culvert would prevent groundwater and NAPL from discharging to the creek (groundwater RAO #2 and soil RAO #3, respectively) regardless of potential future changes in the water table elevation and/or groundwater flow patterns.

Although potentially feasible, the fact that soil removal is indicated on both sides of the creek, on offsite properties, and on both sides of the D&H railroad line, to the north of the site would require an arrangement with property owners or purchase of land in order to complete this alternative. This alternative would also require additional evaluation to assess the stability of the excavation bottom under the strong upward hydraulic gradients at depth and hydraulic forces that would be generated on the bottom of the excavation under the soil removal conditions. Excavation in the wet is not feasible due to the shallow nature of the groundwater and depth of the impacted material.

By removing NAPL-impacted soils and treating impacted groundwater within the excavation dissolved-phase impacts at the site would be addressed. Based on space and property limitations, removal of the entire extent of NAPL- and PAH-impacted soil may not be feasible. Administrative controls, at minimum, consisting of environmental easements in the form of ELURs would be placed on the site to limit future use of groundwater at the site. Additional measures may be required to obtain groundwater use restrictions for properties downgradient from the site. Groundwater at the downgradient property boundary and at existing offsite wells would continue to be monitored periodically to document groundwater COC concentrations over time. New monitoring points would be required following soil excavation.

The total estimated cost for Site-Wide Alternative No. 7 is $162,300,000 and this alternative would require approximately 11 years to complete.

6.2.8 Site-Wide Alternative No. 8

Site-Wide Alternative No. 8 consist of the following:

Soil	Groundwater	Sediment
- Asphaltic Concrete Cap	- Groundwater Extraction and Treatment	- Sediment Removal and Closed Culvert Installation

As indicated in the detailed evaluations presented in Section 5, each of these individual technology processes is implementable at the site and equipment, materials, and contractors necessary to construct these remedies are readily available.

The combination of these individual alternatives provides a comprehensive remedial approach for addressing the site. Installation of an asphalt cap would reduce the mobility of the COCs, as well as limit potential human contact with these materials. Capping of the impacted soils would meet the site-specific RAO of minimizing the potential for exposure to surface and subsurface soil by current and future onsite workers. This alternative would effectively isolate the impacted soils and significantly reduce the potential for human exposure. In addition, this option would provide protection of the environment and contribute to meeting the RAO of mitigating future impacts to groundwater by reducing the volume of water (in the form of precipitation or surface water runoff) which is transported vertically through the impacted soils to the water table. The implementation of groundwater removal and treatment would meet the RAO of mitigating future impacts to groundwater by controlling the offsite migration of impacted groundwater and extracting and treating the impacted groundwater before it leaves the site. The concentrations of COCs in the offsite groundwater may also be reduced.

However, without addressing NAPL-impacted soils, COCs from the NAPL would continue to enter into the dissolved-phase. Without removing or addressing NAPL-impacted soils, active treatment of groundwater may be required for an indeterminate amount of time (as a result of dissolution of COCs from NAPL-impacted soils to the groundwater).

The asphalt cap would meet the RAO of minimizing potential risks to current and future onsite workers by limiting exposure through contact with impacted media.

Sediment within the onsite portion of Schermerhorn Creek would be removed to facilitate installation of a closed culvert. This would directly address each of the sediment RAOs to protect human health and biota from COCs in the portion of Schermerhorn Creek within the site, as well as downgradient of the site. In addition, installation of a closed culvert would prevent groundwater and NAPL from discharging to the creek (groundwater RAO #2 and soil RAO #3, respectively) regardless of potential future changes in the water table elevation and/or groundwater flow patterns.

The total estimated cost for Site-Wide Alternative No. 8 is $13,000,000 and this alternative would require approximately one year to complete; however, groundwater extraction and treatment may be required for an indeterminate amount of time.

6.3 Comparative Analysis of Site-Wide Alternatives

This section presents a comparative analysis of each site-wide remedial alternative using the seven evaluation criteria identified in Section 5. This comparative analysis identifies the advantages and disadvantages of each site-wide alternative relative to each other and with respect to the seven evaluation criteria. The results of the comparative analysis will be used as the basis for recommending a remedial alternative for addressing site-related impacts, as presented in Section 7.

Compliance with SCGs

Each of the site-wide alternatives could be designed and implemented to comply with the majority of the SCGs identified for this site.

- Alternative No. 1 does not address the SCGs for the site;

- Alternative Nos. 2 through 5 would address the SCGs by maintaining hydraulic control and the potential migration of NAPL through a combination of a containment barrier and/or immobilization of the most impacted site soils combined with an asphalt surface cap; passive NAPL recovery (Alternative No. 2 only); continued groundwater monitoring; and impacted sediment removal. Alternative No. 5 would also employ in-situ chemical oxidation to reduce the toxicity of dissolved-phase COCs to help meet the SCGs.

- Alternative Nos. 6 and 7 would address the SCGs through soil removal and offsite treatment/disposal, groundwater monitoring, and impacted sediment removal.

- Alternative No. 8 would address the SCGs through the use of an impermeable asphalt cap, groundwater migration control extraction and treatment, and impacted sediment removal.

Under a pure containment option, with the exception of site-wide Alternative No. 5, impacted soil and groundwater exceeding SCGs would remain untreated inside the limits of the containment barrier. However, combined with administrative controls, the potential risks to current and future employees at the site would be minimized. Alternative No. 5 includes insitu chemical oxidation within the containment barrier and would treat dissolved-phase COCs in groundwater. Soil removal under Alternative Nos. 6 and 7 would likely be the fastest alternatives to achieve the SCGs since they involve the physical removal and offsite treatment/disposal of impacted materials.

Long-Term Effectiveness and Permanence

A comparative analysis of long-term effectiveness and permanence for each of the alternatives is as follows:

- Alternative No. 1 would not be effective at addressing environmental impacts and would not have long-term permanence. Natural process that may reduce the volume of NAPL and COCs would be permanent.

- Under Alternative Nos. 2 and 5, the containment barrier wall alone does not provide for the treatment of NAPL and therefore, if the barrier wall was removed in the future via excavation or other means, the potential exists that NAPL and impacted groundwater within the limits of the barrier wall could migrate offsite. However, institutional controls would be in place to protect the integrity of the containment barrier. Alternative No. 5 also involves chemical oxidation, which is a permanent process. Once chemical constituents are oxidized to a less toxic form, they are permanently treated and the process cannot be reversed. However, after oxidation injection is stopped, groundwater may become reimpacted as chemical oxidation would have limited effectiveness in directly treating NAPL. These alternatives could both have long-term effectiveness under an appropriate O&M program as the impacted materials would be contained within the barrier wall and would be prevented from offsite migration. Additionally, these alternatives would have long-term effectiveness at minimizing ongoing dissolved phase impacts to downgradient groundwater since NAPL-impacted soils would be contained within the barrier wall.

- The remedial technologies included under Alternative Nos. 3 and 4 are generally considered permanent processes. ISS involves solidification (micro- and macro-encapsulation) of NAPL, NAPL-impacted soils, and impacted groundwater. This process is generally irreversible since the material is homogenized with imported stabilizing materials and solidified. These alternatives have long-term permanence. Previous MGP sites that have used this technology process (Attachment F) have shown long term effectiveness at stabilizing impacted materials. A QA/QC program would be implemented during the implementation of this process to demonstrate that a homogeneous stabilized mass is formed, and an ongoing O&M program would be implemented to monitor the effectiveness of this alternative.

- Alternative Nos. 6 and 7 involve removal of impacted soil and transportation of excavated materials for offsite disposal. This is generally considered an irreversible process since the material is no longer present at the site. This alternative has long-term effectiveness at reducing the mass of NAPL-impacted soils; removing soils containing total PAHs at concentrations >500 ppm (and effectively BTEX at concentrations >10 ppm as they are co-located with these soils).

- Alternative No. 8 includes groundwater extraction and treatment. Groundwater extraction and treatment is considered a permanent process as the chemical constituents in the extracted groundwater are removed via the treatment process and are no longer associated with the groundwater. This alternative would be effective at controlling the migration of impacted groundwater. The long-term effectiveness of this alternative is dependant on the presence of NAPL-impacted soils. If NAPL impacted soils remain following shutdown of the groundwater extraction and treatment, it is possible that groundwater could become re-impacted due to the dissolution of COCs from the NAPL-impacted soils.

- Sediment removal and installation of a closed culvert is included in each of the alternatives and is considered a permanent process and irreversible as the material is permanently removed from the site and treated/disposed.

<u>Reduction of Toxicity, Mobility, and Volume</u>

Each site-wide alternative reduces toxicity, mobility, and/or volume of impacted media at the site.

- Alternative Nos. 2 and 5 will prevent potential downgradient migration of NAPL and COCs in soil and groundwater through the installation of a vertical containment barrier. Groundwater mounding within the limits of the containment barrier has been determined not to be an issue when combined with an asphaltic concrete cap. Alternative No. 2 also would reduce the volume of NAPL via passive removal. Toxicity is also reduced under Alternative No. 5 via in-situ chemical oxidation.

- Alternatives Nos. 3 and 4 reduces mobility through stabilization/solidification via ISS. Impacted soil, NAPL, and groundwater would be solidified in a low permeability monolith that would effectively limit the mobility (through solidification) and toxicity (through homogenization) of the material.

- Alternatives Nos. 6 and 7 involve soil removal. The removal of NAPL, impacted soil, and impacted groundwater from the excavation area is certain under these alternatives as it is physically removed from the ground for treatment/disposal.

- Alternative No. 8 reduces the volume of impacted groundwater via extraction and treatment. Toxicity of the extracted water is also reduced under Alternative No. 8 via groundwater treatment.

Short-Term Effectiveness

Each of the alternatives involves potential exposure of onsite workers to chemical constituents within impacted soil, groundwater, sediment, LNAPL, and DNAPL during the remedial activities. The short-term effectiveness of individual alternatives is as follows:

- Alternative Nos. 2 and 5 have the potential for contact between site workers and chemical constituents during installation of the containment barrier, limited soil removal (associated with utility work), construction of the asphalt cap, sediment removal, and onsite monitoring activities.

- Alternatives Nos. 3 and 4 also has the potential for contact between site workers and spoils generated during ISS activities. Each alternative has the potential for exposure to impacted sediments during sediment removal activities.

- In addition to potential exposure to impacted soil during the installation of the containment barrier wall and excavation of impacted sediment under Alternative No. 5, onsite personnel have the potential to be exposed to strong oxidizing agents associated with the in-situ chemical oxidation process.

- Alternative Nos. 6 and 7 have the potential for exposure between onsite workers and impacted soils, groundwater, and sediments and would present the greatest potential for short-term risks, because these alternatives involve the excavation and handling of a large volume of impacted soil with the potential to generate volatile organic vapors and fugitive dust containing chemical constituents.

- Alternative No. 8 has the potential for onsite workers to be exposed to impacted groundwater during treatment system O&M. There also exists the potential for exposure to impacted soils during installation of the asphalt cap and to impacted sediments during sediment removal.

Short-term risks to the community include the potential generation of volatile organic vapors and nuisance odors during implementation of soil excavation and handling activities under Alternative Nos. 6 and 7. Risks to the community would be minimized by providing security at the site and implementing a CAMP to minimize the potential migration of volatile organic vapors and/or particulates from the site and to determine the need for additional engineering controls. Alternative Nos. 6 and 7 would also present the greatest potential nuisance to the community because these alternatives would generate a large volume of excavated soil that would require transport through the community for offsite treatment/disposal.

Overall Protection of Human Health and the Environment

Each of the site-wide alternatives would be protective of human health and the environment and would achieve the established RAOs.

- Alternative Nos. 2 and 5 provide substantial protection of human health and the environment by layering technology processes that contain the most impacted soils and groundwater at the site and minimizing the potential for direct contact with these media through the use of a physical barrier (i.e., asphalt cap), targeted soil removal, and administrative controls. The containment barrier would effectively limit future downgradient impacts from NAPL-impacted soils that would be contained within the limits of the barrier wall. Alternative No. 5 also includes in-situ chemical oxidation to treat dissolved-phase COCs to less toxic forms. Furthermore, these processes are combined with ongoing groundwater monitoring and NAPL recovery (under Alternative No. 2).

- Alternative Nos. 3 and 4 provides protection of human health and the environment by minimizing the potential for contact with impacted media (i.e., through solidification/stabilization of impacted soil, NAPL, and impacted groundwater) and the construction of an asphalt cap. Stabilization of the NAPL-impacted soils also minimizes the potential for ongoing impacts to groundwater.

- Alternative Nos. 6 and 7 would permanently remove impacted soil and soil containing the greatest concentrations of chemical constituents, minimize the potential downgradient migration of constituents, and minimize potential human exposure.

- Alternative No. 8 provides protection of human health and the environment by a technology process that minimizes the potential for direct contact with these media through the use of a physical barrier (i.e., asphalt cap) and administrative controls. The implementation of groundwater removal and treatment would minimize future impacts to groundwater by extracting and treating the impacted groundwater before it leaves the site.

- Each alternative includes removal of sediment for offsite treatment/disposal. Removal of impacted sediment and installation of a closed culvert would minimize potential offsite future exposure concerns associated with the sediment.

Implementability

Each of the site-wide alternatives is technically feasible and could be implemented at the site.

- Alternative Nos. 2 and 5 could be implemented in a phased approach to potentially allow Service Center operations to continue throughout the remedial construction process. The installation of the containment barrier beneath/adjacent to active underground natural gas mains would require extensive engineering support measures or alternative measures to construct a continuous containment barrier wall around the utility piping. Under Alternative No. 2, passive NAPL recovery efforts would be implemented to reduce the volume of NAPL within the CB wall. However, based on the findings of previous investigation/monitoring activities, highly viscous NAPL was encountered in the subsurface beneath the site and NAPL recovery attempts to date in existing onsite monitoring wells have shown limited recovery rates. If following the construction of the CB wall, NAPL recovery continues to be limited, then this aspect of the remedy could be discontinued with little or no impact on the overall effectiveness of the site-wide remedy.

- Alternative No. 5 includes in-situ chemical oxidation, which is an innovative technology with limited full-scale information available to confirm its effectiveness and implementability. Prior to implementing Alternative No. 5, pilot-scale testing would be required to evaluate its implementability and determine appropriate design parameters. Based on the current state of this technology and available data, in-situ chemical oxidation would not address the MGP-related NAPL.

- Alternatives Nos. 3 and 4 would cause more disturbances to typical site operations; however, operations may be able to continue somewhat uninterrupted during the construction of the selected remedy. Preparation for the ISS technology would require accurate location of subsurface utilities and excavation of subsurface impedances (e.g., concrete foundations). However, these activities should all be implementable.

- Difficulties and uncertainties associated with the implementation of Alternative Nos. 2, 3, and 5 consist of conducting activities within active portions of the Service Center (including high-traffic areas). Extensive coordination of the remedial activities under these alternatives with ongoing daily site activities would be required to address these potential difficulties.

- Alternative Nos. 4, 6, and 7 would cause the greatest disruption to site operations and would most likely lead to the permanent relocation of both the Service Center facility and the existing gas regulator station. These alternatives would be more difficult than the other alternatives because soil treatment/excavation would be implemented across a significant portion of the site. Difficulties associated with the alternatives include:

  - excavation of soil beneath the groundwater table, excavation dewatering, and soil dewatering;

  - treatment/excavation adjacent to (or removal of) existing above-grade structures and underground utilities;

  - control of the potential generation and migration of volatile organic vapors, nuisance odors, and fugitive dust; excavation/handling of large volumes of soil within relatively confined areas in close proximity to active work areas (i.e., office areas, garages, etc.); and

  - excavation adjacent to active railroad lines.

- Alternative No. 8 may also require pilot testing to determine the appropriate treatment system configuration for the impacted groundwater.

Implementation of Alternative Nos. 6 though 8 would include compliance with applicable permit requirements in order to treat impacted groundwater and discharge treated water to the POTW and/or surface water. Treatability and pilot-scale studies may be required under these alternatives to confirm that the water treatment system can be designed to meet necessary effluent quality to satisfy POTW and/or SPDES requirements. In addition, pump tests may be required to confirm the groundwater extraction rates necessary to attain hydraulic containment.

The likelihood of technical and administrative problems under Alternative Nos. 4 through 6 is greater than for Alternative Nos. 1 through 3, and 7 due to the increased complexity associated with in-situ oxidation activities (Alternative No. 4) and soil excavation (Alternative Nos. 5 and 6).

Cost

A summary of the estimated cost for each remedial alternative is presented on the following page. Detailed cost estimates for the individual remedial technology processes are (with the exception of the Site-Wide Alternative No. 1 - No Action) provided in Tables 5-1 through 5-13 and Table 6-1.

Site-Wide Remedial Alternative	Estimated Capital Cost	Estimated O&M Cost	Total Estimated Cost
Site-Wide Alternative No. 1 – No Action	$0	$0	$0
Site-Wide Alternative No. 2 – Asphaltic Concrete Cap; Containment Barrier Wall; Soil Removal - NAPL-Impacted Soil Adjacent to Subsurface Utilities; Soil Removal – Potentially NAPL Impacted Soil South of Schermerhorn Creek; Administrative Controls with Continued Groundwater Monitoring; Passive NAPL Recovery; and Sediment Removal and Installation of Closed Culvert	$17,700,000	$2,200,000	$19,900,000
Site-Wide Alternative No. 3 – Asphaltic Concrete Cap; ISS - NAPL-Impacted and Potentially NAPL-Impacted Soil; Administrative Controls with Continued Groundwater Monitoring; and Sediment Removal and Installation of Closed Culvert	$28,800,000	$1,700,000	$30,500,000
Site-Wide Alternative No. 4 – Asphaltic Concrete Cap; ISS - NAPL-Impacted Soil and Soil Containing PAHs > 500 ppm; Administrative Controls with Continued Groundwater Monitoring; and Sediment Removal and Installation of Closed Culvert	$44,300,000	$1,700,000	$46,000,000
Site-Wide Alternative No. 5 – Asphaltic Concrete Cap; Containment Barrier Wall; Soil Removal - NAPL-Impacted Soil Adjacent to Subsurface Utilities; Administrative Controls with Continued Groundwater Monitoring; In-Situ Chemical Oxidation; and Sediment Removal and Installation of Closed Culvert	$21,400,000	$2,100,000	$23,500,000
Site-Wide Alternative No. 6 – Soil Removal NAPL-Impacted and PAHs ≥ 500 ppm; Administrative Controls with Continued Groundwater Monitoring; and Sediment Removal and Installation of Closed Culvert	$83,900,000	$700,000	$84,600,000
Site-Wide Alternative No. 7 – Soil Removal - TAGM 4046 NYSDEC Recommended Soil Cleanup Objective Exceedences; and Sediment Removal and Installation of Closed Culvert	$162,300,000	$0	$162,300,000
Site-Wide Alternative No. 8 – Asphaltic Concrete Cap; Groundwater Extraction and Treatment; and Sediment Removal and Installation of Closed Culvert	$9,200,000	$3,800,000	$13,000,000

7. Recommended Remedial Alternative

7.1 Overview

This section presents the recommended site-wide remedy, as well as justification for the recommended site-wide remedy.

7.2 Recommended Site-Wide Remedy

Based on the results of the detailed analysis of the individual remedial technology processes (presented in Section 5) and the assembled site-wide remedial alternatives (presented in Section 6), Site-Wide Alternative No. 2 has been selected as the recommended remedy.

Soil	Groundwater	Sediment
- Asphalt Cap - Containment Barrier Wall - Soil Removal – NAPL-Impacted Soil Adjacent to Subsurface Structures - Soil Removal – Potentially NAPL-Impacted Soil South of Schermerhorn Creek and Offsite Treatment/ Disposal	- Administrative Controls with Continued Monitoring - Passive NAPL Recovery	- Sediment Removal and Installation of Closed Culvert

Site-wide Alternative No. 2 involves construction of a containment barrier wall; construction of an asphalt cap over the site; excavation of NAPL-impacted soil adjacent to select subsurface utilities; implementation of administrative controls and continued groundwater monitoring; passive NAPL recovery; and sediment removal and installation of closed culvert. Additionally, Site-Wide Alternative No. 2 includes targeted excavation to address potentially NAPL-impacted soil located south of Schermerhorn Creek. The targeted excavation activities would include: removal of existing asphalt; installation of temporary sheetpiling; excavation and handling of 1,200 CY of potentially NAPL-impacted soil; importation and placement of backfill; asphalt restoration; and transportation and offsite disposal of excavated material.

The containment wall would surround the majority of NAPL- or potentially NAPL-impacted soil with an impermeable wall (permeability of 10^{-7} cm/sec or less) to minimize the potential for offsite migration of NAPL and impacted groundwater. This alternative is implementable and would be effective in meeting the site-wide RAOs. The barrier system and soil removal, in concert with the asphalt cap, would minimize the potential for human exposure to NAPL-impacted soils and soils containing BTEX and PAHs at concentrations greater than 10 and greater than 500 ppm, respectively. Implementation of administrative controls would further protect future site workers from exposure to the COCs in the soil and groundwater. In addition, groundwater monitoring would be conducted to document that site-related, impacted groundwater within the containment barrier is not migrating offsite and to demonstrate that COCs in groundwater outside the containment area are attenuating via natural processes.

Passive NAPL recovery would consist of periodically recovering NAPL (via manual methods) from onsite monitoring wells. This would serve to reduce the NAPL volume in the subsurface and remove more mobile NAPL in the subsurface.

Finally, this alternative would include removal of sediment within the onsite portion of Schermerhorn Creek for transportation and offsite treatment/disposal and installation of a closed culvert. This measure would remove impacted sediment for disposal. Because there is potentially-impacted groundwater and NAPL located in areas outside the proposed containment barrier (in the vicinity of the gas regulator station), installation of a closed culvert would provide the required isolation of the Schermerhorn Creek necessary to complete the overall effectiveness of the remedy and meet groundwater RAO #2.

The cost for implementing this alternative is approximately $19,900,000.

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Tables

TABLE 2-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL CHEMICAL-SPECIFIC SCGs

Regulation	Citation	Summary of Requirements	Considerations in the Remedial Process/Action for Attainment
Identification and Listing of Hazardous Wastes	40 CFR Part 261 (Federal) 6 NYCRR Part 371 (New York State)	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 40 CFR Parts 260-266 and 6 NYCRR Parts 371-376.	Applicable to use for determining if soil at the site is a hazardous waste by characteristic. These regulations do not set cleanup standards, but are considered when establishing remedial action objectives.
Groundwater Quality Standards	6 NYCRR Parts 700-705	Establishes quality standards for groundwater.	These criteria are applicable in evaluating groundwater quality.
NYSDEC Ambient Water Quality Standards and Guidance Values	Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1 (June, 1998)	Provides a compilation of ambient water quality standards and guidance values for toxic and non-conventional pollutants for use in the NYSDEC programs.	These standards are applicable in evaluating groundwater quality.
NYSDEC Guidance on Determination of Soil Cleanup Objectives and Cleanup Levels	Technical and Administrative Guidance Memorandum (TAGM) 4046, January 24, 1994	Provides a basis and procedure to determine soil cleanup levels, as appropriate, for sites when cleanup to pre-disposal conditions is not possible or feasible. Contains generic soil cleanup objectives.	These guidance values are to be considered in evaluating soil quality.
NYSDEC Guidance on Management of MGP Waste During Remediation	Technical and Administrative Guidance Memorandum (TAGM) 4061, January 11, 2002	Outlines criteria wherein coal tar waste, soil, and sediment impacted by MGP constituents may be excluded from 6 NYCRR Parts 370-374 and 375.	Applicable for off-site disposal and thermal treatment of constituents.
NYSDEC Technical Guidance for Screening Contaminated Sediments	Division of Fish, Wildlife and Marine Resources (January 1999)	Describes methodology for establishing sediment criteria for the purpose of identifying sediment that potentially may impact marine and aquatic ecosystems.	These criteria are applicable in sediment groundwater quality.
Air Quality Standards	6 NYCRR Part 257	Establishes quality standards for air.	These criteria are applicable in evaluating air quality and will be considered in the preparation of the site-specific HASP and Community Air Monitoring Plans.

TABLE 2-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL ACTION-SPECIFIC SCGs

Regulation	Citation	Summary of Requirements	Considerations in the Remedial Process/Action for Attainment
OSHA - General Industry Standards	29 CFR Part 1910	These regulations specify the 8-hour time-weighted average concentration for worker exposure to various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR Part 1910.120.	Proper respiratory equipment will be worn if it is not possible to maintain the work atmosphere below these concentrations.
OSHA - Safety and Health Standards	29 CFR Part 1926	These regulations specify the type of safety equipment and procedures to be followed during site remediation.	Appropriate safety equipment will be on site and appropriate procedures will be followed during remedial activities.
OSHA - Recordkeeping, Reporting, and Related Regulations	29 CFR Part 1904	These regulations outline recordkeeping and reporting requirements for an employer under OSHA.	These regulations apply to the company(ies) contracted to install, operate, and maintain remedial actions at hazardous waste sites.
RCRA - Preparedness and Prevention	40 CFR Parts 264.30 - 264.31	These regulations outline requirements for safety equipment and spill control.	Safety and communication equipment will be installed at the site as necessary. Local authorities will be familiarized with the site.
RCRA - Contingency Plan and Emergency Procedures	40 CFR Parts 264.50 - 264.56	Provides requirements for outlining emergency procedures to be used following explosions, fires, etc.	Plans will be developed and implemented during remedial design. Copies of the plan will be kept on site.
Clean Water Act (CWA) - Discharge to Water of United States	40 CFR Parts 122, 125, 403, 230, and 402 CWA Section 401	Establishes site-specific pollutant limitations and performance standards which are designated to protect surface water quality. Types of discharges regulated under CWA include: discharge to surface water or ocean, indirect discharge to a POTW, and discharge of dredged or fill material into waters of the United States.	May be relevant and appropriate for remediation alternatives which discharge water back to the Creek or that include dredging/filling.
Use and Protection of Waters	6 NYCRR Part 608	This regulation presents the NYS Stream Protection Program. Applicable sections include excavation and placement of fill in navigable waters.	Would be relevant during remedial activities to address Schermerhorn Creek.
National Pollution Discharge Elimination System (NPDES)	40 CFR Part 122	These regulations detail the specific permit requirements for the discharge of pollutants to the waters of the United States.	Any water discharged from the site would be treated and discharged in accordance with NPDES permit requirements.
New York State Pollution Discharge Elimination System (SPDES)	6 NYCRR Parts 750-758	These regulations detail the specific permit requirements for the discharge of pollutants to the waters of New York State.	Any water discharged from the site would be treated and discharged in accordance with NYSDEC SPDES permit requirements.

TABLE 2-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL ACTION-SPECIFIC SCGs

Regulation	Citation	Summary of Requirements	Considerations in the Remedial Process/Action for Attainment
Land Disposal Facility Notice in Deed	40 CFR Parts 264/265 116-119(b)(1)	Established provisions for a deed notation for closed hazardous waste disposal units to prevent land disturbance by future owners.	The regulations are potentially applicable because closed areas may be similar to closed RCRA units.
Land Disposal Regulations	6 NYCRR Part 376	Land Disposal Restrictions	Identifies wastes that are restricted from land disposal and defines those circumstances under which an otherwise prohibited waste may be land disposed.
New York State Air Quality Classification System	6 NYCRR Part 265	Outlines the air quality classifications for different land uses and population densities.	Air quality classification system will be referenced during the treatment process design.
National Emission Standards for Hazardous Air Pollutants	40 CFR Part 61	Provides emission standards for hazardous air pollutants.	Proper design on air emission controls will be implemented to meet these regulations.
New Source Performance Standards	40 CFR Part 60.52	Provides particulate emission limits for incinerators.	Particulate emission limits should be specified for compliance.
Clean Air Act - National Ambient Air Quality Standards (CAA - NAAQS)	40 CFR Parts 1-99	Applies to major stationary sources, such as treatment units, that have the potential to emit significant amounts of pollutants. Regulations under CAA do not specifically regulate emissions from LTTD units, but prevention of significant deterioration (PSD) provisions may apply to an onsite treatment facility.	The treatment system will be designed to meet these emission limits. If required, PSD procedures will be included in the remedial design/remedial action (RD/RA) process.
New York Permits and Certificates	6 NYCRR Part 201	Gives instructions and regulations for obtaining a permit to operating air emission source. Also gives instructions on what do to in case of malfunction.	Permits are not required for remedial actions taken at hazardous waste sites; however, documentation for relevant and appropriate permit conditions would be provided to the NYSDEC prior to and during implementation of this alternative.
New York Emissions Testing, Sampling, and Analytical Determinations	6 NYCRR Part 202	Outlines requirements for emissions testing for air emission sources. States that independent emission tests can be ordered by the Commissioner of the NYSDEC.	Emissions from the treatment procedure must be analyzed.
New York Regulations for General Process Emission Sources	6 NYCRR Part 212	Outlines the procedure of environment rating. The Commissioner determines a rating of emissions based on sampling.	The Commissioner will issue an environmental rating for emissions based on this regulation.

TABLE 2-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL ACTION-SPECIFIC SCGs

Regulation	Citation	Summary of Requirements	Considerations in the Remedial Process/Action for Attainment
Prevention of Significant Deterioration of Air Quality	40 CFR Part 51.2	New major stationary sources may be subject to PSD review [i.e., require best available control technology (BACT), lowest achievable emission limit (LAEL), and/or emission off-sets].	If necessary, PSD procedures will be included in the RD/RA process. The procedures could be expanded to BACT and LAEL evaluations.
New York Air Quality Area Classifications - Schenectady County	6 NYCRR Part 302	Defines areas of Schenectady County into levels of the air quality classification system.	The site is located in a Level III area.
New York Hazardous Waste Management Facilities	6 NYCRR Part 373-2.15	Provides requirements for the operation of a thermal treatment unit, including information about monitoring, inspections, closure, and hazardous waste constituents.	Operational requirements must be followed during thermal treatment.
New York Hazardous Waste Management Facilities	6 NYCRR Part 373-2.16	Outlines requirements for the operation of a thermal treatment unit, including information about waste analysis, general operating requirements, closure, and standards for particular hazardous wastes.	Operational requirements must be followed during thermal treatment.
New York Requirements Specific to Thermal Treatment	6 NYCRR Part 373-3.16	Outlines requirements for the operation of a thermal treatment unit, including information about waste analysis, general operating requirements, closure, and standards for particular hazardous wastes.	Operational requirements must be followed during thermal treatment.
Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediments from Former Manufactured Gas Plants (MGPs)	NYSDEC Technical Administrative Guidance Memorandum (TAGM) 4061	Outlines criteria wherein coal tar waste, soil, and sediment that have been contaminated with coal tar waste from former MGPs may be conditionally excluded from the requirements of 6 NYCRR Parts 370-374 and 376 when they are destined for permanent thermal treatment.	Applicable for offsite treatment of impacted soils.
New York Air Resources Regulations - General Provisions	6 NYCRR Part 200	Provides definitions and general provisions of New York State Air Resources regulations. Lists references used in developing these laws.	This regulation may serve as a reference during thermal treatment.
New York General Prohibitions	6 NYCRR Part 211	Lists restricted pollution activities.	No restricted activities will occur at the site.
New York Air Quality Standards	6 NYCRR Part 257	Provides air quality standards for different chemicals (including those found at the site), particles, and processes.	Emissions from the treatment process will meet the air quality standards.

TABLE 2-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL ACTION-SPECIFIC SCGs

Regulation	Citation	Summary of Requirements	Considerations in the Remedial Process/Action for Attainment
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	Establishes procedures for identifying solid wastes that are subject to regulation as hazardous wastes.	Materials excavated/removed from the site will be handled in accordance with RCRA and New York State hazardous waste regulations, if appropriate.
RCRA - Regulated Levels for Toxicity Characteristic Leaching Procedure (TCLP) Constituents	40 CFR Part 261	These regulations specify the TCLP constituent levels for identification of hazardous wastes that exhibit the characteristics of toxicity.	Excavated soil/sediment may be sampled and analyzed for TCLP constituents prior to disposal to determine if the materials are hazardous based on the characteristic of toxicity.
Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities	6 NYCRR Part 372	Provides guidelines relating to the use of the manifest system and its recordkeeping requirements. It applies to generators, transporters, and facilities in New York State.	This regulation will be applicable to any company contracted to do treatment work at the site or to transport hazardous material from the site.
Standards Applicable to Transporters of Applicable Hazardous Waste - RCRA Section 3003	40 CFR Parts 262 and 263 40 CFR Parts 170-179	Establishes the responsibility of offsite transporters of hazardous waste in the handling, transportation, and management of the waste. Requires manifesting, recordkeeping, and immediate action in the event of a discharge.	This regulation will be applicable to any company contracted to transport hazardous material from the site.
New York State Department of Transportation (NYSDOT) Rules for Transportation of Hazardous Materials	49 CFR Parts 107, 171.1 - 172.558	Outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous waste.	Any company contracted to transport hazardous material from the site will be required to follow these regulations.
New York Regulations for Transportation of Hazardous Waste	6 NYCRR Part 372.3 a-d	Outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous waste.	These requirements will be applicable to any company contracted to transport hazardous materials from the site.
Waste Transporter Permits	6 NYCRR Part 364	Governs the collection, transport, and delivery of regulated waste within New York State.	Properly permitted haulers will be used if any waste materials are transported off site.
New York Regulations for Hazardous Waste Management Facilities	6 NYCRR Parts 373 - 1.1 - 373 - 1.8	Provides requirements and procedures for obtaining a permit to operate a hazardous waste Treatment, Storage, Disposal Facility (TSDF). Also lists contents and conditions of permits.	Any offsite facility accepting waste from the site must be properly permitted.
USEPA - Administered Permit Program: The Hazardous Waste Permit Program	RCRA Section 3005 40 CFR Part 270.124	Covers the basic permitting, application, monitoring, and reporting requirements for off-site hazardous waste management facilities.	Any offsite facility accepting waste from the site must be properly permitted. Implementation of the site remedy will include consideration of these requirements.

TABLE 2-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL ACTION-SPECIFIC SCGs

Regulation	Citation	Summary of Requirements	Considerations in the Remedial Process/Action for Attainment
New York Hazardous Waste Management System - General	6 NYCRR Part 370	Provides definitions, terms, and general instructions for the Part 370 series of hazardous waste management.	Hazardous waste is to be managed according to this regulation.
New Discharges to Publicly Owned Treatment Works (POTW)	TOGS 1.3.8	Focuses on the effects of a new, increased, or changed discharge to a POTW and the potential effects on the POTWs SPDES permit and pre-treatment program.	Would be applicable for discharge of treated groundwater or other waste waters generated during the remedial activities that are discharged to a POTW.
RCRA - General Standards	40 CFR Part 264.111	General performance standards requiring minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous decomposition products. Also requires decontamination or disposal of contaminated equipment, structures, and soils.	Proper design considerations will be implemented to minimize the need for future maintenance. Decontamination activities and facilities will be included.
CAA-NAAQS	40 CFR Part 50	Establishes ambient air quality standards for protection of public health.	Remedial operations will be performed in a manner that minimizes the production of benzene and particulate matter.
NYSDEC TAGMs	NYSDEC TAGMs	TAGMs are NYSDEC guidance that are to be considered during the remedial process.	Appropriate TAGMs will be considered during the remediation process.

TABLE 2-3

SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL LOCATION-SPECIFIC SCGs

Regulation	Citation	Summary of Requirements	Considerations in the Remedial Process/Action for Attainment
Floodplains Management	40 CFR Appendix A to Part 6	Procedures on floodplain management and wetlands protection.	Activities taking place within floodplains must be done to avoid adverse impacts and preserve beneficial values in floodplains.
Hazardous Waste Facility Located on a Floodplain	40 CFR Part 264.18(b)	Requirements for a Treatment, Storage, Disposal Facility (TSDF) within a 100-year floodplain.	Hazardous waste TSDF activities must be designed and operated to avoid washout.
National Historic Preservation Act	36 CFR Part 800	Requirements for preservation of historic properties.	Activities taking place on a site on or under consideration for placement on the National Register of Historic Places must be planned to preserve the historic property and minimize harm.
Preservation of Area Containing Artifacts	36 CFR Part 65	Requirements for preservation of historical/ archeological artifacts.	Activities must be done to identify, preserve, and recover artifacts if the site has been identified as containing a significant historical artifact.
New York Hazardous Facility Located on Floodplain	6 NYCRR Part 373-2.14	Requirements for a TSDF within 100-year floodplain.	Hazardous waste TSDF activities must be designed and operated to avoid washout.
New York Preservation of Historic Structures or Artifacts	Section 14.09	Requirements for preservation of historical/ archeological artifacts.	Activities must be done to identify, preserve, and recover artifacts if the site has been identified as containing a significant historical artifact.
Discharge of Dredge or Fill Material into Waters of the United States	40 CFR Part 230	Requirements for discharge of fill material or dredge material into waters of the United States.	Activities resulting in the discharge of fill material or dredge material to Schermerhorn Creek must be done under a permit from the United States Army Corps of Engineers.
Modifications to Waterways that Affect Fish or Wildlife	40 CFR Part 6.302	Requirements for protecting fish or wildlife when diverting, channeling, or otherwise modifying a stream or river.	If activities result in the modification of Schermerhorn Creek, measures must be taken to protect fish or wildlife.
National Environmental Policy Act	40 CFR Part 6.302 40 CFR Part 6, App. A	USEPA - two executive orders: 11988 - Floodplain Management - Requires federal agencies, where possible, to avoid or minimize adverse impacts of federal actions upon wetlands/floodplains and enhance natural values of such.	Executive orders may be considered if work conducted will affect floodplains.
Rivers and Harbors Act	33 CFR Parts 320-330	Prohibits unauthorized obstruction or alteration of any navigable water in the U.S. (dredging, fill, cofferdams, piers, etc.). Requirements for permits affecting "navigable waters of the U.S."	Remedial activities may include dredging, damming, and/or armoring. If dredging and/or armoring is performed, a permit may be required for work in "navigable waters of the U.S."

TABLE 2-3

SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL LOCATION-SPECIFIC SCGs

Regulation	Citation	Summary of Requirements	Considerations in the Remedial Process/Action for Attainment
CWA - Discharge to Waters of the U.S.	Section 404	Types of discharges regulated under CWA include: discharge to surface water or ocean, indirect discharge to a POTW, and discharge of dredged or fill material into waters of the U.S. (including wetlands).	May be relevant and appropriate for remediation alternatives which discharge water back to the Creek or include dredging/filling.
Protection of Waters Program	6 NYCRR Part 608	Protection of waters permit program regulates: 1) any disturbance of the bed or banks of a protected stream or water course; 2) construction and maintenance of dams; and 3) excavation or fill in waters of the state.	Remedial actions involving disturbance of a protected water course or excavation fill in waters of the state would require a permit issued by the NYSDEC.
Endangered Species Act	16 USC 1531 et seq. 50 CFR Part 200 50 CFR Part 402	Requires federal agencies to ensure that the continued existence of any endangered or threatened species and their habitat will not be jeopardized by a site action.	The Fish and Wildlife Impact Analysis conducted during the Remedial Investigation does not indicate the presence of endangered species on the site.
Floodplain Management Criteria for State Projects	6 NYCRR Part 502	Establishes floodplain management practices for projects involving state-owned and state-financed facilities.	Remedial activities involving placement of fill in the 100-year floodplain should consider these management practices.

TABLE 4-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SOIL

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
No Action	No Action	No Action	Alternative would not include any remedial action.	Technically feasible
Institutional Controls	Administrative Controls	Environmental Easements	Environmental easements for the property would include restrictions on future site use and subsurface construction or maintenance activities.	Potentially applicable. Can be effective when implemented in combination with other technologies.
In-Situ Containment/ Control	Capping	Clay/Soil Cap	Placing and compacting clay material or soil material over impacted soil areas.	Not retained. Could be compromised by onsite activities.
		Asphalt Concrete Cap	Application of a layer of asphalt or concrete over impacted soil areas.	Technically feasible.
		Multi-Media Cap	Application of clay material and a synthetic membrane over impacted soil areas.	Not retained. Could be compromised by onsite activities.
	Containment	Water-tight Steel Sheetpiling	Steel sheetpiles are driven into the subsurface to contain impacted soil and control potential offsite migrations of impacted groundwater. The sheetpile wall is typically keyed into a confining unit.	Technically feasible.
		Slurry Wall	Involves excavating a trench and adding a slurry (e.g., soil/cement-bentonite mixture) to contain impacted soil and control potential offsite migration of impacted groundwater and NAPL. Slurry walls are typically keyed into a confining unit.	
In-Situ Treatment	Immobilization	Stabilization/Solidification	Treatment process that immobilizes constituents of concern within a solid mass (monolith). A solid monolith is formed by injecting and/or mixing an immobilization agent (e.g., Portland cement, lime, polymerics, proprietary agents) into the media. Several technologies, including large-diameter auger/mixing and jet-grouting, are available.	Technically feasible. Requires bench-scale testing to identify optimal mixture of immobilization components to match site conditions.
		Vitrification	Immobilizes or destroys constituents by melting the media utilizing electrical currents. The melted media then solidifies to form a glass-like monolith.	Not retained. Existing subsurface natural gas utilities are a potential explosion concern.

TABLE 4-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SOIL

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
In-Situ Treatment (cont'd)	Extraction (cont'd)	Steam Stripping	Steam is used to remove VOCs from the media. The removed COCs are collected, recondensed, and treated.	Not retained. Process is not proven to be effective on SVOCs. Presence of underground utilities and active site operations would inhibit this process.
		Soil Vapor Extraction (SVE)	A vacuum is created to extract volatile and some semi-volatile contaminants (VOCs and SVOCs) from the soil. The gas leaving the soil may be treated or destroyed	Not retained. Process may not be effective on NAPL. In addition, the shallow depth to groundwater and depth of NAPL are additional factors that make this technology prohibitive.
		Six-Phase Soil Heating	Electricity is applied to six subsurface electrodes to promote electrical resistive heating of soil and groundwater. This process is conducted in conjunction with SVE to extract organic compounds volatilized by the heating process.	Not retained. Subsurface utilities would impede the implementation of this process. Process requires large amount of surface area to implement.
		Dynamic Underground Stripping and Hydrous Pyrolysis/Oxidation (DUS/HPO)	Steam is injected into the subsurface to mobilize contaminants and NAPLs. The mobilized contaminants are captured and constituents are recondensed, collected, and treated. In addition, HPO can degrade contaminants in subsurface heated zones. In most cases, this technology requires long-term operation and maintenance of onsite injection, collection, and/or treatment systems.	Not retained. This process may facilitate uncontrolled NAPL migration.
		Soil Flushing	Groundwater is extracted via extraction wells, passed through a treatment system (if necessary), extraction media is introduced into the water, and the water is then reinjected into the source areas to flush constituents from the impacted soil.	Not retained. COCs are not readily soluble, the majority of the NAPL encountered at the site is currently within the saturated zone.

TABLE 4-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SOIL

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
In-Situ Treatment (cont'd)	Biodegradation	Enhanced Biodegradation	COCs in soil are degraded by naturally occurring organisms in the soil in an aerobic or anaerobic environment. Typically, oxygen and/or nutrients are added to the impacted materials to stimulate the biodegradation process.	Not retained. Although there is strong evidence that biodegradation is likely occurring, the time frame for treatment of NAPL would be prohibitive.
In-Situ Treatment	Biodegradation	In-situ Anaerobic Biodegradation	Degradation of constituents by utilizing micro-organisms in an anaerobic environment.	Not retained. Nitrate (a regulated compound) injection would be required which may impact groundwater quality.
Removal	Excavation	Excavation	Physical removal of media containing constituents of concern to prevent future migration and exposure. Typical excavation equipment includes backhoes, loaders, and/or bulldozers.	Technically feasible.
Ex-Situ Onsite Treatment	Recycle/Reuse	Onsite Asphalt Batching (Cold-Mix/Hot-Mix)	Impacted soil is excavated and mixed at the site with a heated asphalt emulsion and Portland cement to stabilize the soil. The end product material may be used as structural fill above the groundwater table.	Technically feasible, although the volume of impacted material may be prohibitive for finding use for the asphalt.
	Extraction	Solvent Extraction	Impacted soil and solvent are mixed in an extractor. The extracted solution is placed in a separator, where the contaminants and extract are separated for further treatment.	Not retained. COCs may not readily dissolve. Trace solvent could remain in treated soil and may add to subsurface issues.
		Low-Temperature Thermal Desorption (LTTD)	Process by which soils are heated to temperatures less than 800^{o}F and the organic compounds are desorbed from the soils into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction.	Technically feasible.
		Steam Stripping	Steam is used to remove VOCs from the media. The removed COCs are collected, recondensed, and treated.	Not retained. Process is not as effective on PAHs.
	Thermal Destruction	Onsite Incineration	Use of a mobile incineration unit installed onsite for high-temperature thermal destruction of the organic compounds present in the media.	Technically feasible.

TABLE 4-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SOIL

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
Ex-Situ Onsite Treatment (cont'd)	Biodegradation	Bioreactor	An aqueous slurry is created by combining soil, sediment, or sludge with water and other additives. The slurry is mixed to keep solids suspended and micro-organisms in contact with the soil contaminants. Upon completion of the process, the slurry is dewatered and the treated soil is disposed.	Not retained. Soil volume to be treated, the presence of coal tar NAPL, and required treatment time is prohibitive for this technology.
		Biopile	Air and amendments are circulated throughout an engineered pile of impacted sediments to enhance degradation of organic compounds.	Not retained. Impacted soil volumes make this technology process prohibitive given the time required treatment time and the available space at the site.
		Land Farming	Media is typically mixed with moisture, nutrients, and oxygen to enhance aerobic biodegradation of organic compounds.	Not retained. Space at the site is limited for this process. Potential release of volatile organics during material processing.
		Composting	Piles of media are created to enable oxygen, moisture, and nutrient amendments to be added in order to enhance degradation by aerobic micro-organisms.	Not retained. Space at the site is limited for this process. Large amounts of reducing amendments may be required.
	Chemical Treatment	Chemical Oxidation	Addition of oxidizing agents to degrade organic constituents to less-toxic by-products.	Not retained. Large amounts of oxidizing agents may be required. Not known to be effective when applied to large accumulations of NAPL.
	Onsite Disposal	RCRA Landfill	Construction of a landfill that would meet RCRA requirements.	Not retained. Shallow depth to groundwater may render a landfill infeasible or may preclude construction/state approval of a waste cell. Space limitations further make onsite landfilling infeasible.

TABLE 4-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SOIL

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
Ex-Situ Onsite Treatment (cont'd)	Onsite Disposal (cont'd)	Solid Waste Landfill	Construction of a landfill that would meet NYSDEC solid waste requirements.	Not retained. Shallow depth to groundwater may render a landfill infeasible or may preclude construction/state approval of a waste cell. Space limitations further make onsite landfilling infeasible.
Offsite Treatment/Disposal	Recycle/Reuse	Offsite Asphalt Batching (Cold-Mix/Hot-Mix)	Impacted soil is excavated and mixed at an offsite facility with a heated asphalt emulsion and Portland cement to stabilize the VOCs in the soil. The end product material may be used as structural fill above the groundwater table.	Not retained. Facilities capable of utilizing MGP-impacted material for this purpose are limited.
		Brick/Concrete Manufacture	Soil is used as a raw material in manufacture of bricks or concrete. Heating in ovens during manufacture volatilizes organics and some inorganics. Other inorganics are bound into the product.	Not retained. Facilities capable of utilizing MGP-impacted material for this purpose are limited.
		Fuel Blending/Co-Burn in Utility Boiler	Soil is blended with feed coal to fire a utility boiler used to generate steam. Organics are destroyed.	Not retained. Facilities permitted to accept MGP residuals are limited.
	Extraction	Low-Temperature Thermal Desorption (LTTD)	Process by which soils are heated to temperatures less than 800°F and the organic compounds are desorbed from the soils into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction.	Technically feasible.
	Thermal Destruction	Incineration	Process which uses high temperatures to thermally destruct organic compounds present in media.	Not retained due to limited number of permitted treatment facilities.
	Offsite Disposal	RCRA Landfill	Disposal of media in an existing RCRA permitted landfill.	Technically feasible.
		Solid Waste Landfill	Disposal of media in an existing permitted non-hazardous landfill.	Technically feasible for non-hazardous soil.

Note:

1. Shading indicates that technology process has not been retained for development of a remedial alternative.

TABLE 4-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
No Action	No Action	No Action	Alternative would not include any remedial action.	Technically feasible.
Institutional Controls	Administrative Controls	Environmental Easements/ Groundwater Use Restrictions	Environmental easements for the property and downgradient offsite properties may include restrictions on use of groundwater.	Potentially applicable. Can be effective when implemented in combination with other technologies.
In-Situ Containment/ Control	Capping/Infiltration Control	Clay/Soil Cap	Placing and compacting clay material or soil material to minimize infiltration of storm water.	Not retained. Could be compromised by onsite activities.
		Asphalt Concrete Cap	Application of a layer of asphalt or concrete to minimize infiltration of storm water.	Technically feasible.
		Multi-Media Cap	Application of clay material and a synthetic membrane over impacted soil areas.	Not retained. Could be compromised by onsite activities.
	Hydraulic Containment	Water-tight Steel Sheetpiling	Water-tight steel sheetpiles are driven to the depth of a confining geologic unit to limit offsite migration of groundwater and NAPL. Sheetpiling is typically driven into a confining unit.	Technically feasible.
		Slurry Wall	Involves excavating a trench and backfilling with a cement-bentonite or soil-bentonite slurry to control potential offsite migration of impacted groundwater and NAPL. Slurry walls are typically keyed into a confining unit.	Technically feasible.
In-Situ Treatment	Biological Treatment	Groundwater Monitoring	Natural biological and physical processes that result in the reduction of concentration, toxicity, and mobility of chemical constituents. Conducted in conjunction with long-term monitoring.	Technically feasible.

TABLE 4-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
In-Situ Treatment (cont'd)	Biological Treatment (cont'd)	Enhanced Aerobic Biodegradation	Degradation of constituents by utilizing micro-organisms in an aerobic environment with the addition of amendments and controls to enhance the process performance and decrease treatment duration.	Technically feasible.
		Anaerobic Biodegradation	Degradation of constituents utilizing micro-organisms in an anaerobic environment.	Not retained. Nitrate injection (a regulated compound) would be required which may impact groundwater quality.
		Biosparging	Indigenous micro-organisms are used to biodegrade organic constituents in the saturated (biosparging) zone. Air (or oxygen) and nutrients (if needed) are injected into the saturated and unsaturated zones to increase the biological activity of the indigenous micro-organisms.	Technically feasible.
	Chemical Treatment	Chemical Oxidation	Addition of oxidizing agents (e.g., ozone, hydrogen peroxide) below the water table to degrade organic constituents to less-toxic byproducts.	Technically Feasible
		Permeable Reactive Barrier (PRB)	PRBs are installed in or down gradient from the flow path of a contaminant plume. The contaminants in the plume react with the media inside the barrier to either break the compound down into harmless products or immobilize contaminants by precipitation or sorption.	Technically feasible.

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SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
In-Situ Treatment (cont'd)	Extraction	Dynamic Underground Stripping and Hydrous Pyrolysis/Oxidation (DUS/HPO)	Steam is injected into the subsurface to mobilize contaminants and NAPLs. The mobilized contaminants are captured and constituents are recondensed, collected, and treated. In addition, HPO can degrade contaminants in subsurface heated zones. In most cases, this technology requires long-term operation and maintenance of onsite injection, collection, and/or treatment systems.	Not retained. This process may facilitate uncontrolled NAPL migration.
Removal	Groundwater Removal	Vertical Extraction Wells	Vertical wells are installed and utilized to recover groundwater for treatment/ disposal and containment/migration control.	Technically feasible.
		Horizontal Extraction Wells	Horizontal wells are utilized to replace conventional well clusters in soil and containment/migration control.	Technically feasible.
		Collection Trenches	A zone of higher permeability material is installed within the desired capture area with a perforated collection pipe placed laterally along the base of the trench to direct water to a collection area for treatment and/or disposal.	Technically feasible.
	NAPL Removal	Active Removal	Process by which automated pumps are utilized to remove DNAPL from recovery wells.	Technically feasible.
		Passive Removal	NAPL is passively collected in vertical wells and periodically removed (i.e., via bottom-loading bailers, manually operated pumps, etc.).	Technically feasible. May be applicable for use with a hydraulic containment technology process.

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PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
Removal (cont'd)	NAPL Removal (cont'd)	Collection Trenches	A zone of higher permeability material is installed within the desired capture area with a perforated collection trench placed laterally along the base to direct NAPL and groundwater to a collection area for treatment and/or disposal.	Technically feasible. May be applicable for use with a hydraulic containment technology process.
		Hot Water/Steam Injection	Process involves the injection of hot water and/or steam to heat groundwater and decrease the viscosity of DNAPL to facilitate mobilization and removal. Used in conjunction with one (or more) of the above recovery technologies.	Not retained. This process may facilitate uncontrolled migration of NAPL.
Ex-Situ Onsite Treatment	Chemical Treatment	Ion Exchange	Exchange of constituent cationic or anionic ions in the groundwater with ions held by an ion exchange material. Typically used to remove metallic elements and inorganic ions.	Not retained. Not proven to effectively treat organics.
		Ultra-violet (UV) Oxidation	Oxidation by subjecting groundwater to UV light and ozone. If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts.	Technically feasible. Would need pretreatment to remove grease and reduce turbidity which could foul UV lights and reduce treatment effectiveness.
		Chemical Oxidation	Addition of oxidizing agents to degrade organic constituents to less-toxic byproducts.	Technically feasible
	Physical Separation	Carbon Adsorption	Process by which organic constituents are adsorbed to the carbon as groundwater is passed through carbon units.	Technically feasible for use in groundwater treatment train.

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PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
Ex-Situ Onsite Treatment (cont'd)	Physical Separation (cont'd)	Filtration	Extraction of groundwater and treatment using filtration. Process in which the groundwater is passed through a granular media in order to removed suspended solids by interception, straining, flocculation, and sedimentation activity within the filter.	Technically feasible for use as a pre-treatment method. This technology will not treat dissolved-phase organics.
		Air Stripping	A process in which VOCs are removed through volatilization by increasing the contact between the groundwater and air.	Technically feasible.
		Precipitation/Coagulation/ Flocculation	Process which transforms dissolved constituents into insoluble solids by adding coagulating agents to facilitate subsequent removal from the liquid phase by sedimentation/ filtration.	Technically feasible for use as a pre-treatment method. Would not effectively treat organics.
		Oil/Water Separation	Process by which insoluble oils are separated from water via physical separation technologies, including gravity separation, baffled vessels, etc.	Technically feasible.
Offsite Treatment/ Disposal	Groundwater Discharge	Discharge to a local Publicly Owned Treatment Works (POTW)	Treated or untreated water is discharged to a sanitary sewer and treated at a local POTW facility.	Technically feasible.
		Discharge to Surface Water via Storm Sewer	Treated or untreated water is discharged to surface water, provided that the water quality and quantity meet the allowable discharge requirements for surface waters (NYSDEC SPDES compliance).	Technically feasible.

TABLE 4-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
Offsite Treatment/ Disposal (cont'd)	Groundwater Discharge (cont'd)	Discharge to a privately owned treatment/disposal facility.	Treated or untreated water is collected and transported to a privately owned treatment facility.	Technically feasible.
		Reinjection	Groundwater is extracted via extraction wells, passed through a treatment system, and then reinvested into the ground through injection wells.	Not retained. Difficult to obtain agency approval. Would require a higher level of treatment than other technology processes.

Note:
1. Shading indicates that technology process has not been retained for development of a remedial alternative.

TABLE 4-3

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SEDIMENT

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
No Action	No Action	No Action	Alternative would not include any active remedial action. A "No Action" alternative serves as a baseline for comparison of the overall effectiveness of other remedial alternatives. Consideration of a "No Action" alternative is required by the National Contingency Plan (NCP) and USEPA.	Technically feasible.
Institutional Controls	Institutional Controls	Governmental Controls, Proprietary Controls, Enforcement and Permit Controls, Informational Devices	Institutional controls would include legal and/or administrative controls that mitigate the potential for exposure to impacted sediment. Examples of potential institutional controls include posting of signs to mitigate potential exposure and actions that may disturb impacted sediments and/or jeopardize the integrity of the remedy.	Technically feasible.
In-Situ Containment	Containment	Sheetpile	Installation of metal sheetpile to form a hydraulic barrier at creek banks. The sheetpile wall is typically keyed into a confining unit and could be permeable or impermeable to groundwater flow.	Could be used in conjunction with another remedial technology, but would not address potential downstream migration of impacted sediment.
	Engineered Barrier	Engineered Barrier	Covering or encapsulating impacted sediment with clean sediment, gravel, sand, organoclays, Aquablok® pellet capping, geotextile, membranes, and/or armoring to physically, biologically, and/or chemically isolate impacted sediment.	Not retained. Would decrease the channel storage increasing flooding potential. May be appropriate as a channel liner following sediment removal.
	Sediment Covering	Rip-Rap	Installation of a layer of irregularly placed stones to anchor sediments.	Not retained. Would decrease the channel storage increasing flooding potential. May be appropriate as a channel liner following sediment removal.

TABLE 4-3

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SEDIMENT

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
In-Situ Treatment	Natural Recovery	Enhanced Biodegradation	Natural recovery would include the continuous deposition of clean sediment over impacted sediment and the weathering/degradation of impacted sediments. Sedimentation rates and weathering would be monitored periodically. Process is dependent upon sedimentation and degradation rates.	Not retained. Although there is evidence that biodegradation is likely occurring at the site, the time frame for treatment of NAPL would be prohibitive.
	Immobilization	Solidification/ Stabilization	Addition of material to the impacted sediment that limits the solubility or mobility of the constituents present. Involves treating sediment to produce a stable, non-leachable material that physically or chemically locks the constituents within the solidified matrix.	Not retained. Would decrease the channel storage increasing flooding potential. May be appropriate as a channel liner following sediment removal.
Removal	Dredging	Mechanical	Either conventional construction equipment (e.g., backhoes) or mechanical dredging equipment (e.g., clamshell) is used to remove all or some of the impacted materials for subsequent treatment and/or disposal. Removal can be performed "in the wet" or "in the dry" by using temporary structures (e.g. sheetpiling).	Technically feasible. Removal "in the dry" would be preferable since space to perform water treatment is limited.
		Hydraulic	Sediments are removed in liquid slurry form using pumps, suction hose, horizontal auger, and/or cutterhead dredge. Simultaneously removes large quantities of water. Space needed for dewatering and water treatment facilities.	Not retained. Potentially implementable; however, not appropriate for the relatively small sediment volume and coarse sediment conditions.
Ex-Situ Onsite Treatment	Extraction	Low Temperature Thermal Desorption (LTTD)	Process by which sediment containing organics with boiling point temperatures less than 800^{o}F are heated and the organic compounds are desorbed from the sediment into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction.	Technically feasible.

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SCHENECTADY, NEW YORK

PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SEDIMENT

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
Ex-Situ Onsite Treatment (cont'd)	Extraction (cont'd)	Steam stripping	A steam unit is used to remove constituents from impacted sediment. The removed constituents are recondensed, collected, and treated.	Not retained. Process is not proven to be effective on SVOCs. Presence of underground utilities and active site operations would inhibit this process.
		Solvent Extraction	Impacted sediment and solvent are mixed in an extractor. The extracted solution is placed in a separator, where the contaminants and extract are separated for further treatment.	Not retained. COCs may not readily dissolve. Trace solvent could remain in treated soil and may add to subsurface issues.
	Recycle/Reuse	Onsite Asphalt Batching (Cold-Mix/Hot-Mix)	Impacted sediment is excavated and mixed at the site with a heated asphalt emulsion and Portland cement to stabilize the material. The end product material may be used as structural fill above the groundwater table.	Technically feasible.
	Thermal Destruction	Incineration	Use of a mobile incineration unit installed onsite for high temperature thermal destruction of the organic compounds present in the media.	Technically feasible.
Offsite Treatment and/or Disposal	Recycle/Reuse	Asphalt Concrete Batch Plant	Sediment is used as a raw material in asphalt/concrete paving mixtures. The impacted sediment is transported to an offsite asphalt concrete facility and can replace part of the aggregate and asphalt concrete fraction. The hot-mix process melts asphalt concrete prior to mixing with aggregate. During the cold mix process, aggregate is mixed at ambient temperature with an asphalt-concrete-water emulsion. Organics and inorganics are bound in the asphalt concrete. Some organics may volatilize in the hot mix.	Not retained based on limited facilities that will accept this type of waste material.
		Brick/Concrete Manufacture	Sediment is used as a raw material in manufacture of bricks or concrete. Heating in ovens during manufacture volatilizes organics and some inorganics. Other inorganics are bound into the product.	Not retained based on limited facilities that will accept this type of waste material.

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PRELIMINARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SEDIMENT

General Response Action	Remedial Technology	Technology Process	Description	Screening Comments
Offsite Treatment and/or Disposal (cont'd)	Recycle/Reuse (cont'd)	Co-Burn in Utility Boiler	Sediment is blended with feed coal to fire a utility boiler used to generate steam. Organics are destroyed.	Not retained. Permitted facilities available for burning MGP sediments are limited.
	Extraction	Low-Temperature Thermal Desorption (LTTD)	Process by which sediments are heated to temperatures less than 800^{o}F and the organic compounds are desorbed from the soils into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction.	Technically feasible.
	Thermal Destruction	Incineration	Process which uses high temperatures to thermally destruct organic compounds present in media.	Not retained due to limited number of permitted treatment facilities.
	Disposal	Solid Waste Landfill	Disposal of impacted sediment in an existing permitted non-hazardous landfill.	Technically feasible.
		RCRA Landfill	Disposal of impacted sediment in an existing RCRA permitted landfill facility.	Technically feasible.

Note:
1. Shading indicates that technology process has not been retained for development of a remedial alternative.

TABLE 4-4

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SOIL

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
No Action	No Action	No Action	Does not achieve RAOs for soil. A "No Action" alternative serves as a baseline for comparison of the overall effectiveness of other remedial alternatives. Consideration of a "No Action" alternative is required by the National Contingency Plan (NCP).	Not applicable.	None
Institutional Controls	Administrative Controls	Environmental Easements	This technology process alone would not meet the RAOs for soil. However, institutional controls could be effective when used in conjunction with other remedial technologies.	Readily implementable.	Low
In-Situ Containment/ Control	Capping	Asphalt Concrete Cap	This technology process alone would not meet the RAOs for soil. Effective for reducing storm water infiltration and reducing direct contact. Long-term effectiveness requires ongoing maintenance and monitoring.	Implementable. Equipment and materials necessary to construct the cap are readily available.	Moderate
	Containment	Water-tight Steel Sheetpiling	Would effectively limit the potential for future offsite NAPL migration. Could be used with a low permeability cap to effectively address the RAOs for onsite soil. May be implemented in conjunction with a groundwater extraction/treatment system or Permeable Reactive Barrier.	Implementable, would require trenching through fill material to facilitate installation. May require temporary disconnection of utilities that cross proposed path of wall.	Moderate to High
		Slurry Wall		Implementable, bench-scale study necessary to determine permeability and compatibility of slurry wall with NAPL and COCs. May require specialized design or alternative methods to install beneath subsurface utilities.	Moderate to High

TABLE 4-4

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SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SOIL

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
In-Situ Treatment	Immobilization	Stabilization/ Solidification	In-situ soil stabilization (ISS) would immobilize impacted soil and stabilize/encapsulate NAPL effectively mitigating potential migration. Bench scale testing required to determine appropriate stabilizing agent, long-term compatibility with NAPL and COCs, and the leachate potential for the solidified material. Could be used to focus on areas where NAPL is concentrated to minimize the potential for migration. Could be used in conjunction with a barrier wall to effectively minimize the potential for offsite migration of NAPL. Also could be used in the vicinity of subsurface foundations and utilities to eliminate the need for excavation of foundation and reduce risk of excavating around subsurface gas utilities.	Implementable. Materials, equipment, and contractors capable of implementing this technology are available.	Moderate to High
Removal	Excavation	Excavation	Physical removal of impacted soil. Typical excavation equipment includes backhoes, excavators, loaders, and/or bulldozers. Excavation may be difficult below the groundwater table. Would be very difficult to remove all impacted material.	Technically implementable. Equipment capable of excavating the soil is readily available. Site conditions (i.e., presence of subsurface utilities and shallow groundwater) inhibits excavation in select areas of the site.	High
Ex-Situ Onsite Treatment	Recycle/Reuse	Onsite Asphalt Batching (Cold-Mix/Hot-Mix)	Effective for treating organics and inorganics through volatilization and encapsulation. Thermal pretreatment may be required to prevent leaching. No long-term data available. Quality of resulting asphalt material (e.g., permeability, strength, etc.) may not meet appropriate specification for onsite use. Bench-scale testing would be required to determine effectiveness.	Not retained. Space at project site is limited and volume of impacted soil may be prohibitive for finding a use for asphalt.	Moderate

TABLE 4-4

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SOIL

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
Ex-Situ Onsite Treatment (cont'd)	Extraction	Low-Temperature Thermal Desorption (LTTD)	Proven process for effectively addressing organic constituents.	Not retained. Space at project site is limited. Onsite LTTD system would require at least 1 acre of space for pre-treatment, treatment, and post treatment operations.	High
	Thermal Destruction	Onsite Incineration	Proven process for effectively addressing organic constituents.	Not retained. Space at project site is limited.	High
Offsite Treatment/ Disposal	Extraction	Low-Temperature Thermal Desorption (LTTD)	The target contaminants for LTTD are SVOCs, PAHs, PCBs, and pesticides. VOCs and fuels may also be treated, but treatment may be less efficient.	Implementable. Could potentially be conducted offsite locally using a mobilized LTTD system if land is available. Dewatering/stabilization would be necessary to reduce the amount of energy required to heat the soil.	High
	Offsite Disposal	RCRA Landfill	Offsite disposal is applicable to the complete range of contaminant groups with no particular target group.	Implementable. Would require complying with permitting, manifesting, recordkeeping, packaging, labeling, and transporting requirements provided in the state and federal regulations. Pre-treatment of soil may be required to meet land disposal restrictions (LDRs).	High
		Solid Waste Landfill	Offsite disposal is applicable to the complete range of contaminant groups with no particular target group.	Implementable. Would require complying with permitting, manifesting, recordkeeping, packaging, labeling, and transporting requirements provided in state and federal regulations.	Moderate to High

Note:
1. Shading indicates that technology process has not been retained for development of a remedial alternative.

TABLE 4-5

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
No Action	No Action	No Action	Does not achieve RAOs for groundwater. A "No Action" alternative serves as a baseline for comparison of the overall effectiveness of other remedial alternatives. Consideration of a "No Action" alternative is required by the National Contingency Plan (NCP).	Not applicable.	None
Institutional Controls	Use Restrictions	Environmental Easements/ Groundwater Use Restrictions	This option alone would not meet the RAOs for soil. However, institutional controls could be used in conjunction with other remedial technologies to achieve RAOs.	Readily implementable.	Low capital and O&M costs
In-Situ Containment/ Control	Capping	Asphalt Concrete Cap	This technology process alone would not meet the RAOs for groundwater. Effective for reducing storm water infiltration and reducing direct contact. Long-term effectiveness requires ongoing maintenance and monitoring.	Implementable. Equipment and materials necessary to construct the cap are readily available.	Moderate
	Hydraulic Containment	Water-tight Steel Sheetpiling	Would effectively limit the potential for future offsite migration of impacted groundwater, as well as contain the primary source for ongoing dissolved-phase impacts to offsite groundwater. This technology would not reduce the concentration of COCs in the groundwater within the containment area.	Implementable - may require temporary or permanent relocation of subsurface natural gas utilities.	Moderate to High
		Slurry Wall	Would effectively limit the potential for future offsite migration of impacted groundwater, as well as contain the primary source for ongoing dissolved-phase impacts to offsite groundwater. This technology would not reduce the concentration of COCs in the groundwater within the containment area.	Implementable areas of site may be difficult to trench due to the presence of subsurface natural gas utilities.	Moderate
In-Situ Treatment	Biological Treatment	Groundwater Monitoring	Based on the results of a site-specific natural attenuation evaluation following removal, containment, isolation of NAPL, and/or MNA could be effective at preventing significant migration of the downgradient dissolved-phase impacted groundwater if the source material (i.e., NAPL) was removed or prevented from continuing to contribute to the dissolved-phase impacts to groundwater.	Already occurring. Long-term monitoring is readily implementable.	Low

TABLE 4-5

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
In-Situ Treatment (cont'd)	Biological Treatment (cont'd)	Enhanced Biodegradation	Biodegradation primarily works on dissolved-phase constituents. This technology process may provide potentially marginally increase degradation rates and would not effectively increase the rate that COCs in NAPL would diffuse, dissolve, or disperse into groundwater. Would require large amount of oxygen, air, or other agent to create and support an aerobic environment.	Not retained. Technology available would require large addition of air/amendments to create and sustain aerobic environment.	High
		Biosparging	Would require closely spaced (approximately 15 feet on center) injection points. Dissolved-phase plume extends offsite to the west and northwest. Would require purchase or arrangement with neighboring properties and/or property owners.	Technology is available, but difficult to install injection points, especially downgradient of the site.	High
	Chemical Treatment	Permeable Reactive Barrier (PRB)	NAPL located along downgradient property boundary would inhibit effectiveness of PRB.	Technically feasible, but the presence of NAPL would inhibit effectiveness.	Moderate
		Chemical Oxidation	Proven process for effectively treating organic compounds. Limited full-scale data is available. Unlikely that in-situ chemical oxidation would achieve applicable SCGs.	Easily implemented. May require special provisions for storage of process chemicals. Would require a substantial amount of oxidant and potentially more than 100 injection points.	Moderate
Removal	Groundwater Removal	Vertical Extraction Wells	Could be used to effectively remove groundwater. Without removal/control of source material (i.e., NAPL) pumping would be require for many years. Also would provide hydraulic containment/migration control of dissolved phase plume.	Easily implementable. Equipment and tools necessary to install and operate vertical extraction wells are readily available.	High
		Horizontal Extraction Wells	Proven process for effectively extracting groundwater. Implementation of this process along with treatment could effectively achieve the RAOs for groundwater.	Not retained. Requires specialized horizontal drilling equipment. Not necessarily appropriate for the site.	High
		Collection Trenches	Effective technology to collect and convey groundwater.	Technically feasible.	Low to Moderate

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NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
Removal (cont'd)	NAPL Removal	Collection Trench	Could have limited effectiveness in collecting LNAPL encountered east of Open Garage. DNAPL in impacted soil is discontinuous and the presence of DNAPL is more concentrated in fine sand seams and immediately on top of the silt and clay unit. Distribution of DNAPL at the site indicates minimal lateral migration of DNAPL. Effectiveness of removal may be limited.	Technically implementable. Portions of the site are accessible for installing NAPL collection trenches. Equipment and materials to construct a NAPL collection trench are readily available.	Low to Moderate
		Active Removal	May be effective in removing LNAPL encountered east of Open Garage. Based on the viscosity of DNAPL observed during investigation activities, may have limited effectiveness.	Technically feasible.	Low to Moderate
		Passive Removal	Strategic placement of NAPL recovery wells may have limited effectiveness at collecting NAPL. As indicated above, NAPL is concentrated in fine sand seams and on top of the silt and clay unit.	Technically implementable. Would require several wells screened at various depth intervals due to distribution of NAPL in the subsurface.	Low
Ex-Situ Onsite Treatment	Chemical Treatment	UV Oxidation	Presence of particulates and grease could result in UV lamp fouling and limit treatment effectiveness. Pretreatment would be required to remove grease and reduce turbidity.	Technically feasible.	Moderate to High
		Chemical Oxidation	Proven process for effectively treating organic compounds. Limited full-scale data is available. Unlikely that in-situ chemical oxidation would achieve applicable SCGs.	Technically feasible, but would require the removal of groundwater from the subsurface. Ex-situ treatment of the groundwater would not addres NAPL remaining in the subsurface.	Moderate to High
	Physical Separation	Carbon Adsorption	The target contaminant groups for carbon adsorption are hydrocarbons and SVOCs. Limited effectiveness may be achieved on halogenated VOCs and pesticides.	Implementable.	Low to Moderate
		Filtration	Effective at removing suspended solids as part of groundwater treatment train.	Easily implemented.	Low to Moderate
		Precipitation/ Coagulation/ Flocculation	Process which transforms dissolved constituents into insoluble solids by adding coagulating agents to facilitate subsequent removal from the liquid phase by sedimentation/filtration.	Technically feasible for use as a pre-treatment method.	Low to Moderate

TABLE 4-5

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR GROUNDWATER

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
Ex-Situ Onsite Treatment (cont'd)	Physical Separation (cont'd)	Oil/Water Separation	Effective at separating insoluble oil from groundwater. This process could be used as part of the groundwater treatment train if needed to address separate-phase liquids.	Easily implemented.	Low
		Air Stripping	Air stripping is used to separate VOCs from water. Air stripping is ineffective for inorganic contaminants. Technology is more effective at removing BTEX and somewhat effective at separating SVOCs.	Implementable. May be appropriate for some of the groundwater issues at the site.	Moderate to high
Offsite Treatment/ Disposal	Groundwater Discharge	Discharge to a local Publicly-Owned Treatment Works (POTW)	Proven process for effectively disposing of groundwater. Impacted groundwater would require treatment to achieve water quality criteria established by the POTW. Treated groundwater may be subject to additional treatment at the POTW.	Easily implemented. Equipment and materials necessary to pre-treat and discharge the water to the sanitary sewer system at the site are readily available. Discharges to the sanitary sewer must meet POTW requirements.	Moderate
		Discharge to Surface Water via Storm Sewer	Proven process for effectively disposing of groundwater. Impacted groundwater would require treatment to achieve water quality discharge limits.	Easily implemented. Equipment and materials necessary to treat and discharge the water to the storm sewer system at the site are readily available. Discharges to surface water must meet the substantive requirements of a SPDES permit. Not retained due to the substantive requirements of a SPDES permit.	High
		Discharge to a privately owned treatment facility	Proven process for effectively discharging treated groundwater. Impacted groundwater would require treatment to achieve water quality criteria required by treatment facility.	Not retained would require trucking a prohibitive volume of water.	High

Note:
1. Shading indicates that technology process has not been retained for development of a remedial alternative.

TABLE 4-6

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SEDIMENT

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
No Action	No Action	No Action	Does not achieve RAOs for sediment. A "No Action" alternative serves as a baseline for comparison of the overall effectiveness of other remedial alternatives. Consideration of a "No Action" alternative is required by the National Contingency Plan (NCP).	Not applicable	None
Institutional Controls	Institutional Controls	Governmental Controls, Proprietary Controls, Enforcement and Permit Controls, Informational Devices	This technology process alone would not meet the RAOs for sediment. However, institutional controls could be used in conjunction with other remedial technology processes.	Easily implementable.	Low
In-Situ Containment	Containment	Sheetpile	Would not address potential downstream migration of impacted sediment. Could be used in conjunction with other remedial technology processes.	Implementable, could require temporary or permanent relocation of subsurface utilities.	High
Removal	Dredging	Mechanical	Would effectively address impacted sediment within the onsite portion of Schermerhorn Creek.	Implementable. Removal "in the dry" would be preferable since space to perform water treatment is limited.	Moderate to High
Ex-Situ Onsite Treatment	Recycle/Reuse	Onsite Asphalt Batching (Cold-Mix/Hot-Mix)	Effective method for reuse of the impacted sediment.	Not retained. Insufficient amount of sediment to make cost effective.	Moderate
	Extraction	Low Temperature Thermal Desorption (LTTD)	The target contaminants for LTTD are SVOCs, PAHs, PCBs, and pesticides. VOCs and fuels may also be treated, but treatment may be less cost-effective.	Not retained. Insufficient amount of sediment to make cost effective. Would require extensive dewatering to reduce amount of energy needed to treat sediments.	High
	Thermal Destruction	Incineration	Use of a mobile incineration unit installed onsite for high temperature thermal destruction of the organic compounds present in the media.	Not retained due to limited number of permitted treatment facilities.	High

TABLE 4-6

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SECONDARY REMEDIAL TECHNOLOGY SCREENING EVALUATION FOR SEDIMENT

General Response Action	Remedial Technology	Technology Process	Effectiveness	Implementability	Relative Cost
Offsite Treatment and/or Disposal	Extraction	Low-Temperature Thermal Desorption (LTTD)	The target contaminants for LTTD are SVOCs, PAHs, PCBs, and pesticides. VOCs and fuels may also be treated, but treatment may be less cost-effective.	Not retained. Insufficient amount of sediment to make cost effective. Would require extensive dewatering to reduce amount of energy needed to treat sediments.	High
	Disposal	RCRA Landfill	Offsite disposal is applicable to the complete range of contaminant groups with no particular target group.	Implementable. Would require complying with permitting, manifesting, record keeping, packaging, labeling, and transporting requirements provided in the State and Federal regulations. Pre-treatment of soil may be required to meet land disposal restrictions (LDRs).	High
		Solid Waste Landfill	Off-site disposal is applicable to the complete range of contaminant groups with no particular target group.	Implementable. Would require complying with permitting, manifesting, record keeping, packaging, labeling, and transporting requirements provided in the State and Federal regulations.	Moderate

Note:
1. Shading indicates that technology process has not been retained for development of a remedial alternative.

TABLE 5-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 2
ASPHALTIC CONCRETE CAP

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$50,000	$50,000
2	Construction and Maintenance of Soil Staging Areas	1	LS	$15,000	$15,000
3	Asphalt Removal	48,000	SF	$1.00	$48,000
4	Removal of 6" of Gravel	1,000	CY	$15	$15,000
5	Select Fill Importation	1,000	CY	$25	$25,000
6	Fill Placement, Compaction, and Grading	1,000	CY	$10	$10,000
7	Installation of 4" Bituminous Asphalt Base Course	3,600	ton	$50	$180,000
8	Installation of 2" Bituminous Asphalt Top Course	1,800	ton	$50	$90,000
9	Waste Characterization	6	ea	$750	$4,500
10	Asphalt and Gravel Disposal	3,600	ton	$100	$360,000
11	Miscellaneous Waste Disposal	1	LS	$5,000	$5,000
				Total Capital Cost	$802,500
				Administration and Engineering (10%)	$80,250
				Construction Management (20%)	$160,500
				Contingency (20%)	$160,500
				Subtotal Cost	$1,203,750
OPERATION AND MAINTENANCE COSTS					
12	Annual Cap Monitoring/Maintenance	1	LS	$5,000	$5,000
13	Verification of Institutional Controls and Notifications to NYSDEC	1	LS	$5,000	$5,000
				Total O&M Cost	$10,000
				Contingency (20%)	$2,000
				Subtotal Cost	$12,000
14				30-Year Total Present Worth Cost of O&M	$148,920
				Total Estimated Cost	**$1,352,670**
				Rounded to	**$1,400,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and materials necessary to remove upper 6 inches of existing asphalt paving, gravel, and topsoil and install an asphalt cap over the area inside the limits of the barrier wall.

2. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct an approximate 50-foot by 100-foot material staging area consisting of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil high-density polyethylene (HDPE) liner. Maintenance costs include inspecting and repairing staging area as necessary and covering staged soil with polyethylene sheeting to minimize odors and contact with precipitation.

3. Asphalt removal cost estimate includes all, equipment, and materials necessary to sawcut and remove the existing asphalt pavement (assumed to be 6 inches thick) overlying the area within the limits of the barrier wall.

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 2
ASPHALTIC CONCRETE CAP

4. Removal of 6 inches of gravel cost estimate includes all labor, equipment, and materials necessary to remove the upper 6 inches of gravel and soil to facilitate asphalt cap construction.

5. Select fill importation cost estimate includes all labor, equipment, and materials necessary to import 1,000 cubic yards of select fill material suitable for use as a sub-base material for the construction of the asphalt cap.

6. Fill placement, compaction, and grading cost estimate includes all labor, equipment, and materials necessary to place, compact, and grade 1,000 cubic yards of select fill in the gravel removal areas for the construction of the asphalt cap.

7. Installation of 4" bituminous asphalt course cost estimate includes all labor, equipment, and materials necessary to install a 4-inch layer (approximately 6 inches prior to compaction) of bituminous asphalt. The weight of the material was calculated assuming 2.0 tons per cubic yard.

8. Installation of 2" bituminous asphalt course cost estimate includes all labor, equipment, and materials necessary to install a 2-inch layer (approximately 3 inches prior to compaction) of bituminous asphalt base course. The weight of the material was calculated assuming 2.0 tons per cubic yard.

9. Waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, TPH, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal. The estimated weight of material was based on an assumed 1.5 tons per cubic yard of material.

10. Asphalt and gravel disposal cost estimate includes all labor, equipment, and materials necessary for the transportation and offsite disposal of the excavated asphalt and gravel at a C&D waste landfill.

11. Miscellaneous waste disposal cost estimate is based on disposal of PPE, staging area and decontamination pad materials, and disposable equipment and materials at a facility permitted to accept the waste.

12. Annual cap maintenance cost estimate includes all labor, equipment, and materials necessary to maintain the asphaltic concrete cap (e.g., sealing, repairing cracks).

13. Institutional controls cost estimate includes administrative costs associated with implementing institutional controls to minimize the potential for human exposure to remaining impacted soils. Such institutional controls may include governmental controls, proprietary controls, enforcement tools, and/or informational devices. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.

14. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

TABLE 5-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 3
CONTAINMENT BARRIER WALL

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Pre-design Soil Boring Program	1	LS	$100,000	$100,000
2	Mobilization/Demobilization	1	LS	$140,000	$140,000
3	Construct and Remove Decontamination Pad	1	LS	$15,000	$15,000
4	Install Temporary Fencing	2,000	LF	$20	$40,000
5	Construction and Maintenance of Soil Staging Areas	1	LS	$25,000	$25,000
6	Utility Location and Markout	1	LS	$7,000	$7,000
7	Pretrench Excavation	1,400	CY	$50	$70,000
8	Soil Excavation/Stabilization/Handling	10,000	CY	$40	$400,000
9	Installation of Slurry Wall	98,000	SF	$15	$1,470,000
10	Jet Grouting	2,000	CY	$525	$1,050,000
11	Provide Water	1,800,000	gal	$0.005	$9,000
12	Vapor/Odor Control	1	LS	$100,000	$100,000
13	Waste Characterization	37	ea	$750	$27,750
14	Solid Waste Transportation and Disposal	18,500	ton	$100	$1,850,000
15	Miscellaneous Waste Disposal	1	LS	$5,000	$5,000
				Total Capital Cost	$5,308,750
				Administration and Engineering (10%)	$530,875
				Construction Management (20%)	$1,061,750
				Contingency (20%)	$1,061,750
				Subtotal Cost	$7,963,125
OPERATION AND MAINTENANCE COSTS					
16	Semi-Annual Groundwater Monitoring	1	LS	$50,000	$50,000
17	Verification of Institutional Controls and Notifications to NYSDEC	1	LS	$3,000	$3,000
				Total O&M Cost	$53,000
				Contingency (20%)	$10,600
				Subtotal Cost	$63,600
18				30-Year Total Present Worth Cost of O&M	$789,276
				Total Estimated Cost	**$8,752,401**
				Rounded to	**$8,800,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Pre-design soil boring program cost includes all labor, equipment, and materials necessary to complete soil borings to the depth of till (average depth of 65 feet). Cost assumes that one boring would be completed every 50 linear-feet at the proposed location of the containment barrier wall. Cost includes drilling crew, onsite observation, and geotechnical testing (standard penetration testing and soil grain size analysis).

2. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and materials necessary to install cement-bentonite (CB) slurry containment wall.

TABLE 5-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 3
CONTAINMENT BARRIER WALL

3. Construct and remove equipment decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 40-mil high-density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

4. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

5. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct an approximate 100-foot by 200-foot material staging area consisting of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner. Maintenance costs include inspecting and repairing staging area as necessary and covering staged soil with polyethylene sheeting or odor suppressing foam, as necessary.

6. Utility location and markout cost estimate includes labor, equipment, and materials necessary to locate, identify, and markout underground utilities at the site. Cost assumes that utility location and markout would be conducted by a private utility locating company over a period of 7 days at a daily rate of $1,000 per day.

7. Pretrench excavation cost estimate includes labor, equipment, and materials necessary to identify, remove, and protect (as appropriate) subsurface utilities, historic foundations, and other shallow obstacles to facilitate excavation for the installation of the CB slurry wall. Cost estimate assumes pretrench excavation measuring approximately 2.5 feet wide, 10 feet deep, and 1,500 feet long.

8. Soil excavation, stabilization, and handling, cost estimate includes labor, equipment, and materials necessary to excavate material to facilitate installation of the CB slurry wall. Costs also include handling (i.e., transferring material from the trench excavation to the material staging area) and stabilization (e.g., addition and mixing of lime, Portland cement, or dry soil) of the excavated materials to facilitate transportation for offsite disposal. Cost assumes a trench excavation measuring approximately 2.5 feet wide, 65 feet deep, and 1,500 feet long.

9. Installation of slurry wall cost estimate includes labor, equipment, and materials necessary to install CB slurry wall. Costs provided on an installed per foot basis assuming a slurry wall measuring approximately 65 feet deep and 1,500 long Cost estimate is based on information provided by Geo-Solutions, Inc. to BBL on 10/26/06.

10. Jet-grouting cost estimate includes labor, equipment, and materials necessary to perform jet grouting to form the CB slurry wall around subsurface utilities. Cost estimate assumes approximately 160 LF of jet-grouting to a depth of 65 feet and an effective wall thickness of 3 feet (5 foot installed wall thickness assumed for overlapping jet-grout applications). Jet-grouting cost is based on information provided by Geo-Solutions, Inc. to BBL on 10/26/06.

11. Providing water cost estimate includes cost for providing mix water that would be using during construction of the CB slurry wall. Costs assume that water would be obtained from the onsite municipal water supply.

12. Vapor/odor control cost estimate includes labor, equipment, and materials necessary to apply foam/latex to soil staging area. The cost estimate assumes that a technician will be onsite 8 hours a day, 2 days a week, for 10 months. The cost assumes that a trailer-mounted foam/latex applicator will rented for 5 months and foam/latex will be applied to soils requiring vapor/odor control (assumed to be 25% of excavated soil).

13. Waste characterization cost estimate includes costs for the analysis of soil samples for PCBs, TCLP VOCs, TCLP SVOCs, TCLP metals, ignitability, corrosivity, and reactivity. Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal.

14. Solid waste transportation and disposal cost estimate includes all labor, equipment, and materials necessary to transport and dispose of excavated soils as non-hazardous waste at a permitted disposal facility. The weight of the material was calculated assuming 1.5 tons per cubic yard plus approximately 10% of weight for addition of soil stabilization materials.

15. Miscellaneous waste disposal cost estimate is based on disposal of PPE, staging area and decontamination pad materials, and disposable equipment and materials at a facility permitted to accept the waste.

TABLE 5-2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 3
CONTAINMENT BARRIER WALL

16. Semi-annual groundwater monitoring cost estimate includes all labor, equipment, and materials necessary to conduct semi-annual sampling events, analyze groundwater samples, and prepare an annual groundwater monitoring report to summarize the results of the groundwater monitoring activities. This cost estimate also includes containerizing groundwater and NAPL (if present) waste materials generated during the sampling activities. This cost estimate also includes transportation of the containerized liquid waste for disposal as a non-hazardous waste at an appropriate treatment/ disposal facility.

17. Institutional controls cost estimate includes administrative costs associated with implementing institutional controls to minimize the potential for human exposure to remaining impacted soils. Such institutional controls may include governmental controls, proprietary controls, enforcement tools, and/or informational devices. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.

18. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

TABLE 5-3

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 4
IN-SITU SOIL STABILIZATION - NAPL-IMPACTED AND POTENTIALLY NAPL-IMPACTED SOIL

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$150,000	$150,000
2	Construct and Remove Decontamination Pad	1	LS	$15,000	$15,000
3	Install Temporary Fencing	2,000	LF	$20	$40,000
4	Construction and Maintenance of Soil Staging Areas	1	LS	$25,000	$25,000
5	Utility Location and Markout	1	LS	$7,000	$7,000
6	Removal of Open Garage	1	LS	$20,000	$20,000
7	Pre-Excavation	15,500	CY	$50	$775,000
8	Jet Grouting	5,000	CY	$525	$2,625,000
9	ISS Treatment	60,000	CY	$75	$4,500,000
10	Spoils Handling	20,000	CY	$40	$800,000
11	Fill Importation, Placement, Compaction, and Grading	9,500	CY	$20	$190,000
12	Provide Mixing Water	1,800,000	gal	$0.005	$9,000
13	Vapor/Odor Control	1	LS	$100,000	$100,000
14	Waste Characterization	88	ea	$750	$66,000
15	Solid Waste Transportation and Disposal	44,000	ton	$100	$4,400,000
16	Miscellaneous Waste Disposal	1	LS	$5,000	$5,000
17	Quality Control Testing	1	LS	$122,000	$122,000
				Total Capital Cost	$13,849,000
				Administration and Engineering (10%)	$1,384,900
				Construction Management (20%)	$2,769,800
				Contingency (20%)	$2,769,800
				Subtotal Cost	$20,773,500
OPERATION AND MAINTENANCE COSTS					
18	Semi-Annual Groundwater Monitoring	1	LS	$50,000	$50,000
19	Verification of Institutional Controls and Notifications to NYSDEC	1	LS	$2,500	$2,500
				Total O&M Cost	$52,500
				Contingency (20%)	$10,500
				Subtotal Cost	$63,000
20				30-Year Total Present Worth Cost of O&M	$781,830
				Total Estimated Cost	**$21,555,330**
				Rounded to	**$21,600,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and material necessary to perform in-situ soil stabilization of NAPL-impacted potentially NAPL-impacted soil.

TABLE 5-3

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 4
IN-SITU SOIL STABILIZATION - NAPL-IMPACTED AND POTENTIALLY NAPL-IMPACTED SOIL

2. Construct and remove equipment decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 20-mil high density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct an approximate 100-foot by 200-foot material staging area consisting of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner. Maintenance costs include inspecting and repairing staging area as necessary and covering staged soil with polyethylene sheeting or odor suppressing foam, as necessary.

5. Utility location and markout cost estimate includes labor, equipment, and materials necessary to locate, identify, and markout underground utilities at the site. Cost assumes that utility location and markout would be conducted by a private utility locating company over a period of 7 days at a daily rate of $1,000 per day.

6. Removal of open garage cost estimate includes all labor, equipment, and materials necessary to dismantle/demolish the existing open garage, excavate the concrete floor slab, and recycle/dispose of the demolition debris. Cost have not been included to replace the open garage with a similar structure. Structure measures approximately 10,000 SF and cost estimate is based on $2 per square foot for demolition and disposal.

7. Pre-excavation cost estimate includes all labor, equipment, and materials necessary to remove soil to a depth of approximately 5 feet to facilitate removal of subsurface foundations associated with the former MGP operations that are located in the areas of ISS treatment including: former ammonia concentrator, tar tank, tar separator, and purifier house located north of Creek; trestle and coke bin located in the western portion of the site; and generator and condenser house located beneath open garage.

8. Jet-grouting cost estimate includes labor, equipment, and materials necessary to perform jet-grouting to facilitate ISS around subsurface utilities. Cost estimate assumes jet grouting at: 400 linear feet to a depth of 25 feet along sections of subsurface utilities and 600 SF to a depth of 25 feet under the 800,000 cu. ft holder foundation. Jet-grouting cost estimate based on information provided by Geo-Solutions, Inc. to BBL on 10/26/06.

9. ISS Treatment cost estimate includes all labor, equipment, and materials necessary to stabilize/immobilize NAPL-impacted soils using ISS technology to an average depth of 25 feet. Cost estimate is based on information provided by Geo-Solutions, Inc. to BBL on 10/26/06.

10. Spoils handling cost estimate includes labor, equipment, and materials necessary to manage ISS spoils (i.e., excess material generated during ISS treatment). Soils volume was assumed to be 25% of the ISS treatment volume and 100% of the jet-grouting volume as estimated based on information provided by Geo-Solutions, Inc. to BBL on 6/22/05.

11. Fill importation, placement, compaction, and grading cost estimate includes all labor, equipment, and materials necessary to import, place, compact, and grade 9,500 CY of backfill. Cost assumes that 2 feet of pre-excavation (5 feet) will be filled with ISS bulk material and the remaining 3 feet will be filled with imported backfill.

12. Provide mixing water cost estimate includes cost for providing mix water that would be using during implementation of the ISS process. Costs assume that water would be obtained from onsite municipal water supply.

13. Vapor/odor control cost estimate includes labor, equipment, and materials necessary to apply foam/latex to soil staging area. The cost estimate assumes that a technician will be onsite 8 hours a day, 2 days a week, for 10 months. The cost assumes that a trailer-mounted foam/latex applicator will rented for 10 months and foam/latex will be applied to soils requiring vapor/odor control (assumed to be 25% of excavated soil).

TABLE 5-3

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 4
IN-SITU SOIL STABILIZATION - NAPL-IMPACTED AND POTENTIALLY NAPL-IMPACTED SOIL

14. Waste characterization cost estimate includes costs for the analysis of soil samples for PCBs, TCLP VOCs, TCLP SVOCs, TCLP metals, ignitability, corrosivity, and reactivity. Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal.

15. Solid waste transportation and disposal cost estimate includes all labor, equipment, and materials necessary to transport and dispose of ISS spoils soils as non-hazardous waste at a permitted disposal facility.

16. Miscellaneous waste disposal cost estimate includes disposal of PPE, staging area and decontamination pad materials, and disposable equipment and materials at a facility permitted to accept the waste.

17. Quality control testing cost estimate includes all labor, equipment, and materials necessary to perform quality control testing of the stabilized soil to verify the achievement of the performance criteria relative to unconfined compressive strength (UCS), permeability, and synthetic precipitate leaching procedure (SPLP) PAHs. Cost assumes that approximately 300 cores (1 core every 5 vertical mixing shafts) would be analyzed for UCS ($60 per core) and 10% of the cores (30) would be analyzed for permeability ($200 per core) and SPLP PAHs ($250 per core). Cost assumes 8 cores can be collected per day, drill/core rig and crew onsite at a rate of $1,600 per day, and an onsite observer onsite at a rage of $800 per day.

18. Semi-annual groundwater monitoring cost estimate includes all labor, equipment, and materials necessary to conduct semi-annual sampling events, analyze groundwater samples, and prepare an annual groundwater monitoring report to summarize the results of the groundwater monitoring activities. This cost estimate also includes containerizing groundwater and NAPL (if present) waste materials generated during the sampling activities. This cost estimate also includes transportation of the containerized liquid waste for disposal as a non-hazardous waste at an appropriate treatment/ disposal facility.

19. Institutional controls cost estimate includes administrative costs associated with implementing institutional controls to minimize the potential for human exposure to remaining impacted soils. Such institutional controls may include governmental controls, proprietary controls, enforcement tools, and/or informational devices. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.

20. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

TABLE 5-4

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 5
IN-SITU SOIL STABILIZATION - NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHs > 500 ppm

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$150,000	$150,000
2	Construct and Remove Decontamination Pad	1	LS	$15,000	$15,000
3	Install Temporary Fencing	2,000	LF	$20	$40,000
4	Construction and Maintenance of Soil Staging Areas	1	LS	$25,000	$25,000
5	Relocate Personnel	1	LS	$4,000,000	$4,000,000
6	Utility Location and Markout	1	LS	$10,000	$10,000
7	Relocate Gas Regulator Station	1	LS	$2,000,000	$2,000,000
8	Removal of Open Garage	1	LS	$20,000	$20,000
9	Pre-Excavation	30,000	CY	$50	$1,500,000
10	ISS Treatment	100,000	CY	$75	$7,500,000
11	Spoils Handling	25,000	CY	$40	$1,000,000
12	Fill Importation, Placement, Compaction, and Grading	18,000	CY	$20	$360,000
13	Provide Mixing Water	3,000,000	gal	$0.005	$15,000
14	Vapor/Odor Control	1	LS	$180,000	$180,000
15	Waste Characterization	140	ea	$750	$105,000
16	Solid Waste Transportation and Disposal	70,000	ton	$100	$7,000,000
17	Miscellaneous Waste Disposal	1	LS	$5,000	$5,000
18	Quality Control Testing	1	LS	$203,000	$203,000
				Total Capital Cost	$24,128,000
				Administration and Engineering (10%)	$2,412,800
				Construction Management (20%)	$4,825,600
				Contingency (20%)	$4,825,600
				Subtotal Cost	$36,192,000
OPERATION AND MAINTENANCE COSTS					
19	Semi-Annual Groundwater Monitoring	1	LS	$50,000	$50,000
20	Verification of Institutional Controls and Notifications to NYSDEC	1	LS	$2,500	$2,500
				Total O&M Cost	$52,500
				Contingency (20%)	$10,500
				Subtotal Cost	$63,000
21				30-Year Total Present Worth Cost of O&M	$781,830
				Total Estimated Cost	**$36,973,830**
				Rounded to	**$37,000,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and material necessary to perform in-situ soil stabilization of NAPL-impacted soil and soil containing PAHs > 500 ppm.

TABLE 5-4

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 5
IN-SITU SOIL STABILIZATION - NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHs > 500 ppm

2. Construct and remove equipment decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 20-mil high density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct an approximate 100-foot by 200-foot material staging area consisting of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner. Maintenance costs include inspecting and repairing staging area as necessary and covering staged soil with polyethylene sheeting or odor suppressing foam, as necessary.

5. Relocate personnel cost estimate includes all labor, materials, and equipment necessary for the acquisition of new property, construction of a new service center, and relocation of all personnel and equipment currently present at the Schenectady (Broadway) location.

6. Utility location and markout cost estimate includes labor, equipment, and materials necessary to locate, identify, and markout underground utilities at the site. Cost assumes that utility location and markout would be conducted by a private utility locating company over a period of 10 days at a daily rate of $1,000 per day.

7. Relocate gas regulator station cost estimate includes all labor, materials, and equipment necessary to remove and relocate all utilities and equipment associated with the onsite gas regulator station. Cost includes design and construction of a new gas regulator piping and equipment. Cost based on similar efforts conducted during 2003 at another former MGP facility.

8. Removal of open garage cost estimate includes all labor, equipment, and materials necessary to dismantle/demolish the existing open garage, excavate the concrete floor slab, and recycle/dispose of the demolition debris. Cost have not been included to replace the open garage with a similar structure. Structure measures approximately 10,000 SF and cost estimate is based on $2 per square foot for demolition and disposal.

9. Pre-excavation cost estimate includes all labor, equipment, and materials necessary to remove soil to a depth of approximately 5 feet to facilitate removal of subsurface foundations associated with the former MGP operations that are located in the areas of ISS treatment including: former ammonia concentrator, tar tank, tar separator, and purifier house located north of Creek; trestle and coke bin located in the western portion of the site; and generator and condenser house located beneath open garage.

10. ISS Treatment cost estimate includes all labor, equipment, and materials necessary to stabilize/immobilize NAPL-impacted soils using ISS technology to an average depth of 25 feet. Cost estimate is based on information provided by Geo-Solutions, Inc. to BBL on 10/26/06. Because the majority of the site will be decommissioned under this alternative (including subsurface utilities), the estimate assumes no jet-grouting is required.

11. Spoils handling cost estimate includes labor, equipment, and materials necessary to manage ISS spoils (i.e., excess material generated during ISS treatment). Soils volume was assumed to be 25% of the ISS treatment volume as estimated based on information provided by Geo-Solutions, Inc. to BBL on 10/26/06.

12. Fill importation, placement, compaction, and grading cost estimate includes all labor, equipment, and materials necessary to import, place, compact, and grade 18,000 CY of backfill. Cost assumes that 2 feet of pre-excavation (5 feet) will be filled with ISS bulk material and the remaining 3 feet will be filled with imported backfill.

13. Provide water cost estimate includes cost for providing mix water that would be using during implementation of the ISS process. Costs assume that water would be obtained from onsite municipal water supply.

TABLE 5-4

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 5
IN-SITU SOIL STABILIZATION - NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHs > 500 ppm

14. Vapor/odor control cost estimate includes labor, equipment, and materials necessary to apply foam/latex to soil staging area. The cost estimate assumes that a technician will be onsite 8 hours a day, 2 days a week, for 18 months. The cost assumes that a trailer-mounted foam/latex applicator will rented for 18 months and foam/latex will be applied to soils requiring vapor/odor control (assumed to be 25% of excavated soil).

15. Waste characterization cost estimate includes costs for the analysis of soil samples for PCBs, TCLP VOCs, TCLP SVOCs, TCLP metals, ignitability, corrosivity, and reactivity. Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal.

16. Solid waste transportation and disposal cost estimate includes all labor, equipment, and materials necessary to transport and dispose of ISS spoils soils as non-hazardous waste at a permitted disposal facility.

17. Miscellaneous waste disposal cost estimate includes disposal of PPE, staging area and decontamination pad materials, and disposable equipment and materials at a facility permitted to accept the waste.

18. Quality control testing cost estimate includes all labor, equipment, and materials necessary to perform quality control testing of the stabilized soil to verify the achievement of the performance criteria relative to unconfined compressive strength (UCS), permeability, and synthetic precipitate leaching procedure (SPLP) PAHs. Cost assumes that approximately 500 cores (1 core every 5 vertical mixing shafts) would be analyzed for UCS ($60 per core) and 10% of the cores (50) would be analyzed for permeability ($200 per core) and SPLP PAHs ($250 per core). Cost assumes 8 cores can be collected per day, drill/core rig and crew onsite at a rate of $1,600 per day, and an onsite observer onsite at a rage of $800 per day.

19. Semi-annual groundwater monitoring cost estimate includes all labor, equipment, and materials necessary to conduct semi-annual sampling events, analyze groundwater samples, and prepare an annual groundwater monitoring report to summarize the results of the groundwater monitoring activities. This cost estimate also includes containerizing groundwater and NAPL (if present) waste materials generated during the sampling activities. This cost estimate also includes transportation of the containerized liquid waste for disposal as a non-hazardous waste at an appropriate treatment/ disposal facility.

20. Institutional controls cost estimate includes administrative costs associated with implementing institutional controls to minimize the potential for human exposure to remaining impacted soils. Such institutional controls may include governmental controls, proprietary controls, enforcement tools, and/or informational devices. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.

21. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

TABLE 5-5

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 6
SOIL REMOVAL - NAPL-IMPACTED SOIL ADJACENT TO SUBSURFACE UTILITIES

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$10,000	$10,000
2	Construct and Remove Decontamination Pad	1	LS	$15,000	$15,000
3	Install Temporary Fencing	400	LF	$20	$8,000
4	Construction and Maintenance of Soil Staging Areas	1	LS	$10,000	$10,000
5	Utility Location and Markout	1	LS	$2,000	$2,000
6	Soil Excavation, Handling, and Screening of Excavated Materials	150	CY	$150	$22,500
7	Controlled Low-Strength Material	60	CY	$100	$6,000
8	Fill Importation, Placement, Compaction, and Grading	110	CY	$20	$2,200
9	Demarcation Layer	250	SY	$3	$750
10	Waste Characterization	1	ea	$1,200	$1,200
11	Soil Waste Transportation and Disposal - LTTD	225	ton	$75	$16,875
12	Miscellaneous Waste Disposal	1	LS	$1,000	$1,000
				Total Capital Cost	$95,525
				Administration and Engineering (10%)	$9,553
				Construction Management (20%)	$19,105
				Contingency (20%)	$19,105
				Total Estimated Cost	**$143,288**
				Rounded to	**$140,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and material necessary to perform removal of NAPL-impacted soil adjacent to subsurface utilities.

2. Construct and remove equipment decontamination pad cost estimate includes all labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 20-mil high density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct an approximate 75-foot by 75-foot material staging area consisting of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner. Maintenance costs include inspecting and repairing staging area as necessary and covering staged soil with polyethylene sheeting or odor suppressing foam, as necessary.

TABLE 5-5

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 6
SOIL REMOVAL - NAPL-IMPACTED SOIL ADJACENT TO SUBSURFACE UTILITIES

5. Utility location and markout cost estimate includes labor, equipment, and materials necessary to locate, identify, and markout underground utilities at the site. Cost assumes that utility location and markout would be conducted by a private utility locating company over a period of 2 days at a daily rate of $1,000 per day.

6. Soil excavation, handling, and screening of excavated materials cost estimate includes all labor, equipment, and materials necessary to hand excavate soil to a depth of approximately 6 feet below grade surface to facilitate backfilling with imported clean fill. Cost estimate assumes excavation will be required for 150-linear-feet of subsurface utilities and trench excavation will be 5-feet-wide. Cost estimate includes over excavation to slope excavation side walls.

7. Controlled low-strength material (CLSM) cost estimate includes all labor, equipment, and materials necessary to place CLSM (i.e., low-strength concrete) in the bottom 2 feet of the utility trench excavation. Cost estimate assumes 150 liner-feet of a 5-foot-wide trench will be excavated.

8. Fill importation, placement, compaction, and grading cost estimate includes all labor, equipment, and materials necessary to import, place, compact, and grade 110 CY of backfill to located subsurface utilities to facilitate jet-grouting of subsurface utilities in areas containing NAPL-impacted soils.

9. Demarcation layer cost estimate includes all labor, equipement, and materials necessary to place a woven, light-weight, non-biodegradable, high-visibility demarcation layer within the subsurface utilitiy excavation. Cost estimate assumes the demarcation layer will placed along the side walls (bottom 4 feet) and across the width of the excavation for 150 linear feet.

10. Waste characterization cost estimate includes costs for the analysis of soil samples for PCBs, TCLP VOCs, TCLP SVOCs, TCLP metals, ignitability, corrosivity, and reactivity. Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal.

11. Solid waste transportation and disposal cost estimate includes all labor, equipment, and materials necessary to transport and dispose of excavated soils as non-hazardous waste at a permitted disposal facility.

12. Miscellaneous waste disposal cost estimate includes disposal of PPE, staging area and decontamination pad materials, and disposable equipment and materials at a facility permitted to accept the waste.

TABLE 5-6

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 7
SOIL REMOVAL - NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHS > 500PPM/
OFFSITE TREATMENT/DISPOSAL

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$250,000	$250,000
2	Construct and Remove Decontamination Pad	1	LS	$15,000	$15,000
3	Install Temporary Fencing	2,000	LF	$20	$40,000
4	Construction and Maintenance of Soil Staging Areas	1	LS	$75,000	$75,000
5	Utility Location and Markout	1	LS	$10,000	$10,000
6	Relocate Personnel	1	LS	$4,000,000	$4,000,000
7	Relocate Gas Regulator Station	1	LS	$2,000,000	$2,000,000
8	Asphalt Removal	48,000	SF	$1	$48,000
9	Install and Remove Temporary Steel Sheetpiling	235,000	SF	$56	$13,160,000
10	Soil Excavation, Handling, and Screening of Excavated Materials	144,000	CY	$37	$5,328,000
11	Soil Excavation Area Dewatering	4	year	$100,000	$400,000
12	Vapor/Odor Control	1	LS	$1,600,000	$1,600,000
13	Fill Importation, Placement, Compaction, and Grading	144,000	CY	$35	$5,040,000
14	Temporary Onsite Groundwater Treatment System	1	LS	$600,000	$600,000
15	O&M of Temporary Groundwater Treatment System	4	year	$140,000	$560,000
16	Waste Characterization	460	ea	$1,200	$552,000
17	Miscellaneous Waste Disposal	1	LS	$30,000	$30,000
18	Soil Waste Transportation and Disposal - LTTD	235,000	ton	$75	$17,625,000
				Total Capital Cost	$51,333,000
				Administration and Engineering (10%)	$5,133,300
				Construction Management (20%)	$10,266,600
				Contingency (20%)	$10,266,600
				Total Estimated Cost	**$76,999,500**
				Rounded to	**$77,000,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and materials necessary to excavate, transport, and dispose of NAPL-impacted and soils containing PAHs ≥ 500 ppm. This cost assumes that the work will be performed without temporary enclosure(s) and associated air treatment system(s).

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 7
SOIL REMOVAL - NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHS > 500PPM/
OFFSITE TREATMENT/DISPOSAL

2. Construct and remove equipment decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 40-mil high-density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct a material staging, mixing, and dewatering area capable of staging approximately 150 by 200 feet (5,000 CY of impacted soil). The staging area would consist of a 1-foot stone sub-base, 6-inch bituminous asphalt base coat, and 2-inch bituminous asphalt top coat, bermed and sloped to a sump. Maintenance would include covering the excavated material and repairing the berm as necessary. Cost assumes construction cost of approximately $3 per square foot of pad.

5. Utility location and markout cost estimate includes labor, equipment, and materials necessary to locate, identify, and markout underground utilities at the site. Cost assumes that utility location and markout would be conducted by a private utility locating company over a period of 10 days at a daily rate of $1,000 per day.

6. Relocate personnel cost estimate includes all labor, materials, and equipment necessary for the acquisition of new property, construction of a new service center, and relocation of all personnel and equipment currently present at the Schenectady (Broadway) location.

7. Relocate gas regulator station cost estimate includes all labor, materials, and equipment necessary to remove and relocate all utilities and equipment associated with the onsite gas regulator station. Cost includes design and construction of a new gas regulator piping and equipment. Cost based on similar efforts conducted during 2003 at another former MGP facility.

8. Asphalt removal cost estimate includes all labor, equipment, and materials necessary to saw cut and remove the existing asphalt pavement (assumed to be 6 inches thick).

9. Install and remove temporary steel sheetpiling cost estimate includes labor, equipment, and materials necessary to install, remove, and decontaminate steel sheetpiling at each excavation area. It was assumed that pretrenching to a depth of 10 feet (i.e., below the bottom of the fill unit) would be necessary to facilitate installation of sheetpiling. Sheetpiling assumed to be 65 feet below grade for 3,600 LF. Sheetpile wall length was calculated assuming that the perimeter of the excavation would require sheetpiling (2,100 LF) and six-250 LF (1,500 LF) lengths of sheeting piling would be required to transect the excavation area to complete excavation activities.

10. Soil excavation, handling, and screening of materials cost estimate includes labor, equipment, and materials necessary to excavate NAPL-impacted material from above and below the water table; transferring excavated soil and debris to the material staging area; and screening excavated soil to remove debris larger than 2 inches in diameter to facilitate LTTD treatment.

11. Soil excavation area dewatering cost estimate includes labor, equipment, and materials necessary to collect and transfer liquids from within the soil removal areas to a temporary onsite treatment system. Cost based on annual cost to install dewatering points, operation and maintenance of pumps, and associated equipment materials (i.e., hoses, piping, etc.) Cost assumes dewatering pumps operating 24 hours per day, 7 days per week.

12. Vapor/odor control cost estimate includes labor cost for a technician to apply foam to soil staging area (2 times a day) and open excavation 2 hours per day, 5 days per week, 52 weeks per year, for 4 years. The cost estimate also includes the cost for the purchase/rental of the trailer-mounted equipment and chemicals needed to facilitate the application of the foam.

TABLE 5-6

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 7
SOIL REMOVAL - NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHS > 500PPM/
OFFSITE TREATMENT/DISPOSAL

13. Fill importation, placement, compaction, and grading cost estimate includes all labor, equipment, and materials necessary to import, place, compact, and grade 144,000 CY of backfill.

14. Temporary onsite groundwater treatment system cost estimate includes all labor, equipment, and materials necessary to construct the temporary onsite groundwater treatment system. The cost estimate includes: mobilization/demobilization, two 5,000-gallon equalization tanks, oil-water separator, two transfer pump stations, clarifier system, bag filter system, OrganoClay Vessel skid, low-profile air stripper, vapor-phase carbon skid, liquid phase carbon skid, ion exchange resin vessel skid, two 21,000-gallon effluent holding tanks, miscellaneous instrumentation, control system, enclosure, utility installation, miscellaneous electrical, and miscellaneous mechanical equipment.

15. O&M of temporary onsite groundwater treatment system cost estimate includes all labor, equipment, and materials necessary to operate and maintain the temporary onsite groundwater treatment. The cost estimate includes: onsite labor, office administration, vapor-phase carbon changeout (once annually), liquid-phase carbon changeout (once annually), spare parts & miscellaneous expenses, treatment system monitoring, electrical usage, waste disposal of NAPL, and a discharge fee to the local POTW (assuming disposal of approximately 4 million gallons of treated water per year at $0.005 per gallon).

16. Waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, TPH, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal. The estimated weight of material was based on an assumed 1.5 tons per cubic yard of material plus approximately 10% of the excavated soil weight for the addition of soil stabilization materials.

17. Miscellaneous waste disposal cost estimate is based on disposal of PPE, staging area and decontamination pad materials, and disposable equipment and materials at a facility permitted to accept the waste.

18. Soil treatment cost estimate includes all labor, equipment, and material necessary to treat NAPL-impacted soils via LTTD at Environmental Soil Management, Inc.'s (ESMI) Fort Edward Facility. Cost based on information provided to BBL by ESMI on 6/29/05. Costs also include disposal at an appropriate permitted facility following treatment.

TABLE 5-7

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 8
SOIL REMOVAL - SOIL CONTAINING CONSTITUENTS GREATER THAN TAGM 4046 CLEANUP OBJECTIVES/ OFFSITE TREATMENT/DISPOSAL

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$250,000	$250,000
2	Construct and Remove Decontamination Pad	1	LS	$15,000	$15,000
3	Install Temporary Fencing	4,000	LF	$20	$80,000
4	Construction and Maintenance of Soil Staging Areas	1	LS	$80,000	$80,000
5	Railroad Property Coordination	1	LS	$1,000,000	$1,000,000
6	Utility Location and Markout	1	LS	$10,000	$10,000
7	Relocate Personnel	1	LS	$4,000,000	$4,000,000
8	Relocate Gas Regulator Station	1	LS	$2,000,000	$2,000,000
9	Asphalt Removal	48,000	SF	$1	$48,000
10	Install and Remove Temporary Steel Sheetpiling	347,000	SF	$56	$19,432,000
11	Soil Excavation, Handling, and Screening of Excavated Materials	360,000	CY	$37	$13,320,000
12	Soil Excavation Area Dewatering	9	year	$100,000	$900,000
13	Vapor/Odor Control	1	LS	$3,400,000	$3,400,000
14	Fill Importation, Placement, Compaction, and Grading	360,000	CY	$35	$12,600,000
15	Temporary Onsite Groundwater Treatment System	1	LS	$600,000	$600,000
16	O&M of Temporary Groundwater Treatment System	9	year	$160,000	$1,440,000
17	Waste Characterization	1,160	ea	$1,200	$1,392,000
18	Miscellaneous Waste Disposal	1	LS	$30,000	$30,000
19	Soil Waste Transportation and Disposal - LTTD	576,000	ton	$75	$43,200,000
				Total Capital Cost	$103,797,000
				Administration and Engineering (10%)	$10,379,700
				Construction Management (20%)	$20,759,400
				Contingency (20%)	$20,759,400
				Total Estimated Cost	**$155,695,500**
				Rounded to	**$155,700,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and materials necessary to excavate, transport, and dispose of soils containing VOCs or SVOCs at concentrations exceeding NYSDEC-recommended soil cleanup objectives presented in TAGM 4046. This cost assumes that the work will be performed without temporary enclosure(s) and associated air treatment system(s).

TABLE 5-7

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 8
SOIL REMOVAL - SOIL CONTAINING CONSTITUENTS GREATER THAN TAGM 4046 CLEANUP OBJECTIVES/
OFFSITE TREATMENT/DISPOSAL

2. Construct and remove equipment decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 40-mil high-density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct a material staging, mixing, and dewatering area capable of staging approximately 150 by 200 feet (5,000 CY of impacted soil). The staging area would consist of a 1-foot stone sub-base, 6-inch bituminous asphalt base coat, and 2-inch bituminous asphalt top coat, bermed and sloped to a sump. Maintenance would include covering the excavated material and repairing the berm as necessary. Cost assumes construction cost of approximately $3 per square foot of pad.

5. Railroad property coordination cost estimate includes costs for obtaining an agreement with the D&H railroad to remove and reconstruct or excavate beneath the railroad. Costs are also included for design and construction of engineering mechanisms to stabilize the railroads while excavation activities are conducted adjacent to and beneath the rail line. Cost is a general estimate as the exact mechanisms to conduct these activities would require additional investigation.

6. Utility location and markout cost estimate includes labor, equipment, and materials necessary to locate, identify, and markout underground utilities at the site. Cost assumes that utility location and markout would be conducted by a private utility locating company over a period of 10 days at a daily rate of $1,000 per day.

7. Relocate personnel cost estimate includes all labor, materials, and equipment necessary for the acquisition of new property, construction a new Service Center, and relocate all personnel and equipment present at the Schenectady (Broadway) location.

8. Relocate gas regulator station cost estimate includes all labor, materials, and equipment necessary to remove and relocate all utilities and equipment associated with the onsite gas regulator station to a new location. Cost includes design and construction of new gas regulator piping and equipment. Cost based on similar efforts conducted during 2003 at another former MGP facility.

9. Asphalt removal cost estimate includes all labor, equipment, and materials necessary to sawcut and remove the existing asphalt pavement (assumed to be 6 inches thick).

10. Install and remove temporary steel sheetpiling cost estimate includes labor, equipment, and materials necessary to install, remove, and decontaminate steel sheetpiling at each excavation area. It was assumed that pretrenching to a depth of 10 feet (i.e., below the bottom of the fill unit) would be necessary to facilitate installation of sheetpiling. Sheetpiling assumed to be 65 feet below grade for 5,400 LF. Sheetpile wall length was calculated assuming that the perimeter of the excavation would require sheetpiling (3,400 LF) and 2,000 LF of sheeting piling would be required to transect the excavation area to complete excavation activities.

11. Soil excavation, handling, and screening of materials cost estimate includes labor, equipment, and materials necessary to excavate material exceeding TAGM 4046 guidance values to a depth of 30 feet; transferring excavated soil and debris to the material staging area; and screening excavated soil to remove debris larger than 2 inches in diameter to facilitate LTTD treatment.

12. Soil excavation area dewatering cost estimate includes labor, equipment, and materials necessary to collect and transfer liquids from within the soil removal areas to a temporary onsite treatment system. Cost based on annual cost to install dewatering points, operation and maintenance of pumps, and associated equipment and materials (e.g., hoses, piping, etc.). Cost assumes dewatering pumps operating 24 hours per day, 7 days per week.

TABLE 5-7

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SOIL ALTERNATIVE 8
SOIL REMOVAL - SOIL CONTAINING CONSTITUENTS GREATER THAN TAGM 4046 CLEANUP OBJECTIVES/
OFFSITE TREATMENT/DISPOSAL

13. Vapor/odor control cost estimate includes labor cost for a technician to apply foam to soil staging area (2 times a day) and open excavation 2 hours per day, 5 days per week, 52 weeks per year, for a 9 years. The cost estimate also includes the cost for the purchase/rental of the trailer mounted equipment and chemicals needed to facilitate the application of the foam.

14. Fill importation, placement, compaction, and grading cost estimate includes all labor, equipment, and materials necessary to import, place, compact, and grade 360,000 CY of backfill.

15. Temporary onsite groundwater treatment system cost estimate includes all labor, equipment, and materials necessary to construct the temporary onsite groundwater treatment system. The cost estimate includes: mobilization/demobilization, two 5,000-gallon equalization tanks, oil-water separator, two transfer pump stations, clarifier system, bag filter system, OrganoClay Vessel skid, low-profile air stripper, vapor-phase carbon skid, liquid phase carbon skid, ion exchange resin vessel skid, two 21,000-gallon effluent holding tanks, miscellaneous instrumentation, control system, enclosure, utility installation, miscellaneous electrical, and miscellaneous mechanical.

16. O&M of temporary onsite groundwater treatment system cost estimate includes all labor, equipment, and materials necessary to operate and maintain the temporary onsite groundwater treatment system. The cost estimate includes: onsite labor, office administration, vapor-phase carbon changeout (once annually), liquid-phase carbon changeout (once annually), spare parts & miscellaneous expenses, treatment system monitoring, electrical usage, waste disposal of NAPL, and a discharge fee to local POTW (assumed disposal of approximately 4.6 million gallons per year at $0.005 per gallon).

17. Waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, TPH, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal. The estimated weight of material was based on an assumed 1.5 tons per cubic yard of material plus approximately 10% of the excavated soil weight for addition of soil stabilization materials.

18. Miscellaneous waste disposal cost estimate is based on disposal of PPE, staging area and decontamination pad materials, and disposable equipment and materials at a facility permitted to accept the waste.

19. Soil treatment cost estimate includes all labor, equipment, and material necessary to treat NAPL-impacted soils via LTTD at Environmental Soil Management, Inc.'s (ESMI) Fort Edward Facility. Cost based on information provided by ESMI to BBL on 6/29/05. Costs also include disposal at an appropriate permitted facility following treatment.

TABLE 5-8

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 2
ADMINISTRATIVE CONTROLS WITH CONTINUED MONITORING

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Legal Expenses for Deed Restrictions	1	LS	$50,000	$50,000
2	Monitoring Well Clusters	3	ea	$7,000	$21,000
3	Quarterly Groundwater Monitoring	4	ea	$12,000	$48,000
4	Laboratory Analysis	4	ea	$10,000	$40,000
5	Prepare Annual Groundwater Monitoring Report	1	LS	$15,000	$15,000
6	Waste Disposal	8	drum	$250	$2,000
				Total Capital Cost	$176,000
				Administration and Engineering (10%)	$17,600
				Construction Management (20%)	$35,200
				Contingency (20%)	$35,200
				Total Cost	$264,000
OPERATION AND MAINTENANCE COSTS					
7	Semi-Annual Groundwater Monitoring	1	LS	$50,000	$50,000
				Total O&M Cost	$50,000
				Contingency (20%)	$10,000
				Total Cost	$60,000
8				30-Year Total Present Worth Cost of O&M	$744,600
				Total Estimated Cost	**$1,008,600**
				Rounded to	**$1,000,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Legal expenses for deed restrictions cost estimate includes all labor and materials necessary to institute deed restrictions for the site to prevent potential future use of site groundwater.

2. Monitoring well clusters cost estimate includes all labor, equipment, and materials necessary to install monitoring well clusters each consisting of three groundwater monitoring wells. Cost estimate assumes that average well depths are: 15 feet for shallow wells; 30 feet for intermediate wells; and 50 feet for deep wells. Cost estimate assumes that groundwater monitoring wells will be constructed of PVC and include cast iron flush-mounted covers.

3. Quarterly groundwater monitoring cost estimate includes: all labor, equipment, travel, subsistence, and materials necessary to conduct quarterly groundwater monitoring for a 1-year period. Groundwater monitoring will consist of collecting groundwater samples from select monitoring points using low-flow sampling methods. Cost assumes two project level personnel could complete the monitoring activities in 4 work days.

4. Laboratory analysis cost estimate includes all labor, equipment, and materials necessary to submit groundwater sample to an analytical laboratory for analysis of the groundwater samples for chemical constituents of concern (BTEX compounds and PAHs) and natural attenuation indicator parameters (i.e., total biomass, PAH-degrading indicator compounds, geochemical parameters). Cost assumes standard analytical turnaround time. No cots have been included for data validation.

TABLE 5-8

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 2
ADMINISTRATIVE CONTROLS WITH CONTINUED MONITORING

5. Prepare annual groundwater monitoring report cost estimate includes all labor, equipment, and materials necessary to prepare a report summarizing the results of the groundwater monitoring activities and the observed trends from the first year of monitored natural attenuation.

6. Waste disposal cost estimate includes all labor, equipment, and materials necessary to dispose of NAPL and groundwater waste material generated during the quarterly groundwater monitoring activities. Costs assume that the NAPL and groundwater would be disposed of as a non-hazardous waste at an appropriate treatment/disposal facility. Cost assumes two drums of liquid would be generated during each sampling event.

7. Semi-annual groundwater monitoring cost estimate includes all labor, equipment, and materials necessary to conduct semi-annual sampling events, analyze groundwater samples, and prepare an annual groundwater monitoring report to summarize the results of the groundwater monitoring activities. This cost estimate also includes containerizing NAPL and groundwater waste materials generated during the sampling activities. This cost estimate also includes transportation of the containerized liquid waste for disposal as a non-hazardous waste at an appropriate treatment/ disposal facility.

8. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

TABLE 5-9

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 3
PASSIVE NAPL RECOVERY

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$30,000	$30,000
2	Construct and Remove Decontamination Pad	1	LS	$20,000	$20,000
3	Install NAPL Recovery Wells	8	ea	$5,000	$40,000
4	Miscellaneous Waste Disposal	1	LS	$5,000	$5,000
				Total Capital Cost	$95,000
				Administration and Engineering (10%)	$9,500
				Construction Management (20%)	$19,000
				Contingency (20%)	$19,000
				Subtotal Cost	$142,500
OPERATION AND MAINTENANCE COSTS					
5	NAPL Monitoring/Recovery	1	LS	$35,000	$35,000
6	Waste Disposal	1	LS	$1,000	$1,000
				Total O&M Cost	$36,000
				Contingency (20%)	$7,200
				Total Cost	$43,200
7				30-Year Total Present Worth Cost of O&M	$536,112
				Total Estimated Cost	**$678,612**
				Rounded to	**$680,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and material necessary to install new wells to facilitate passive recovery of LNAPL and DNAPL from the site.

2. Construct and remove equipment decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 40-mil high density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

3. Install NAPL collection wells cost estimate includes all labor, equipment, and materials necessary to install and develop up to eight 4-inch diameter passive NAPL recovery wells.

4. Miscellaneous waste disposal cost estimate is based on disposal of PPE and disposable equipment used during construction/installation of NAPL recovery structures at a facility permitted to accept the waste. Cost estimate includes waste characterization sampling and analysis and assumes that material will be disposed of as non-hazardous waste.

5. NAPL monitoring/recovery cost estimate includes all labor, equipment, and materials, necessary to monitor NAPL collection wells and passively remove accumulated NAPL, if encountered. Cost estimates assume NAPL monitoring/ recovery will be performed on a monthly basis. Cost estimate includes preparation of quarterly summary reports for the NAPL monitoring. Cost assumes on average one 55-gallon drum of NAPL would require management and disposal per year.

6. Waste disposal cost estimate includes all labor, equipment, and materials necessary to dispose of waste material generated during O&M activities. Costs assume that waste would be disposed of once per year and would be managed as a hazardous waste. Cost assumes on average one 55-gallon drum of NAPL would require management and disposal per year.

7. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

TABLE 5-10

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 4
IN-SITU CHEMICAL OXIDATION

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$120,000	$120,000
2	Construct and Remove Decontamination Pad	1	LS	$15,000	$15,000
3	Install Temporary Fencing	500	LF	$20	$10,000
4	Pre-Design Investigation	1	LS	$50,000	$50,000
5	Pilot-Scale Testing	1	LS	$150,000	$150,000
6	Final Remedial Action Work Plan and Engineering Design	1	LS	$75,000	$75,000
7	Permitting	1	LS	$25,000	$25,000
8	Drilling - Remediation Points	1	LS	$100,000	$100,000
9	Remediation Equipment and Licensing	1	LS	$1,000,000	$1,000,000
10	Remediation System Installation	1	LS	$200,000	$200,000
11	Ozone Monitoring System	1	LS	$100,000	$100,000
12	System Startup	1	LS	$25,000	$25,000
13	Oxidation Treatment System O&M	36	month	$25,000	$900,000
14	Post-Injection Monitoring	1	LS	$50,000	$50,000
15	Electrical Usage	1	LS	$500,000	$500,000
16	Project Management and Administration	1	LS	$150,000	$150,000
17	Miscellaneous Waste Disposal	1	LS	$5,000	$5,000
18	Monitoring Well Clusters	3	ea	$7,000	$21,000
				Total Capital Cost	$3,496,000
				Administration and Engineering (10%)	$349,600
				Construction Management (20%)	$699,200
				Contingency (20%)	$699,200
				Subtotal Cost	$5,244,000
OPERATION AND MAINTENANCE COSTS					
19	Verification of Institutional Controls and Notifications to NYSDEC	1	LS	$2,500	$2,500
20	Annual Groundwater Monitoring	1	LS	$25,000	$25,000
				Total O&M Cost	$27,500
				Contingency (20%)	$5,500
				Total Cost	$33,000
21				30-Year Total Present Worth Cost of O&M	$409,530
				Total Estimated Cost	**$5,653,530**
				Rounded to	**$5,700,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and material necessary to conduct a pilot study and install/construct an in-situ chemical oxidation system at the site.

TABLE 5-10

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 4
IN-SITU CHEMICAL OXIDATION

2. Construct and remove decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 40-mil high density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Pre-design investigation cost estimate includes; project data review and work plan; total oxidant demand - sample analyses and interpretation; remedial investigation report and preliminary remedial action work plan; and project management cost. Cost estimate based on information provided to BBL by Blue Lightning Underground Enterprises (Resource Control Corporation) on July 1, 2005.

5. Pilot-scale testing cost estimate includes all labor, equipment, and materials, necessary to conduct a one-month ozone injection pilot-scale study including injection point installation, equipment rental, and monitoring. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

6. Final remedial action work plan and engineering design will be conducted following the completion of the pre-design investigation and pilot-scale testing. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

7. Permitting cost estimate includes all costs to obtain appropriate permits necessary for the operation and maintenance of the full-scale ozone injection system.

8. Drilling cost estimate includes all labor, equipment, and materials necessary to install up 100 injection points, 40 soil vapor extraction (SVE) wells and up to 10 new monitoring wells. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

9. Remediation equipment and licensing cost estimate includes all materials and equipment necessary for the in-situ chemical oxidation and SVE systems including but not limited to pumps, compressors, tubing, electronic controls, etc. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

10. Remediation system installation cost estimate includes all labor necessary to install the in-situ chemical oxidation and SVE systems including, but not limited to, pumps, compressors, tubing, electronic controls, etc. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

11. Ozone monitoring system cost estimate includes labor to install ozone monitoring system. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

12. System startup cost estimate includes labor to support initial startup of ozone injection and SVE systems. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

13. Oxidation Treatment System O&M cost estimate includes all labor necessary to operate and maintain the oxidation treatment system. It is assumed that the system will operate 24-hr/day for 36 months. Estimate includes costs for a Blue Lightning representative to visit the site once per week to monitor field parameters and perform general maintenance on the in-situ chemical oxidation system. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

14. Post-injection monitoring cost estimate includes all labor, equipment, and materials to collect and analyze soil and groundwater samples following ozone injection. Cost assumes two rounds of post-injection sampling consisting or soil sample collection using macrocore or split-spoon sampling methods and groundwater sampling. Cost assumes that up to 40 soil samples and 20 groundwater samples would be collected and submitted for laboratory analysis for BTEX and PAHs.

TABLE 5-10

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 4
IN-SITU CHEMICAL OXIDATION

15. Electrical Utility cost estimate includes the cost of electrical utility charges needed to operate the ozone injection and SVE systems. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

16. Project management and administration cost estimate includes all labor needed by Blue Lightning Enterprises to oversee the ozone injection and SVE systems. Cost estimate based on information provided to BBL by Resource Control Corporation on July 1, 2005.

17. Miscellaneous waste disposal cost estimate is based on disposal of PPE and disposal equipment at a facility permitted to accept the waste.

18. Monitoring well clusters cost estimate includes all labor, equipment, and materials necessary to install monitoring well clusters consisting of three groundwater monitoring wells. Cost estimate assumes that average well depths are: 15 feet for shallow wells; 30 feet for intermediate wells; and 50 feet for deep wells. Cost estimate assumes that groundwater monitoring wells will be constructed of PVC and include cast iron flush-mounted covers.

19. Institutional controls cost estimate includes administrative costs associated with implementing institutional controls to minimize the potential for human exposure to remaining impacted soils. Such institutional controls may include governmental controls, proprietary controls, enforcement tools, and/or informational devices. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.

20. Annual groundwater monitoring cost estimate includes all labor, equipment, and materials necessary to sample and analyze groundwater samples and report the results. This cost estimate also includes costs for all labor, equipment, and materials necessary to remove accumulated NAPL (if encountered) from the wells and containerize recovered NAPL and purged groundwater in 55-gallon drums. This cost estimate also includes costs for all labor, equipment, and materials necessary to dispose of the containerized NAPL/groundwater as a hazardous liquid as a hazardous waste at a permitted disposal facility.

21. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

TABLE 5-11

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 5
GROUNDWATER EXTRACTION AND TREATMENT

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Groundwater Flow Model Data Collection	1	LS	$10,000	$10,000
2	Mobilization/Demobilization	1	LS	$10,000	$10,000
3	Extraction Well Installation and Development	6	ea	$10,000	$60,000
4	Extraction Well Piping, Pumps, and Controls Installation	6	ea	$40,000	$240,000
5	Equalization Tanks (5000 gal)	2	ea	$5,000	$10,000
6	Oil-Water Separator	1	ea	$10,000	$10,000
7	Transfer Pump Stations	2	ea	$7,000	$14,000
8	Clarifier System	1	ea	$40,000	$40,000
9	Bag Filter System	1	ea	$10,000	$10,000
10	Organoclay Vessel Skid	1	ea	$15,000	$15,000
11	Low-Profile Air Stripper	1	ea	$50,000	$50,000
12	Vapor-Phase Carbon Skid	1	ea	$20,000	$20,000
13	Liquid-Phase Carbon Skid	1	ea	$10,000	$10,000
14	Ion Exchange Resin Vessel Skid	1	ea	$10,000	$10,000
15	Effluent Holding Tanks	2	ea	$20,000	$40,000
16	Solids Holding Tank	2	ea	$5,000	$10,000
17	Miscellaneous Instrumentation	1	LS	$25,000	$25,000
18	Control System	1	LS	$50,000	$50,000
19	Enclosure (Sprung Structure)	2,000	SF	$35	$70,000
20	Utilities	1	LS	$10,000	$10,000
21	Miscellaneous Electrical	1	LS	$100,000	$100,000
22	Miscellaneous Mechanical	1	LS	$80,000	$80,000
23	Miscellaneous Disposal	1	LS	$8,000	$8,000
				Total Capital Cost	$902,000
				Administration and Engineering (10%)	$90,200
				Construction Management (20%)	$180,400
				Contingency (20%)	$180,400
				Subtotal Cost	$1,353,000
ANNUAL OPERATION AND MAINTENANCE (O&M) COSTS					
24	Operation & Maintenance Labor and Expenses	1	LS	$30,000	$30,000
25	Waste Disposal/Water Disposal	1	LS	$100,000	$100,000
26	Treatment System Monitoring	1	LS	$25,000	$25,000
27	Vapor and Liquid-Phase Carbon Changeout	1	LS	$45,000	$45,000
28	Operation & Maintenance Utilities	1	LS	$20,000	$20,000
				Subtotal O&M Costs	$220,000
				Contingency (20%)	$44,000
				Total Cost	$264,000
29				30-Year Total Present Worth Cost of Annual O&M	$3,276,240
5 -Year Equipment Change Out					
30	All Pumps & Blowers	1	LS	$80,000	$80,000
	Catalytic Oxidizer Catalyst	1	LS	$55,000	$55,000
				Subtotal 5-Year Equipment Change Out Costs	$135,000
				Contingency (20%)	$27,000
				Total Cost	$162,000
31				Total Present Worth of O&M (Every Five Years for 30 Years @ 7%)	$334,206
15 -Year Equipment Change Out					
32	Air Stripper Modifications	1	LS	$55,000	$55,000
	Carbon Adsorption Modifications	1	LS	$45,000	$45,000
				Subtotal 15-Year Equipment Change Out Costs	$100,000
				Contingency (20%)	$20,000
				Total Cost	$120,000
33				Total Present Worth of O&M (Every Fifteen Years for 30 Years @ 7%)	$43,488
				Total O&M Cost	$3,653,934
				Total Estimated Cost	**$5,006,934**
				Rounded to	**$5,000,000**

TABLE 5-11

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 5
GROUNDWATER EXTRACTION AND TREATMENT

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Groundwater flow model data collection cost estimate includes all labor, equipment, and materials necessary to obtain additional groundwater data and complete groundwater flow modeling in support of this alternative. Cost includes: obtaining access agreements with neighboring property owners; installing/developing up to 15 new groundwater monitoring wells; specific capacity testing; data evaluations; and completing the groundwater flow model that was started during the Remedial Investigation.

2. Mobilization/Demobilization cost includes: mobilization and demobilization of labor, equipment, and materials necessary to install the groundwater extraction and treatment system.

3. Extraction well installation and development cost estimate includes costs for all labor, equipment, and materials to install and develop six extraction wells to facilitate groundwater removal under this alternative. Cost assumes standard drilling equipment will be used to install and develop 4-inch diameter pumping wells. Cost includes all well installation activities and well construction materials including: well casing; sand pack; annular seal; and surface completion.

4. Extraction well piping, pumps, and controls installation cost estimate includes all labor, equipment, and materials necessary to purchase and install piping, pumps, and controls to facilitate operation of the groundwater extraction wells. Cost includes six submersible pumps capable of pumping at a rate of 7gpm and associated wiring and controls. Cost includes construction and installation of extraction well service manholes including excavation and backfilling. Cost includes conventional trenching of approximately 2,200 cubic-yards of soil to facilitate installation of wiring and conveyance piping conduit and replacement of excavated material following completion of conduit installation. Cost includes purchase and installation of approximately 3,200 linear-feet of 2-inch-diameter HDPE piping to convey extracted groundwater to the proposed water treatment system. Cost includes purchase and placement of approximately 360 cubic-yards of type "D" sand backfill for wiring and piping conduit trench.

5. Equalization tank cost estimate includes the cost to purchase, deliver, and set up two 5,000-gallon equalization tanks.

6. Oil-water separator cost estimate includes costs to purchase a 50-gallon per minute (gpm) oil water separator and oil collection drum to separate groundwater and non-aqueous phase liquids.

7. Transfer pump station costs include two 50 gpm transfer pumps to transfer water to the clarifier system.

8. Clarifier system cost estimated includes costs to purchase a 50 gpm inclined plate clarifier equipped with integral rapid mix/flocculation influent basin for solids and metals removal.

9. Bag filter system cost estimate includes costs to purchase one 50 gpm duplex bag filter system to facilitate removal of suspended solids.

10. Organoclay vessel skid cost estimate includes the cost to purchase for two 1,000-pound Organoclay vessels piped in series to facilitate the removal of emulsified oils.

11. Low-profile air stripper system cost estimate includes cost to purchase a 50 gpm low-profile air stripper to facilitate the removal of volatile organic compounds (VOCs).

12. Vapor-phase carbon skid cost estimate include costs to purchase two 3,000 pound vapor-phase carbon vessels piped in series for the removal of VOCs in the air stripper off-gas.

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 5
GROUNDWATER EXTRACTION AND TREATMENT

13. Liquid-phase carbon skid cost estimate include costs to purchase two 1,000-pound vapor-phase carbon vessels piped in series for the removal of remaining VOCs and semi-volatile organic compounds (SVOCs) present in the air stripper effluent stream.

14. Ion exchange resin vessel skid includes cost estimate includes cost to purchase two 50 gpm resin vessels piped in series for the removal of ferric cyanide.

15. Effluent holding tank cost estimate includes the cost to purchase three 21,000-gallon storage tanks.

16. Solids holding tank cost estimate includes cost to purchase one 5,000-gallon holding tank used to store solid materials collected from the clarifier system.

17. Miscellaneous instrumentation cost estimated includes the cost to purchase all gauges, meters, and instrumentation not included in the costs of the equipment specified.

18. Control system cost estimate includes the cost for all labor, equipment, and materials necessary to set up a Programmable Logic Control (PLC) system to monitor and control the activity of the system.

19. Enclosure cost estimate includes cost for all labor, equipment, and materials for one 2,000-square-foot sprung structure equipped with lighting and heating, ventilation, and air conditioning (HVAC).

20. Utilities cost estimate includes all labor, equipment, and materials to supply electricity to the groundwater treatment system.

21. Miscellaneous electrical cost estimate includes all wire, aboveground conduit, and labor necessary to install the treatment system electrical components.

22. Miscellaneous mechanical cost estimate includes all labor and materials necessary to place the equipment, install interconnecting piping, and make necessary connections associated with the treatment system.

23. Miscellaneous disposal costs include costs to dispose of solid and liquid waste generated during extraction well installation activities. Cost assumes waste will be disposed of as non-hazardous at a permitted facility.

24. Operation and maintenance labor and expenses includes all labor, equipment, and materials necessary to provide personnel to operate and maintain the proposed groundwater treatment system for one year period. Cost assumes operator will be onsite 8 hours per week.

25. Waste disposal/water disposal cost estimate includes all labor, equipment, and materials, necessary to dispose of solid waste at a solid waste landfill facility and dispose of the treated water via discharge to the City of Schenectady wastewater treatment facility. Cost estimate also assumes that on an annual basis, up to two 55-gallon drums of NAPL will be collected, containerized, and disposed of as a hazardous liquid waste at an appropriately permitted facility.

26. Treatment system monitoring cost estimate includes all labor, equipment, and materials necessary to conduct treatment system monitoring consisting of monitoring treatment system components, analyzing water samples collected from various points in the treatment train to monitor for break through, and presenting the results of the findings in quarterly letter reports.

27. Vapor and liquid-phase carbon changeout cost estimate includes the cost for all labor, equipment, and materials to replace activated carbon in treatment equipment as needed (based on the results or treatment system monitoring described in Item 21) assumed to be once per year.

28. Operation & maintenance cost estimate includes all labor, equipment, and materials necessary to provide electrical utility service and maintenance for the proposed treatment system for one year.

29. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

30. Five-year equipment change out cost estimate includes all labor, equipment, and materials necessary to provide and install extraction pumps, process pumps, and a 25 HP blower. These changeouts are assumed to be every 5 years for 30 years (i.e., five changeout events).

TABLE 5-11

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR GROUNDWATER ALTERNATIVE 5
GROUNDWATER EXTRACTION AND TREATMENT

31. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

32. Fifteen-year equipment change out cost estimates include all labor, equipment, and materials necessary to provide redevelopment of the extraction wells, significant modifications to the air stripper and carbon adsorption system. These changeouts are assumed to every 15 years for 30 years (i.e., one changeout event).

33. Present worth is estimated based on a 7% beginning-of-year discount rate (adjusted for inflation) in accordance with OSWER Directive 9355.3-20 "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis" (USEPA, 1993). It is assumed that "year zero" is 2006.

TABLE 5-12

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SEDIMENT ALTERNATIVE 2
IMPACTED SEDIMENT REMOVAL

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$100,000	$100,000
2	Construction and Maintenance of Soil Staging Areas	1	LS	$20,000	$20,000
3	Install Temporary Fencing	2,500	LF	$20	$50,000
4	Relocate/Temporary Disconnection of Gas Utilities	1	LS	$50,000	$50,000
5	Site Preparation	1	LS	$20,000	$20,000
6	Temporary Creek Diversion	1	LS	$120,000	$120,000
7	Install and Remove Temporary Steel Sheetpiling	25,000	SF	$30	$750,000
8	Sediment Excavation, Handling, and Screening of Materials	630	CY	$35	$22,050
9	Sediment Excavation Dewatering	1	LS	$40,000	$40,000
10	Waste Characterization	3	ea	$750	$2,250
11	Soil Waste Transportation and Disposal	950	ton	$100	$95,000
12	Backfill	630	CY	$35	$22,050
13	Sediment and Erosion Control	1	LS	$65,000	$65,000
				Total Capital Cost	$1,356,350
				Administration and Engineering (10%)	$135,635
				Construction Management (20%)	$271,270
				Contingency (20%)	$271,270
				Total Estimated Cost	**$2,034,525**
				Rounded to	**$2,000,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and material necessary to remove potentially impacted sediments from Schermerhorn Creek.

2. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct a material staging area consisting of a 12-inch gravel fill layer and geomembrane liner. Maintenance costs include inspecting, repairing staging areas as necessary, and covering staged soil with polyethylene sheeting.

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Relocate/temporarily disconnect subsurface gas utilities cost estimate includes costs to disconnect the existing natural gas utility piping and either reinstall or relocate the distribution piping following backfilling.

5. Site preparation cost estimate includes all labor, equipment, and materials necessary to collect additional sediment samples to further delineate impacted sediment prior to removal.

TABLE 5-12

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SEDIMENT ALTERNATIVE 2
IMPACTED SEDIMENT REMOVAL

6. Temporary creek diversion cost estimate includes all labor, equipment, and materials necessary to temporarily divert the Schermerhorn Creek to facilitate sediment removal.

7. Install and remove temporary steel sheetpiling cost estimate includes labor, equipment, and materials necessary to install, remove, and decontaminate steel sheetpiling at each excavation area. It was assumed that pretrenching to a depth of 10 feet would be necessary to facilitate installation of sheetpiling. Sheetpiling assumed to be 25 feet below grade (based on assumed excavation depth of no more than 10 feet and basis of 2.5 times excavation depth for cantilevered sheetpiling) for 1,000 LF. Sheetpile wall length was calculated assuming that sheetpiling would require along both sides of the creek in areas where impacted sediment would be removed. Cost estimate includes a reduced price due to assumed ease of sheetpile installation along the creek.

8. Sediment excavation, handling, and screening of materials cost estimate includes labor, equipment, and materials necessary to excavate material from above and below the water table; handling of removed soil, debris, and gravel within the staging area and subsequently loading into trucks prior to offsite disposal.

9. Sediment excavation dewatering cost estimate includes all labor, equipment, and materials necessary to collect and handle liquids from within the removal areas. Costs assume that trash pumps or sump pumps will be capable of maintaining dry conditions within the excavation area.

10. Waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, TPH, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal. The estimated weight of material was based on an assumed 1.5 tons per cubic yard of material plus approximately 10% of weight for the addition of soil stabilization materials.

11. Soil waste transportation and disposal cost estimate includes all labor, equipment, and materials necessary to transport and dispose of excavated soils as non-hazardous waste at a permitted facility.

12. Backfill cost estimates includes all labor, equipment, and materials necessary to return Schermerhorn Creek to original elevation prior to sediment removal. Cost assumes that backfill materials will consist of general sand and gravel fill to within 1 foot of the adjacent creek sediment elevation and 1 foot of course sand similar to existing creek sediment conditions to match adjacent lines and grades.

13. Sediment and erosion control cost estimate includes all labor, equipment, and materials necessary to stabilize Schermerhorn Creek banks following sediment removal and backfilling, as necessary, to minimize the potential for sloughing of the creek banks.

TABLE 5-13

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SEDIMENT ALTERNATIVE 3
SEDIMENT REMOVAL AND INSTALLATION OF CLOSED CULVERT

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$150,000	$150,000
2	Construction and Maintenance of Soil Staging Areas	1	LS	$20,000	$20,000
3	Install Temporary Fencing	2,500	LF	$20	$50,000
4	Relocate/Temporary Disconnection of Gas and Electric Utilities	1	LS	$50,000	$50,000
5	Site Preparation	1	LS	$20,000	$20,000
6	Temporary Creek Diversion	1	LS	$120,000	$120,000
7	Install and Remove Temporary Steel Sheetpiling	66,000	SF	$30	$1,980,000
8	Sediment and Soil Excavation, Handling, and Screening of Materials	5,900	CY	$35	$206,500
9	Sediment Excavation Dewatering	1	LS	$40,000	$40,000
10	Waste Characterization	25	ea	$750	$18,750
11	Soil Waste Transportation and Disposal	11,000	ton	$100	$1,100,000
12	Treatment of Groundwater	1	LS	$30,000	$30,000
13	Culvert Bedding	1,000	CY	$40	$40,000
14	Culvert	1,100	LF	$300	$330,000
15	Backfill	1,400	CY	$35	$49,000
16	Sediment and Erosion Control	1	LS	$65,000	$65,000
17	Installation of 4" Bituminous Asphalt Base Course	1,250	ton	$50	$62,500
18	Installation of 2" Bituminous Asphalt Top Course	650	ton	$50	$32,500
19	Stormwater Management	1	LS	$50,000	$50,000
				Total Capital Cost	$4,414,250
				Administration and Engineering (10%)	$441,425
				Construction Management (20%)	$882,850
				Contingency (20%)	$882,850
				Total Estimated Cost	**$6,621,375**
				Rounded to	**$6,600,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes mobilization and demobilization of all labor, equipment, and material necessary to remove all sediments from Schermerhorn Creek and all labor, equipment, and materials necessary to install concrete box culvert for the entire onsite length of Schermerhorn Creek.

2. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct a material staging area consisting of a 12-inch gravel fill layer and geomembrane liner. Maintenance costs include inspecting, repairing staging areas as necessary, and covering staged soil with polyethylene sheeting.

TABLE 5-13

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SEDIMENT ALTERNATIVE 3
SEDIMENT REMOVAL AND INSTALLATION OF CLOSED CULVERT

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Relocate/temporarily disconnect subsurface gas and electric utilities cost estimate includes costs to disconnect the existing natural gas and electric utility piping and either reinstall or relocate the distribution piping following culvert installation.

5. Site preparation cost estimate includes all labor, equipment, and materials necessary to collect additional sediment and soil samples to further delineate sediment limits and soil conditions prior to removal.

6. Temporary creek diversion cost estimate includes all labor, equipment, and materials necessary to temporarily divert the Schermerhorn Creek to facilitate sediment removal and culvert installation.

7. Install and remove temporary steel sheetpiling cost estimate includes labor, equipment, and materials necessary to install, remove, and decontaminate steel sheetpiling. Sheetpiling assumed to be 30 feet below grade (based on assumed excavation depth of no more than 12 feet and basis of 2.5 times excavation depth for cantilevered sheetpiling) for 1,100 LF on each side of the creek. Sheetpile wall length was calculated assuming that sheetpiling would be required along both sides of the onsite portion of the creek. Cost estimate includes a reduced price due to assumed ease of sheetpile installation along the creek.

8. Sediment excavation, handling, and screening of materials cost estimate includes labor, equipment, and materials necessary to excavate material from above and below the water table; handling of removed soil, debris, and gravel within the staging area and subsequently loading into trucks prior to offsite disposal. Cost assumes excavation dimensions of 12-feet-wide, 12-feet-deep, for entire 1,100-foot-length of Schermerhorn Creek.

9. Sediment excavation dewatering cost estimate includes all labor, equipment, and materials necessary to collect and handle liquids from within the removal areas. Costs assume that trash pumps or sump pumps will be capable of maintaining dry conditions within the excavation area.

10. Waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, TPH, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal. The estimated weight of material was based on an assumed 1.7 tons per cubic yard of material plus approximately 10% of weight for the addition of soil stabilization materials.

11. Soil waste transportation and disposal cost estimate includes all labor, equipment, and materials necessary to transport and dispose of excavated soils as non-hazardous waste at a permitted facility.

12. Treatment of groundwater cost estimate includes all labor, equipment, and materials necessary to collect and treat groundwater that may be encountered during the sediment removal and culvert installation activities.

13. Culvert bedding cost includes all labor, equipment, and materials needed to place and compact crushed stone culvert bedding during installation of concrete box culvert. Cost assumes that approximately 1,000 cubic-yards (bottom 2 feet of the culvert excavation [12-foot-width]) of crushed stone will be used for culvert bedding.

14. Culvert cost estimate includes all labor, equipment, and materials necessary to install 8-foot by 6-foot (inside dimensions, assumed outside dimensions of 10-feet by 8-feet) concrete closed box culvert to replace the 1,100 LF onsite portion of Schermerhorn Creek.

15. Backfill cost estimate includes all labor, equipment, and materials necessary to import, place, compact, and grade 1,400 CY of backfill.

16. Sediment and erosion control cost estimate includes all labor, equipment, and materials necessary to stabilize Schermerhorn Creek banks following sediment removal and backfilling, as necessary, to minimize the potential for sloughing of the creek banks.

TABLE 5-13

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE FOR SEDIMENT ALTERNATIVE 3
SEDIMENT REMOVAL AND INSTALLATION OF CLOSED CULVERT

17. Installation of 4" bituminous asphalt course cost estimate includes all labor, equipment, and materials necessary to install a 4-inch layer (approximately 6 inches prior to compaction) of bituminous asphalt 30 feet wide for the entire 1,100-foot-length of the creek. The weight of the material was calculated assuming 2.0 tons per cubic yard.

18. Installation of 2" bituminous asphalt course cost estimate includes all labor, equipment, and materials necessary to install a 2-inch layer (approximately 3 inches prior to compaction) of bituminous asphalt base course 30 feet wide for the entire 1,100-foot-length of the creek. The weight of the material was calculated assuming 2.0 tons per cubic yard.

19. Stormwater management cost includes all labor, equipment, and materials necessary to address stormwater management concerns following closed culvert installation. Cost includes 2 lateral tie-ins from Broadway storm sewer drainage, 2 manholes installed to facilitate access to interior of culvert, 2 stormwater runoff sewer grates, and construction of drainage swales to convey onsite stormwater runoff to the culvert.

TABLE 6-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE
SOIL REMOVAL - POTENTIALLY NAPL-IMPACTED SOIL SOUTH OF SCHERMERHORN CREEK
OFFSITE TREATMENT/DISPOSAL

Item #	Description	Estimated Quantity	Unit	Unit Price (materials and labor)	Estimated Amount
CAPITAL COSTS					
1	Mobilization/Demobilization	1	LS	$30,000	$30,000
2	Construct and Remove Decontamination Pad	1	LS	$7,500	$7,500
3	Install Temporary Fencing	400	LF	$20	$8,000
4	Construction and Maintenance of Soil Staging Areas	1	LS	$25,000	$25,000
5	Asphalt Removal	2,250	SF	$1	$2,250
6	Install and Remove Temporary Steel Sheetpiling	7,500	SF	$56	$420,000
7	Soil Excavation, Handling, and Screening of Excavated Materials	1,200	CY	$37	$44,400
8	Soil Excavation Area Dewatering	1	LS	$50,000	$50,000
9	Vapor/Odor Control	1	LS	$25,000	$25,000
10	Fill Importation, Placement, Compaction, and Grading	1,200	CY	$35	$42,000
11	Installation of 4" Bituminous Asphalt Base Course	85	ton	$50	$4,250
12	Installation of 2" Bituminous Asphalt Top Course	45	ton	$50	$2,250
13	Temporary Onsite Groundwater Treatment System	1	LS	$50,000	$50,000
14	Waste Characterization	4	ea	$1,200	$4,800
15	Asphalt Disposal	85	ton	$100	$8,500
16	Miscellaneous Waste Disposal	1	LS	$5,000	$5,000
17	Soil Waste Transportation and Disposal - LTTD	2,000	ton	$75	$150,000
				Total Capital Cost	$878,950
				Administration and Engineering (10%)	$87,895
				Construction Management (20%)	$175,790
				Contingency (20%)	$175,790
				Total Estimated Cost	**$1,318,425**
				Rounded to	**$1,300,000**

General Notes:

1. Cost estimate is based on Blasland, Bouck, and Lee, Inc.'s (BBL's) past experience and vendor estimates using 2006 Dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended. BBL is not licensed to provide financial or legal consulting services; as such; this cost estimate information is not intended to be utilized for complying with financial reporting requirements associated with liability services.

Assumptions:

1. Mobilization/Demobilization cost includes: mobilization and demobilization of all labor, equipment, and materials necessary to excavate, transport, and dispose of potentially NAPL-impacted soil located south of Schermerhorn Creek. This cost assumes that the work will be performed without temporary enclosure(s) and associated air treatment system(s).

TABLE 6-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE
SOIL REMOVAL - POTENTIALLY NAPL-IMPACTED SOIL SOUTH OF SCHERMERHORN CREEK
OFFSITE TREATMENT/DISPOSAL

2. Construct and remove equipment decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 60-foot by 30-foot decontamination pad and appurtenances. The decontamination pad would consist of 40-mil high-density polyethylene (HDPE) with a 6-inch gravel drainage layer placed over the HDPE liner, surrounded by a 1-foot high berm and sloped to a collection sump for the collection of decontamination water.

3. Temporary fencing cost estimate includes labor, equipment, and materials necessary to install and remove temporary fencing around the working area.

4. Construction and maintenance of soil staging area cost estimate includes labor, equipment, and materials to construct an approximate 100-foot by 200-foot material staging area consisting of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner. Maintenance costs include inspecting and repairing staging area as necessary.

5. Asphalt removal cost estimate includes all labor, equipment, and materials necessary to saw cut and remove the existing asphalt pavement (2,250 square-feet assumed to be 6 inches thick).

6. Install and remove temporary steel sheetpiling cost estimate includes labor, equipment, and materials necessary to install, remove, and decontaminate steel sheetpiling. It was assumed that pretrenching to a depth of 10 feet (i.e., below the bottom of the fill unit) would be necessary to facilitate installation of sheetpiling. Sheetpiling assumed to be 37.5 feet below grade (basis of 2.5 times excavation depth for cantilevered sheetpiling) for 200 LF (an excavation area of approximately 50 feet by 45 feet).

7. Soil excavation, handling, and screening of materials cost estimate includes labor, equipment, and materials necessary to excavate potentially NAPL-impacted material to a maximum depth of 15 feet bgs; transferring excavated soil and debris to the material staging area; and screening excavated soil to remove debris larger than 2 inches in diameter to facilitate LTTD treatment.

8. Soil excavation area dewatering cost estimate includes labor, equipment, and materials necessary to collect and transfer liquids from within the soil removal areas to a temporary onsite treatment system. Cost estimate includes installation of dewatering points, operation and maintenance of pumps, and associated equipment materials (i.e., hoses, piping, etc.) Cost assumes dewatering pumps operating 24 hours per day, 7 days per week, for one month.

9. Vapor/odor control cost estimate includes labor cost for a technician to apply foam to soil staging area (2 times a day) and open excavation 2 hours per day, 5 days per week, for 1 month. The cost estimate also includes the cost for the purchase/rental of the trailer-mounted equipment and chemicals needed to facilitate the application of the foam.

10. Fill importation, placement, compaction, and grading cost estimate includes all labor, equipment, and materials necessary to import, place, compact, and grade 1,200 CY of backfill.

11. Installation of 4" bituminous asphalt course cost estimate includes all labor, equipment, and materials necessary to install a 4-inch layer (approximately 6 inches prior to compaction) of bituminous asphalt. The weight of the material was calculated assuming 2.0 tons per cubic yard.

12. Installation of 2" bituminous asphalt course cost estimate includes all labor, equipment, and materials necessary to install a 2-inch layer (approximately 3 inches prior to compaction) of bituminous asphalt base course. The weight of the material was calculated assuming 2.0 tons per cubic yard.

13. Temporary groundwater treatment system cost estimate includes the monthly rental of a 100 gallon-per-minute groundwater treatment system which includes a 600-gallon influent polyethylene tank, oil/water separator, carbon and sand filtration, and 5 effluent holding tanks. Cost estimate also includes operation and maintenance of the groundwater treatment system including: operator labor and discharge fee (assumed $0.005 per gallon) for 20,000 gallons.

TABLE 6-1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

COST ESTIMATE
SOIL REMOVAL - POTENTIALLY NAPL-IMPACTED SOIL SOUTH OF SCHERMERHORN CREEK
OFFSITE TREATMENT/DISPOSAL

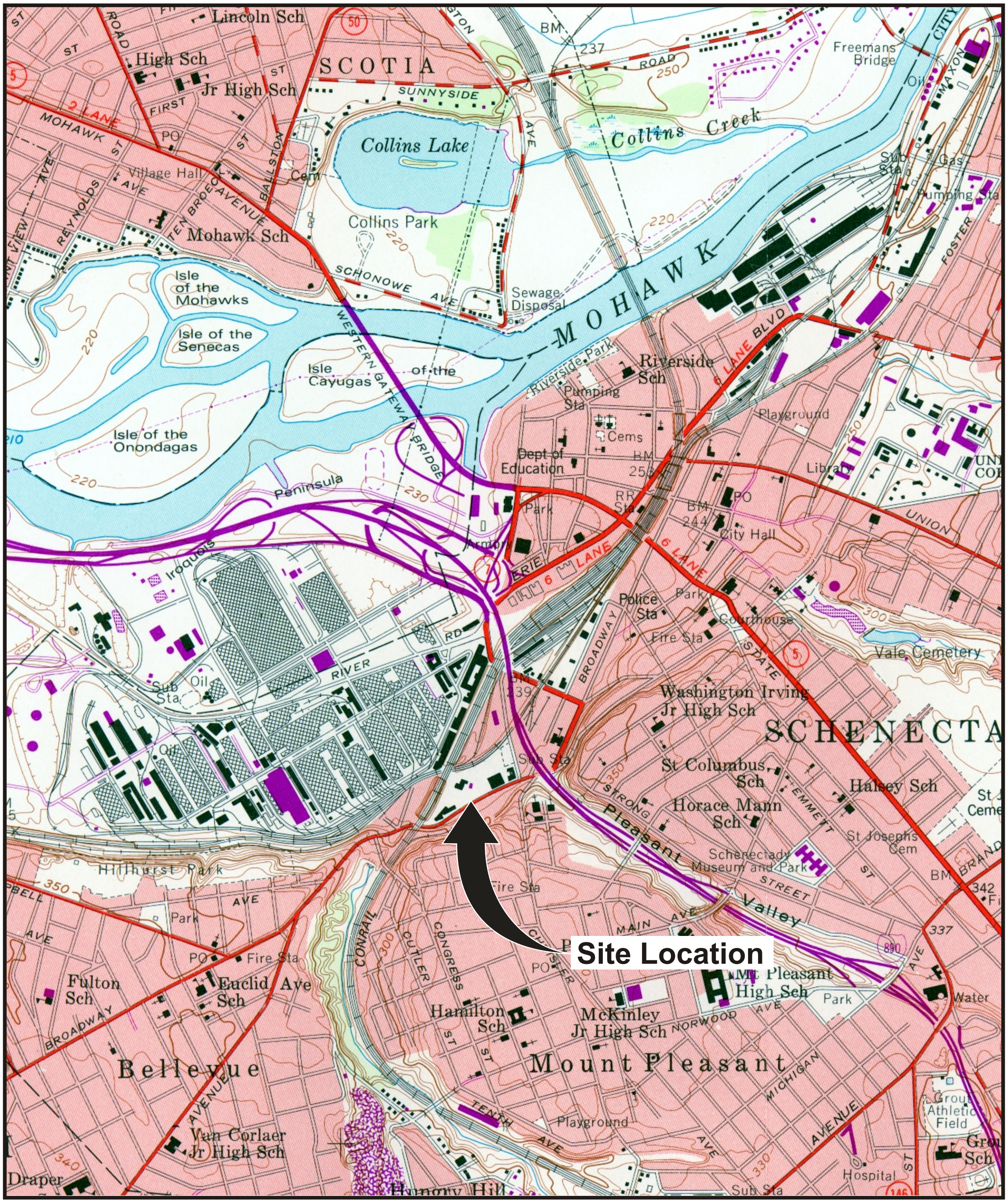
14. Waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, TPH, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for offsite treatment/disposal. The estimated weight of material was based on an assumed 1.5 tons per cubic yard of material plus approximately 10% of the excavated soil weight for the addition of soil stabilization materials.

15 Asphalt disposal cost estimate includes all labor, equipment, and materials necessary for the transportation and offsite disposal of the excavated asphalt at a C&D waste landfill. The estimated weight of material was based on an assumed 2.0 tons per cubic yard.

16. Miscellaneous waste disposal cost estimate is based on disposal of PPE, staging area and decontamination pad materials, and disposable equipment and materials at a facility permitted to accept the waste.

17. Soil treatment cost estimate includes all labor, equipment, and material necessary to treat potentially NAPL-impacted soils via LTTD at Environmental Soil Management, Inc.'s (ESMI) Fort Edward Facility. Cost based on information provided to BBL by ESMI on 6/29/05. Costs also include disposal at an appropriate permitted facility following treatment.

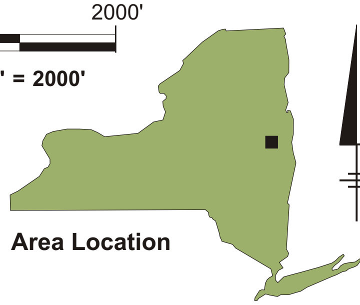
Figures



REFERENCE: BASE MAP SOURCE USGS 7.5 MINUTE QUADS. SERIES SCHENECTADY, NEW YORK, 1954, PHOTOREVISED 1980.

2000' 0 2000'

Approximate Scale: 1" = 2000'



Area Location

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

FEASIBILITY STUDY REPORT

SITE LOCATION MAP

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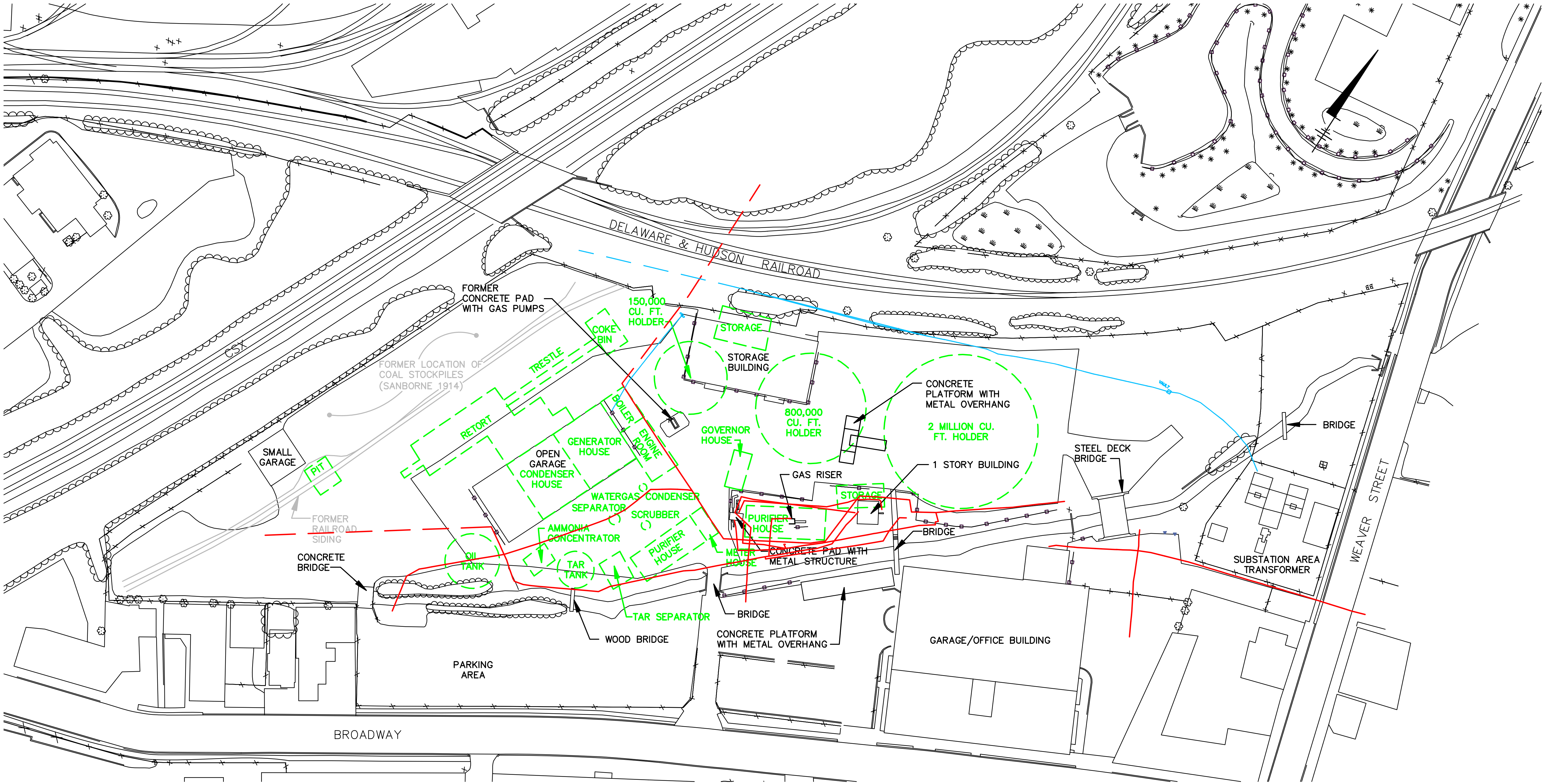
FIGURE
1

11/07/06 SYR-D85-DJH
36657018/36657n01.cdr



NOTES:

1. BASE MAP PROVIDED BY NIAGARA MOHAWK POWER CORPORATION ON 5/21/99, FROM NIAGARA MOHAWK POWER CORPORATION SURVEY REFERENCE FILE DRAWING 3277.DGN, DATED 10/26/94 AT A SCALE OF 1"=100'.
2. HISTORICAL STRUCTURE LOCATIONS WITH THE EXCEPTION OF THE SEPARATOR, WATERGAS CONDENSER, AND SCRUBBER WERE DIGITIZED FROM PARSONS ENGINEERING SCIENCE, INC. FIGURE 1.5, "HISTORICAL STRUCTURES, PREVIOUS SAMPLE LOCATIONS." LOCATIONS OF SEPARATOR, WATERGAS CONDENSER, AND SCRUBBER BASED ON HISTORICAL SANBORN INSURANCE MAPS (1914 AND 1980).
3. SUBSURFACE UTILITY LOCATIONS ARE BASED ON FIELD SURVEY OF UTILITY MARKOUTS. ALL LOCATIONS ARE APPROXIMATE. ALL SUBSURFACE UTILITIES MAY NOT BE MARKED.
4. ALL LOCATIONS ARE APPROXIMATE.

LEGEND

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- FENCE LINE

0 100' 200'
GRAPHIC SCALE

NATIONAL GRID
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SCHENECTADY, NEW YORK
FEASIBILITY STUDY REPORT

CURRENT AND HISTORICAL MGP FEATURES

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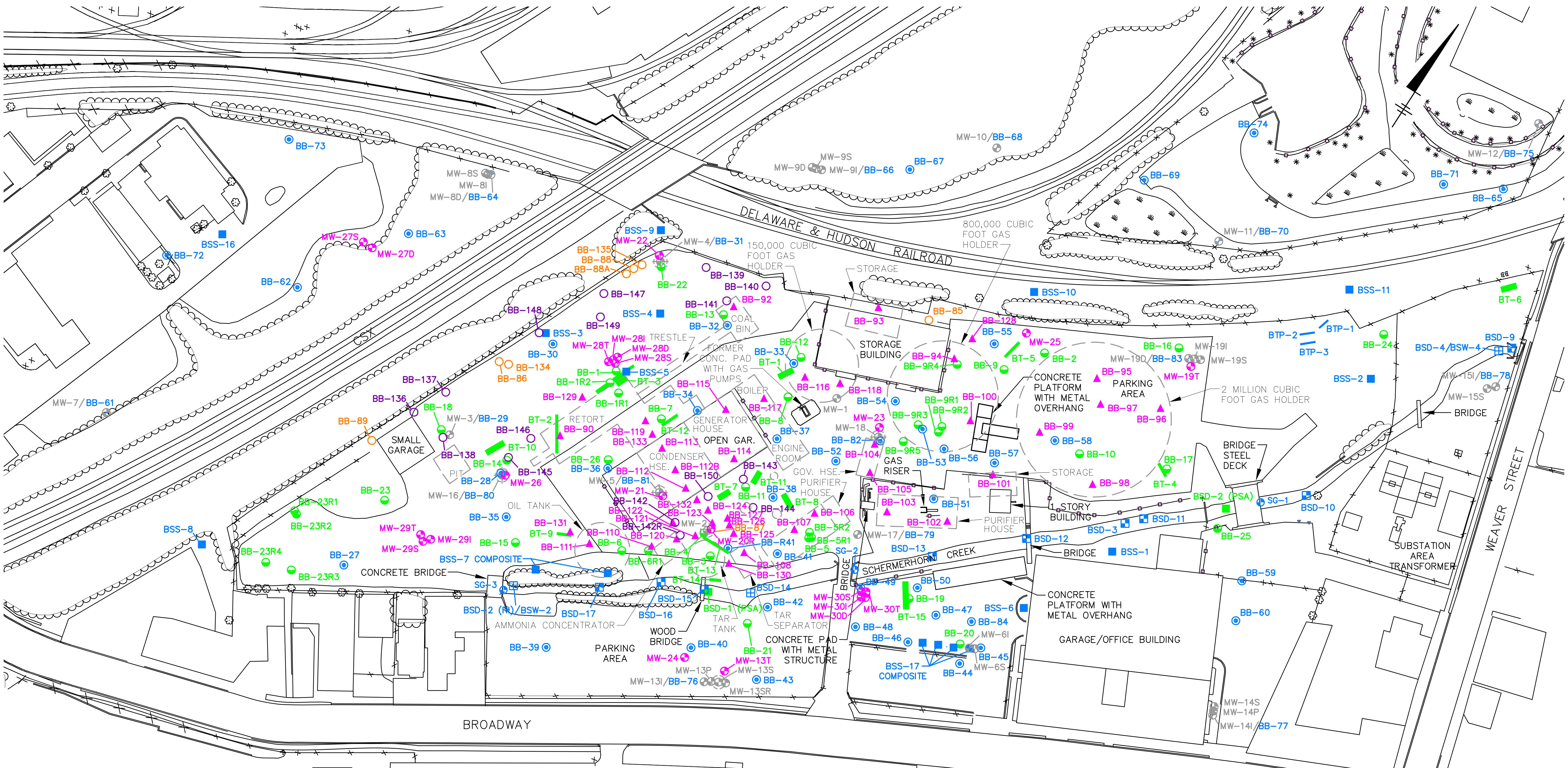
FIGURE **1-2**



0 100' 200'
GRAPHIC SCALE

NOTES:

1. BASE MAP PROVIDED BY NIAGARA MOHAWK POWER CORPORATION ON 5/21/99, FROM NIAGARA MOHAWK POWER CORPORATION SURVEY REFERENCE FILE DRAWING 3277.DGN, DATED 10/26/94 AT A SCALE OF 1"=100'.
2. SAMPLING LOCATIONS WERE SURVEYED BY NIAGARA MOHAWK AND BLASLAND, BOUCK & LEE, INC.. LOCATIONS OF OTHER SITE FEATURES ARE APPROXIMATE.
3. HORIZONTAL DATUM IS NEW YORK STATE PLANE OF 1983, EAST ZONE.
4. MONITORING WELL MW-20 WAS ABANDONED AND REPLACED WITH MONITORING WELL MW-20R IN JANUARY 2005.

LEGEND:

- BB-X · SOIL BORING LOCATION ID:
  - BB-1 THROUGH BB-26 COMPLETED DURING PSA/IRM
  - BB-27 THROUGH BB-84 AND BB-R41 COMPLETED DURING RI
  - BB-85 THROUGH BB-89 AND BB-88A COMPLETED DURING NAPL INVESTIGATION
  - BB-90, BB-92 THROUGH BB-108, AND BB-110 THROUGH BB-133 COMPLETED DURING HISTORICAL SUBSURFACE STRUCTURE INVESTIGATION
  - BB-134 THROUGH BB-150 COMPLETED DURING ADDITIONAL SUBSURFACE INVESTIGATION
- MW-15S MONITORING WELL
- MW-2/BMW-1 DECOMMISSIONED MONITORING WELL
- MW-23 BBL ADDITIONAL SUBSURFACE INVESTIGATION MONITORING WELL LOCATION
- BB-102 BBL HISTORICAL SUBSURFACE STRUCTURE INVESTIGATION SOIL BORING LOCATION
- BB-138 ADDITIONAL NAPL DELINEATION SOIL BORING LOCATION
- BB-85 NAPL DELINEATION SOIL BORING LOCATION
- BB-6 PSA/IRM SOIL BORING LOCATION
- BT-14 PSA/IRM TEST PIT LOCATION
- BSD-1 PSA/IRM SEDIMENT SAMPLE LOCATION
- BB-35 RI SOIL BORING LOCATION
- BSS-6 RI SURFACE SOIL SAMPLE LOCATION
- BTP-1 RI TEST PIT LOCATION
- BSD-2 RI SEDIMENT SAMPLE LOCATION
- BSD-2/BSW-2 RI SEDIMENT/SURFACE WATER SAMPLE LOCATION
- SG-1 STAFF GAUGE
- APPROXIMATE LOCATION OF EXISTING SITE FEATURE
- APPROXIMATE LOCATION OF HISTORICAL SITE FEATURE
- —X— FENCE LINE

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SAMPLE LOCATION MAP

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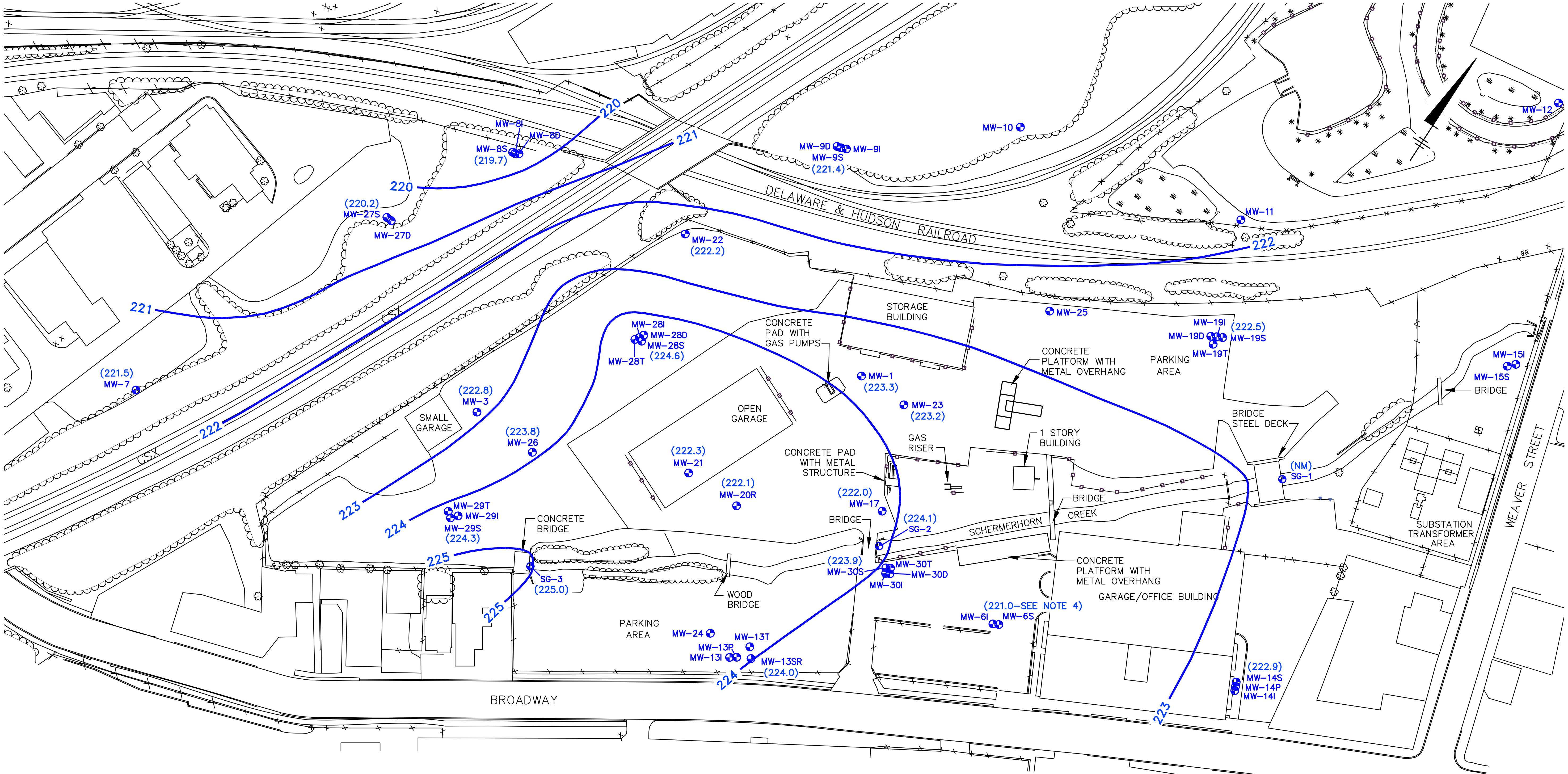
FIGURE
1-3



NOTES:

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2. MONITORING WELL LOCATIONS SURVEYED BY BBL.
3. HORIZONTAL DATUM IS NEW YORK STATE PLANE OF 1983, EAST ZONE.
4. WATER LEVEL MEASURED AT MW-6S APPEARS ANOMALOUS AND WAS NOT USED FOR CONTOURING.
5. MONITORING WELLS MW-17, MW-20R, AND MW-21 WERE INSTALLED SUCH THAT THEIR SCREENS STRADDLE THE SHALLOW AND INTERMEDIATE HYDROSTRATIGRAPHIC ZONES. THEREFORE THE WATER LEVELS MEASURED AT THESE LOCATIONS ARE NOT INDICATIVE OF THE WATER LEVELS FOR EITHER OF THESE ZONES AND WERE NOT USED FOR CONTOURING.
6. MONITORING WELLS MW-20R, REPLACED MONITORING WELL MW-20; MW-21 REPLACED MW-5; MW-22 REPLACED MW-4; MW-23 REPLACED MW-18; AND MW-26 REPLACED MW-16.

LEGEND:

MW-15S	MONITORING WELL
X	FENCE LINE
	APPROXIMATE LOCATION OF EXISTING SITE FEATURE
224	INFERRED GROUNDWATER ELEVATION CONTOUR
(224.0)	GROUNDWATER ELEVATION
(NM)	NOT MEASURED

0 100' 200'

GRAPHIC SCALE

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WATER TABLE ELEVATION CONTOUR MAP - MAY 2005

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FIGURE **1-4**

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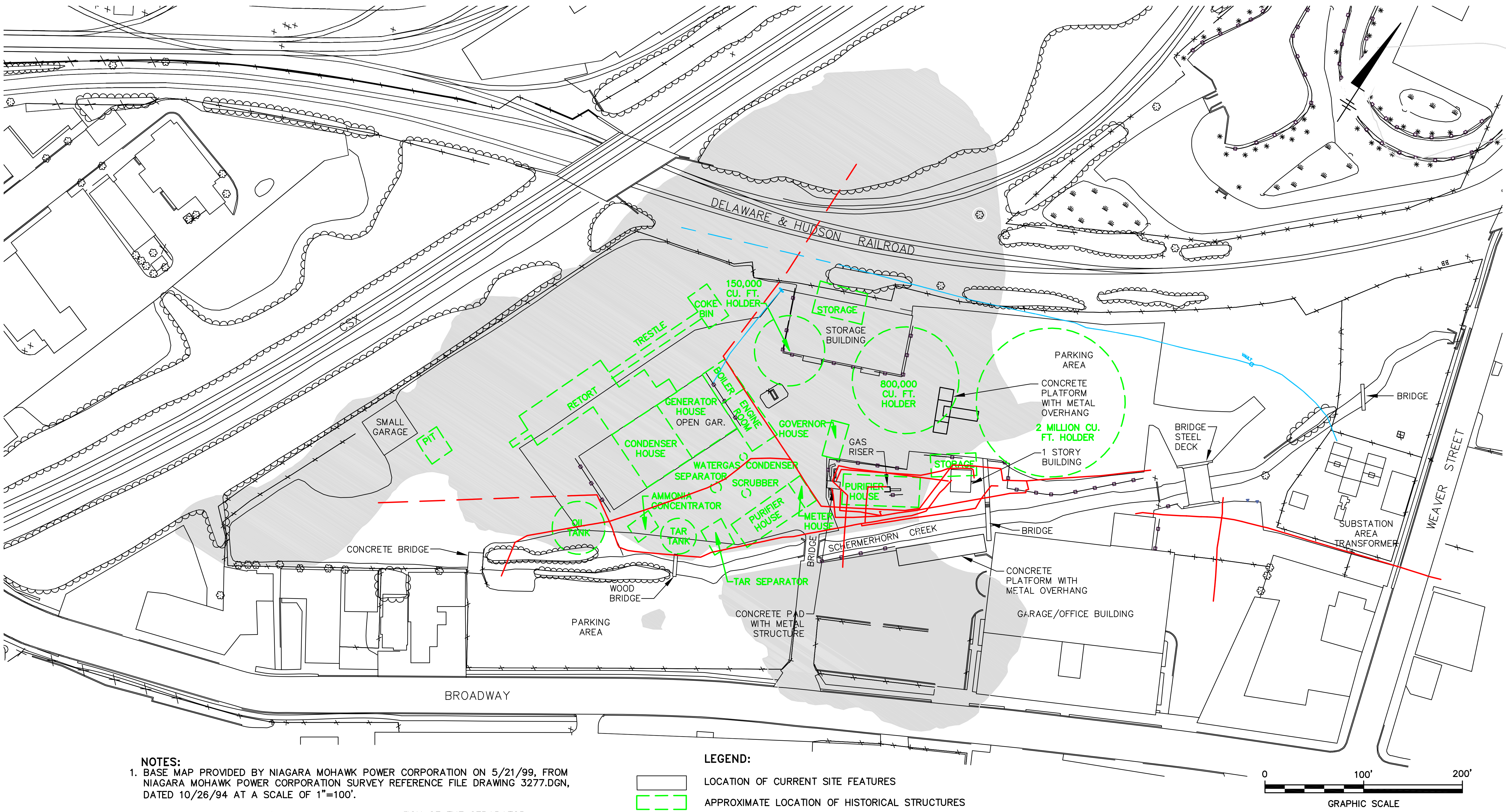

NOTES:

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3. DELINEATION OF SOIL CONTAINING CONSTITUENTS AT CONCENTRATIONS EXCEEDING RECOMMENDED SOIL CLEANUP OBJECTIVES WAS DETERMINED BASED ON MINING VISUALIZATION SOFTWARE (MVS) COMPUTER MODELING THAT UTILIZED A DATABASE OF FIELD OBSERVATIONS RECORDED ON SOIL BORING LOGS AND BASED ON SOIL SAMPLE ANALYTICAL RESULTS.
4. ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- APPROXIMATE EXTENT OF SOIL CONTAINING CONSTITUENTS GREATER THAN NYSDEC TAGM 4046 RECOMMENDED SOIL CLEANUP OBJECTIVES
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- FENCE LINE

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SCHENECTADY, NEW YORK
FEASIBILITY STUDY REPORT

EXTENT OF SOIL CONTAINING CONSTITUENTS GREATER THAN NYSDEC TAGM 4046 RECOMMENDED SOIL CLEANUP OBJECTIVES

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FIGURE
1-5

SYR-85-RCB GMSL WLJ L: ON=*, OFF=REF
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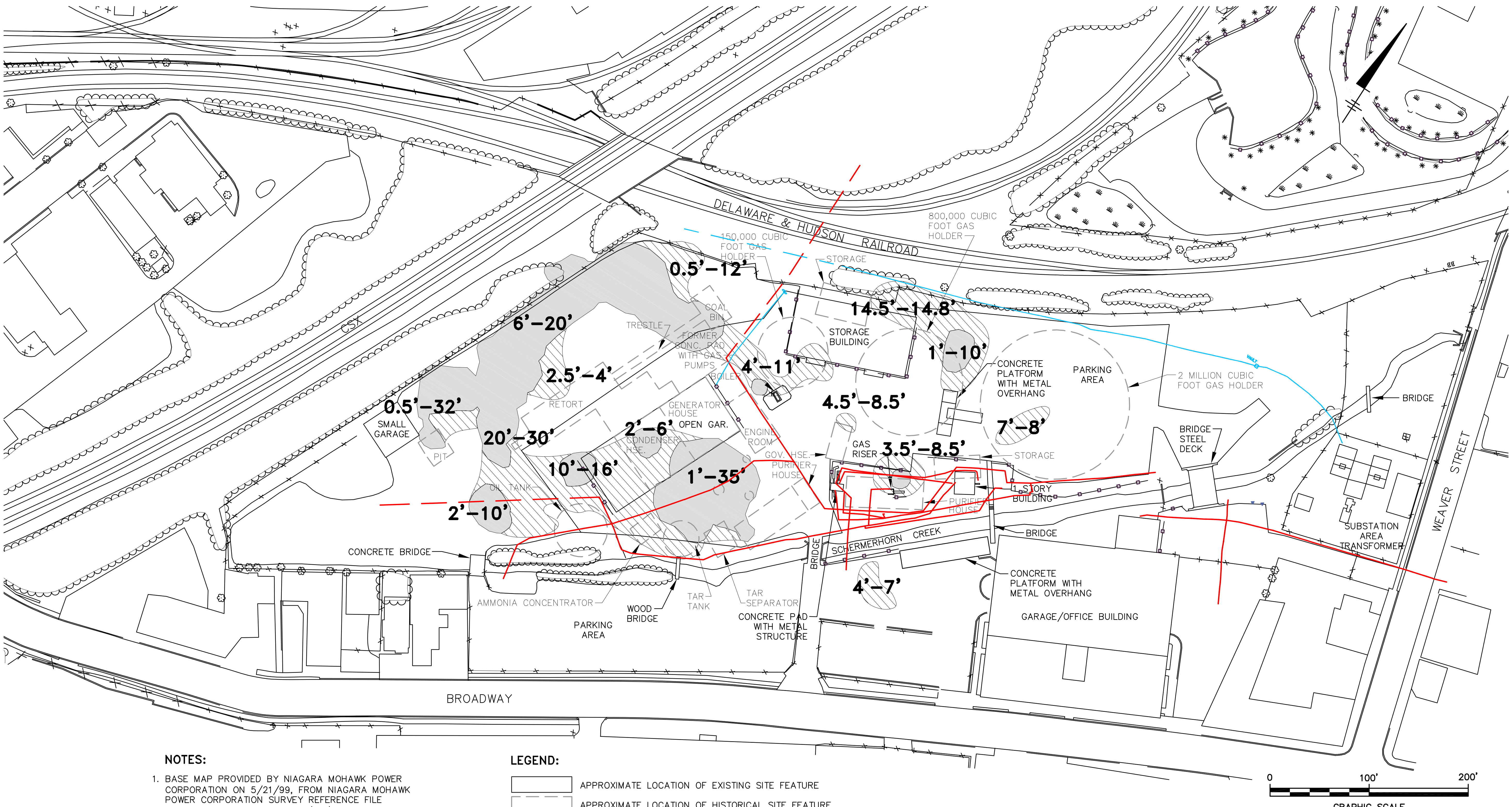

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2. HORIZONTAL DATUM IS NEW YORK STATE PLANE OF 1983, EAST ZONE.
3. DELINEATION OF NAPL–IMPACTED SOIL WAS DETERMINED BASED ON MINING VISUALIZATION SOFTWARE (MVS) COMPUTER MODELING THAT UTILIZED A DATABASE OF FIELD OBSERVATIONS RECORDED ON SOIL BORING LOGS.
4. DELINEATION OF POTENTIAL NAPL DISTRIBUTION AREAS IS BASED ON INTERPRETATION BETWEEN SOIL BORINGS AND VISUAL CHARACTERIZATION OF SOILS (i.e., TEST PITS, TEST BORINGS, AND SOIL EXCAVATIONS) NOT INCORPORATED INTO THE MVS DATABASE.

LEGEND:

- APPROXIMATE LOCATION OF EXISTING SITE FEATURE
- APPROXIMATE LOCATION OF HISTORICAL SITE FEATURE
- APPROXIMATE EXTENT OF NAPL–IMPACTED SOIL
- X — FENCE LINE
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- INTERPRETED AREAS OF POTENTIAL NAPL–IMPACTED SOIL
- **6'–20'** APPROXIMATE DEPTH TO TOP AND BOTTOM OF NAPL–IMPACTED SOIL (BASED ON VISUAL SOIL CHARACTERIZATION AND MODELING USING MVS)

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SCHENECTADY, NEW YORK
FEASIBILITY STUDY REPORT

EXTENT OF NAPL–IMPACTED SOILS

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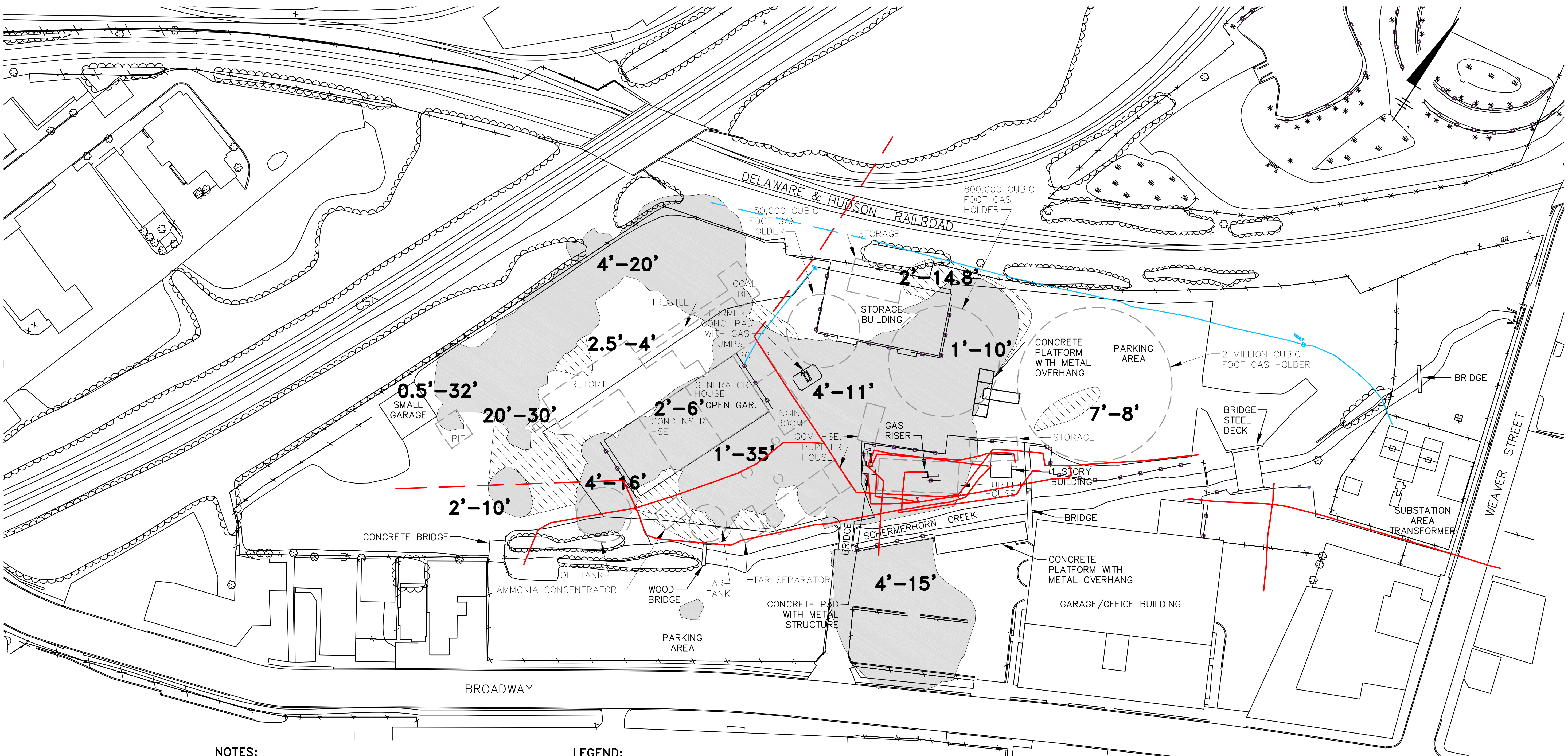
FIGURE **1-6**



NOTES:

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2. HORIZONTAL DATUM IS NEW YORK STATE PLANE OF 1983, EAST ZONE.
3. DELINEATION OF NAPL–IMPACTED SOIL AND SOIL CONTAINING PAHs AT CONCENTRATIONS >500 PPM WAS DETERMINED BASED ON MINING VISUALIZATION SOFTWARE (MVS) COMPUTER MODELING THAT UTILIZED A DATABASE OF FIELD OBSERVATIONS RECORDED ON SOIL BORING LOGS AND BASED ON SOIL SAMPLE ANALYTICAL RESULTS.
4. DELINEATION OF POTENTIAL NAPL DISTRIBUTION AREAS IS BASED ON INTERPRETATION BETWEEN SOIL BORINGS AND VISUAL CHARACTERIZATION OF SOILS (i.e., TEST PITS, TEST BORINGS, AND SOIL EXCAVATIONS) NOT INCORPORATED INTO THE MVS DATABASE.

LEGEND:

	APPROXIMATE LOCATION OF EXISTING SITE FEATURE
	APPROXIMATE LOCATION OF HISTORICAL SITE FEATURE
	APPROXIMATE EXTENT OF NAPL–IMPACTED SOIL AND SOIL CONTAINING PAHs >500 ppm
	INTERPRETED AREAS OF POTENTIAL NAPL–IMPACTED SOIL
6'–20'	APPROXIMATE DEPTH TO TOP AND BOTTOM OF NAPL–IMPACTED SOIL AND SOIL CONTAINING PAHs >500ppm (BASED ON VISUAL SOIL CHARACTERIZATION AND SOIL SAMPLE ANALYTICAL RESULTS, RESPECTIVELY)
—X—	FENCE LINE
	SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
	SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)

0 100' 200'

GRAPHIC SCALE

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SCHENECTADY, NEW YORK

FEASIBILITY STUDY REPORT

EXTENT OF NAPL–IMPACTED SOIL AND SOIL CONTAINING PAHs >500 ppm

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FIGURE
1-7

SYR-85-RCB WLJ L: ON=*, OFF=REF*
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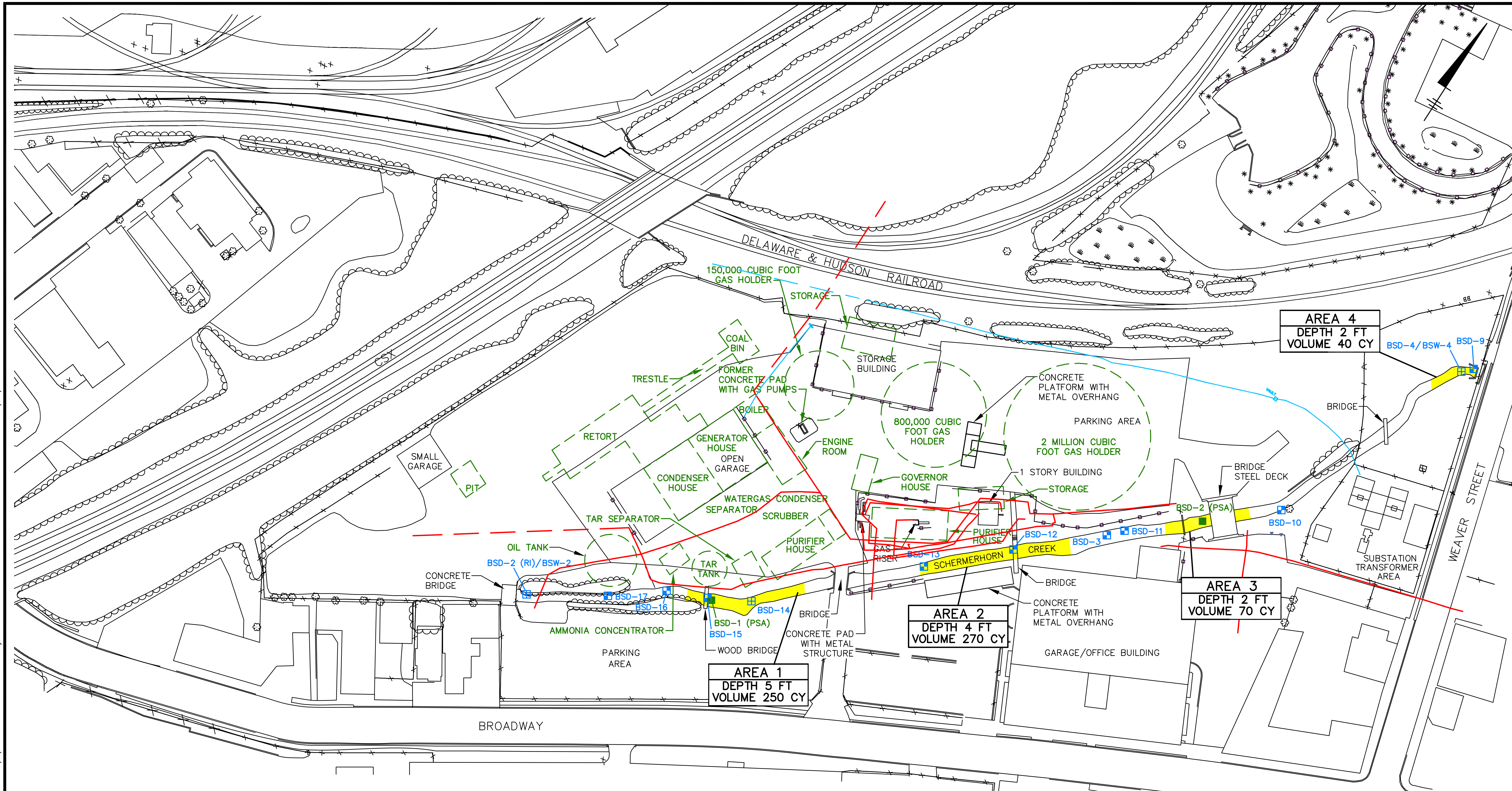

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2. ALL LOCATIONS ARE APPROXIMATE.
3. PROPERTY LINE LOCATION ESTIMATED.

LEGEND:

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL SITE FEATURES
- AREAS OF POTENTIAL SEDIMENT REMOVAL
- SUBSURFACE GAS FEATURES (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC FEATURES (DASHED WHERE INFERRED)
- X — FENCE LINE
- BSD-1 RI SEDIMENT SAMPLE LOCATION
- BSD-2 RI SEDIMENT SURFACE WATER SAMPLE LOCATION
- BSD-2/BSW-2 RI SEDIMENT/SURFACE WHATER SAMPLE LOCATION

0 100' 200'
GRAPHIC SCALE

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SCHENECTADY, NEW YORK

REVISED FEASIBILITY STUDY

AREAS OF POTENTIAL SEDIMENT REMOVAL

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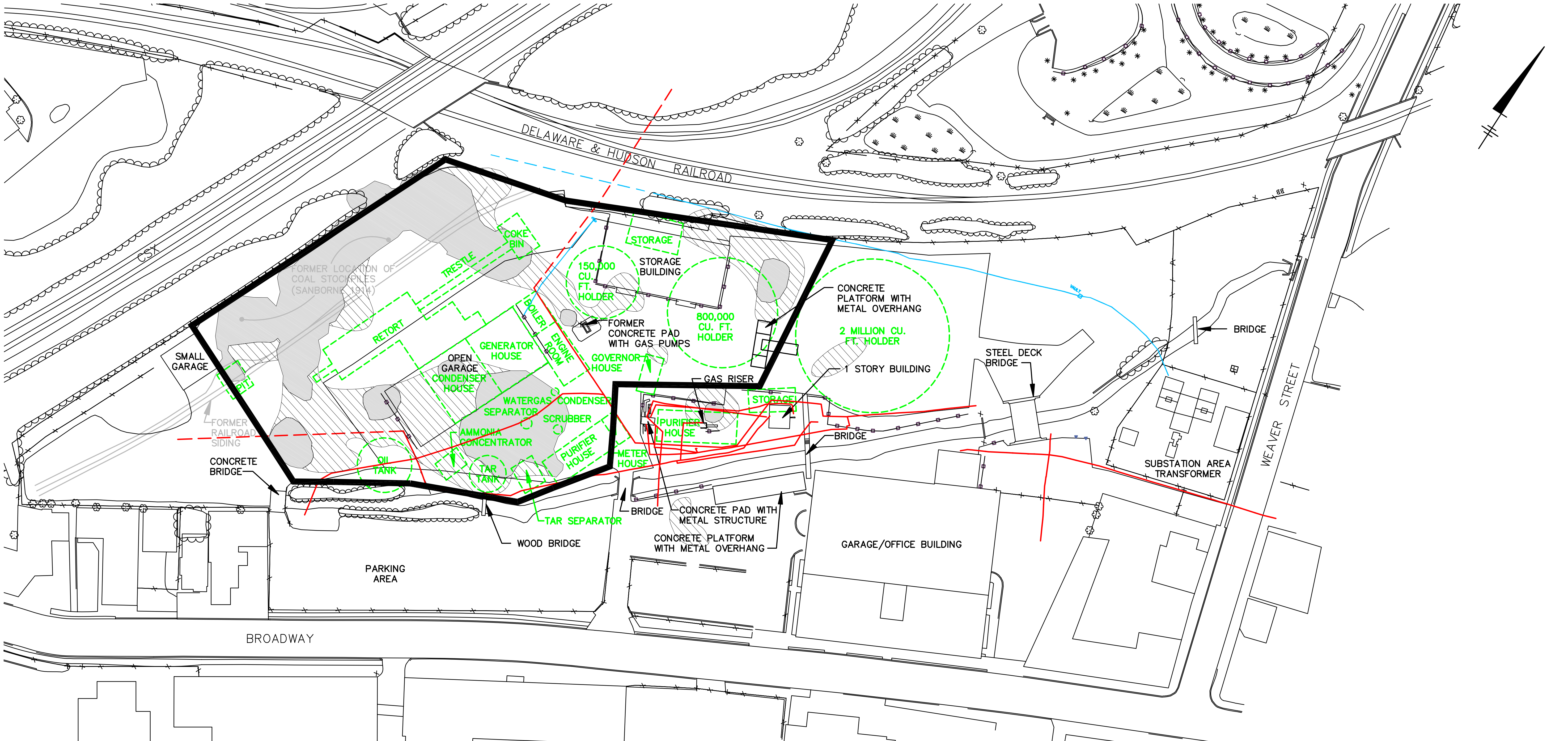
FIGURE **1-8**



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3. DELINEATION OF POTENTIAL NAPL-IMPACTED SOIL DISTRIBUTION AREAS IS BASED ON INTERPRETATION BETWEEN SOIL BORINGS AND VISUAL CHARACTERIZATION OF SOILS (i.e., TEST PITS, TEST BORINGS, AND SOIL EXCAVATIONS) NOT INCORPORATED INTO THE MVS DATABASE.
4. THE INDICATED EXTENT SHOWN FOR THE ASPHALT CAP WOULD BE SIMILAR UNDER SITE WIDE ALTERNATIVE NOS. 1, 2, 3, AND 6.
5. SUBSURFACE UTILITY LOCATIONS ARE BASED ON FIELD SURVEY OF UTILITY MARKOUTS. ALL LOCATIONS ARE APPROXIMATE. ALL SUBSURFACE UTILITIES MAY NOT BE MARKED.
6. ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- APPROXIMATE EXTENT OF NAPL IMPACTED SOIL
- INTERPRETED AREAS OF POTENTIAL NAPL-IMPACTED SOIL
- EXTENT OF ASPHALTIC CONCRETE CAP
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- FENCE LINE

0 100' 200'
GRAPHIC SCALE

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ASPHALTIC CONCRETE CAP

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FIGURE **4-1**

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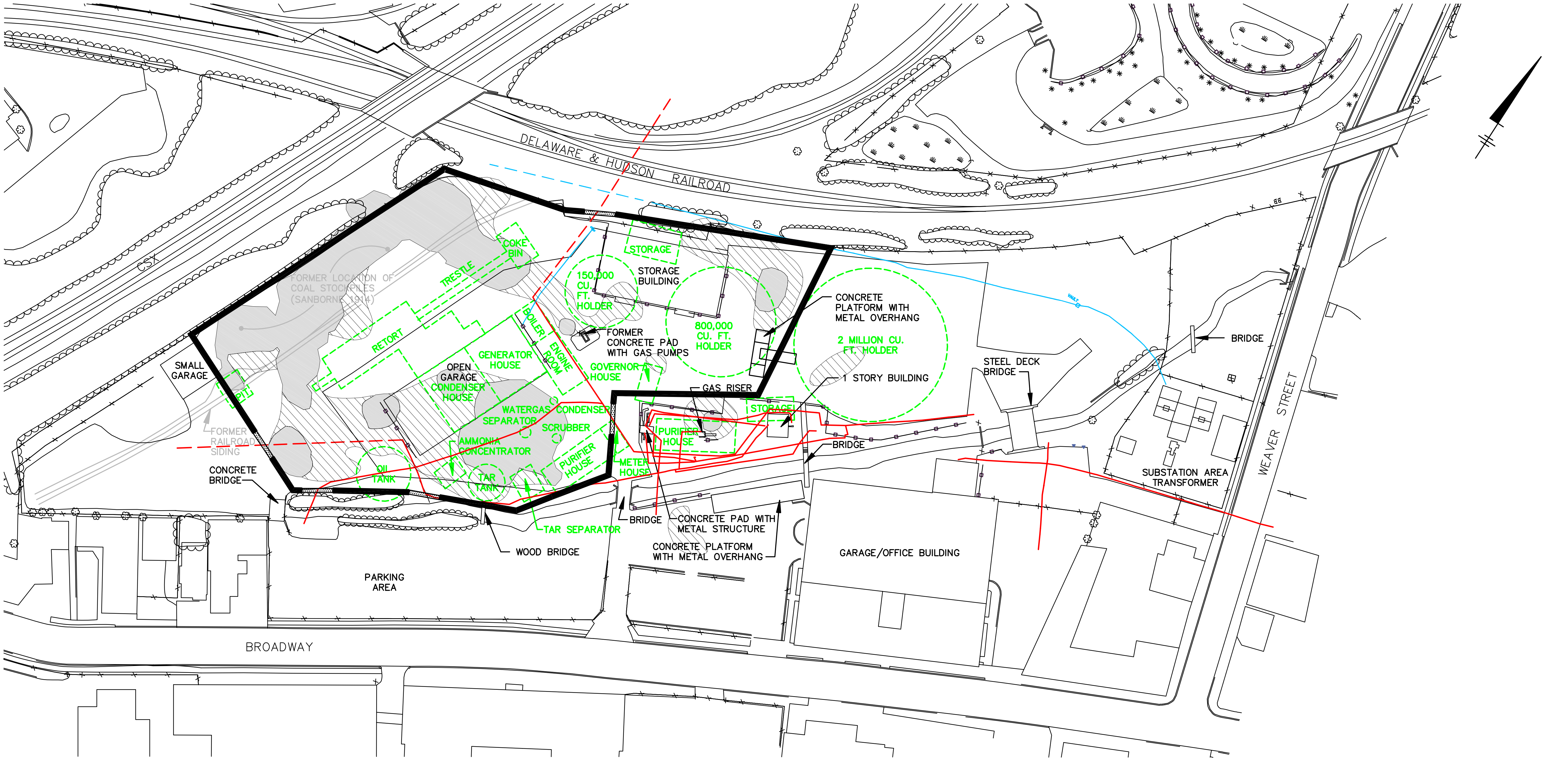

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5. ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- APPROXIMATE EXTENT OF NAPL IMPACTED SOIL
- INTERPRETED AREAS OF POTENTIAL NAPL-IMPACTED SOIL
- CONTAINMENT BARRIER WALL (TO BE INSTALLED TO A DEPTH OF APPROX. 65 FEET BGS)
- HIGH-PRESSURE JET GROUTING (TO BE INSTALLED TO A DEPTH OF APPROX. 65 FEET BGS)
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- FENCE LINE

0 100' 200'

GRAPHIC SCALE

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CONTAINMENT BARRIER WALL

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FIGURE
4-2

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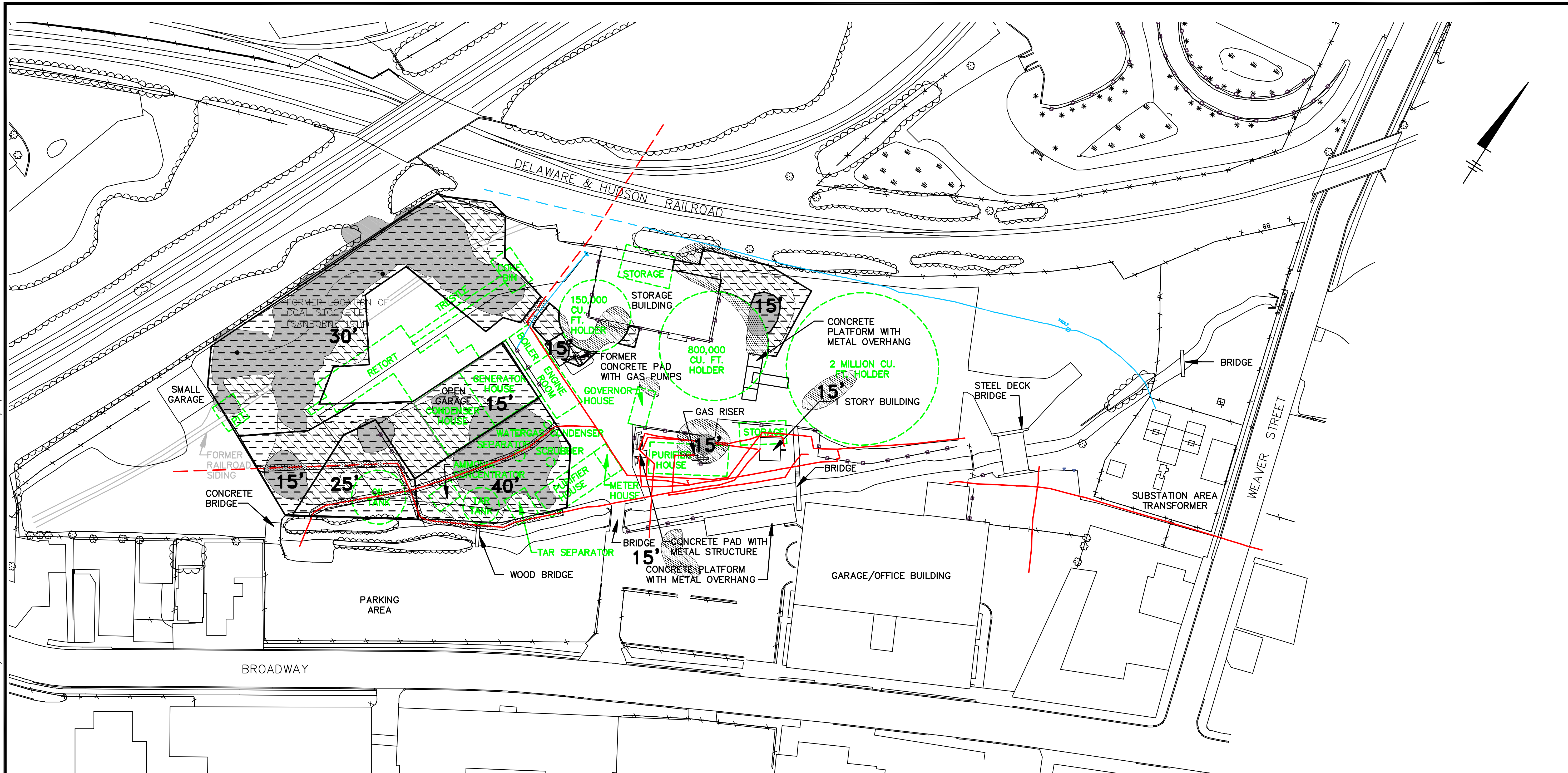

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5. ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- APPROXIMATE LOCATION OF ISS TREATMENT AREAS
- APPROXIMATE EXTENT OF NAPL IMPACTED SOIL
- INTERPRETED AREAS OF POTENTIAL NAPL-IMPACTED SOIL
- APPROXIMATE LOCATION OF JET GROUT TREATMENT AREAS
- 15' APPROXIMATE DEPTH OF ISS TREATMENT
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- FENCE LINE

0 100' 200'

GRAPHIC SCALE

NATIONAL GRID
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SCHENECTADY, NEW YORK

FEASIBILITY STUDY REPORT

IN-SITU SOIL STABILIZATION-NAPL-IMPACTED AND POTENTIALLY NAPL-IMPACTED SOIL

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FIGURE **4-3**

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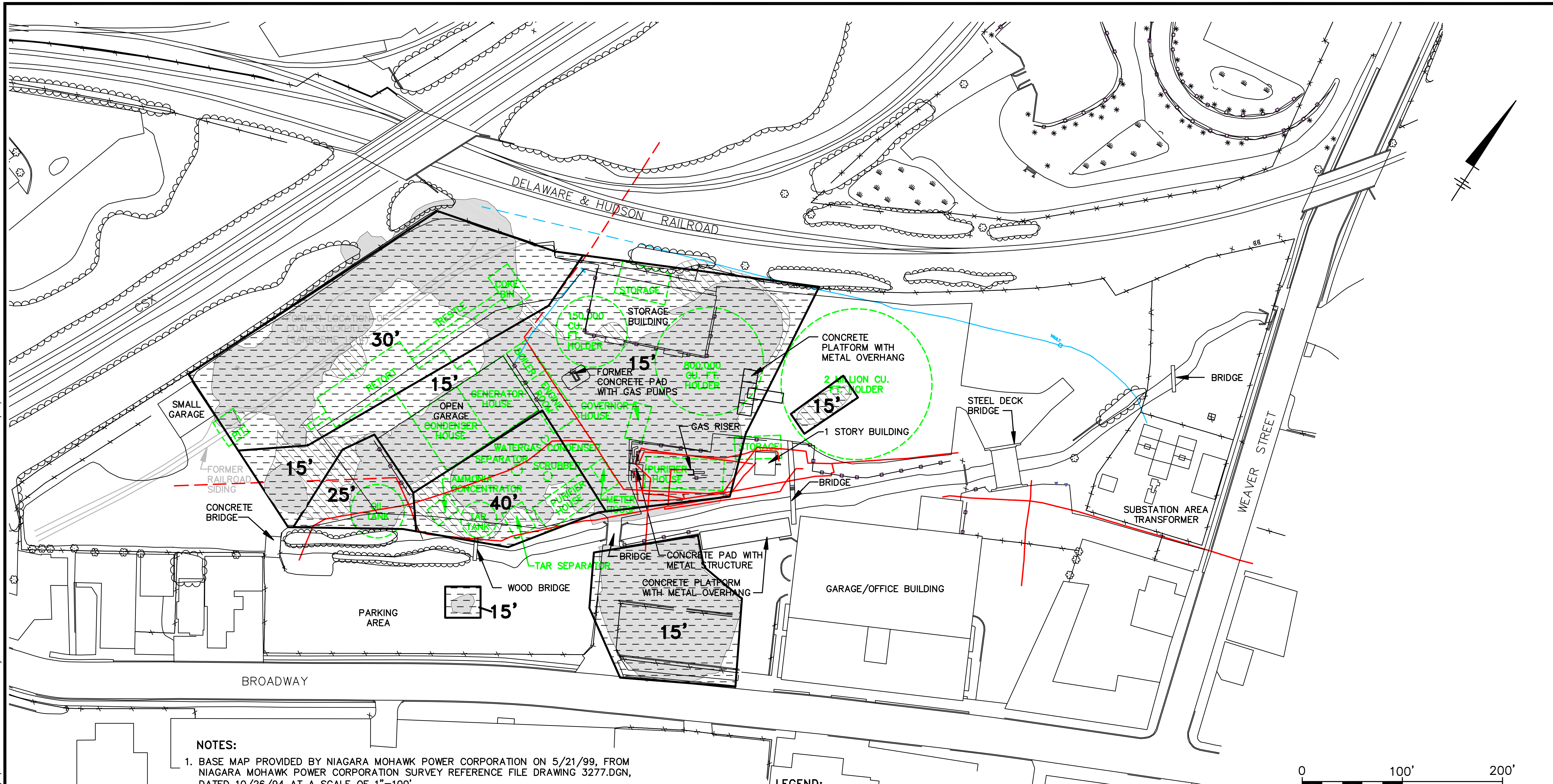

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DELINEATION OF NAPL-IMPACTED SOIL WAS DETERMINED BASED ON MINING VISUALIZATION SOFTWARE (MVS) COMPUTER MODELING THAT UTILIZED A DATABASE OF FIELD OBSERVATIONS RECORDED ON SOIL BORING LOGS.

DELINEATION OF POTENTIAL NAPL DISTRIBUTION AREAS IS BASED ON INTERPRETATION BETWEEN SOIL BORINGS AND VISUAL CHARACTERIZATION OF SOILS (i.e., TEST PITS, TEST BORINGS, AND SOIL EXCAVATIONS) NOT INCORPORATED INTO THE MVS DATABASE.

SUBSURFACE UTILITY LOCATIONS ARE BASED ON FIELD SURVEY OF UTILITY MARKOUTS. ALL LOCATIONS ARE APPROXIMATE. ALL SUBSURFACE UTILITIES MAY NOT BE MARKED.

ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

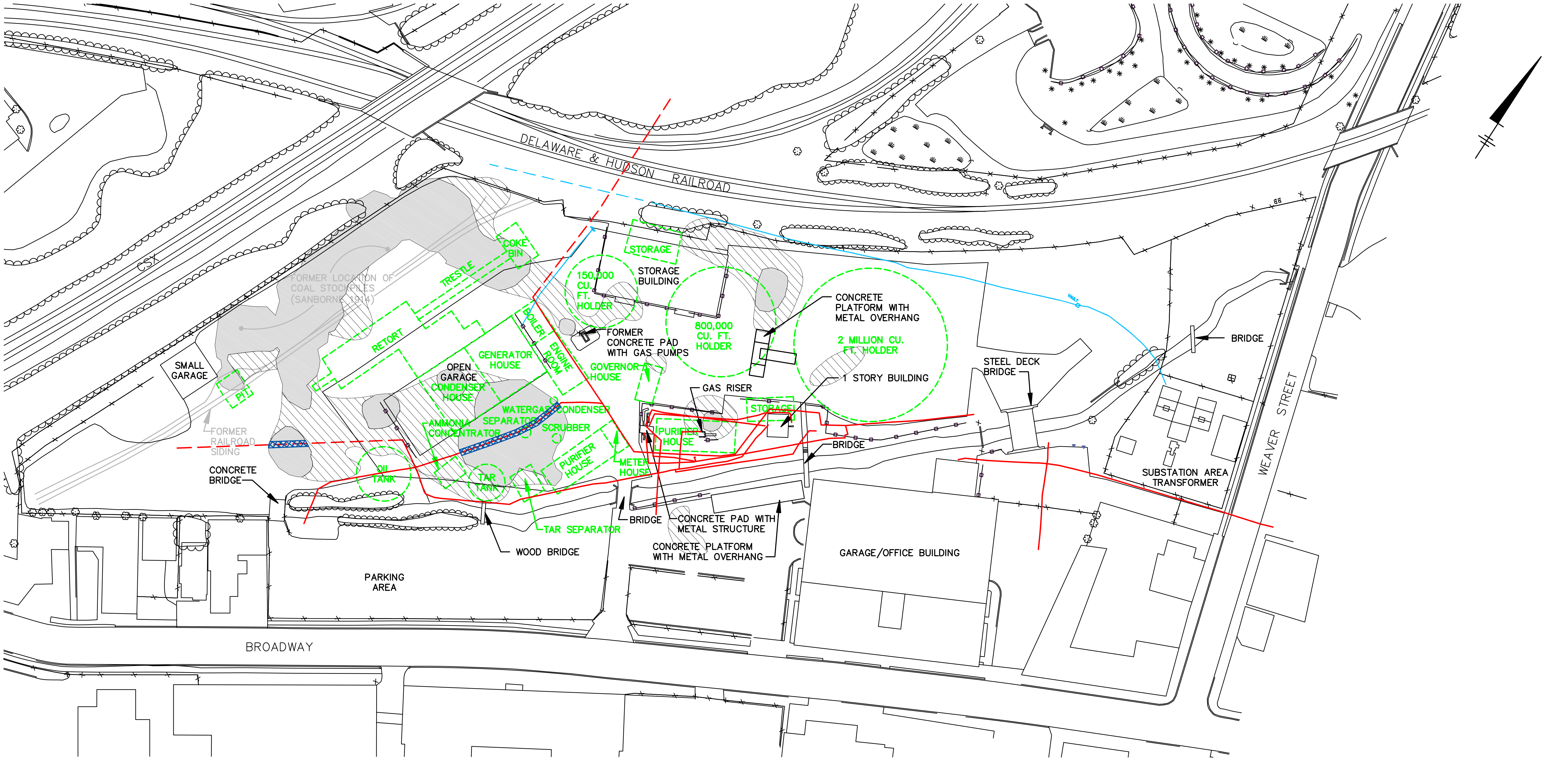
- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- APPROXIMATE EXTENT OF NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHs >500 ppm
- INTERPRETED AREAS OF POTENTIAL NAPL-IMPACTED SOIL
- LIMITS OF ISS TREATMENT AREAS
- 15' APPROXIMATE DEPTH OF ISS TREATMENT
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- FENCE LINE

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK
FEASIBILITY STUDY REPORT

IN-SITU SOIL STABILIZATION - NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHs > 500 ppm

BBL an ARCADIS company

FIGURE
4-4



NOTES:

1. BASE MAP PROVIDED BY NIAGARA MOHAWK POWER CORPORATION ON 5/21/99, FROM NIAGARA MOHAWK POWER CORPORATION SURVEY REFERENCE FILE DRAWING 3277.DGN, DATED 10/26/94 AT A SCALE OF 1"=100'.
2. HISTORICAL STRUCTURE LOCATIONS WITH THE EXCEPTION OF THE SEPARATOR, WATERGAS CONDENSER, AND SCRUBBER WERE DIGITIZED FROM PARSONS ENGINEERING SCIENCE, INC. FIGURE 1.5, "HISTORICAL STRUCTURES, PREVIOUS SAMPLE LOCATIONS." LOCATIONS OF SEPARATOR, WATERGAS CONDENSER, AND SCRUBBER BASED ON HISTORICAL SANBORN INSURANCE MAPS (1914 AND 1980).
3. DELINEATION OF POTENTIAL NAPL DISTRIBUTION AREAS IS BASED ON INTERPRETATION BETWEEN SOIL BORINGS AND VISUAL CHARACTERIZATION OF SOILS (i.e., TEST PITS, TEST BORINGS, AND SOIL EXCAVATIONS) NOT INCORPORATED INTO THE MVS DATABSE.
4. SUBSURFACE UTILITY LOCATIONS ARE BASED ON FIELD SURVEY OF UTILITY MARKOUTS. ALL LOCATIONS ARE APPROXIMATE. ALL SUBSURFACE UTILITIES MAY NOT BE MARKED.
5. ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- APPROXIMATE EXTENT OF NAPL IMPACTED SOIL
- INTERPRETED AREAS OF POTENTIAL NAPL–IMPACTED SOIL
- LIMITS OF SOIL EXCAVATION
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- FENCE LINE

0 100' 200'
GRAPHIC SCALE

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FEASIBILITY STUDY REPORT

SOIL REMOVAL - NAPL-IMPACTED SOIL ADJACENT TO SUBSURFACE UTILITIES

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FIGURE
4-5

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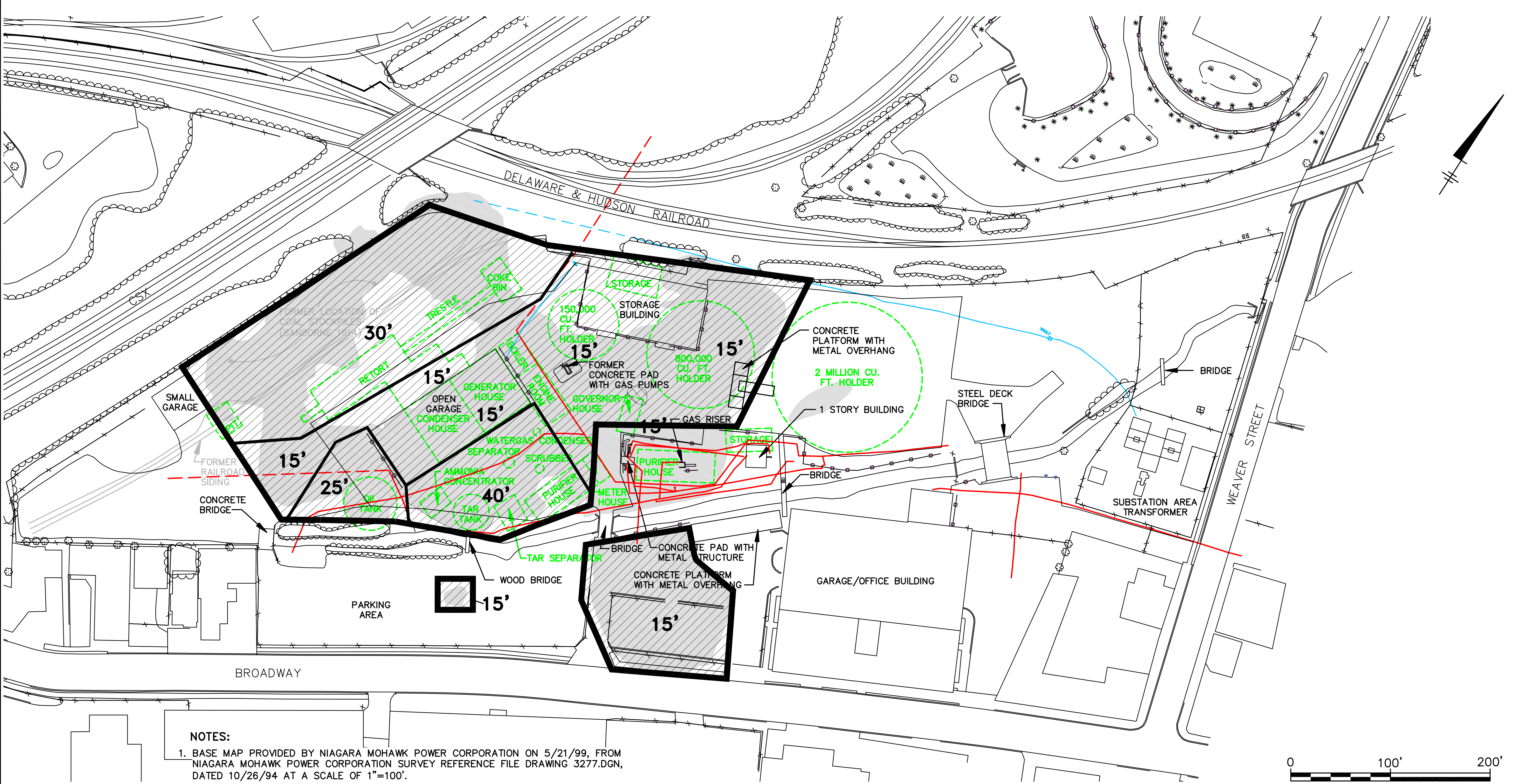

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3. DELINEATION OF NAPL–IMPACTED SOIL WAS DETERMINED BASED ON MINING VISUALIZATION SOFTWARE (MVS) COMPUTER MODELING THAT UTILIZED A DATABASE OF FIELD OBSERVATIONS RECORDED ON SOIL BORING LOGS.
4. DELINEATION OF POTENTIAL NAPL DISTRIBUTION AREAS IS BASED ON INTERPRETATION BETWEEN SOIL BORINGS AND VISUAL CHARACTERIZATION OF SOILS (i.e., TEST PITS, TEST BORINGS, AND SOIL EXCAVATIONS) NOT INCORPORATED INTO THE MVS DATABASE.
5. SUBSURFACE UTILITY LOCATIONS ARE BASED ON FIELD SURVEY OF UTILITY MARKOUTS. ALL LOCATIONS ARE APPROXIMATE. ALL SUBSURFACE UTILITIES MAY NOT BE MARKED.
6. ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- APPROXIMATE EXTENT OF NAPL–IMPACTED SOIL AND SOIL CONTAINING PAHs >500 ppm
- APPROXIMATE EXTERIOR SHEETPILE WALL LOCATION
- LIMITS OF SOIL REMOVAL
- 15' APPROXIMATE DEPTH OF SOIL REMOVAL
- SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)
- FENCE LINE

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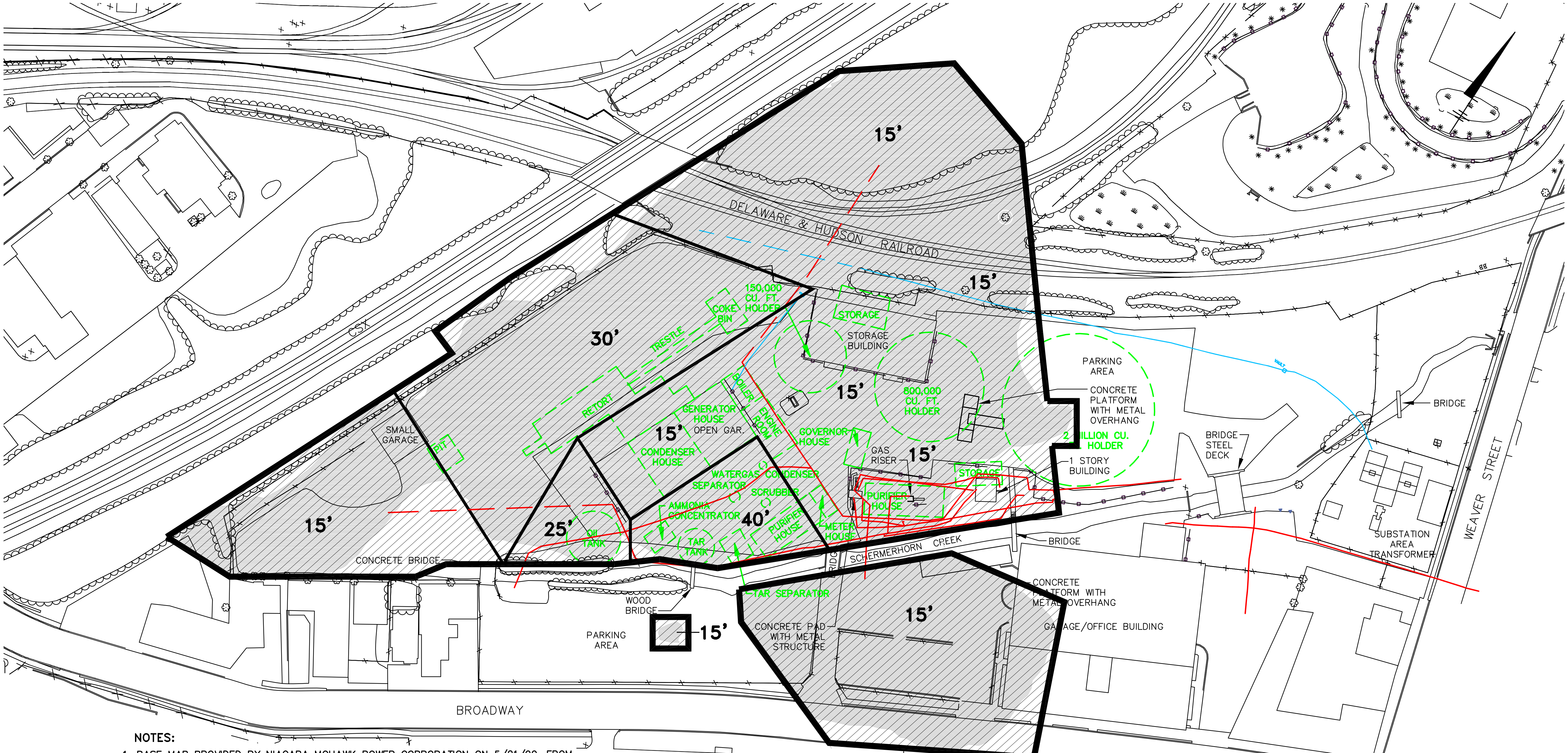
FEASIBILITY STUDY REPORT

SOIL REMOVAL - NAPL-IMPACTED SOIL AND SOIL CONTAINING PAHs >500 ppm

BBL an ARCADIS company

FIGURE **4-6**



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3. DELINEATION OF SOIL CONTAINING CONSTITUENTS AT CONCENTRATIONS EXCEEDING RECOMMENDED SOIL CLEANUP OBJECTIVES WAS DETERMINED BASED ON MINING VISUALIZATION SOFTWARE (MVS) COMPUTER MODELING THAT UTILIZED A DATABASE OF FIELD OBSERVATIONS RECORDED ON SOIL BORING LOSS AND BASED ON SOIL SAMPLE ANALYTICAL RESULTS.
4. SUBSURFACE UTILITY LOCATIONS ARE BASED ON FIELD SURVEY OF UTILITY MARKOUTS. ALL LOCATIONS ARE APPROXIMATE. ALL SUBSURFACE UTILITIES MAY NOT BE MARKED.
5. ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

LOCATION OF CURRENT SITE FEATURES

APPROXIMATE LOCATION OF HISTORICAL STRUCTURES

APPROXIMATE EXTENT OF SOIL CONTAINING CONSTITUENTS GREATER THAN NYSDEC TAGM 4046 RECOMMENDED SOIL CLEANUP OBJECTIVES

APPROXIMATE EXTERIOR SHEETPILE WALL LOCATION

LIMITS OF SOIL REMOVAL

15' APPROXIMATE DEPTH OF SOIL REMOVAL

SUBSURFACE GAS UTILITY (DASHED WHERE INFERRED)

SUBSURFACE ELECTRIC UTILITY (DASHED WHERE INFERRED)

FENCE LINE

0 100' 200'

GRAPHIC SCALE

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

FEASIBILITY STUDY REPORT

SOIL REMOVAL - SOIL CONTAINING CONSTITUENTS GREATER THAN NYSDEC TAGM 4046 RECOMMENDED SOIL CLEANUP OBJECTIVES

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FIGURE **4-7**

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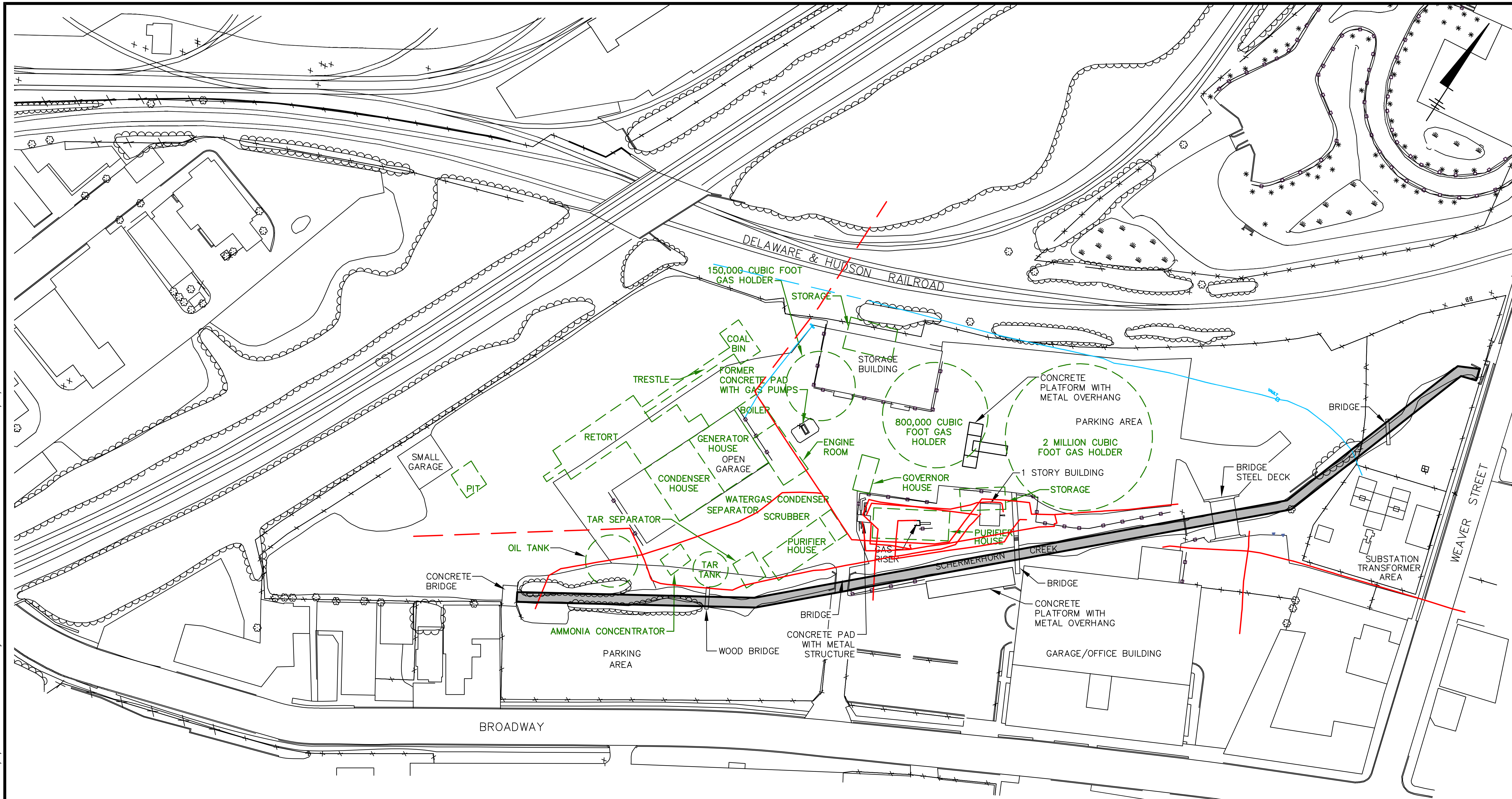

NOTES:

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2. ALL LOCATIONS ARE APPROXIMATE.
3. PROPERTY LINE LOCATION ESTIMATED.

LEGEND:

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL SITE FEATURES
- APPROXIMATE LOCATION OF CLOSED CULVERT
- SUBSURFACE GAS FEATURES (DASHED WHERE INFERRED)
- SUBSURFACE ELECTRIC FEATURES (DASHED WHERE INFERRED)
- FENCE LINE

0 100' 200'

GRAPHIC SCALE

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

REVISED FEASIBILITY STUDY

SEDIMENT REMOVAL AND INSTALLATION OF CLOSED CULVERT

BBL® an ARCADIS company

FIGURE **4-8**

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Appendices

Appendix A

Natural Attenuation Evaluation Report

BBL®

an ARCADIS company

Natural Attenuation Evaluation Report

National Grid
Schenectady (Broadway) Service Center
Schenectady, New York

December 2005

Table of Contents

Tables

Attachment

1 BBL's 2005 *Site Remedial Investigation Report* - Select Figures

Appendix

A Fate and Transport Calculations for DPH in Groundwater

1. Introduction

1.1 General

This report has been prepared by Blasland, Bouck & Lee, Inc. (BBL) to present an evaluation of the subsurface fate and transport of dissolved-phase hydrocarbons (DPH) in groundwater at the National Grid Schenectady (Broadway) Service Center located in Schenectady, New York. The information contained within this report is intended to support the detailed evaluation and selection of remedial alternatives in a revised Feasibility Study (FS) per the *Work Plan for Investigation of Historical Subsurface Structures and Evaluation of Monitored Natural Attenuation Approach for Site Groundwater* (Work Plan) prepared by BBL (April 2003), which was approved by the New York State Department of Environmental Conservation (NYSDEC) in a September 12, 2003 letter to Niagara Mohawk. This report includes the following:

- A summary of current and historic groundwater and soil analytical data;
- A summary of the DPH fate and transport calculations used for this evaluation;
- Discussions of DPH fate and transport at the site; and
- An evaluation of natural attenuation of DPH compounds in groundwater.

1.2 Report Organization

This report is organized as follows:

Section	Purpose
Section 1 – Introduction	Provides general information; a brief description of the report format; and background information including site setting, site history, geology and hydrogeology, and relevant conclusions from previous site investigations.
Section 2 – Fate and Transport of DPH	Provides a detailed description of DPH physical and chemical characteristics, site geochemistry, microbiological characteristics of the site groundwater, and conceptual model of DPH fate and transport.
Section 3 – Conclusions	Presents a summary regarding fate and transport of DPH compounds in onsite groundwater.

1.3 Background

1.3.1 Site Setting

The site is generally located within the property that was formerly utilized as a manufactured gas plant (MGP). The property, covering approximately 9 acres, is located in an industrial and commercial area at the corner of Broadway and Weaver Street, approximately three quarters of a mile southwest of downtown Schenectady, New York (Attachment 1, Figure 1). The site is occupied by an active service facility owned by National Grid. As identified in BBL's 2005 *Site Remedial Investigation Report* (SRI Report), currently, the principal structure onsite is an office building with an attached garage and repair shop near the eastern corner of the property (BBL, 2005a). A natural gas regulator and distribution station is near the center of the site, west of the office building.

Parking areas are north of the natural gas regulator and distribution station. Open storage areas are near the northwest and northeast corners of the site and west of the office building. A National Grid electrical substation (Weaver Street Substation) is on the east side of the site. Figure 2 from the SRI Report presents the locations of the current site features (Attachment 1).

The entire perimeter of the site is fenced and access is provided via two gated entrances, one on Broadway and one on Weaver Street. The site is bounded to the north by the Delaware & Hudson Railroad (D&H Railroad), to the south by Broadway, to the west by the CSX Transportation, Inc. (CSX) railroad line, and to the east by Weaver Street.

1.3.2 Site History

The site history was previously presented in the *Feasibility Study Report for the Schenectady (Broadway) Site, City of Schenectady, New York* (FS Report) and is not reiterated in this document. Aspects of site history relevant to DPH migration include:

- Gas was manufactured at the site from 1903 to the mid-1940s using coal carbonization and water gas processes and weekly testing of gas production equipment occurred during the 1950s.

- In 1914, the principle structures included the three gas holders; a retort house; a central manufacturing building containing an engine room, boiler room, generator house, and condenser house; and a purifier house. Smaller structures included a governor house, a concrete oil tank, an ammonia concentrator, a tar separator, and a tar tank.

- By 1930, a second purifier house and second boiler room were added to the site (Atlantic Environmental Services, Inc. [AES], 1993).

- The gas holders were reportedly removed from the site in 1961.

1.3.3 Geology and Hydrology

A detailed presentation of the regional and site geology and hydrology are presented in the FS Report. Aspects of regional and site geology and hydrology relevant to DPH fate and transport are summarized below.

1.3.3.1 Regional and Site Geology

As described in the SRI Report, regional geologic mapping indicates that unconsolidated sediments consisting of alluvium and glacial deposits overlie shale, siltstone, and sandstone bedrock in the vicinity of the site. Generalized cross sections and their respective locations are shown on Figures 9, 10, and 11 from the SRI Report included in Attachment 1. The surficial deposits beneath the site are identified below in Table 1. Recent-age alluvium is present immediately north of the site. This material is confined to the floodplain of the Mohawk River and consists of silt and fine to coarse sand and gravel deposited by the Mohawk River. The thickness of the alluvium ranges from 3 feet to more than 30 feet. Unconsolidated sediments, deposited by glacial melt waters more than 10,000 years ago, are present at or near the ground surface in the site vicinity. Based on review of the soil boring logs, silt,clay, and sand of glacio-lacustrine origin underlie the site and areas north. Additionally, glacio-deltaic deposits underlie regions south and west of the site. Regional mapping indicates that the lacustrine deposits are generally laminated, with thicknesses exceeding 300 feet in some places.

Till deposits underlie lacustrine sediments in the site vicinity and are exposed on the northeast side of the City of Schenectady. Till, which was deposited by, or in direct contact with, glacial ice, generally consists of poorly sorted materials ranging in grain size from clay particles to boulders. Generally, the till deposits are dense and characterized by low hydraulic conductivity. Regionally, the till ranges in thickness from none present to more than 150 feet.

The Middle to Upper Ordovician Schenectady Formation and the Middle Ordovician Canajoharie Shale underlie the till in the site vicinity. The Schenectady Formation consists of bluish-gray greywacke, tan sandstone, siltstone, and gray shale. The Canajoharie Shale consists of calcareous, black, fissile shale.

As identified in the SRI Report, DPHs (volatile organic compounds [VOCs] and polynuclear aromatic hydrocarbons [PAHs]) have been detected in groundwater beneath the site in the alluvium and glacial deposits that are above the till deposits, the Schenectady Formation, and the Canajoharie Shale.

1.3.3.2 Regional and Site Hydrology

The site topography is generally level with a total relief of approximately 7 feet. The CSX railroad line located west of the site is approximately 20 feet higher than the site. Two small ponds are located north of the site on the City of Schenectady property.

Based on information presented in the RI Report, the City of Schenectady obtains its public water supply from 16 pumping wells located approximately 2 miles northwest of the property near the southern bank of the Mohawk River. Three additional wells that supply drinking water to the City of Rotterdam are located approximately 1,000 feet north of the Schenectady wells. A review of regional groundwater flow patterns however, suggests that groundwater at the property does not flow toward the Schenectady public water supply wells. The NYSDEC Division of Environmental Remediation's Proposed Remedial Action Plan (PRAP) for the General Electric (GE) Main Plant (Site No. 447004) (NYSDEC, 2004) states: "*There is a well established hydrogeologic divide west of the western boundary of the* (GE) *site that separates groundwater beneath the site from the groundwater west of the* (GE) *site. The groundwater beneath the* (GE) *site and east of the divide migrates towards the Mohawk River. The groundwater west of the hydrogeologic divide migrates toward the Mohawk River or the Schenectady-Rotterdam municipal well field.*" Therefore, because the Schenectady (Broadway) site is east of the western portion of the GE site, groundwater beneath the National Grid property likely flows northwestward toward the Mohawk River and not to the municipal well field.

The Mohawk River is approximately 4,000 feet north of the site. The river flows eastward discharging to the Hudson River approximately 15 miles east of the site. The site is outside the 100-year floodplain of the Mohawk River, but is within the 500-year floodplain. Schermerhorn Creek, which is primarily a conduit for stormwater runoff in the area, crosses the site and flows northeast discharging to the Mohawk River.

The general pattern of groundwater flow in the unconsolidated deposits across the site is east to west, and there is no indication that subsurface utilities at the site substantially affect groundwater flow direction. Also, the following hydrostratigraphic zones underlying the site were defined based on their relative position to the silt and clay subunit:

- A shallow zone, comprised of saturated fill and the upper fine sand unit, located above the silt and clay unit;

- A silt and clay unit that includes seams of interbedded fine sands – classified as a "leaky" semi-confining unit;
- An intermediate zone, comprised of the upper portion of the lower fine sand subunit below the silt and clay subunit;
- A deep zone, comprised of the lower portion of the lacustrine lower fine sand subunit, below the silt and clay subunit; and
- A till zone located below the glaciolacustrine deposits.

As detailed in the SRI Report and summarized below in Section 1.3.4.1, DPHs (VOCs and PAHs) have been detected in groundwater collected from monitoring wells screened in three different hydrostratigraphic zones beneath the site (i.e; shallow zone, intermediate zone, and deep zone).

1.3.4 Previous Investigations

Various subsurface investigations were performed at the site. Soil samples were collected as part of the investigatory efforts conducted during the preliminary site assessment/interim remedial measure (PSA/IRM), remedial investigation (RI), non-aqueous phase liquid (NAPL) investigation, historical subsurface structure investigation, and additional subsurface investigation activities. Relevant information from these previous investigations is summarized below with respect to the investigation of historical groundwater analytical data and historical data regarding NAPL.

As summarized in the SRI Report, a total of 234 soil samples were submitted for laboratory analysis for benzene, toluene, ethylbenzene, and xylenes (BTEX) and 261 soil samples were submitted for laboratory analysis for PAHs (Table 2). Soil containing relatively elevated PAH concentrations were located primarily in the northern portion of the property; in the central portion of the property; and along the western fence line. PAH-impacted soil also extends south of Schermerhorn Creek in the vicinity of a former underground storage tank (UST) previously located west of the existing Garage/Office Building. The majority of the soil containing PAHs at relatively elevated concentrations is located below the water table.

1.3.4.1 Historical Groundwater Analytical Data

Various groundwater investigations were conducted as part of the RI effort and the historical subsurface structures investigation activities. As discussed below, these investigations included estimations of hydraulic conductivity of the saturated zone beneath the site and site vicinity. As discussed in the SRI Report, the results of the hydraulic conductivity testing estimated the following geometric means for the four hydrostratigraphic zones (i.e., shallow, intermediate, deep, and till) beneath the site:

- Shallow – 9.70×10^{-4} centimeter per second (cm/sec);
- Intermediate – 8.59×10^{-4} cm/sec;
- Deep – 2.50×10^{-3} cm/sec; and
- Till – 4.15×10^{-7} cm/sec.

Groundwater Analyses

The primary dissolved-phase chemical constituents at the property are BTEX and PAHs. The monitoring wells used for the groundwater investigation activities conducted at the site are summarized in Table 3, which has been organized into the upper three hydrostratigraphic units (i.e., shallow, intermediate, and deep). A summary of the results obtained from the analysis of the groundwater samples for BTEX, PAHs (including select non-PAH semi-volatile organic compounds (SVOCs) (e.g.; SVOCs with concentrations greater than the NYSDEC Class GA Standards) are presented in Tables 4 and 5, respectively. Key findings of site investigation activities, as they relate to the natural attenuation (NA) evaluation described in Section 2, are summarized below respective to their hydrostratigraphic zone (i.e., shallow, intermediate, and deep). The individual groundwater investigations are described in more detail in the SRI Report, as well as in summary reports for the individual investigations. Table 6 summarizes groundwater sampling events conducted during the site investigation activities.

Shallow Hydrostratigraphic Zone

- As shown in Table 4, historically, BTEX was detected in shallow groundwater samples (i.e., the saturated zone above the silt and clay unit), with the highest BTEX concentrations reported in samples collected near the former location of the 800,000-cubic-foot (CF) holder, and tar separator and tar tank (the highest detected concentration of BTEX in the groundwater samples was 21 milligrams per liter [mg/L]).

- BTEX compounds were detected in groundwater samples collected from 8 of the 15 shallow monitoring wells (MW-3, MW-9S, MW-13SR, MW-21, MW-22, MW-23, MW-24, and MW-26) during the most recent (November 2004/January 2005) sampling event (see Table 4). Generally, these site monitoring locations are in the northern area (including the former 800,000 CF and 2-million CF gas holders, extending along northern portion of the property); central area (including the area between the former oil tank and 150,000 CF gas holder, and former retort and eastward to the tar tank); and western area (including the area near the western fence line extending from the small garage northward to monitoring well MW-22, west of the former retort). One monitoring well (MW-26) is located on the south side of Schermerhorn Creek, hydraulically downgradient from the former oil tank.

- As indicated in Table 5, historically, PAHs were detected in shallow groundwater samples, with the highest PAH concentrations reported in groundwater samples collected west of the former oil tank and near the locations of the former 150,000-CF and 800,000-CF holders and tar separator (the highest detected concentration of PAHs in the groundwater samples was 5.9 mg/L).

- PAHs were detected at concentrations greater than the NYSDEC Class GA Standards in groundwater samples collected from 7 of the 15 shallow monitoring wells (monitoring wells MW-3, MW-9S, MW-21, MW-22, MW-23, MW-24, and MW-26) during the most recent (November 2004/January 2005) sampling event (see Table 5).

- PAH concentrations generally appear to have been decreasing over time in shallow monitoring wells located to the east of the storage building in the central portion of the property (see Table 5).

- PAH concentrations generally appear to have generally increased over time in groundwater samples collected from shallow monitoring wells located to the south of the open garage, hydraulically downgradient from the former oil storage tank (see Table 5).

Intermediate Hydrostratigraphic Zone

- As indicated in Tables 4 and 5 (respectively), BTEX and PAHs were detected in groundwater samples collected from 4 of the 12 intermediate monitoring wells (monitoring wells MW-8I, MW-9I, MW-17, and MW-25) that were sampled during the most recent sampling event. Generally, these locations are the northern, central, and western areas of the site.

- A general upward trend in groundwater PAH concentrations is inferred by groundwater samples collected from the monitoring well (MW-8I) located offsite west of the CSX Railroad right-of-way (see Table 5).

Deep Hydrostratigraphic Zone

- Between 1996 and 2005, BTEX has only been detected at one monitoring well screened in the deep zone (MW-9D) (see Table 4). This groundwater monitoring well is located northwest of the Service Center property on the west side of the D&H Railroad right-of-way.

- As shown in Table 5, PAHs were detected at two monitoring wells screened in the deep zone, MW-8D and MW-19D, prior to 2002 and 1996, respectively. However, the only PAH (acenaphthene) detected at MW-8D in 2002 was detected at a concentration (estimated 0.7 µg/L) less than the Class GA Groundwater Criteria of 20 µg/L. None of the groundwater samples collected from the deep monitoring wells during the most recent sampling event in November 2004/January 2005 contained PAHs at detectable concentrations.

2. Fate and Transport of Dissolved Phase Hydrocarbons

2.1 General

This section presents an analysis of the fate and transport of DPH compounds in groundwater contained in the shallow fill/upper sand and intermediate fine sand hydrostratigraphic units. Analysis of groundwater samples collected from monitoring wells screened within the deep hydrostratigraphic unit did not detect DPH; therefore this unit is no longer considered in this evaluation. The analysis includes the following:

- Nature of DPH;
- Extent of DPH;
- Advective transport of DPH;
- Diffusive transport of DPH; and
- Intrinsic biodegradation of DPH.

2.2 Nature of Dissolved Phase Hydrocarbons

Many of the VOCs and SVOCs found in NAPL at the site can dissolve into and potentially be transported by groundwater. Physical-chemical properties governing the dissolution process are summarized in Table 7. VOCs tend to be more soluble, more volatile, less sorptive, and overall more mobile in groundwater compared to SVOCs based on their molecular weight, organic carbon partition coefficient, Henry's law constant, pure compound solubility, effective solubility, density, distribution coefficient, and retardation factor (Table 7). BTEX are the most soluble DPH compounds and their effective solubilities exceed effective solubilities of the PAHs by one to two orders of magnitude; therefore, the BTEX compounds are of particular interest in evaluating the fate and transport of DPH compounds in groundwater.

Dissolved phase hydrocarbons can sorb to solid organic carbon particles in the shallow fill/upper sand and intermediate fine sand hydrostratigraphic units. The affect of sorption on organic compound transport in groundwater is to slow, or retard, the migration rate of the compounds compared to the rate of groundwater migration as predicted by the average linear groundwater velocity. This retardation of DPH migration can be measured by using retardation factors to evaluate DPH sorption. The retardation factors presented in Table 7 were estimated according to methods in Freeze and Cherry (1979) (calculations provided in Appendix A). As shown in Table 7, retardation factors ranged from 12 for the least sorptive compound (benzene) to greater than 600,000 for the most sorptive compound (benzo[a]pyrene). On this basis, benzene is most mobile of the compounds of interest at the site.

2.3 Extent of Dissolved Phase Hydrocarbons

The horizontal and vertical extent of DPH at the site has been evaluated through collection and analysis of more than 120 groundwater samples from a monitoring well network consisting of 29 wells screened within the shallow and intermediate hydrostratigraphic units. Groundwater quality data were collected during several sampling events to evaluate the potential for DPH migration, if present. Current and historical groundwater analytical results are summarized in Tables 4 and 5, which presents detected analytes and associated concentrations. As shown in Tables 4 and 5, DPH compounds are present in the shallow and intermediate units. In summary, the analytical results indicate that the highest concentration of DPH compounds are present (both onsite and offsite) near and immediately downgradient of areas associated with historical site operations.

2.4 Advective Transport of Dissolved Phase Hydrocarbons in Groundwater

As part of the analysis of fate and transport of DPH, advective transport of DPH was evaluated. Advective transport occurs when compounds are transported in the bulk liquid motion of flowing groundwater (Freeze and Cherry, 1979).

Calculations for estimating the migration rate of DPH compounds in groundwater via advective transport are presented in Appendix A. As discussed above, benzene was used as a metric to evaluate advective transport of DPH in groundwater because of all the DPH compounds, benzene has the lowest retardation factor. The potential average migration rates of benzene in the shallow fill/upper sand, silt and clay, and intermediate fine sand layers are summarized in Table 8.

As shown in Table 8, the average benzene horizontal migration rate in the shallow fill/upper sand unit was calculated as approximately 0.015 feet per day (ft/day), which is equivalent to 5.5 feet per year (ft/year). The average benzene vertical migration rate in the silt and clay unit (semi-confining layer) could potentially be 0.00005 ft/day (0.018 ft/year). The average horizontal migration rate in the intermediate fine sand unit could potentially be 0.013 ft/day (4.7 ft/year).

As discussed in the SRI Report, upward vertical gradients were observed between the till and deep hydrostratigraphic zones at the site, making advective transport of DPH in groundwater unlikely between these hydrostratigraphic zones.

In addition to retardation and dispersion, other natural attenuation processes, such as biodegradation, may be present and affecting the migration of BTEX and PAHs at the site.

2.5 In-Situ Biodegradation of Dissolved Phase Hydrocarbons in Groundwater

In-situ biodegradation of DPH in groundwater was evaluated at the site by assessing groundwater analytical data (BTEX and PAHs) from November 2004; and biological indicator parameters from November 2004 and January 2005. The objective of this evaluation was to determine if in-situ biodegradation of DPH in groundwater at the site was occurring. This analysis was performed based on results obtained for previous investigations indicating potential biodegradation of BTEX compounds. The biological indicator parameters collected during the November 2004 and January 2005 sampling events, coupled with field indicator parameters, support the observation that in-situ biodegradation of DPH is likely an active fate process occurring in groundwater at the site. In-situ biodegradation can limit the extent of the DPH plume and may prevent offsite DPH migration.

In performing this analysis, two primary factors were evaluated:

- Geochemical characteristics of site groundwater with respect to the nutrients and environmental conditions required to support subsurface microbial populations; and

- The presence of specific microorganisms and enzyme systems at the site known to facilitate the biodegradation of specific DPH compounds.

A more detailed discussion of this analysis is presented below.

2.5.1 Groundwater Geochemical Characteristics

To assess the potential of the intrinsic remediation of DPH compounds in groundwater at the site, field and laboratory geochemical data were collected during recent groundwater sampling events. The data summarized in Table 9 provide information to evaluate the geochemical characteristics of the groundwater. The list of analytes used to perform this assessment included the following:

- Electron acceptors (e.g., dissolved oxygen);
- Alternative electron acceptors (e.g., nitrate, ferric iron, manganese oxides, sulfate, and carbon dioxide);
- Electron donors (e.g., BTEX, PAHs, and total organic carbon [TOC]);
- Metabolic byproducts (e.g., nitrogen gas, alkalinity, and methane); and
- General environmental indicators (pH, temperature, oxidation-reduction potential [ORP]).

A summary of the parameters analyzed and their role in DPH biodegradation processes is provided in the following paragraphs.

Dissolved oxygen (DO) (as analyzed in the field using a flow-through cell) was not detected in the groundwater samples analyzed. This absence of DO indicates the presence of anaerobic conditions in the site groundwater (Table 9).

Nitrate (NO_3) was detected in the groundwater samples analyzed at concentrations ranging from non-detect (in 3 of the samples) to 0.29 milligrams per liter (mg/L) suggesting the limited potential for denitrification in site groundwater (Table 9). Denitrification is an anaerobic reaction in which denitrifying bacteria are known to oxidize DPH by-products (carbon dioxide and water) and nitrate is converted to nitrogen gas.

Ferric Iron (FeIII) was detected in the groundwater samples analyzed, as indicated by unfiltered iron analytical results, at concentrations ranging from 2.19 to 90.3 mg/L indicating the potential for iron reduction in the site groundwater (Table 9). Iron reduction is an anaerobic reaction in which iron-reducing bacteria are known to oxidize DPH to byproducts and ferric iron is reduced to ferrous iron (FeII). The highest ferric iron concentration was detected at MW-6, which is not impacted by DPH. The DPH-impacted monitoring wells had lower ferric iron concentrations, indicating that there is potentially greater iron reduction occurring at the impacted monitoring wells.

Total manganese was detected in the groundwater samples analyzed at concentrations ranging from 0.585 to 5.46 mg/L, indicating the potential for manganese reduction in site groundwater (Table 9). Manganese reduction is an anaerobic reaction in which manganese reducing bacteria are known to oxidize DPH to byproducts (carbon dioxide and water) and manganese is reduced. The highest concentration of manganese was detected at monitoring well MW-6, which is not impacted by DPH. The DPH-impacted monitoring wells had lower manganese concentrations, indicating that there is potentially greater manganese reduction occurring at the impacted monitoring wells.

Sulfate in the groundwater samples ranged from non-detect to 1,100 mg/L. Sulfide was detected in the groundwater samples analyzed at concentrations ranging from 1.0 to 3.6 mg/L indicating the potential for sulfate reduction in site groundwater (Table 9). Sulfate reduction is an anaerobic reaction in which sulfate reducing bacteria are known to oxidize DPH to byproducts (carbon dioxide and water) and sulfate is reduced to sulfide. The highest concentration of sulfate was detected at the monitoring well not impacted by DPH (MW-6). The lower sulfate concentrations detected at the DPH-impacted monitoring well indicate that there is potentially greater sulfate reduction occurring at the impacted monitoring wells.

Dissolved methane was detected in the groundwater samples analyzed at concentrations ranging from 0.0087 to 9.8 mg/L indicating the potential for methanogenesis in site groundwater (Table 9). Methanogenesis is an anaerobic reaction in which DPH and carbon dioxide are reduced to methane gas. The concentration of methane at DPH-impacted monitoring well MW-3, was greater than the methane concentration at MW-6S (upgradient monitoring well – background location), indicating that methanogenesis is occurring in the presence of DPH.

Alkalinity concentration in the site groundwater samples ranged from 46 to 698 mg/L (as calcium carbonate [$CaCO_3$]) (Table 9).

The pH of site groundwater samples analyzed ranged from 5.01 to 6.96 standard units. Temperature of the site groundwater samples ranged from 10.97 to 14.78 degrees Centigrade (°C) indicating suitable conditions for microbiologic growth in site groundwater (Table 9). Generally, pH between approximately 5 and 8 standard units is required by most subsurface microorganisms. Temperatures greater than approximately 20 °C indicate favorable conditions for microbiologic growth. (Wiedemeier, et al, 1996) Note that the groundwater samples were collected during the months of November and January when groundwater temperatures are most likely to be lower than at other times of the year.

ORP readings of site groundwater samples ranged from -128 to +100 millivolts (mV) indicating reducing conditions in site groundwater (Table 9). ORP measurements are used to evaluate the redox conditions in groundwater. Generally, reducing conditions are indicated by low to negative ORP readings (<+100 mV), while oxidizing conditions are indicated by moderate to high ORP readings (>+100 mV). Anaerobic reactions typically occur under reducing conditions.

The site groundwater geochemical setting can be characterized as a generally anaerobic environment, which has the potential for anaerobic oxidation-reduction (redox) reactions including iron, manganese, and sulfate reduction and methanogenesis (defined below). During the redox reactions electron acceptors are reduced (e.g., iron, manganese, sulfate, and carbon dioxide) and DPH compounds (i.e., VOCs and SVOCs) are oxidized, resulting in the formation of metabolic byproducts (e.g., reduced iron and manganese, sulfides, carbon dioxide, and methane). Based on the geochemical data, sulfate reduction, iron reduction, and manganese reduction appear to be the potential redox reactions in groundwater at the site that result in oxidation (and therefore degradation) of DPH compounds.

2.5.2 Groundwater Microbiological Characteristics

To further assess the potential for naturally occurring intrinsic biological processes to biodegrade DPH compounds in groundwater at the site, cellular and genetic components of the microorganisms were analyzed. Specifically, biomarkers associated with phospholipid fatty acids (PLFAs) and deoxyribonucleic acids (DNA) were measured in groundwater samples. PLFA concentrations can be used to evaluate in-situ cell biomass, community structure, and metabolic status of subsurface microbial populations, as well as to identify specific microorganisms in some cases (White, 1988; Findlay and Dobbs, 1993). DNA data identifies the presence of specific enzymes expressed by the indigenous microorganisms, which are necessary for DPH biodegradation.

Groundwater samples were collected for microbial analysis from five groundwater monitoring locations at the site (i.e., MW-3, MW-6S, MW-8D, MW-21, and MW-22) in November 2004 and one groundwater sample was collected from monitoring location MW-9S in January 2005. In addition, five Biotrap samples were collected for microbial analysis in January 2005 at monitoring locations MW-3, MW-6S, MW-8D, MW-21, and MW-22. The carbon media contained in the Biotraps adsorbs the DPH, thus providing a medium for microbial growth so the microbial analysis can focus on DPH-degrading bacteria. The results of these sampling events are provided in Tables 10 and 11 and are discussed below.

The DNA data obtained from the two sampling events were evaluated to determine whether or not the mechanisms needed for microorganisms to catalyze reactions which result in biodegradation of the DPH-related compounds are present in the groundwater at the site. Microorganisms can catalyze biodegradation reactions by the induction of enzymes when the following components are in place:

- Sufficient electron acceptors;
- Sufficient electron donors;
- Nutrients (necessary for bacteria energy and growth);
- Evolutionary precedents (i.e., exposure to the DPH-related compounds result in microbes evolving to express the enzyme required to degrade the DPH); and
- Metabolic need (i.e., the microbes need to use the DPH-related compounds for energy and growth).

When these components are in place, enzyme (catechol dioxygenase, toluene monooxygenase, or toluene dioxygenase) is synthesized by DNA sequences that can be detected [by the polymerase chain reaction (PCR) analysis]. The enzymes catechol dioxygenase, toluene monooxygenase, or toluene dioxygenase are synthesized when the microorganism's metabolic circumstances requires the need for these enzymes. As previously discussed, these enzymes are expressed by microorganisms to metabolize DPH-related compounds.

The presence of certain DNA sequences provides evidence of DPH-degrading microorganisms at the site capable of expressing enzymes known to degrade DPH compounds. Specifically, groundwater and Biotrap samples were analyzed for the presence of the DNA sequence that regulates the synthesis (by microorganisms) of catechol dioxygenase (C12O and C23O), toluene monooxygenase, and toluene dioxygenase. Catechol dioxygenase are specific enzymes expressed by many microorganisms to metabolize catechol and catechol-related compounds (e.g., methylcatechol), which are metabolites of DPH-related compounds. Toluene monooxygenase and toluene dioxygenase are specific enzymes believed to be expressed by microorganisms to metabolize benzene.

DNA sequences for the enzyme catechol dioxygenase were detected in groundwater and Biotrap samples collected from all monitoring wells sampled except at MW-9S (Table 10). DNA sequences for the enzyme toluene monooxygenase was detected only in groundwater and Biotrap samples collected from monitoring wells MW-22 and MW-8D and toluene dioxygenase was detected in groundwater samples collected from all monitoring wells sampled (Table 10). The detection of these DNA sequences in groundwater and Biotrap samples is evidence that microorganisms capable of biodegrading certain DPH compounds are present in groundwater at the site as discussed below.

PLFA are essential components of the membranes of most cells and can provide three different types of information about the microbial community in groundwater: biomass, community structure, and physiological status.

PLFAs are components of cell membranes and, therefore, their presence and quantification in groundwater and Biotrap samples can be used as an indicator of biomass. The PLFA analysis results for the groundwater and Biotrap samples collected for this evaluation indicate that the biomass levels for groundwater range from 6.46×10^4 to 5.44×10^6 cells/milliliter (cells/ml) (Table 11). Typically, biomass levels in groundwater range between 1×10^1 and 1×10^3 cells/ml. The average biomass concentration at impacted wells was approximately 10 times greater than the biomass concentration detected at the non-impacted groundwater monitoring well (MW-6S). Generally, PLFA concentrations greater than background are an indication that microbial growth associated with site-related organic compounds is occurring.

The results of PLFA analysis of the groundwater samples can reflect the proportions of different organisms, which can be identified into broad groups of microorganisms because they have different fatty acid profiles. The groundwater and Biotrap samples collected for this evaluation were analyzed for six major structural groups (i.e., monoenoic, terminally branched saturates, branched monoenoic, mid-chain branched saturates, normal saturates, and polyenoic). The results of the PLFA analysis of the samples collected from the groundwater monitoring wells indicate a diverse community structure composed primarily of monoenoic PLFA (Table 11). Monoenoic PLFA are generally found in gram negative bacteria, which are fast growing bacteria that utilize many carbon sources, and adapt quickly to a variety of environments. The most abundant group of anaerobic bacteria detected within the groundwater and Biotrap samples was Firmcutes, which include Bacteroides/Clostridia-like fermenting bacteria. Sulfate reducers were the second most populous anaerobe detected in the groundwater and Biotrap samples.

PLFA analysis can be used to identify adaptations of microbes to changes in the groundwater environment. The physiological status biomarkers for stress and for starvation/toxicity are calculated by dividing the amount of the fatty acid made by bacteria as a reaction to starvation and/or exposure to an environmental stress, by the amount of the biosynthetic precursor to the fatty acid. In general, the results of the PLFA analysis of the groundwater and Biotrap samples indicate low levels of starvation and low to moderate stress response (Table 11). However, the Biotrap sample collected from monitoring wells MW-6S had a moderate level of starvation, which suggests that the gram-negative bacteria population at this location is likely growing more slowly than at other locations at the site.

In general, the data obtained from the microbial analysis of the Biotrap samples collected from MW-3, MW-8D, MW-21, and MW-22 were relatively consistent with the data obtained from the microbial analysis of the groundwater samples collected from these same monitoring locations. The Biotraps function as a DPH-specific growth media for DPH degrading bacteria, and the similarity in microbial analysis between the Biotraps and groundwater samples indicate that the DPH degrading bacteria are present in the groundwater at the site.

3. Conclusions

DPH (including BTEX and PAHs) are present in the upper sand and fill, within seams of the silt and clay unit, and in the upper portion of the Lower Fine Sand. A relatively healthy and diverse anaerobic microbial community structure capable of effectively degrading DPH compounds to less toxic byproducts (e.g., carbon dioxide and water) appears to be present in groundwater beneath the site. Subsurface conditions at the site appear to be favorable for natural microbial degradation of DPH compounds

Since DPH constituents are nearly absent in groundwater within the deep zone, and MGP operations at the site began over 100 years ago, it appears that the upward hydraulic gradient from the till unit is inhibiting migration of DPH from the site to the deep zone.

4. References

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Tables

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

TABLE 1

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SURFICIAL DEPOSITS

Surficial Geologic Unit	Approximate Thickness (feet)	Description
Fill	≤ 13	
Upper fine sand	0 - 10	
Silt and clay	≤ 10	Interbedded packet of silt, clay, and fine sand with rootlets (not a continuous clay or silt layer)
Lower fine sand	30	
Basal Till	> 45	Confining unit (approximately 60 feet below grade)

TABLE 2

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL SOIL SAMPLING SUMMARY

Analysis	Number of Samples/Investigation					Totals
	PSA/IRM	RI	NAPL Investigation	HSSI	ASI	
BTEX	73	152	0	8	1	234
PAHs	73	152	27	8	1	261

Notes:
1. For some investigations, soil samples were analyzed for an expanded list of volatile organic compounds and semivolatile organic compounds.
2. Number of samples does not include QA/QC or waste characterization samples.
3. PSA/IRM = Preliminary Site Assessment/Interim Remedial Measure.
4. RI = Remedial Investigation.
5. NAPL = non-aqueous phase liquid.
6. HSSI = Historical Subsurface Structure Investigations.
7. ASI = Additional Subsurface Investigations.
8. BTEX = Benzene, Toluene, Ethylbenzene, and Xylene.
9. PAHs = polynuclear aromatic hydrocarbons.

TABLE 3

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

EXISTING GROUNDWATER MONITORING WELLS SUMMARY

Hydrostratigraphic Zone	Monitoring Well ID
Shallow	MW-3, MW-6S, MW-7, MW-8S, MW-9S, MW-10, MW-13SR, MW-14S, MW-19S, MW-20R, MW-21, MW-22, MW-23, MW-24, MW-26, MW-27S, MW-28S, MW-29S, MW-30S
Intermediate	MW-6I, MW-8I, MW9I, MW-11, MW-13P, MW-14P, MW-15S, MW-17, MW-19I, MW-25, MW-28I, MW-29I, and MW-30I
Deep	MW-8D, MW-9D, MW-12, MW-13I, MW-14I, MW-15I, MW-19D, MW-28D, and MW-30D
Till	MW-13T, MW-19T, MW-27D, MW-28T, MW-29T, MW-30T

Note:
1. Well construction information for monitoring well MW-1 is not available. Therefore the hydrostratigraphic zone in which the well is screened cannot be determined.

TABLE 4

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER BTEX ANALYTICAL RESULTS SUMMARY

Sample ID:	Date Collected:	Benzene	Ethylbenzene	Toluene	Total Xylenes	Total BTEX
Class GA Groundwater Criteria		1	5	5	5	- -
Shallow Hydrostratigraphic Unit						
MW-2	7/23/92	550	560	39	500	**1,649**
	6/20/96	500 J	370 J	120	510 J	**1,500 J**
	07/31/96	850 D	130	77	360	**1,417**
MW-3	11/11/04	2,100 D	660 D	18	580 D	**3,358**
	11/11/04	2,200	680	ND	570	**3,450**
MW-6S	06/21/96	5 J	22 J	1 J	4 J	**32 J**
	07/30/96	3 J	5 J	ND	ND	**8 J**
	6/12/02	1.8 J	ND	1 J	ND	**2.8 J**
	11/9/04	ND	ND	ND	ND	**ND**
MW-7	06/18/96	ND	ND	ND	ND	**ND**
	07/31/96	ND	ND	ND	ND	**ND**
	6/12/02	ND	ND	ND	ND	**ND**
	11/4/04	ND	ND	ND	ND	**ND**
MW-8S	06/19/96	ND	ND	ND	ND	**ND**
	07/31/96	ND	ND	ND	ND	**ND**
	6/12/02	ND	ND	ND	ND	**ND**
	11/9/04	ND	ND	ND	ND	**ND**
MW-9S	06/20/96	10	360 D	16	780 D	**1,166**
	07/31/96	3 J	83	2 J	240	**328 J**
	6/13/02	20	870 D	38 B	2,900 D	**3,828**
	1/12/05	5 J	110	2 J	270	**387 J**
	1/12/05 DUP	5 J	100	2 J	270	**377 J**
MW-10	06/20/96	ND	ND	ND	ND	**ND**
	07/31/96	ND	ND	ND	ND	**ND**
	6/13/02	ND	ND	ND	ND	**ND**
	6/13/02 DUP	ND	ND	ND	ND	**ND**
	1/12/05	ND	ND	ND	ND	**ND**
MW-13S/MW-13SR	06/18/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/11/02	ND	ND	ND	ND	**ND**
	11/4/04	5 J	2 J	ND	1 J	**8 J**
MW-14S	06/18/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/11/02	ND	ND	ND	ND	**ND**
	11/3/04	ND	ND	ND	ND	**ND**
MW-19S	06/19/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/11/02	ND	ND	ND	ND	**ND**
	11/3/04	ND	ND	ND	ND	**ND**
MW-20	6/13/02	2,300 D	940 D	59 B	1,000 D	**4,299**
MW-21	11/12/04	220 D	320 D	110	400	**1,050**

TABLE 4

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER BTEX ANALYTICAL RESULTS SUMMARY

Sample ID:	Date Collected:	Benzene	Ethylbenzene	Toluene	Total Xylenes	Total BTEX
Class GA Groundwater Criteria		1	5	5	5	- -
Shallow Hydrostratigraphic Unit (continued)						
MW-22	11/10/04	2 J	2 J	2 J	3 J	**9 J**
MW-23	11/08/04	6,700 D	2,100 D	330 JD	4,400 D	**13,530 JD**
MW-24	11/04/04	200	5 J	2 J	5 J	**212 J**
MW-26	11/08/04	69	830 D	41	840 D	**1,780**
MW-27S	11/04/04	ND	ND	ND	ND	**ND**
Intermediate Hydrostratigraphic Unit						
MW-6I	06/21/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/12/02	ND	ND	ND	ND	**ND**
	11/10/04	ND	ND	ND	ND	**ND**
MW-8I	06/19/96	1,000 D	410 D	1 J	24	**1,435 J**
	07/31/96	110	ND	ND	3 J	**113 J**
	6/12/02	26	2.1 J	ND	ND	**28.1 J**
	08/11/04	49	3 J	ND	2 J	**54 J**
	11/9/04	530 D	49	0.8 J	9 J	**588.8 J**
MW-9I	06/20/96	6 J	190	3 J	540 D	**739 J**
	08/01/96	5 J	57	2 J	210	**274 J**
	6/13/02	9.2	140	3 JB	560 D	**712.2 J**
	6/13/02 DUP	9.4	140 D	2.8 JB	590 D	**742.2 J**
	1/12/05	4 J	81	1 J	520 D	**606 J**
MW-11	06/19/96	ND	ND	ND	ND	**NA**
	07/31/96	ND	ND	ND	ND	**ND**
	6/12/02	ND	ND	ND	ND	**ND**
	11/1/04	ND	ND	ND	ND	**ND**
MW-13P	06/18/96	7 J	ND	ND	ND	**7 J**
	07/30/96	6 J	ND	ND	ND	**6 J**
	6/11/02	ND	ND	ND	ND	**ND**
	11/2/04	ND	ND	ND	ND	**ND**
	11/2/04 DUP	ND	ND	ND	ND	**ND**
MW-14P	06/18/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/11/02	ND	ND	ND	ND	**ND**
	11/3/04	ND	ND	ND	ND	**ND**
MW-15S	06/19/96	ND	ND	ND	ND	**ND**
	07/31/96	ND	ND	ND	ND	**ND**
	6/12/02	ND	ND	ND	ND	**ND**
	11/9/04	ND	ND	ND	ND	**ND**
MW-17	06/20/96	8 J	430 D	8 J	180	**626 J**
	07/30/96	5 J	95	4 J	20	**124 J**
	11/5/04	9 J	390 D	6 J	70	**475 J**

TABLE 4

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER BTEX ANALYTICAL RESULTS SUMMARY

Sample ID:	Date Collected:	Benzene	Ethylbenzene	Toluene	Total Xylenes	Total BTEX
Class GA Groundwater Criteria		1	5	5	5	- -
Intermediate Hydrostratigraphic Unit (continued)						
MW-19I	06/19/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/11/02	ND	ND	ND	ND	**ND**
	11/3/04	ND	ND	ND	ND	**ND**
MW-25	11/01/04	1,400 D	650 D	14	180	**2,244**
Deep Hydrostratigraphic Unit						
MW-8D	06/19/96	ND	ND	ND	ND	**ND**
	07/31/96	ND	ND	ND	ND	**ND**
	6/12/02	ND	ND	ND	ND	**ND**
	8/11/04	ND	ND	ND	ND	**ND**
	11/9/04	ND	ND	ND	ND	**ND**
MW-9D	06/20/96	15	ND	ND	2 J	**17 J**
	08/01/96	27	ND	ND	2 J	**29 J**
	6/13/02	20	ND	ND	1.2 J	**21.2 J**
	1/12/05	18	ND	ND	ND	**18**
MW-12	06/19/96	ND	ND	ND	ND	**ND**
	07/31/96	ND	ND	ND	ND	**ND**
	6/12/02	ND	ND	ND	ND	**ND**
	11/2/04	ND	ND	ND	ND	**ND**
MW-13I	06/18/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/11/02	9.2	ND	1 J	ND	**10.2 J**
	11/2/04	5 J	ND	ND	ND	**5 J**
MW-14I	06/18/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/11/02	ND	ND	ND	ND	**ND**
	11/3/04	ND	ND	ND	ND	**ND**
MW-15I	06/19/96	ND	ND	ND	ND	**ND**
	07/31/96	ND	ND	ND	ND	**ND**
	6/12/02	ND	ND	ND	ND	**ND**
	11/9/04	ND	ND	ND	ND	**ND**
MW-19D	06/19/96	ND	ND	ND	ND	**ND**
	07/30/96	ND	ND	ND	ND	**ND**
	6/11/02	ND	ND	ND	ND	**ND**
	11/3/04	ND	ND	ND	ND	**ND**
Till						
MW-27D	11/04/04	ND	ND	ND	ND	**ND**
Other						
MW-1 (See Note 15)	06/20/96	220 D	100	30	110 D	**460**
	07/31/96	150	3 J	17	52	**222 J**
	6/11/02	150	31	4.8 JB	14 J	**199.8 J**
	11/5/04	10	1 J	2 J	3 J	**16 J**

TABLE 4

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER BTEX ANALYTICAL RESULTS SUMMARY

Sample ID:	Date Collected:	Benzene	Ethylbenzene	Toluene	Total Xylenes	Total BTEX
Class GA Groundwater Criteria		1	5	5	5	- -
Other (continued)						
MW-16 (See Note 16)	06/21/96	110	630 D	18	320	**1,078**
	08/01/96	110	350 D	18	280	**758**
MW-18 (See Note 16)	06/20/96	8,000 D	1,800 D	3,100 D	7,800 D	**20,700 D**
	07/31/96	4,600 D	1,500 D	3,000 D	8,300 D	**17,400 D**
	6/11/02	2,800 D	990 D	470 D	2,900 D	**7,160 D**

Notes:

1. Samples were collected by Atlantic Environmental Services during 1992; Parsons Engineering Science between 1994 and 1997; and Blasland, Bouck & Lee, Inc. between 2001and 2005.
2. VOCs = volatile organic compounds.
3. Laboratory analysis was conducted by Energy and Environmental Engineering, Inc. for samples collected during 1992; Nytest Environmental, Inc. located in Port Washington, New York for samples collected during 1996; Severn Trent Laboratories, Inc. located in Amherst, New York for samples collected during 2002 and by CompuChem located in Cary, North Carolina for samples collected during 2004.
4. Samples were analyzed for VOCs using USEPA SW-846 Method 8260.
5. NYSDEC Class GA Standards/Guidance Values from New York State Department of Environmental Conservation (NYSDEC) document entitled, "Division of Water,Technical and Operational Guidance Series (TOGS 1.1.1) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations" (NYSDEC, reissued June 1998 and addended April 2000).
6. Concentrations reported in micrograms per liter (µg/L).
7. ND = Compound was not detected at a concentration exceeding laboratory detection limits.
8. NA = Not Analyzed.
9. J = Indicates an estimated concentration. Presented concentration is less than the method detection limit but greater than the instrument detection limit.
10. B = Indicates that the compound was detected in the laboratory sample as well as the associated laboratory blank.
11. D = Indicates that the presented concentration is based on the analysis of a diluted sample.
12. Shaded values indicate that the compound was detected at a concentration greater than or equal to the NYSDEC Class GA (groundwater) standard or guidance value presented in TOGS 1.1.1.
13. Monitoring wells MW-16 and MW-17 were not able to be located during the 2002 sampling event, and therefore, were not sampled.
14. -- = Indicates that a Class GA water quality standard or guidance value was not available for this compound.
15. Well construction information for monitoring well MW-1 is not available. Therefore, the hydrostratigraphic zone in which the well is screened cannot be determined.
16. Monitoring wells MW-16 and MW-18 were installed such that their screens and sand packs straddled the silt and clay layer between the shallow and intermediate hydrostratigraphic zones.

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

		Shallow																
Sample ID:	**Class GA Groundwater Criteria**	**MW-2**			**MW-3**		**MW-6S**				**MW-7**				**MW-8S**			
Date Collected:		**7/23/92**	**6/20/96**	**7/31/96**	**11/11/04**	**11/11/04 DUP**	**6/21/96**	**7/30/96**	**6/12/02**	**11/9/04**	**6/18/96**	**7/31/96**	**6/12/02**	**11/4/04**	**6/19/96**	**7/31/96**	**6/12/02**	**11/9/04**
1,3-Dichlorobenzene	3	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
1,4-Dichlorobenzene	3	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2,4-Dimethylphenol	50	NA	700 JD	2,000 D	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2-Methyl phenol	- -	NA	360 JD	940 D	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2-Methylnaphthalene	- -	NA	44	7 J	360 D	350 D	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl phenol	- -	NA	240 JD	710 D	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Acenaphthene	20	43	82	65	120	140	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	- -	12	ND	5 J	8 J	7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	50	8	6 J	7 J	22	24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.002	2 J	2 J	1 J	8 J	7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	1 J	1 J	1 J	7 J	6 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.002	ND	ND	ND	3 J	3 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	- -	ND	ND	ND	4 J	3 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	0.002	ND	ND	ND	4 J	3 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	5	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Carbazole	- -	NA	53	45	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Chrysene	0.002	2 J	2 J	1 J	8 J	7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	- -	NA	22	17	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Diethylphthalate	50	NA	ND	ND	NA	NA	2 J	ND	NA	NA	ND	ND	NA	NA	2 JN	ND	NA	NA
Di-n-Octylphthalate	50	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Fluoranthene	50	7	7 J	6 J	18	18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	50	22	22	26	47	54	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	0.002	ND	ND	ND	3 J	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	10	ND	1,600 D	66 JD	1500 D	1500 D	2 J	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	50	37	32	6 J	78	88	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	1	NA	360 J	300 JD	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Pyrene	50	6	6 J	6 J	27	27	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PAHs	**- -**	**122**	**1,804 J**	**197 J**	**2,217 J**	**2,239 J**	**4 J**	**ND**	**2 J**	**ND**	**ND**	**ND**	**ND**	**ND**	**2 JN**	**ND**	**ND**	**ND**

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

		Shallow																		
Sample ID:	**Class GA Groundwater Criteria**	**MW-9S**					**MW-10**					**MW-13S**				**MW-14S**				
Date Collected:		**6/20/96**	**7/31/96**	**6/13/02**	**1/12/05**	**1/12/05 DUP**	**6/20/96**	**7/31/96**	**6/13/02**	**6/13/02 DUP**	**1/12/05**	**6/18/96**	**7/30/96**	**6/11/02**	**11/4/04**	**6/18/96**	**7/30/96**	**6/11/02**	**11/3/04**	
1,3-Dichlorobenzene	3	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
1,4-Dichlorobenzene	3	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
2,4-Dimethylphenol	50	ND	5 J	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
2-Methyl phenol	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
2-Methylnaphthalene	- -	ND	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	
4-Methyl phenol	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
Acenaphthene	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2 J	ND	ND	ND	ND	
Acenaphthylene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Anthracene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Benzo(a)anthracene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Benzo(b)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Benzo(ghi)perylene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Benzo(k)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
bis(2-Ethylhexyl)phthalate	5	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
Carbazole	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
Chrysene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Dibenzo(a,h)anthracene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Dibenzofuran	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
Diethylphthalate	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	10 J	ND	NA	NA	
Di-n-Octylphthalate	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
Fluoranthene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Fluorene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Indeno(1,2,3-cd)pyrene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Naphthalene	10	140 D	130 D	450 D	100 J	68	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Phenanthrene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Phenol	1	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	
Pyrene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Total PAHs	**- -**	**140 D**	**135**	**452 J**	**100 J**	**68**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**2 J**	**10 J**	**ND**	**ND**	**ND**	

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

		Shallow											Intermediate			
Sample ID:	**Class GA**	**MW-19S**				**MW-20**	**MW-21**	**MW-22**	**MW-23**	**MW-24**	**MW-26**	**MW-27S**	**MW-6I**			
Date Collected:	**Groundwater Criteria**	**6/19/96**	**7/30/96**	**6/11/02**	**11/3/04**	**6/13/02**	**11/12/04**	**11/10/04**	**11/8/04**	**11/4/04**	**11/8/04**	**11/4/04**	**6/21/96**	**7/30/96**	**6/12/02**	**11/10/04**
1,3-Dichlorobenzene	3	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
1,4-Dichlorobenzene	3	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
2,4-Dimethylphenol	50	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
2-Methyl phenol	- -	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
2-Methylnaphthalene	- -	ND	ND	ND	NA	380 D	250 D	ND	NA	24	NA	ND	ND	ND	ND	ND
4-Methyl phenol	- -	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
Acenaphthene	20	ND	ND	ND	ND	140	280 D	78	26 J	32	270 J	ND	ND	ND	ND	ND
Acenaphthylene	- -	ND	ND	ND	ND	11	44	42	ND	16	ND	ND	ND	ND	ND	ND
Anthracene	50	ND	ND	ND	ND	19	52	6 J	ND	8 J	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.002	ND	ND	ND	ND	6 J	28	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	4 J	23	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.002	ND	ND	ND	ND	2 J	14	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	- -	ND	ND	ND	ND	2 J	14	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	0.002	ND	ND	ND	ND	2 J	17	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	5	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
Carbazole	- -	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
Chrysene	0.002	ND	ND	ND	ND	6 J	24	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	- -	ND	ND	ND	ND	0.6 J	3 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	- -	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
Diethylphthalate	50	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	1 J	ND	NA	NA
Di-n-Octylphthalate	50	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
Fluoranthene	50	ND	ND	ND	ND	12	80	ND	ND	3 J	ND	3 J	ND	ND	ND	ND
Fluorene	50	10 J	ND	ND	ND	66	88	34	11 J	39	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	0.002	ND	ND	ND	ND	1 J	15	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	10	ND	ND	ND	ND	2,500 D	2,200 D	110	480	86	5,900	ND	ND	ND	ND	ND
Phenanthrene	50	ND	ND	ND	ND	84	290 D	21	14 J	33	110 J	ND	ND	ND	ND	ND
Phenol	1	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA
Pyrene	50	ND	ND	ND	ND	18	78	2 J	ND	3 J	ND	2 J	ND	ND	ND	ND
Total PAHs	**- -**	**10 J**	**ND**	**ND**	**ND**	**3,254 J**	**3,500 J**	**293 J**	**531 J**	**244 J**	**6,280 J**	**5 J**	**1 J**	**ND**	**ND**	**ND**

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

		Intermediate													
Sample ID:	**Class GA Groundwater Criteria**	**MW-8I**					**MW-9I**					**MW-11**			
Date Collected:		**6/19/96**	**7/31/96**	**6/12/02**	**8/11/04**	**11/9/04**	**6/20/96**	**8/1/96**	**6/13/02**	**6/13/02 DUP**	**1/12/05**	**6/19/96**	**7/31/96**	**6/12/02**	**11/1/04**
1,3-Dichlorobenzene	3	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
1,4-Dichlorobenzene	3	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
2,4-Dimethylphenol	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
2-Methyl phenol	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
2-Methylnaphthalene	- -	ND	ND	2 J	NA	13	ND	ND	ND	ND	ND	ND	ND	ND	NA
4-Methyl phenol	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
Acenaphthene	20	ND	2 J	20	46	31	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	50	ND	ND	0.7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	5	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
Carbazole	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
Chrysene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
Diethylphthalate	50	1 J	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
Di-n-Octylphthalate	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	1 J	NA	NA
Fluoranthene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	50	ND	ND	4 J	10	6 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	10	ND	ND	0.9 J	2 J	11	79	ND	110	100	52	ND	ND	ND	ND
Phenanthrene	50	ND	ND	0.7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	1	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA
Pyrene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PAHs	**- -**	**1 J**	**2 J**	**28.3 J**	**58 J**	**61 J**	**79**	**ND**	**110**	**100**	**52**	**ND**	**1 J**	**ND**	**ND**

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

		Intermediate															
Sample ID:	**Class GA**	**MW-13P**					**MW-14P**				**MW-15S**				**MW-17**		
Date Collected:	**Groundwater Criteria**	**6/18/96**	**7/30/96**	**6/11/02**	**11/1/04**	**11/1/04 DUP**	**6/18/96**	**7/30/96**	**6/11/02**	**11/3/04**	**6/19/96**	**7/31/96**	**6/12/02**	**11/9/04**	**6/20/96**	**7/30/96**	**11/5/04**
1,3-Dichlorobenzene	3	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	1 J	2 J	NA
1,4-Dichlorobenzene	3	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	3 J	NA
2,4-Dimethylphenol	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	12	NA
2-Methyl phenol	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA
2-Methylnaphthalene	- -	ND	ND	ND	NA	NA	ND	ND	ND	NA	ND	ND	ND	NA	1 J	ND	ND
4-Methyl phenol	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA
Acenaphthene	20	20	33 J	ND	ND	21	ND	ND	ND	ND	ND	ND	ND	ND	5 J	4 J	5 J
Acenaphthylene	- -	5 J	8 J	ND	ND	7 J	5 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	5	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA
Carbazole	- -	ND	1 J	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA
Chrysene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA
Diethylphthalate	50	2 J	ND	NA	NA	NA	2 J	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA
Di-n-Octylphthalate	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA
Fluoranthene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	50	3 J	8 J	ND	ND	ND	3 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	110 D	24	81
Phenanthrene	50	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	1	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA
Pyrene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PAHs	**- -**	**30 J**	**52 J**	**ND**	**ND**	**28 J**	**10**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**116 J**	**28 J**	**86 J**

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

		Intermediate					Deep												
Sample ID:	**Class GA**	**MW-19I**				**MW-25**	**MW-8D**					**MW-9D**				**MW-12**			
Date Collected:	**Groundwater Criteria**	**6/19/96**	**7/30/96**	**6/11/02**	**11/3/04**	**11/1/04**	**6/19/96**	**7/31/96**	**6/12/02**	**8/11/04**	**11/9/04**	**6/20/96**	**8/1/96**	**6/13/02**	**1/12/05**	**6/19/96**	**7/31/96**	**6/12/02**	**11/2/04**
1,3-Dichlorobenzene	3	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
1,4-Dichlorobenzene	3	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2,4-Dimethylphenol	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2-Methyl phenol	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2-Methylnaphthalene	- -	ND	ND	ND	NA	NA	150 JD	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
4-Methyl phenol	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Acenaphthene	20	ND	ND	ND	ND	45 J	110 JD	ND	0.7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	5	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Carbazole	- -	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Chrysene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	- -	ND	ND	NA	NA	NA	6 J	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Diethylphthalate	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Di-n-Octylphthalate	50	ND	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	1 J	NA	NA
Fluoranthene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	50	ND	ND	ND	ND	ND	32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	10	ND	ND	ND	ND	1,700	1,800 D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	50	ND	ND	ND	ND	ND	2 JN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	1	19	ND	NA	NA	NA	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Pyrene	50	ND	ND	ND	ND	ND	ND	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PAHs	**- -**	**19**	**ND**	**ND**	**ND**	**1,745 J**	**2,100 J**	**ND**	**0.7 J**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**1 J**	**ND**	**ND**

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

		Deep															
Sample ID:	**Class GA**	**MW-13I**				**MW-14I**				**MW-15I**				**MW-19D**			
Date Collected:	**Groundwater Criteria**	**6/18/96**	**7/30/96**	**6/11/02**	**11/1/04**	**6/18/96**	**7/30/96**	**6/11/02**	**11/3/04**	**6/19/96**	**7/31/96**	**6/12/02**	**11/9/04**	**6/19/96**	**7/30/96**	**6/11/02**	**11/3/04**
1,3-Dichlorobenzene	3	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
1,4-Dichlorobenzene	3	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2,4-Dimethylphenol	50	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2-Methyl phenol	- -	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
2-Methylnaphthalene	- -	ND	ND	ND	NA	ND	ND	ND	NA	ND	ND	ND	NA	ND	ND	ND	NA
4-Methyl phenol	- -	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Acenaphthene	20	ND	ND	26	21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	- -	ND	ND	8 J	7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	5	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Carbazole	- -	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Chrysene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	- -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	- -	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Diethylphthalate	50	ND	ND	NA	NA	2 J	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Di-n-Octylphthalate	50	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Fluoranthene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	50	ND	ND	2 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	10 J	ND	ND	ND
Indeno(1,2,3-cd)pyrene	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	1	ND	ND	NA	NA	46	66 J	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA
Pyrene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PAHs	**- -**	**ND**	**ND**	**36 J**	**28 J**	**46**	**66 J**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**10 J**	**ND**	**ND**	**ND**

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

		Till	Other						
Sample ID:	Class GA	MW-27D	MW-1 (See Note 14)				MW-18 (See Note 15)		
Date Collected:	Groundwater Criteria	11/4/04	6/20/96	7/31/96	6/11/02	11/5/04	6/20/96	7/31/96	6/11/02
1,3-Dichlorobenzene	3	NA	ND	ND	NA	NA	ND	ND	NA
1,4-Dichlorobenzene	3	NA	ND	ND	NA	NA	ND	ND	NA
2,4-Dimethylphenol	50	NA	67 J	ND	NA	NA	ND	62	NA
2-Methyl phenol	- -	NA	8 J	ND	NA	NA	31	57	NA
2-Methylnaphthalene	- -	ND	22	ND	ND	ND	130 JD	140 J	39 J
4-Methyl phenol	- -	NA	3 J	ND	NA	NA	67	94 JD	NA
Acenaphthene	20	ND	74	ND	4 J	4 J	37	24	15 J
Acenaphthylene	- -	ND	7 J	6 J	3 J	ND	5 J	6 J	ND
Anthracene	50	ND	10 J	2 J	1 J	ND	6 JN	5 J	ND
Benzo(a)anthracene	0.002	ND	3 J	3 J	0.7 J	ND	1 J	1 J	ND
Benzo(a)pyrene	ND	ND	2 J	4 J	1 J	ND	ND	ND	ND
Benzo(b)fluoranthene	0.002	ND	1 J	2 J	0.6 J	ND	ND	ND	ND
Benzo(ghi)perylene	- -	ND	ND	4 J	3 J	ND	ND	ND	ND
Benzo(k)fluoranthene	0.002	ND	ND	2 J	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	5	NA	ND	ND	NA	NA	64	83	NA
Carbazole	- -	NA	4 J	ND	NA	NA	10 J	9 J	NA
Chrysene	0.002	ND	3 J	3 J	0.6 J	ND	1 J	1 J	ND
Dibenzo(a,h)anthracene	- -	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	- -	NA	ND	ND	NA	NA	ND	3 J	NA
Diethylphthalate	50	NA	ND	ND	NA	NA	ND	ND	NA
Di-n-Octylphthalate	50	NA	ND	ND	NA	NA	ND	ND	NA
Fluoranthene	50	ND	9 J	3 J	ND	ND	3 J	3 J	ND
Fluorene	50	ND	33	ND	ND	ND	18	16	ND
Indeno(1,2,3-cd)pyrene	0.002	ND	ND	2 J	2 J	ND	ND	ND	ND
Naphthalene	10	ND	500 D	2 JN	ND	ND	2,000 D	750 D	520
Phenanthrene	50	ND	47	2 J	ND	ND	19	18	16 J
Phenol	1	NA	8 J	4 J	NA	NA	ND	380 D	NA
Pyrene	50	ND	11	6 J	ND	ND	4 J	4 J	6 J
Total PAHs	**- -**	**ND**	**722 J**	**41 J**	**15.9 J**	**4 J**	**2,224 J**	**968 J**	**596 J**

TABLE 5

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

HISTORICAL GROUNDWATER PAH ANALYTICAL RESULTS SUMMARY

Notes:

1. Samples were collected by Blasland, Bouck & Lee, Inc. on the dates indicated.
2. SVOCs = semi-volatile organic compounds.
3. Laboratory analysis was conducted by Severn Trent Laboratories, Inc. located in Amherst, New York for samples collected during 2002 and by CompuChem located in Cary, North Carolina for samples collected during 2004.
4. Samples were analyzed for SVOCs using USEPA SW-846 Method 8270.
5. NYSDEC Class GA Standards/Guidance Values from New York State Department of Environmental Conservation (NYSDEC) document entitled, "Division of Water, Technical and Operational Guidance Series (TOGS 1.1.1) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations" (NYSDEC, reissued June 1998 and addended April 2000).
6. Concentrations reported in micrograms per liter (µg/L).
7. ND = Compound was not detected at a concentration exceeding laboratory detection limits.
8. NA = Not Analyzed.
9. J = Indicates an estimated concentration. Presented concentration is less than the method detection limit but greater than the instrument detection limit.
10. D = Indicates that the presented concentration is based on the analysis of a diluted sample.
11. Shaded values indicate that the compound was detected at a concentration greater than or equal to the NYSDEC Class GA (groundwater) standard or guidance value presented in TOGS 1.1.1.
12. Monitoring wells MW-16 and MW-17 were not able to be located during the 2002 sampling event, and therefore, were not sampled.
13. Well construction information for monitoring well MW-1 is not available. Therefore, the hydrostratigraphic zone in which the well is screened cannot be determined.
14. Monitoring wells MW-18 was installed such that its screens and sand packs straddled the silt and clay layer between the shallow and intermediate hydrostratigraphic zones.

TABLE 6

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

GROUNDWATER SAMPLING EVENTS SUMMARY

Site Investigation	Groundwater Sampling Event	Number of Wells Sampled	TCL VOCs	BTEX	TCL SVOCs	PAHs	PCBs/Pesticides	TAL Metals	Cyanide	NA Parameters
PSA/IRM	Jul-92	1	✓		✓				✓	
RI	Jun-96	28	✓		✓		✓	✓	✓	
	Jul-96	28	✓		✓		✓	✓	✓	
NAPL/Groundwater Investigation	Jun-02	26	✓			✓			✓	
Additional Subsurface	Aug-04	2		✓		✓				
	Nov-04/Jan-05	34		✓		✓				✓

Notes:
1. TCL VOCs = Target Compound Level for Volatile Organic Compounds
2. BTEX = Benzene, Toluene, Ethylbenzene, and Xylene
3. TCL SVOCs = Target Compound Level for Semi-Volatile Organic Compounds
4. PAHs = polynuclear aromatic hydrocarbons
5. PCBs = polychlorinated biphenyls
6. TAL Metals = Target Analyte List for Metals
7. NA Parameters = natural attenuation indicator parameters
8. PSA/IRM = Preliminary Site Assessment/Interim Remedial Measure
9. RI = Remedial Investigation
10. NAPL = non-aqueous phase liquid

TABLE 7

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

DPH PHYSICAL AND CHEMICAL CHARACTERISTICS

Parameter	MW	K_{oc} (cc/g)	θ	ρ_s (g/cc)	ρ_b (g/cc)	f_{oc} (mg/kg)	R_c (unitless)
Soil			0.293	2.44	1.73	21,528	
BTEX							
Benzene	78	83					12
Ethylbenzene	92	1,100					140
Toluene	106	300					39
Xylene	106	240					31
PAHs							
Naphthalene	128.2	1,300					166
Acenaphthylene	152.2	2,056					262
Acenaphthene	154.2	4,600					584
Fluorene	166.2	7,300					926
Phenanthrene	178.2	4,365					554
Anthracene	178.2	14,000					1,775
Fluoranthene	202.3	38,000					4,817
Pyrene	202.1	13,295					1,686
Benzo(a)anthracene	228.3	1,380,000					174,915
Chrysene	228.3	200,000					25,351
Benzo(b)fluoranthene	252.3	550,000					69,713
Benzo(k)fluoranthene	252.3	550,000					69,713
Benzo(a)pyrene	252.3	5,000,000					633,747
Indeno(1,2,3-cd)pyrene	276.3	1,600,000					202,800
Dibenzo(a,h)anthracene	278.3	3,300,000					418,273
Benzo(g,h,i)perylene	276.4	1,600,000					202,800

Notes:

1. MW = molecular weight
2. Octanol-water coefficient s (K_{oc}) are presented in grams per cubic centimeter (g/cc) and were obtained from New York State Department of Environmental Conservation (NYSDEC) Technical Administrative Guidance Manual (TAGM) #4046 Table 1 [Volatile Organic Compounds] VOCs Soil Cleanup Criteria Table and Table 2 [Semi-Volatile Organic Compounds] SVOCs Soil Cleanup Criteria Table (January 24, 1994).
3. θ = porosity
4. ρ_s = Specific density is presented in g/cc (Specific Density = Specific Gravity).
5. ρ_b = Bulk density is presented in g/cc.
6. f_{oc} = Fraction of organic carbon in soil (mass fraction) is presented in milligrams per kilogram (mg/kg).
7. R_c = retardation factor of compound
8. BTEX = Benzene, Toluene, Ethylbenzene, and Xylene
9. PAHs = polynuclear aromatic hydrocarbons
10. Bulk density, specific gravity, and porosity values are the results of geotechnical analysis of soil samples collected from soil boring BB-135 at the 10 to 12-foot depth interval. The geotechnical analyses were conducted by PW Laboratories, Inc.

TABLE 8

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

POTENTIAL AVERAGE MIGRATION RATES OF BENZENE

Hydrostratigraphic Unit	Groundwater Flow Direction	Average Linear Groundwater Velocity (ft/day)	Benzene Retardation Factor	Average Potential Benzene Migration Rate (ft/day)[1]
Shallow Fill/Upper Fine Sand	Horizontal	0.18	12	0.015
Silt and Clay (semi-confining layer)	Vertical	0.00054	12	0.00005
Intermediate Fine Sand	Horizontal	0.16	12	0.013

Notes:
1. The calculated average potential benzene migration rate a ssumes no attenuation processes are occurring.
2. ft/day = feet per day

TABLE 9

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

GROUNDWATER GEOCHEMICAL CHARACTERISTICS SUMMARY

Parameter	Units	MW-3	DUP-1/DUP-2 (MW-3)	MW-6S	MW-8D	MW-21	MW-22
Inorganics							
Sulfate	mg/L	ND	ND	1,100	29	43	266
Sulfide	mg/L	1.4	1.4	1.2	1.0	3.6	1.4
Nitrate	mg/L	0.29	0.19	ND	0.11	ND	ND
Alkalinity, as CaCO3	mg/L	553	562	46	347	698	353
Iron	mg/L	42.4	44.0	90.3	2.19	13.6	10.2
Manganese	mg/L	3.20	3.32	5.46	0.59	1.72	0.90
Dissolved Gases							
Nitrogen	mg/L	18	15	17	17	14	22
Methane	mg/L	9.8	7.9	0.64	0.16	5.5	0.0087
Field Parameters							
Temperature	°C	13.69		14.78	10.97	13.25	11.51
pH	SU	6.96		5.01	6.61	6.05	6.43
Turbidity	NTU	3.5		164	0.4	25.9	9.5
Dissolved Oxygen	mg/L	ND		ND	ND	ND	ND
Conductivity	mS/cm	1.24		5.91	1.2	2.21	1.25
Oxidation-Reduction Potential	mV	-128		+100	-76	-113	-39

Notes:
1. mg/L = milligrams per liter
2. °C = degree celcius
3. NTU = nephelometric turbidity units
4. mS/cm = millisiemens per centimeter
5. mV = millivolts
6. ND = Compound was not detected.
7. CaCO3 = Calcium Carbonate
8. SU = standard units

TABLE 10

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

DPH DEGRADING ENZYMES ANALYSIS SUMMARY

Parameter	Sample Date	Units	MW-3	DUP-1/DUP-2 (MW-3)	MW-6S	MW-8D	MW-21	MW-22	MW-9S
Biomass	11/9/04 - 11/12/04	Pmoles PLFA/mL	1.27E+06	2.25E+06	7.43E+05	8.38E	6.46E+04	3.11E+06	-
Biomass	1/11/05 - 1/12/05	Pmoles PLFA/mL	4.60E+06	4.81E+06	3.45E+05	2.51E+06	5.44E+06	1.25E+06	5.26E+06
Universal Bacteria	11/9/04 - 11/12/04	Pmoles PLFA/mL	6.25E+07	9.61E+06	4.35E+06	6.49E+05	8.49E+06	5.72E+07	-
Toluene Dioxygenase	11/9/04 - 11/12/05	Pmoles PLFA/mL	ND	ND	1.66E+05	1.58E+05	7.42E+03	9.07E+05	-
Toluene Dioxygenase	1/11/05 - 1/12/05	Pmoles PLFA/mL	1.41E+06	3.61E+08	3.39E+05	1.38E+08	3.98E+06	1.63E+07	4.25E+08
Toluene Monoxygenase	11/9/04 - 11/12/04	Pmoles PLFA/mL	ND	ND	ND	5.95E+01	ND	6.50E+02	-
Catechol Dioxygenase	11/9/04 - 11/12/04	Pmoles PLFA/mL	1.26E+06	7.54E+05	1.89E+06	4.47E+05	6.33E+06	1.93E+07	-
Catechol Dioxygenase	1/11/05 - 1/12/05	Pmoles PLFA/mL	9.94E+06	ND	7.60E+04	9.72E+05	4.99E+04	6.43E+05	ND

Notes:
1. Pmoles PLFA/mL = picomoles of phospholipids fatty acids per milliliter.
2. ND = Compound was not detected above the laboratory detection limit.
3. - = Parameter was not analyzed for.

TABLE 11

NATURAL ATTENUATION EVALUATION REPORT

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

PLFA ANALYSIS SUMMARY

Parameter	Sample Date	Units	MW-3	DUP-1/DUP-2 (MW-3)	MW-6S	MW-8D	MW-21	MW-22	MW-9S
Community Structure									
TerBrSats	11/04	%	15.6	12.1	27.1	5.2	30.6	8.6	-
	1/05	%	0.6	9.7	0.0	2.3	1.0	2.2	9.8
Monos	11/04	%	53.6		44.8	50.7	41.6	58.8	-
	1/05	%	74.9	60.8	63.8	73.8	76.0	68.7	58.2
BrMonos	11/04	%	1.2		4.6	0.7	3.3	0.9	-
	1/05	%	0.4	1.3	0.0	0.7	0.2	0.0	1.1
MidBrSats	11/04	%	1.7	0.8	5.1	1.8	4.6	2.1	-
	1/05	%	0.3	2.7	0.0	1.2	0.2	2.0	2.7
Nsats	11/04	%	26.3		17.9	38.1	19.3	28.6	-
	1/05	%	23.7	15.7	35.1	18.1	22.7	26.4	16.6
Polyenoics	11/04	%	1.6		0.4	3.6	0.6	0.9	-
	1/05	%	0.2	9.9	1.1	3.9	0.0	0.8	11.7
Physiological Status									
Starved cy/cis	11/04		0.41	0.31	2.87	0.22	0.25	1.33	-
Starved cy/cis	1/05		0.18	0.36	0.75	0.10	0.08	0.37	0.35
Membrane Stress trans/cis	11/04		0.14	0.13	0.26	0.20	0.07	0.15	-
Membrane Stress trans/cis	1/05		0.01	0.34	0	0.02	0.01	0.01	0.35

Notes:
1. Community structure values are presented in percent (%) of total phospholipid fatty acids (PLFA).
2. - = Parameter was not analyzed for.
3. TerBrSats = terminally branched saturates
4. Monos = monoeonics
5. BrMonos = branched monoenoics
6. Nsats = normal saturates
7. MidBrSats = midbranched saturates
8. cy/cis = ratio of cyclopropyl PLFA/cis-isomer PLFA
9. trans/cis = ratio of tran-isomer PLFA/cis-isomer PLFA

Attachment

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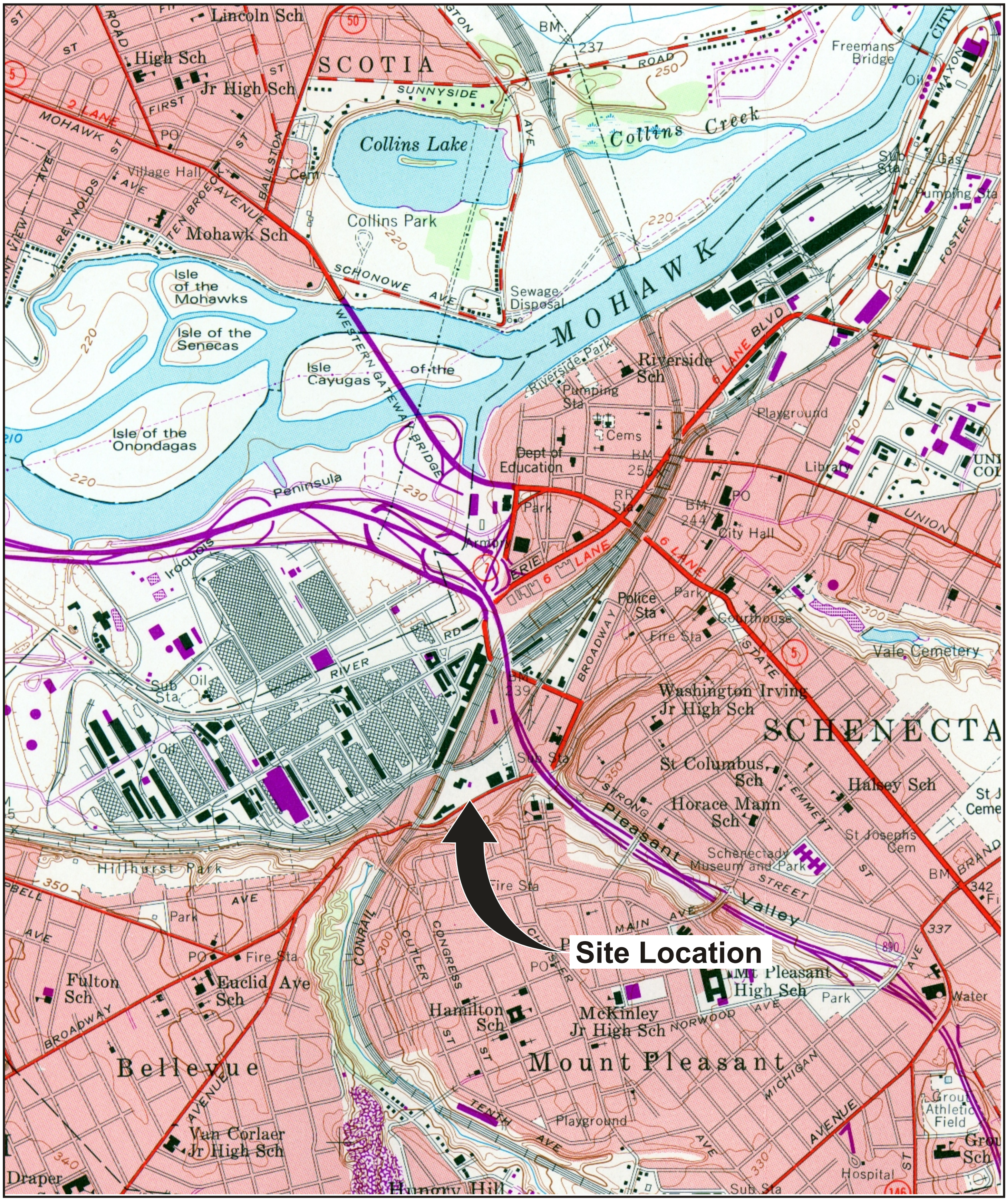
engineers, scientists, economists

Attachment 1

BBL's 2005 *Site Remedial Investigation Report* - Select Figures

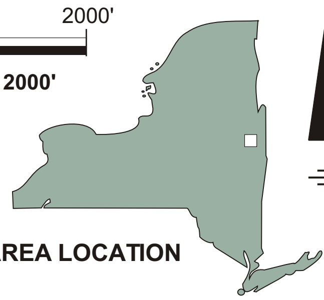
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists



REFERENCE: BASE MAP SOURCE USGS 7.5 MINUTE QUADS. SERIES SCHENECTADY, NEW YORK, 1954, PHOTOREVISED 1980.

2000'   0   2000'

Approximate Scale: 1" = 2000'



AREA LOCATION

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SITE REMEDIAL INVESTIGATION REPORT

SITE LOCATION MAP

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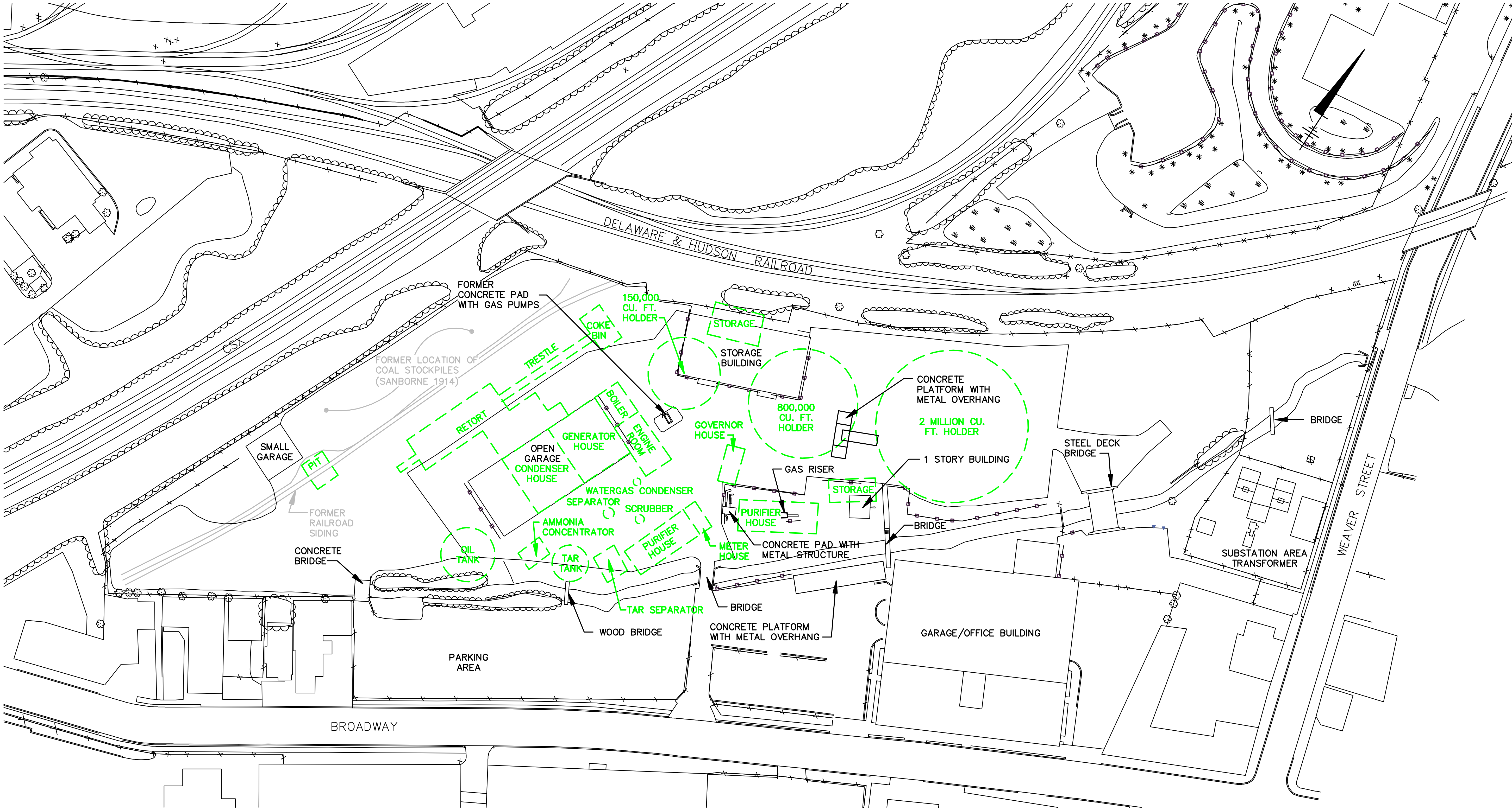
FIGURE
1

11/08/05 SYR-D85-DJH
36657011/36657n01.cdr



NOTES:

1. BASE MAP PROVIDED BY NIAGARA MOHAWK POWER CORPORATION ON 5/21/99, FROM NIAGARA MOHAWK POWER CORPORATION SURVEY REFERENCE FILE DRAWING 3277.DGN, DATED 10/26/94 AT A SCALE OF 1"=100'.

2. HISTORICAL STRUCTURE LOCATIONS WITH THE EXCEPTION OF THE SEPARATOR, WATERGAS CONDENSER, AND SCRUBBER WERE DIGITIZED FROM PARSONS ENGINEERING SCIENCE, INC. FIGURE 1.5, "HISTORICAL STRUCTURES, PREVIOUS SAMPLE LOCATIONS." LOCATIONS OF SEPARATOR, WATERGAS CONDENSER, AND SCRUBBER BASED ON HISTORICAL SANBORN INSURANCE MAPS (1914 AND 1980).

3. ALL LOCATIONS ARE APPROXIMATE.

LEGEND

- LOCATION OF CURRENT SITE FEATURES
- APPROXIMATE LOCATION OF HISTORICAL STRUCTURES
- FENCE LINE

0 100' 200'

GRAPHIC SCALE

X: 36622X01.DWG
L: ON=*, OFF=REF*
P: PAGESET/PLT-BL
11/8/05 SYR-85-GJD RCB WLJ
36657011/36657B01.DWG

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

SITE REMEDIAL INVESTIGATION REPORT

CURRENT AND HISTORICAL MGP FEATURES

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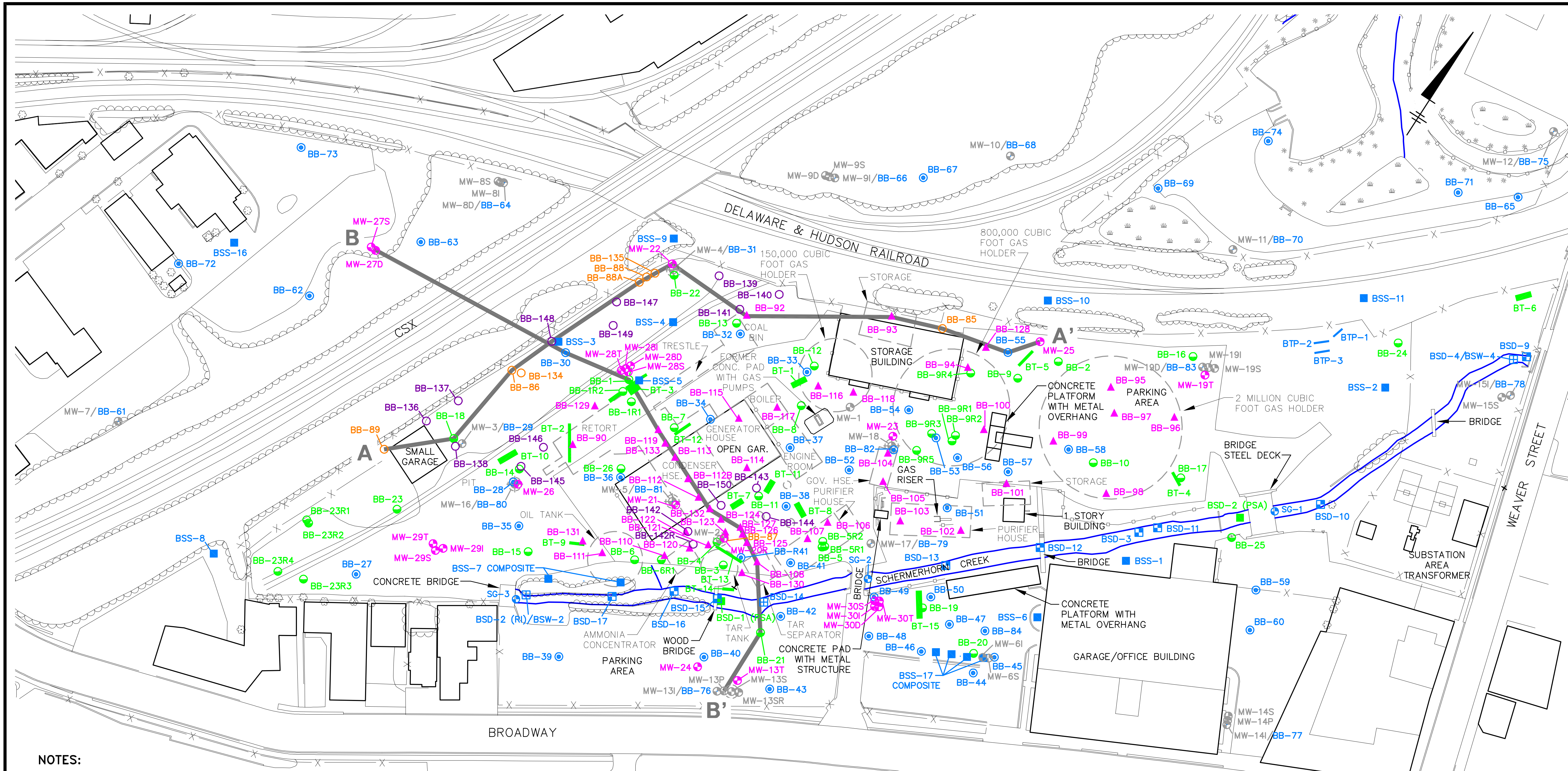
FIGURE **2**



NOTES:

1. BASE MAP PROVIDED BY NIAGARA MOHAWK POWER CORPORATION ON 5/21/99, FROM NIAGARA MOHAWK POWER CORPORATION SURVEY REFERENCE FILE DRAWING 3277.DGN, DATED 10/26/94 AT A SCALE OF 1"=100'.
2. HISTORICAL STRUCTURE LOCATIONS ARE BASED ON RESULTS OBTAINED FROM THE GEOPHYSICAL INVESTIGATION CONDUCTED BY BBL DURING MAY 2004.
3. SAMPLING LOCATIONS WERE SURVEYED BY NIAGARA MOHAWK AND BLASLAND, BOUCK & LEE, INC.. LOCATIONS OF OTHER SITE FEATURES ARE APPROXIMATE.
4. HORIZONTAL DATUM IS NEW YORK STATE PLANE OF 1983, EAST ZONE.
5. MONITORING WELL MW-20 WAS ABANDONED AND REPLACED WITH MONITORING WELL MW-20R IN JANUARY 2005.

X: 36657X01.DWG
L: ON=*, OFF=REF*
P: PAGESET/PLT-BL
11/8/05 SYR-85-RCB RCB WLJ
36657011/SITE-RI/36657V01.DWG

LEGEND:

BB-X · SOIL BORING LOCATION ID:
- BB-1 THROUGH BB-26 COMPLETED DURING PSA/IRM
- BB-27 THROUGH BB-84 AND BB-R41 COMPLETED DURING RI
- BB-85 THROUGH BB-89 AND BB-88A COMPLETED DURING NAPL INVESTIGATION
- BB-92 THROUGH BB-133 COMPLETED DURING HISTORICAL SUBSURFACE STRUCTURE INVESTIGATION
- BB-134 THROUGH BB-148 COMPLETED DURING ADDITIONAL SUBSURFACE INVESTIGATION

MW-15S MONITORING WELL

MW-2/BMW-1 DECOMMISSIONED MONITORING WELL

MW-23 BBL ADDITIONAL SUBSURFACE INVESTIGATION MONITORING WELL LOCATION

BB-102 BBL HISTORICAL SUBSURFACE STRUCTURE INVESTIGATION SOIL BORING LOCATION

BB-138 ADDITIONAL NAPL DELINEATION SOIL BORING LOCATION

BB-85 NAPL DELINEATION SOIL BORING LOCATION

BB-6 PSA/IRM SOIL BORING LOCATION

BT-14 PSA/IRM TEST PIT LOCATION

BSD-1 PSA/IRM SEDIMENT SAMPLE LOCATION

BB-35 RI SOIL BORING LOCATION

BSS-6 RI SURFACE SOIL SAMPLE LOCATION

BTP-1 RI TEST PIT LOCATION

BSD-2 RI SEDIMENT SAMPLE LOCATION

BSD-2/BSW-2 RI SEDIMENT SURFACE WATER SAMPLE LOCATION

SG-1 STAFF GAUGE

—X— FENCE LINE

— — — APPROXIMATE LOCATION OF HISTORICAL SITE FEATURE

——— APPROXIMATE LOCATION OF EXISTING SITE FEATURE

A—A' LINE OF CROSS SECTION

0 100' 200'

GRAPHIC SCALE

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK
SITE REMEDIAL INVESTIGATION REPORT

GEOLOGIC CROSS SECTION LOCATION MAP

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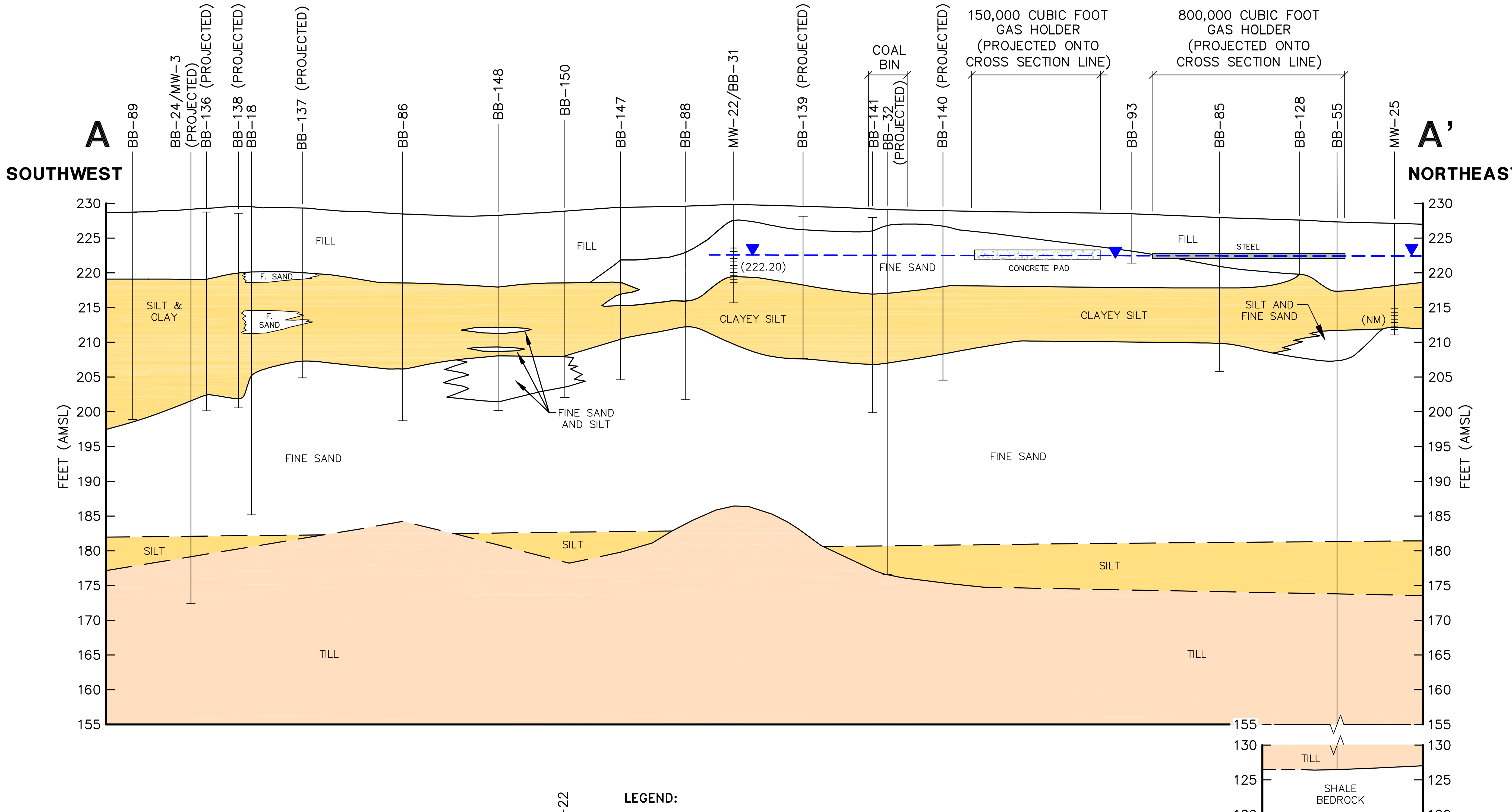
FIGURE
9



LEGEND:

- MW-22 — WELL/BORING ID
- WELL/BORING
- APPROXIMATE WATER TABLE (MAY 2005)
- SCREENED INTERVAL
- (222.20) HYDRAULIC HEAD ELEVATION (MAY 2005)
- (NM) NOT MEASURED
- TOTAL DEPTH OF BORING/WELL

0 15' 30'
VERTICAL SCALE

0 60' 120'
HORIZONTAL SCALE

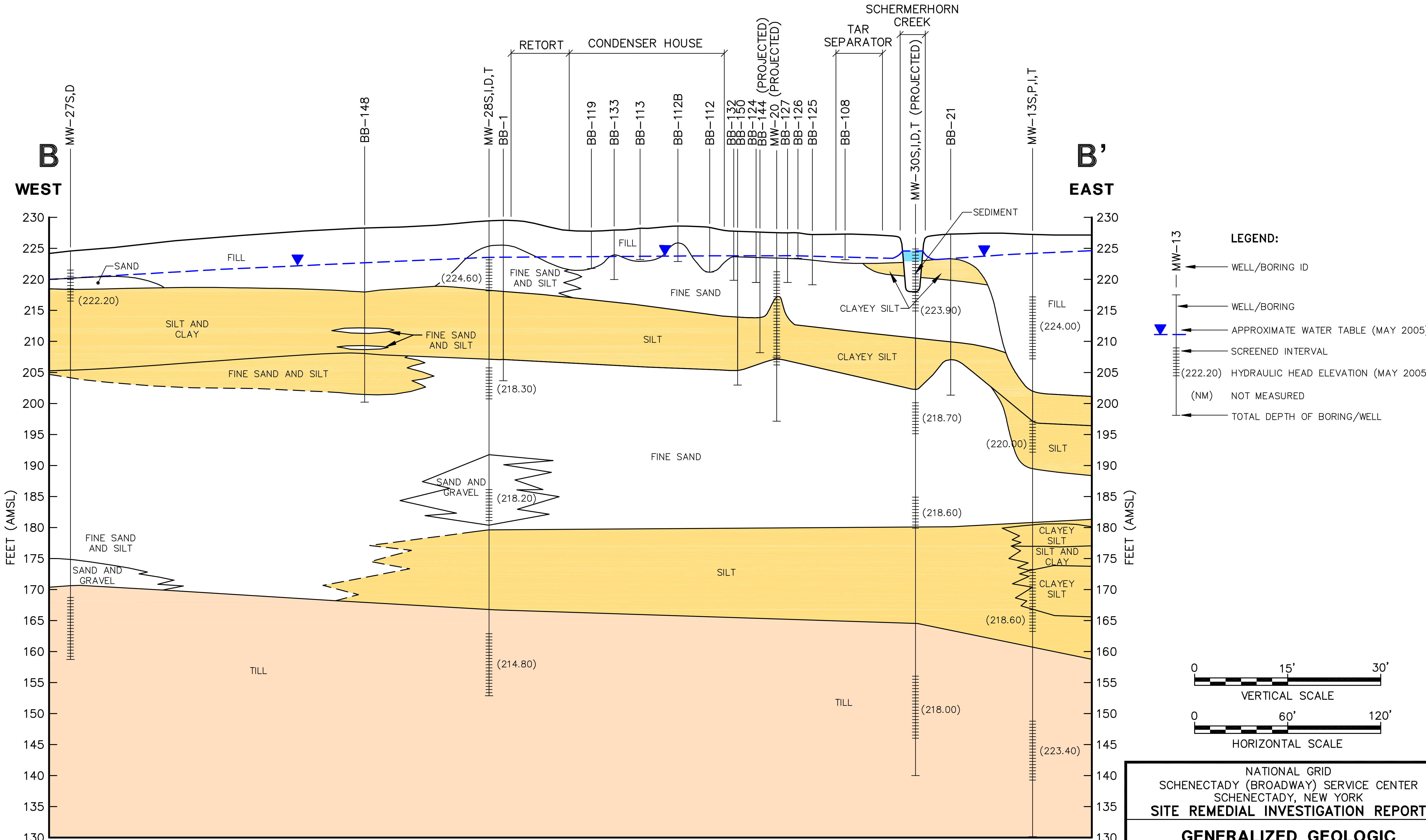
X: (NONE)
L: ON= * OFF= REF
P: PAGESET/PLT-BL1
11/8/05 SYR.-DIV-85-RCA RCB WLJ
36657011/36657V06.DWG

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK
SITE REMEDIAL INVESTIGATION REPORT

GENERALIZED GEOLOGIC CROSS SECTION A - A'

BBL BLASLAND, BOUCK & LEE, INC. engineers, scientists, economists

FIGURE 10



X: (NONE)
L: ON= * OFF= REF*, NAPL, SHEEN
P: PAGESET/PLT-BL1
11/8/05 SYR.-DIV-85-RCA RCB WLJ
36657011/36657V05.DWG

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK
SITE REMEDIAL INVESTIGATION REPORT

GENERALIZED GEOLOGIC CROSS SECTION B - B'

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FIGURE 11

Appendix

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Appendix A

Fate and Transport Calculations for DPH

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Appendix A
Fate and Transport Calculations for DPH

Average Linear Groundwater Velocity

The average linear horizontal groundwater velocities in the shallow-water bearing units were evaluated using Darcy's Law (Freeze and Cherry, 1979):

$$V = KI_h/n_e$$

Where V = average linear groundwater velocity (ft/day)
K = hydraulic conductivity (ft/day)
I_h = hydraulic gradient (ft/ft)
n_e = effective porosity (unitless)

Average linear groundwater velocities for the shallow water-bearing units are summarized in the following table:

Water-Bearing Unit	Hydraulic Conductivity (ft/day)	Hydraulic Gradient (ft/ft)	Effective Porosity[2]	Average Linear Groundwater Velocity (ft/day)
Shallow Fill/Upper Fine Sand [3]	2.75	0.022[1]	0. 33	0.18
Silt and Clay (semi-confining layer) [4]	7.4×10^{-4}	0.146[5]	0.20	0.00054
Intermediate Fine Sand [3]	2.43	0.022[1]	0.33	0.16

Notes:
[1] The highest hydraulic gradient measured at the site in the Shallow Fill/Upper Fine Sand Unit is presented in the table above. The Intermediate Fine Sand Unit is assumed to have a similar hydraulic gradient as the Shallow Fill/Upper Fine Sand Unit.
[2] The effective porosity values are from Argonne National Laboratory (Yu, et al., 1993). The mean value of the range of effective porosity values of fine sand (0.01 to 0.46) is presented in the table above. The mean value of the range of effective porosity values of silt/clay (0.01-0.39) is presented in the table above.
[3] Horizontal groundwater flow.
[4] Vertical groundwater flow across the Silt and Clay Unit (i.e., from the Shallow Fill/Upper Fine Sand Unit to the Intermediate Fine Sand Unit).
[5] Geomean value of vertical hydraulic gradients across the Silt and Clay Unit (i.e., from the Shallow Fill/Upper Fine Sand Unit to the Intermediate Fine Sand Unit).

As shown in the above table, the average linear horizontal groundwater velocity in the shallow fill/upper fine sand unit is approximately 0.18 ft/day. This value is conservative and likely represents the upper range of average linear groundwater velocities in the shallow unit because it is based on the highest hydraulic gradient observed in the 2004/2005 data.

Based on the 2004/2005 data, the average downward vertical gradient across the silt and clay unit is approximately 0.146 ft/ft. Based on hydraulic information developed for the silt and clay unit, the average linear vertical groundwater velocity through the silt and clay semi-confining layer (where present) is approximately 5.4×10^{-4} ft/day and the vertical hydraulic conductivity is 7.4×10^{-4} ft/day.

As shown in the above table, the average linear horizontal groundwater velocity in the intermediate fine sand unit is approximately 0.16 ft/day. This value is conservative and likely represents the upper range of average linear groundwater velocities in the shallow unit because it is based on the highest hydraulic gradient observed in the 2004/2005 data.

Retardation Factors

The rate of DPH migration in groundwater can be retarded compared to the average linear groundwater velocity due to the partitioning of DPH compounds from the dissolved phase to solid organic carbon naturally present in soils. The extent to which individual DPH compounds partition from the dissolved phase to the solid phase (sorption) is a function of the DPH compound molecular weight, aqueous solubility, and octanol-water partition coefficient, as well as the quantity of organic carbon present in the soil. Retardation of DPH compounds in groundwater can be quantitatively evaluated by computing a compound-specific retardation factor for each compound of interest using the following equation (Freeze & Cherry, 1979):

$R_c = 1 + (\rho_b \times K_{oc} \times f_{oc})/\theta$

where: R_c = retardation factor of compound (unitless)
ρ_b = bulk density (g/cc): ρ_s x (1-θ)
ρ_s = specific density (g/cc): specific density = specific gravity
θ = effective porosity
K_{oc} = organic carbon-water partition coefficient of compound (cc/g)
f_{oc} = fraction of organic carbon in soil (mass fraction) (mg/kg)

Advective Transport of DPH in Groundwater

The equation describing the migration rate of DPH compounds in groundwater is (Freeze and Cherry, 1979):

$v_c = v_w/R_c$

where: v_c = average migration rate of dissolved compound in groundwater (ft/day)
v_w = average linear groundwater velocity (ft/day)
R_c = retardation factor of compound (unitless)

References

Fetter, C.W. 1993. *Contaminant Hydrogeology*. MacMillian Publishing Company, New York.
Freeze, R.A. and J.A. Cherry. 1979. *Groundwater*. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

Appendix B

Cultural Resources Survey

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PHASE IA ARCHEOLOGICAL SENSITIVITY ASSESSMENT

NIAGARA MOHAWK SCHENECTADY (BROADWAY)
FORMER MANUFACTURED GAS PLANT SITE
CITY OF SCHENECTADY
SCHENECTADY COUNTY, NEW YORK
HAA #1275

Submitted To:

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AN ACRA MEMBER FIRM

JULY 1999

ABSTRACT

Hartgen Archeological Associates, Inc. was retained by Blasland, Bouck, & Lee, Inc. to conduct a Phase IA literature review and archeological sensitivity assessment for the Niagara Mohawk Schenectady (Broadway) manufactured gas plant remedial feasibility study.

The Phase 1A literature review included an examination of the archeological site files of the New York State Museum (NYSM) and the Office of Parks, Recreation, and Historic Preservation (OPRHP) for reported sites within one mile of the project area. The OPRHP building-structure inventory and the State/National Register files were examined for inventoried properties and properties listed in, or determined eligible for listing in, the State/National Registers located within the immediate vicinity of the project area. Historic maps documenting the development of the project area were also examined.

A review of the OPRHP and NYSM archeological site files identified one prehistoric and six historic archeological sites within one mile of the project area. Additionally, a review of the computer inventory files at the OPRHP identified two National Register Districts, ten National Register listed buildings, eleven National Register eligible structures, and one eligible archeological site. Although there are a number of historic sites and structures within one mile of the project area, an examination of historic maps indicates that there was a historic industrial complex within the project area. Dwellings that once stood within the project area were removed in the early 20th century to facilitate construction of buildings for the Mohawk Gas Company.

Due to the absence of reported historic and prehistoric sites within or immediately adjacent to the project area, the historic and prehistoric archeological sensitivity is low, however the historic industrial archeological sensitivity is high, since the Mohawk Gas facility, 1907-1927, once stood on the site. However, Niagara Mohawk has completed a thematic study on gas complexes for OPRHP and this class of industrial site is no longer a concern.

CONTENTS

REPORT FOR ARCHEOLOGICAL POTENTIAL

INTRODUCTION

Hartgen Archeological Associates, Inc. was retained by Blasland, Bouck, and Lee, Inc. Engineers and Scientists to conduct a Phase 1A literature review and archeological sensitivity assessment for the Niagara Mohawk Schenectady (Broadway) manufactured gas plant remedial feasibility study.

PROJECT INFORMATION

Location

The project area is located in the City of Schenectady, Schenectady County, New York. The proposed project area is bound to the north by Delaware and Hudson Railroad track, to the west by Conrail Railroad tracks, to the east by Weaver Street, and to the south by Broadway (Maps 1and 2).

Description

The proposed project includes the excavation and removal of impacted soils. The site was used for gas manufacturing between 1907 and 1927. Three gas holding tanks, located in the north-central area of the site, were used for the manufacturing. In 1956 gas manufacturing ceased and the site was used for natural gas distribution. The gas holders were removed from the site in 1961. Presently, there is a storage building (Photo 1) along the northernmost edge of the project area. The southeastern and southwestern corners of this building are in the area of two former gas holding tanks. An open garage (Photos 2 and 3) stands southwest of the storage building. The southwestern corner of the project area is not developed but the soil is a sandy fill indicating prior disturbance (Photo 4).

ENVIRONMENTAL INFORMATION

Topography and Bedrock Geology

The project area is characterized by level topography at approximately 230 feet above mean sea level. Outside of the project area the topography ranges from 200 to 350 feet above mean sea level.

Underlying bedrock geology in the project area consists of Canajoharie Shale from the Loraine, Trenton, and Black River Groups. Adjacent to the eastern border of the project area is a large deposit of the Schenectady formation composed of sandstone, siltstone, and shale (Fisher et al. 1970).

Soils and Drainage

The project area is identified as cut and fill land (USDA 1978). In Schenectady County, this includes areas where flooding is a problem. Cut and fill land is an area where the original soil has been stripped and removed or is covered by three feet or more of soil material.

Schermerhorn Creek (formerly called Mill Creek) flows northeastward across the site and discharges into the Mohawk River approximately 4,000 feet due north of the site.

Vegetation and Forest Zone

The project and surrounding areas are in the Northern Hardwoods Zone in which maple, birch, beech, and hemlock predominate (Kuchler 1964). There are few trees in the project area (Photo 5).

Manmade Features and Alterations

The project area has been extensively developed. A historic structures map provided by Parsons Engineering Science, Inc. indicates that the majority of the project area was occupied by industrial buildings between 1907 and 1961 (Map 2a). Many of the original buildings have been replaced or razed. Immediately adjacent to the southeast corner of the project area, at the intersection of Weaver and Broadway, there have been dwellings, hotels, and stores since the early 19th century. The buildings at this intersection now belong to Donald Forgette and are used for industrial purposes. Additionally, immediately adjacent to the southwest corner of the site there are buildings along Broadway that were dwellings in the early 19th century and are now stores.

DOCUMENTARY RESEARCH

Office of Parks, Recreation, and Historic Preservation (OPRHP)

Archeological Sites

An examination of the archeological site files at OPRHP did not identify any reported sites in the project area, however seven archeological sites are indicated within one mile of the project area. All of the sites are concentrated in downtown Schenectady, northeast of the project area. The sites are listed in the following table.

OPRHP #	Site Identifier	Site Description
093.40.001198	Durham Project #44/ Binnekill Harbor	historic; no other information provided.

OPRHP #	Site Identifier	Site Description
A093.40.001144	Stockade Site	NRE; evidence of the third Schenectady stockade dating to the 18th century on YWCA property.
A093.40.0101	Van Velsen Mill Site	no information provided
A093.40.0014	Abraham Yates House	collection of historic artifacts associated with the c.1700 Dutch style brick house
A093.40.0713	Stockade	two walls constructed of wood and Dutch brick c. 17th or 18th century; Front St.
A093.40.0720	Schenectady Museum	NYSM#6281; prehistoric: no other information provided
A093.40.0103	Old Erie Canal Wall	no other information provided

State and National Registers

In addition to the National Register eligible (NRE) site above (A093-40-001144), a review of the computer inventory files at the OPRHP identified two National Register Districts, ten National Register listed (NRL) buildings, and eleven NRE structures within one mile of the project area.

The Stockade Historic District is located in downtown Schenectady, three quarters of a mile northeast of the project area. The district is bounded on the north and west by the Mohawk River, on the east by the Delaware and Hudson Railroad, and on the south by Route 5. Historic buildings in the district date from early Dutch settlements in 1664 to the 1930s. The Union Street Historic District (NRL) is located half a mile east of the project area. This district follows Union Street south out of downtown Schenectady. Only the western third of the district falls within one mile of the project area. The National Register properties display a variety of stages in American architecture from the 1830s to 1930s.

The majority of individual National Register eligible/listed properties is located northeast of the project area in the vicinity of the historic districts and OPRHP archeological sites. The closest NR building to the project area is an eligible structure located on Strong Street across I-890 from the project area. There are two National Register listed structures located west of the project area, the Dellemont-Wemple Farm on Turner Avenue and the Pleasant Valley Elementary School on Main Avenue.

OPRHP #	Property Name	Address	Description (from form)
	Stockade Historic District (NRL)	bordered by the Mohawk River, railroads, and Union Street	15 block residential neighborhood in downtown Schenectady with 386 historic properties c. 1664-1930.
	Union Street Historic District (NRL)	306-1364, 307-1355 Union St.; 2-4 Nott Terrace, 20½ Union Ave.	190 properties c. 1830-1930 illustrate a range of American architectural styles.
	Schenectady City Hall (NRL)	Jay Street	built in 1930, this brick building in Georgian Revival style has elaborate marble trim, tall cupola, and an interior rotunda.
	United States Post Office – Schenectady (NRL)	Jay and Liberty Streets	built 1911-1913 and enlarged 1934-35, this building represents Neoclassical architecture with Corinthian and Ionic colonnades.
	Hotel Van Curler / Elston Hall of Schenectady county Community College (NRL)	78 Washington Avenue	the hotel was built in 1925 in the neoclassical tradition as part of a civic pride movement
	General Electric Realty Plot	Union Ave. and Nott Street	approximately 100 large early 20th century Queen Anne, Shingle, Georgian, and Colonial style homes that housed scientists working at the GE Corporation.
	Foster Building/ Hotel Foster (NRL)	508 State St.	built in 1907 as a hotel, this building is an example of early Beaux-Arts commercial architecture.
	Central Fire Station (NRL)	Erie Boulevard	built between 1924-1929, this building is an example of Georgian Revival architecture.

OPRHP #	Property Name	Address	Description (from form)
	H.S Barney Building (NRL)	217-229 State Street	constructed between 1873 and 1923, this building is historically and architecturally significant.
	Schenectady Armory (NRL)	125 Washington Ave	built in 1936 this building represents both Tudor Revival and Art Deco architecture
	Pleasant Valley Elem. School (NRL)	Forest Rd	no information provided
	Mt. Pleasant High School (NRL)	Forest Rd.	no information provided
	Proctor Theater and Arcade (NRL)	422 State Street	built in 1926 with an Adamesque style auditorium
	Dellemont-Wemple Farm (NRL)	Wemple Road west of Schenectady	a 90-acre farmstead with large Dutch Colonial vernacular brick residence built c.1790 and Dutch barn built c.1770.
093.40.0487	Superintendent's Residence (NRE)	907 State Street	this structure, c. 1890, is a representation of Queen Anne architecture
093.40.001154	not provided (NRE)	2 Grove Place	a residential structure built in 1890
093.40.001146	Former Gazette Press Building (NRE)	1492 Central Ave	1904, eligible despite alterations to windows
093.40.000371	Friends United Church of Christ (NRE)	120 Clinton St.	built in 1902 by Hermann Franck this church architecturally reflects the ethnicity of its original German congregation
093.40.0150	Parker Building (NRE)	434 State Street	this building was built in 1906 and was the tallest building in Schenectady until 1978

OPRHP #	Property Name	Address	Description (from form)
093.40.0148.003	Hough Building (NRE)	402-408 State St.	built in the 1850s, this building is significant to Schenectady history
093.40.000146	Old Carley Residence and Business House (NRE)	102 State Street	built in the early 1800s, the Carley building is one of the oldest remaining structures on State St. It is an example of Late Federal Period brick architecture.
093.40.0506	Market Building (NRE)	Jan Guysing Ave	no information provided
093.40.00727	not provided (NRE)	411 Mumford St.	no information provided
093.40.001179	Odd Fellows Hall (NRE)	440 State Street	no information provided
	Schenectady Gazette Building (NRE)	334 State St.	no information provided
093.40.001180	Delamont "railroad flat" (Determined eligible as part of a district	933 Delamont Ave	architecturally and historically significant "railroad flat" built in the early 20th century representing the industrial expansion of Schenectady at this time
093.40.001182	Vale Cemetery and Vale Park (NRE)	Nott Terrace and State Street	historically and architecturally significant as an example of Picturesque rural cemetery design, est. 1857

Previous Surveys

The library at the OPRHP contained one previously conducted archeological survey located partially within the project area and six surveys within one mile of the project area. A small section of one survey falls within the southern half of the Niagara Mohawk project area. This survey was prepared in 1984 by the NYSM for the New York State Department of Transportation (NYSDOT) PIN 1751.34 located at the intersection of Broadway, Crane Street, and Interstate 890 (NSYM 1984a). The survey did not reveal any historic significance in the study area. Additionally, the report classifies the area as very disturbed from urban construction.

An additional survey was completed in 1984 by the NYSM for NYSDOT PIN1751.38. The study area was on Congress Street over the Conrail railroad in an area adjacent to the western edge of the Niagara Mohawk project area (NYSM 1984b). The report found the entire ground surface of the area to be extensively disturbed. Although there had been historic buildings in the study area, there are no remains of them on the surface. Sub-surface remains are assumed to be disturbed, however, no sub-surface testing was completed. None of the current structures in the area were reported to have historical or archeological significance.

A survey was conducted for NYSDOT PIN1751.04 in 1982 on the Oak Street Bridge one half mile southwest of the Niagara Mohawk project area (NYSM 1982). The study consisted of a literature review of the area. The results showed that there was no evidence of historic or archeological significance in the study area.

The OPRHP conducted a survey in 1975 for the Schenectady County Planning Department (OPRHP 1975). The survey area covers the northern portion of downtown Schenectady and extends across the Mohawk River just south of Collins Lake. The southern half of the study falls within one mile of the Niagara Mohawk project area. Eight shovel test pits (STPs) were excavated in a line across the center of the study area. These STPs revealed no prehistoric cultural materials and an abundance of historic materials. Historic maps of Schenectady dating to the 17th and 18th century indicated that the area of this survey was heavily populated. The survey recommended further excavation in the survey area to salvage historically significant materials and data.

Hartgen Archeological Associates, Inc. conducted a survey for the Schenectady County Historical Society in an area along the Mohawk River in the southwestern edge of the OPRHP survey area (HAA 1988). This survey consisted of a literature review and field reconnaissance. The literature review indicated the historical significance of the study area. Field reconnaissance revealed historic features consisting of cultural stains, historic cultural materials, and post molds from historic structures. Additionally, foundations of an 18th century structure and evidence of an 18th century stockade were discovered. The survey recommended further archeological excavation in the area.

Hartgen Archeological Associates, Inc. conducted a survey in 1990 for the Schenectady YWCA (HAA 1990). This survey was located along the Mohawk River in the southern half of Hartgen's previous survey and included nine backhoe trenches that revealed a variety of historic cultural materials ranging from the early to mid-18th century. These materials were analyzed in Hartgen's lab and then returned to the YWCA.

State Museum

A site file search at the NYSM revealed four reported prehistoric archeological sites within one mile of the project area. One site, reported as traces of occupation, is located along the southern bank of the Mohawk River and covers the majority of downtown Schenectady. The Niagara Mohawk project area is in the southernmost section of the reported site. The remaining three sites are located northeast of the project area in the cluster of National Register eligible/listed buildings and OPRHP reported sites.

NYSM #	Site Identifier	Site Description (NYSM files)
4747	ACP Stdy-13	reported by A.C. Parker in 1922; village site, date unknown
6281	Schenectady Museum	reported by Schaefer in 1989
4752	ACP Stdy	traces of occupation; reported by A.C. Parker in 1922
6479	ACP Stdy	traces of occupation; reported by A.C. Parker in 1922

Historic Map Review

Several historic maps, including 19th century landowner maps, Sanborn Fire Insurance maps, and topographic quadrangles, were examined for this report. The project area is indicated on each.

1763 Plan of Schenectady

The earliest map that was examined for this report was a 1763 Plan of Schenectady (Map 3). The map shows undeveloped land south of the stockade at Schenectady. The Niagara Mohawk project area is in this undeveloped area.

19th Century Landowner Maps

The 1856 Fagan Map of Schenectady County was examined. The New York Central Railroad (the project's western boundary) is shown on this map. Although it does not show any structures within the project area, a structure identified as a wool carding shop is shown on the south side of the creek near its intersection with the railroad, west of the project area. Map 4 is a portion of the 1866 Beers atlas of Schenectady. On this map, the project area is within the City of Schenectady, southwest of downtown. Unnamed roads are mapped in the present day location of Broadway (the project area's southern boundary) and Weaver Street (the project area's western boundary). Mill Creek (Schermerhorn Creek) runs through the center of the project area. No structures are shown within the project area.

Topographic Quadrangles

Maps 1, 5, 6, and 7 are topographic quadrangles. Map 5, a 1904 USGS map, indicates the Delaware and Hudson Railroad, which is the northern project boundary. There is one building shown within the project area. The location of this building corresponds with the location of the present day garage and office building at the Niagara Mohawk facility. Outside of the project area is a building located at the corner of Weaver and Broadway. This building is indicated outside of the project area as shown on the current Niagara Mohawk site map (Map 2).

A 1954 USGS map (Map 6) indicates the project area with the three gas holding tanks used by Mohawk Gas for gas production. There are two additional buildings in the project area that no longer exist according to the current site layout map (Map 2). The map also indicates buildings on Broadway adjacent to the southwest corner of the project area.

An examination of the 1974 NYSDOT map (Map 7) indicates that the three gas holding tanks in the project area have been removed. No other changes have been made to the area.

The 1993 NYSDOT map (Map 1) shows the present site layout. There are four buildings in the area. According to the site layout map (Map 2), the southernmost building which is on Broadway is the garage/office building, the northernmost building is a storage building, the westernmost building is an open garage, and the centrally located building is a 1-story storage building.

Sanborn Fire Insurance Maps

The earliest Sanborn map that includes the project area is from 1914 (Map 8). An examination of this map indicates that the project area was the site of the Mohawk Gas Company. The gas company had three steel gas holding tanks in the northern and eastern areas of the site, a generator/condenser building centrally located, a concrete oil holding tank along Mill Creek south of the generator/condenser building, a tar tank along the creek next to the oil tank, and two additional buildings on either side of the generator/condenser building. Within the project area there are also dwellings along Center (Broadway) Road on the south side of the creek, and along Weaver Street in the eastern edge of the project area. At the corner of Weaver and Center (Broadway), outside of the project area, there is the Villa hotel, two dwellings, and five additional buildings. The Schenectady Railway Company has a small stretch of track running across the eastern third of the project area that connects the Delaware and Hudson Rail Road with Center Road.

An examination of the Sanborn map from 1930 (Map 9) indicates that the dwellings on Broadway within the project area on the 1914 Sanborn map (Map 8) have been removed and replaced by a stock room and two other buildings, including a shed and one housing a blacksmith/welding shop. The latter are all associated with the New York Power and Light Corporation. The Schenectady Railway Company track has also been removed. A pond has been built next to the tar tank, which is no longer in use. The generator building is now a meter control house, the condenser building is used for storage, and a new building has been built connecting the storage building and the retort house to its west. The building east of the storage building is now a blacksmith shop. East of the blacksmith shop is a new purifier building. The Mohawk Gas company has changed its name to the New York Power and Light Corporation.

The 1945 Sanborn map (Map 10) shows the project area with a new building. The stock room and adjacent unnamed small buildings on Map 9 have been incorporated into a garage/office/storage/repair shop building (Photo 6). This building is indicated on the Niagara Mohawk site map (Map 2). An area of the site on Weaver street has been fenced off to serve as a transformer yard and sub station. The gas, oil, and tar holding tanks still exist. The New York Power and Light corporation has been changed to Niagara Mohawk Power Corporation.

Sanborn maps covering the project area were produced in 1988, 1989, and 1990. The building layout in the project area is unchanged during these three years. However, between 1945 and 1988 the site under went extensive changes. According to the 1988 Sanborn (Map 11), the gas, oil and tar holding tanks have been removed, along with the large meter control and storage building, blacksmith building, purifier house, and pond. The site layout in 1988 (which is the present site layout) consisted of, from east to west, the fenced off transformer yard (Photo 7) along Weaver Street, the large garage/service/office (Photo 6) building on Broadway, two rectangular storage buildings, and an open truck repair garage (Photos 2 and 3). Along the northern edge of the project is an additional storage building (Photo 1). An extension of the Delaware and Hudson Railroad runs into the western edge of the project area. A large parking lot is in the southern half of the project area along Broadway between the large service/office/garage building and the western edge of the project area.

ARCHEOLOGICAL SENSITIVITY ASSESSMENT

Prehistoric Archeological Sensitivity

A review of NYSM and OPRHP site files revealed no prehistoric archeological sites within the project area. Although one site, reported as traces of occupation, covers the majority of downtown Schenectady including the project area, due to the development of the site, prehistoric sensitivity is low.

Historic Archeological Sensitivity

A review of the OPRHP files indicated no known National Register historic sites and/or structures in the project area. Although an examination of historic maps indicates historic structures adjacent to the southwest and southeast corners of the site, the majority of these buildings have been razed for construction at the Niagara Mohawk site. There are no plans for building construction in the project area. Therefore, there is no visual impact on historic structures in the general area of the project. However, the former Mohawk Gas Company complex once stood on this site, thus the historic sensitivity in the project area is high for industrial archeological features and deposits.

RECOMMENDATIONS

Due to the absence of historic and prehistoric sites within or immediately adjacent to the project area, the historic and prehistoric archeological sensitivity is low. The historic industrial archeological sensitivity is high, since the Mohawk Gas facility, 1907-1927, once stood on the site. However, Niagara Mohawk has completed a thematic study on gas complexes for OPRHP and this class of industrial site is no longer a concern.

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1984b A Cultural Resource Management Survey of NYSDOT Project 1751.38: Congress St. over Conrail.

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1930
1945
1988
1989
1990

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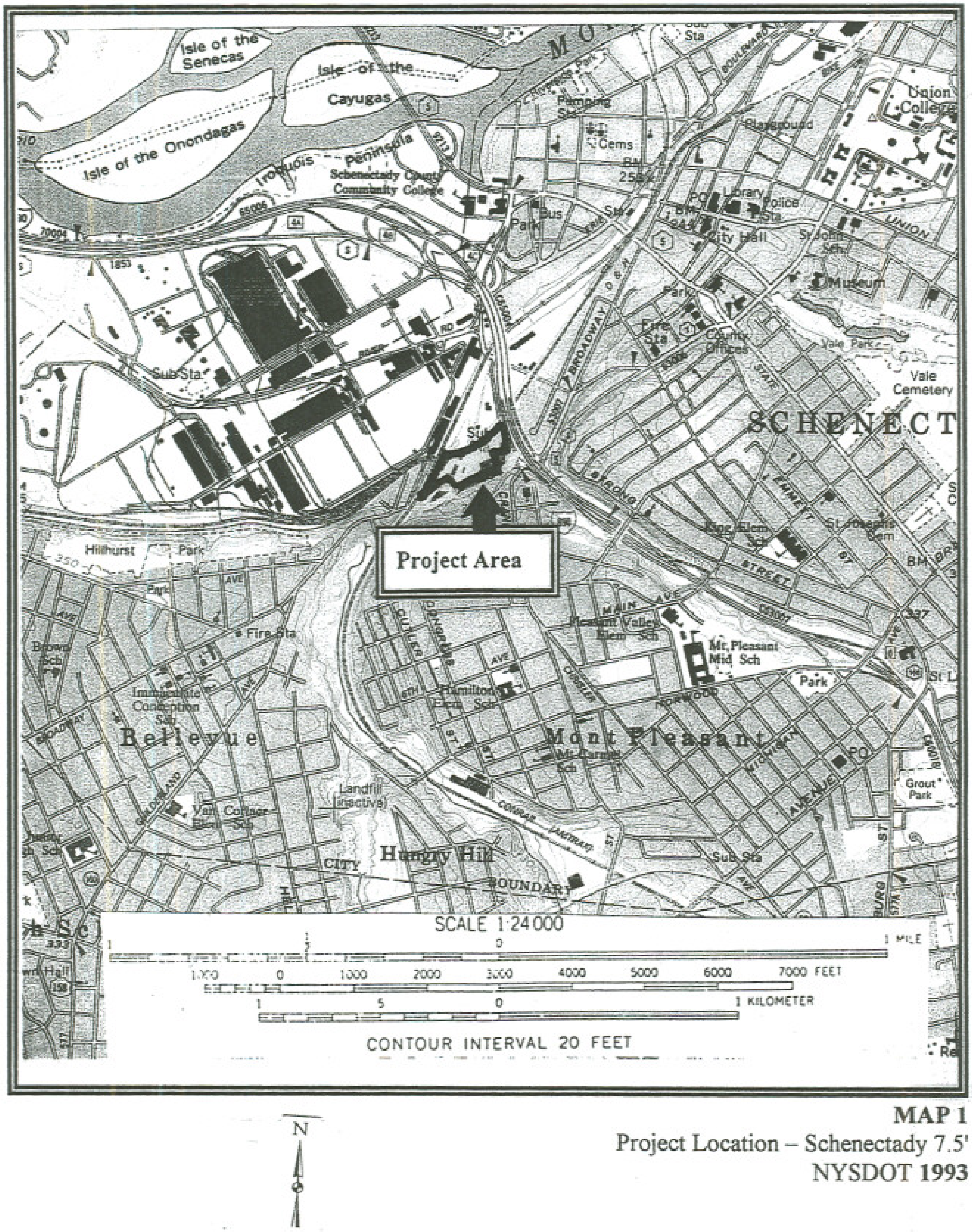
1898/1904 Schenectady 15' Topographic Quadrangle.
1954 Schenectady 7.5' Topographic Quadrangle.

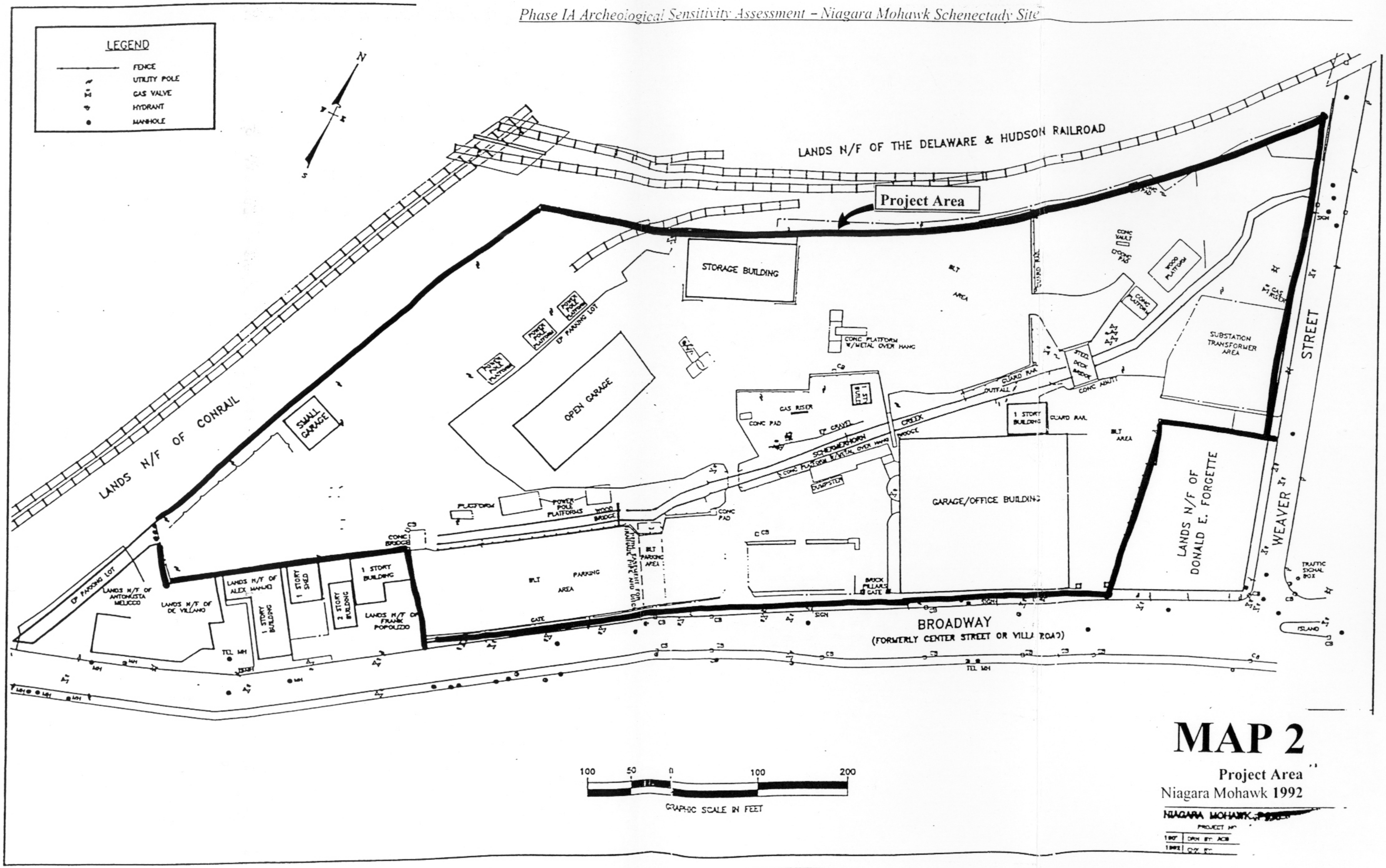
—
1763 A Plan of Schenectady

MAPS

MAP LIST

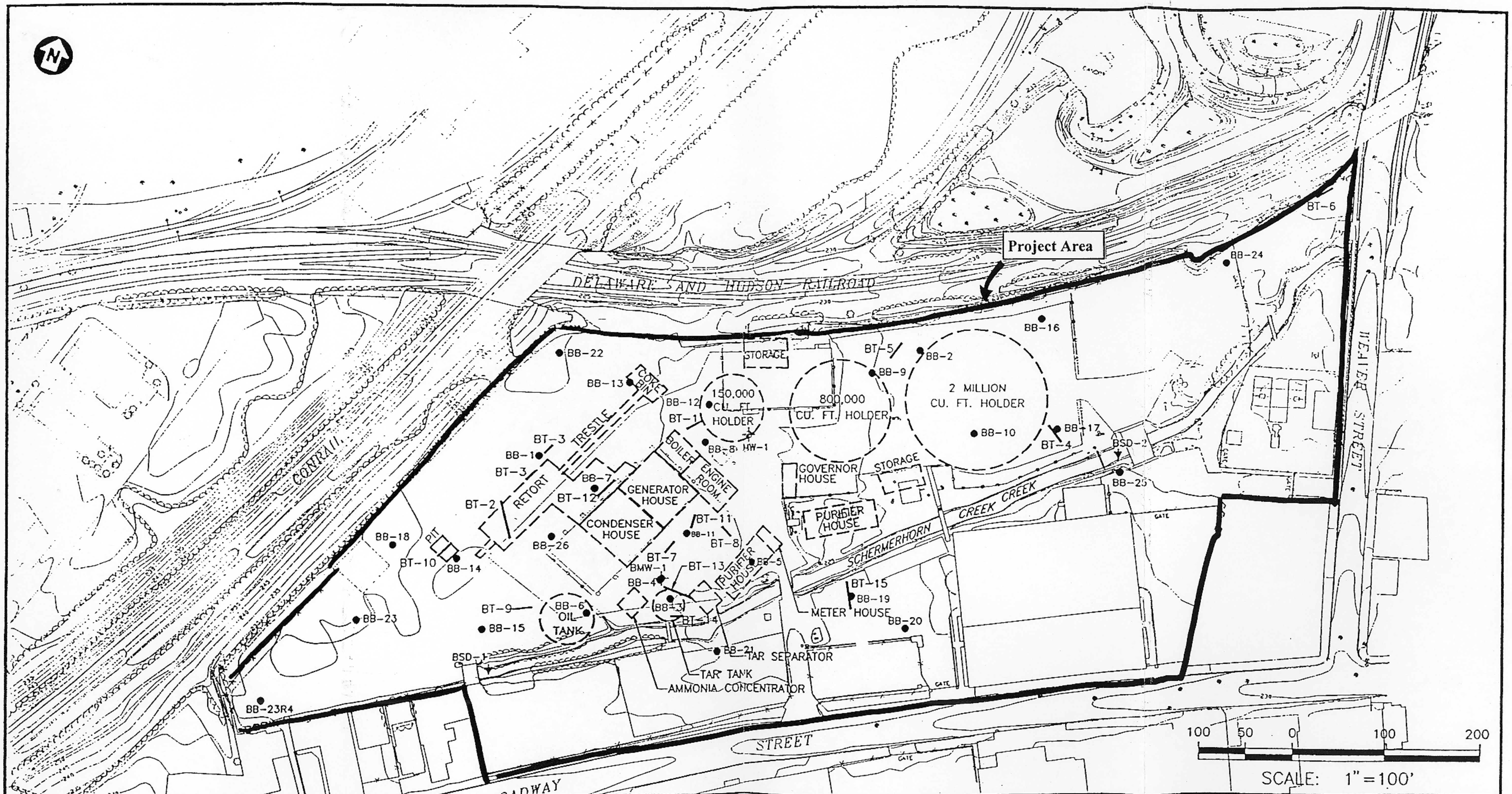


MAP 1
Project Location – Schenectady 7.5'
NYSDOT **1993**



MAP 2

Project Area
Niagara Mohawk **1992**



NOTE

SOME OF THE HISTORICAL INFORMATION PRESENTED ON THIS MAP WAS OBTAINED FROM OUTSIDE SOURCES SUCH AS HISTORIC INDUSTRY REFERENCE MATERIALS. NMPC IS NOT AWARE OF THE DEGREE OF RELIABILITY OF INFORMATION GLEANED FROM HISTORIC INDUSTRY SOURCES.

LEGEND

FORMER LOCATION OF STRUCTURES

BT-9 TEST PIT LOCATION

BB-10 SOIL BORING LOCATION

BSD-4 SEDIMENT SAMPLE LOCATION

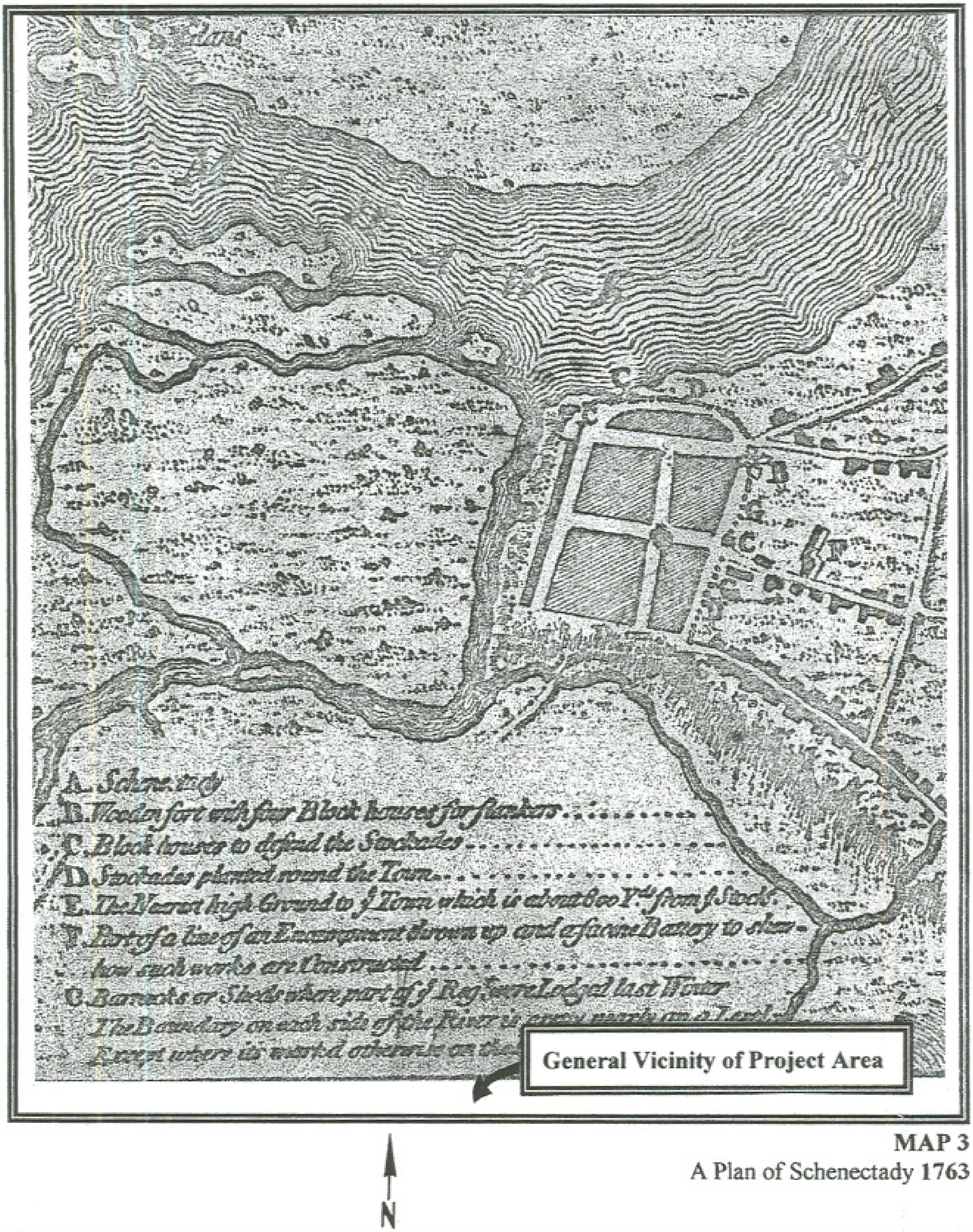
MW-29 MONITORING WELL LOCATION

MAP 2a

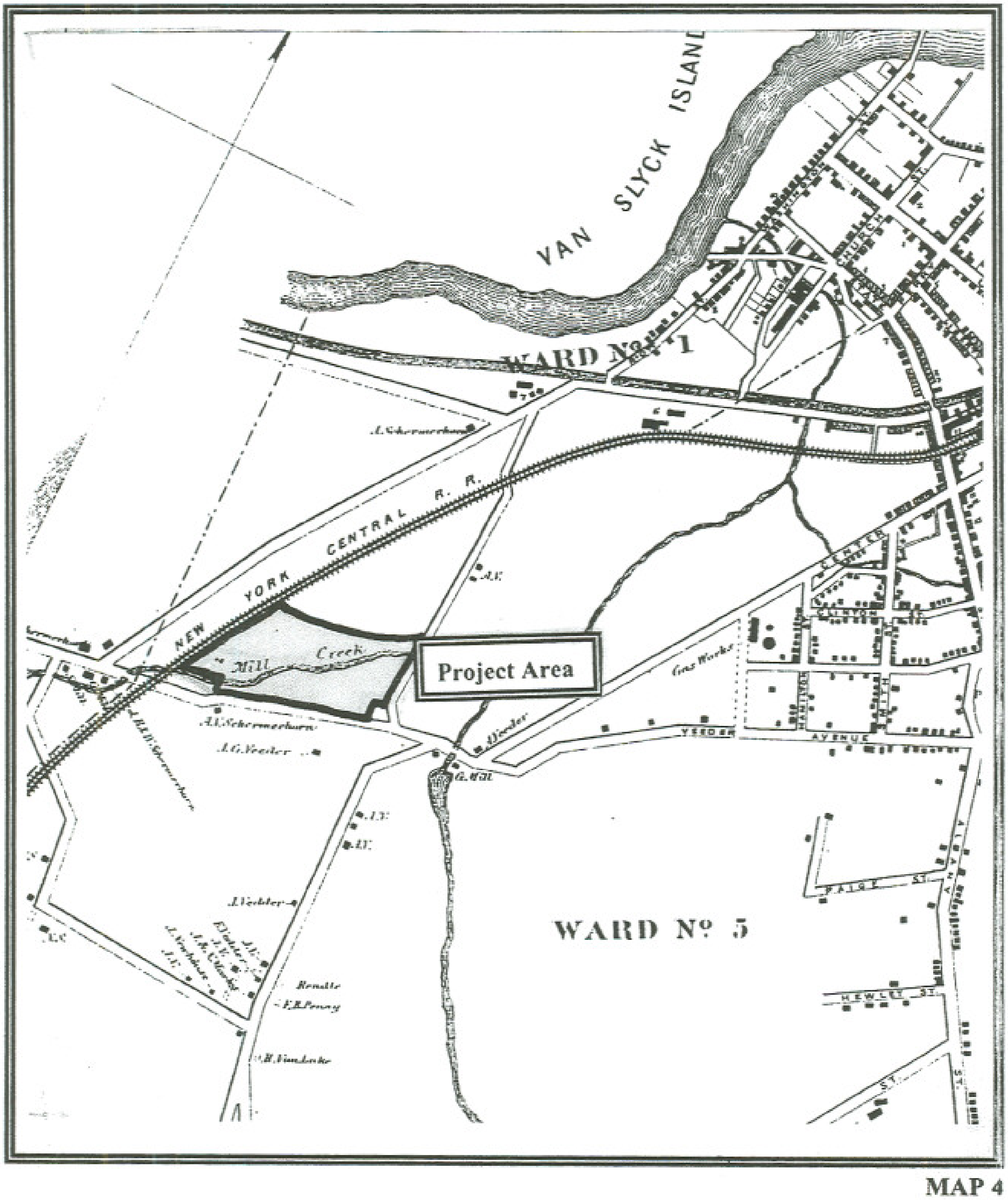
HISTORICAL STRUCTURES
PREVIOUS SAMPLE LOCATIONS

PARSONS ENGINEERING SCIENCE, INC.
DESIGN • RESEARCH • PLANNING

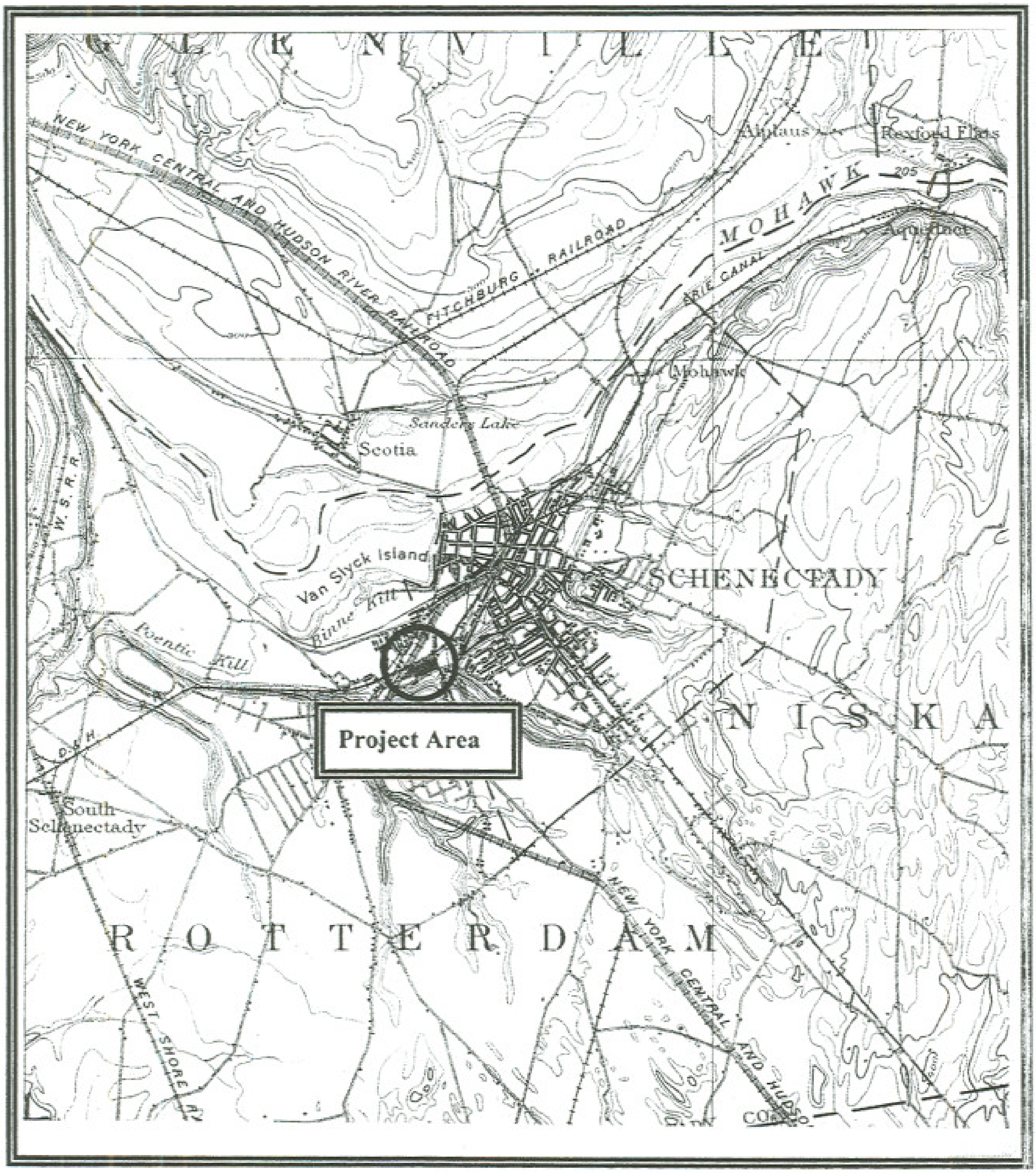
DATE: 11/13/96 (JAR)
H:\CAD\725727\25727G10.DWG (PAPER SPACE 1/100XP)



MAP 3
A Plan of Schenectady **1763**

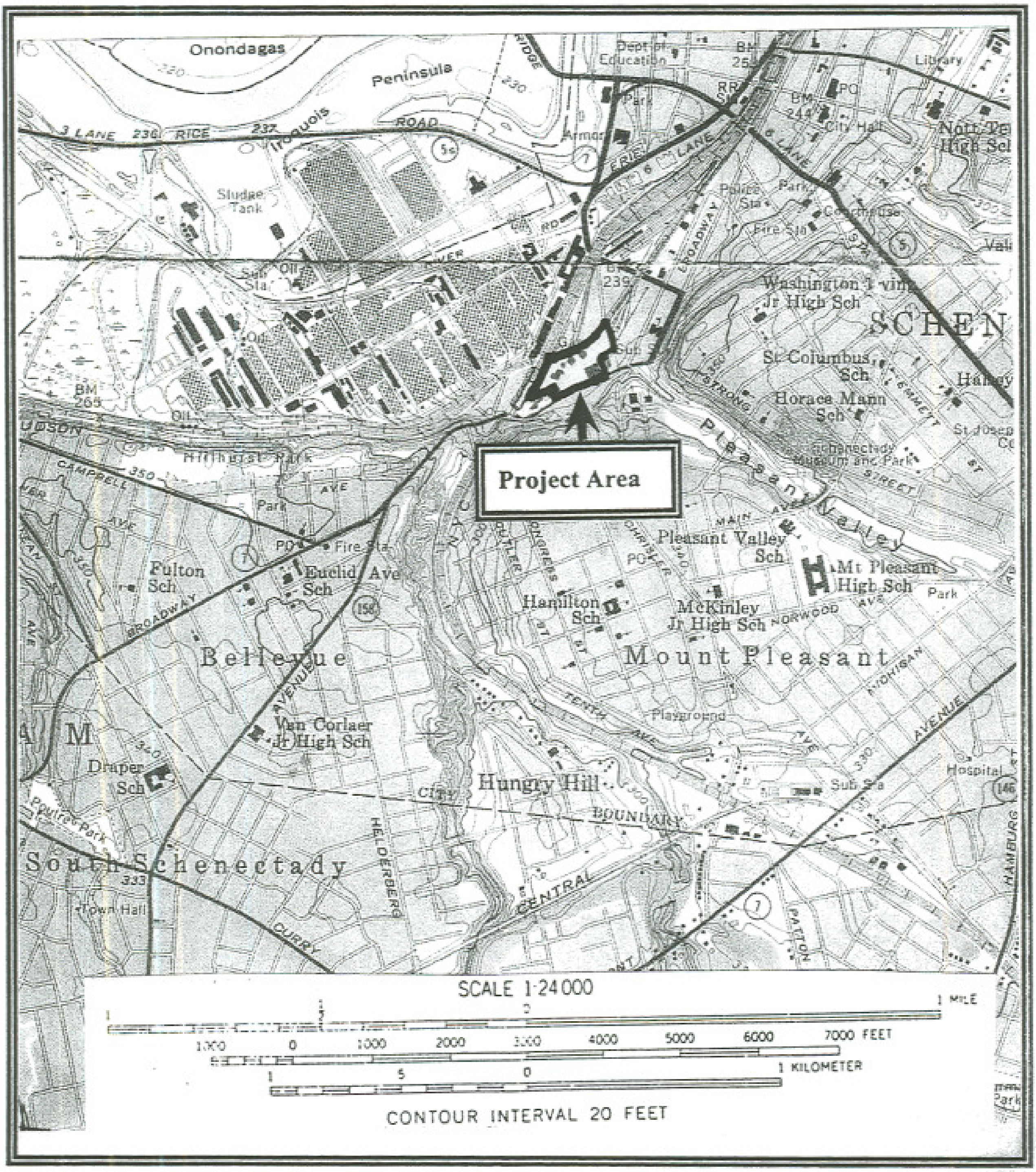


MAP 4
Schenectady County 1866

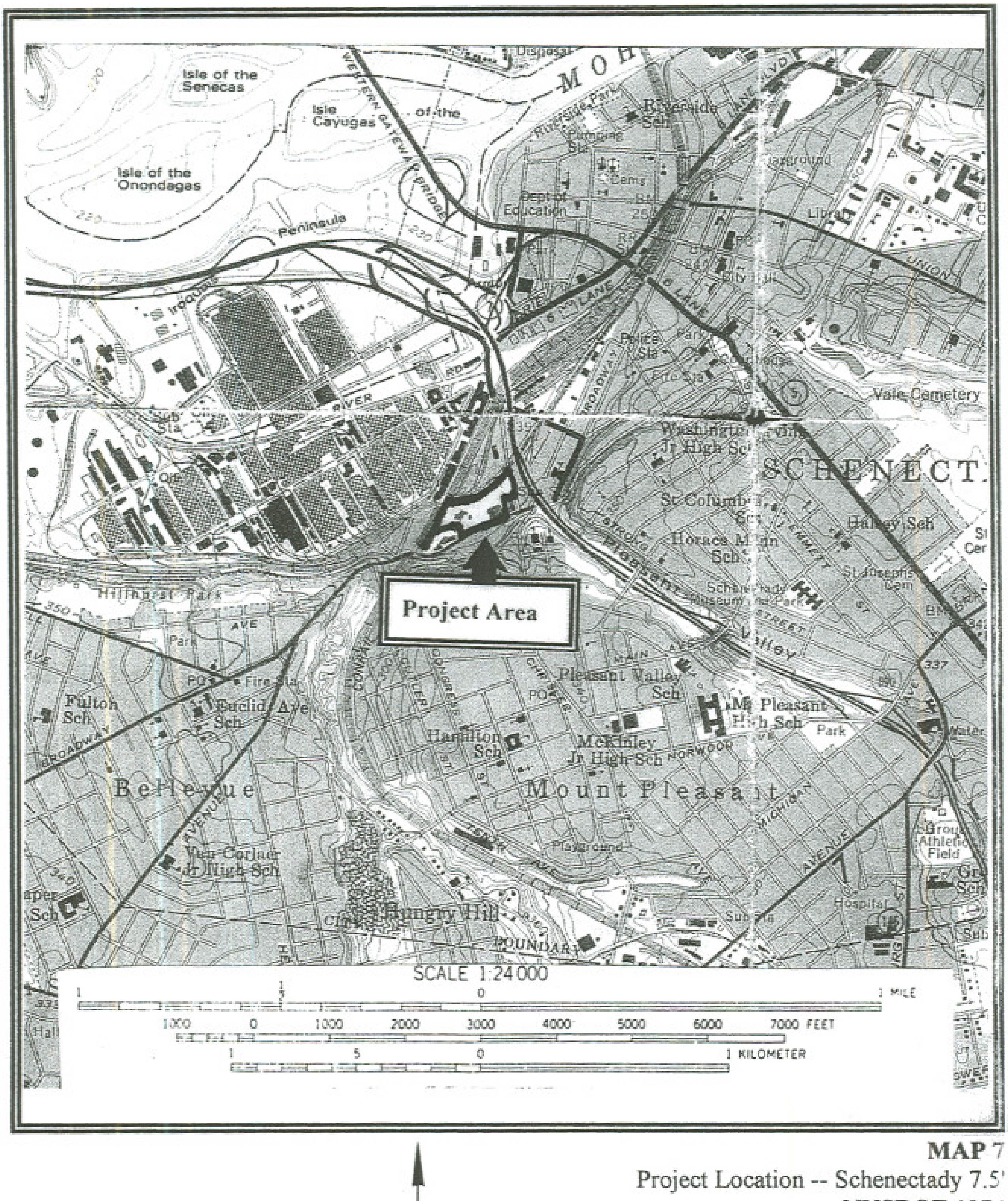


N

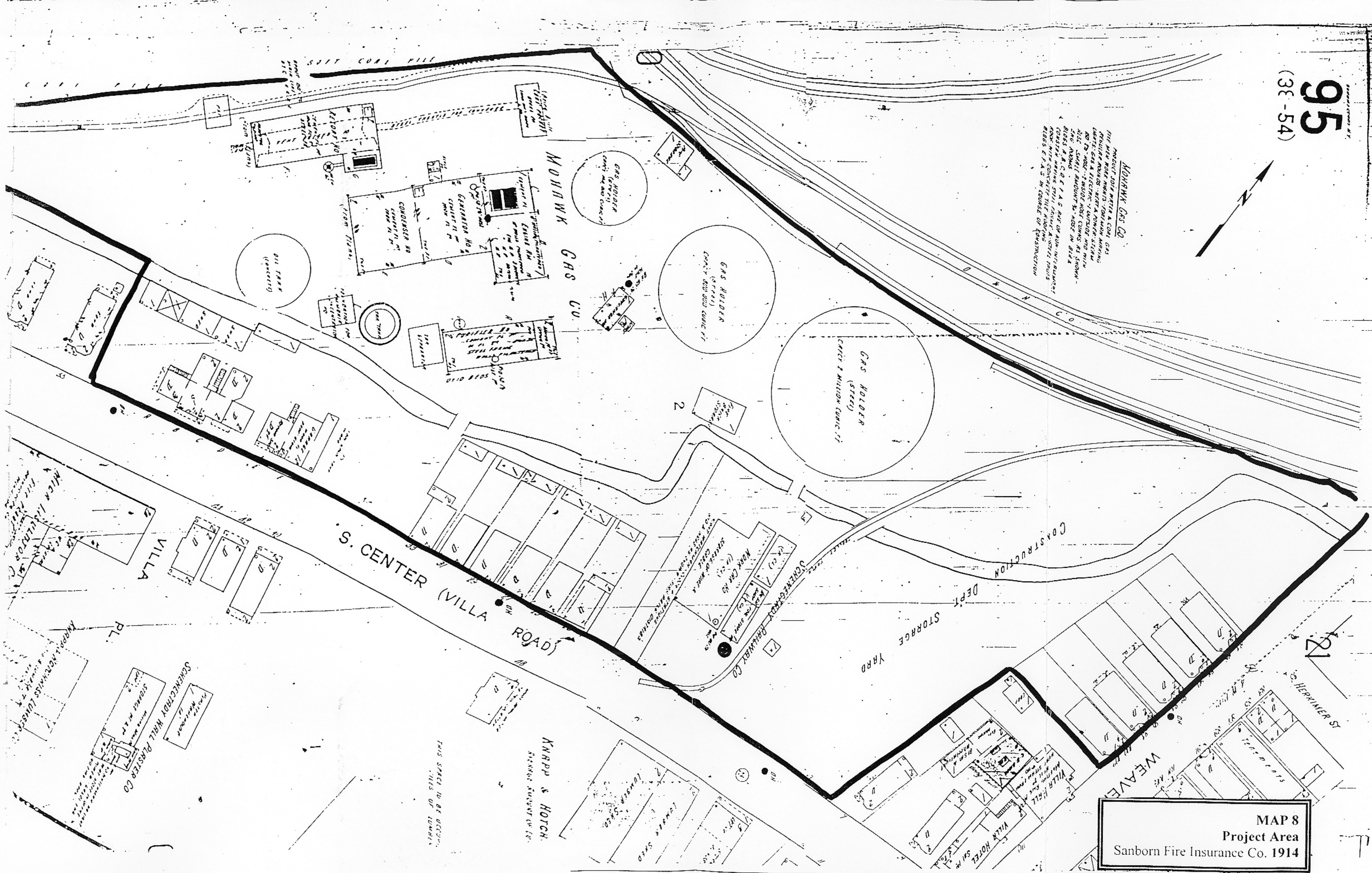
MAP 5
Project Location – Schenectady 15'
USGS **1898/1904**



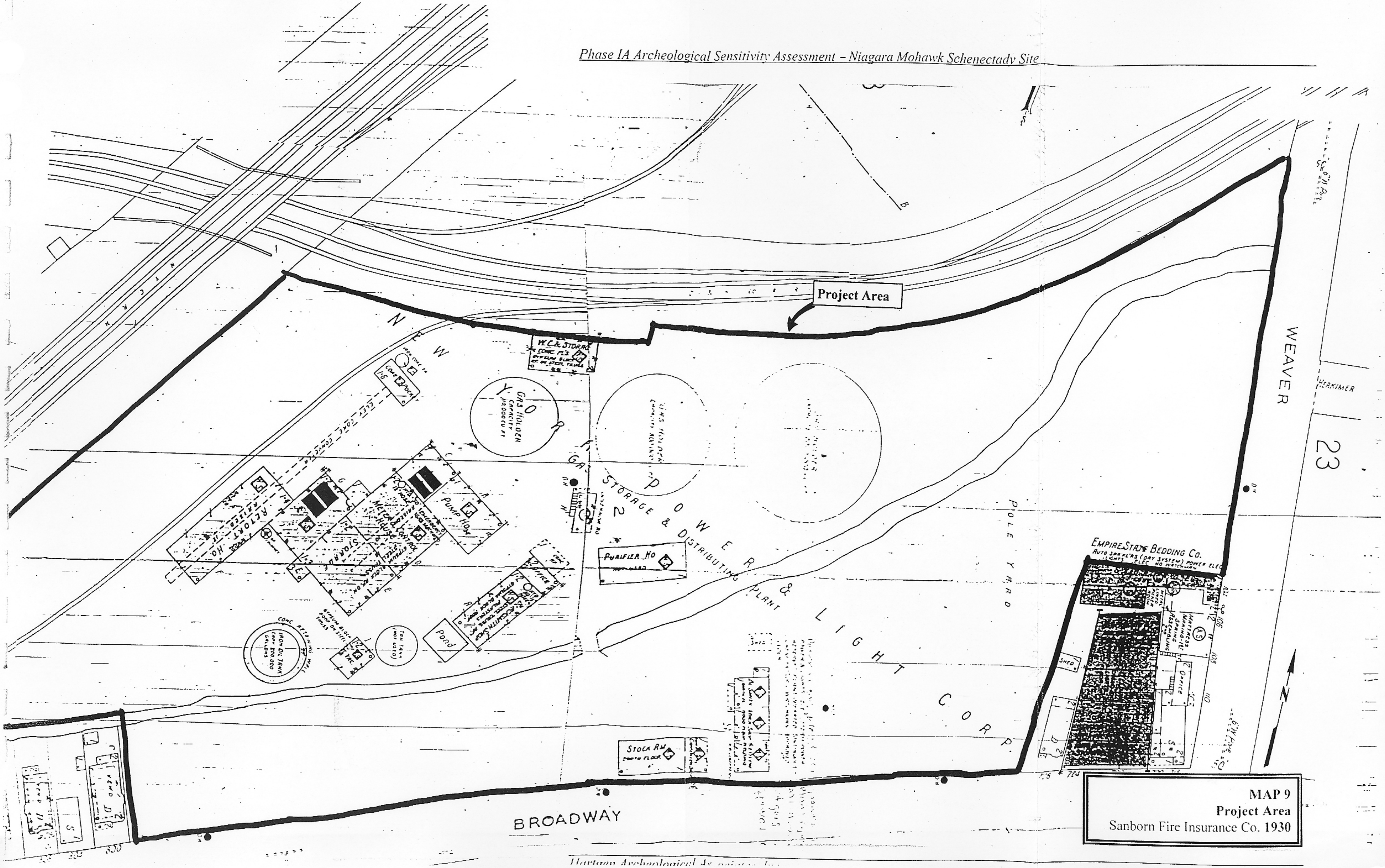
MAP 6
Project Location – Schenectady 7.5'
USGS 1954



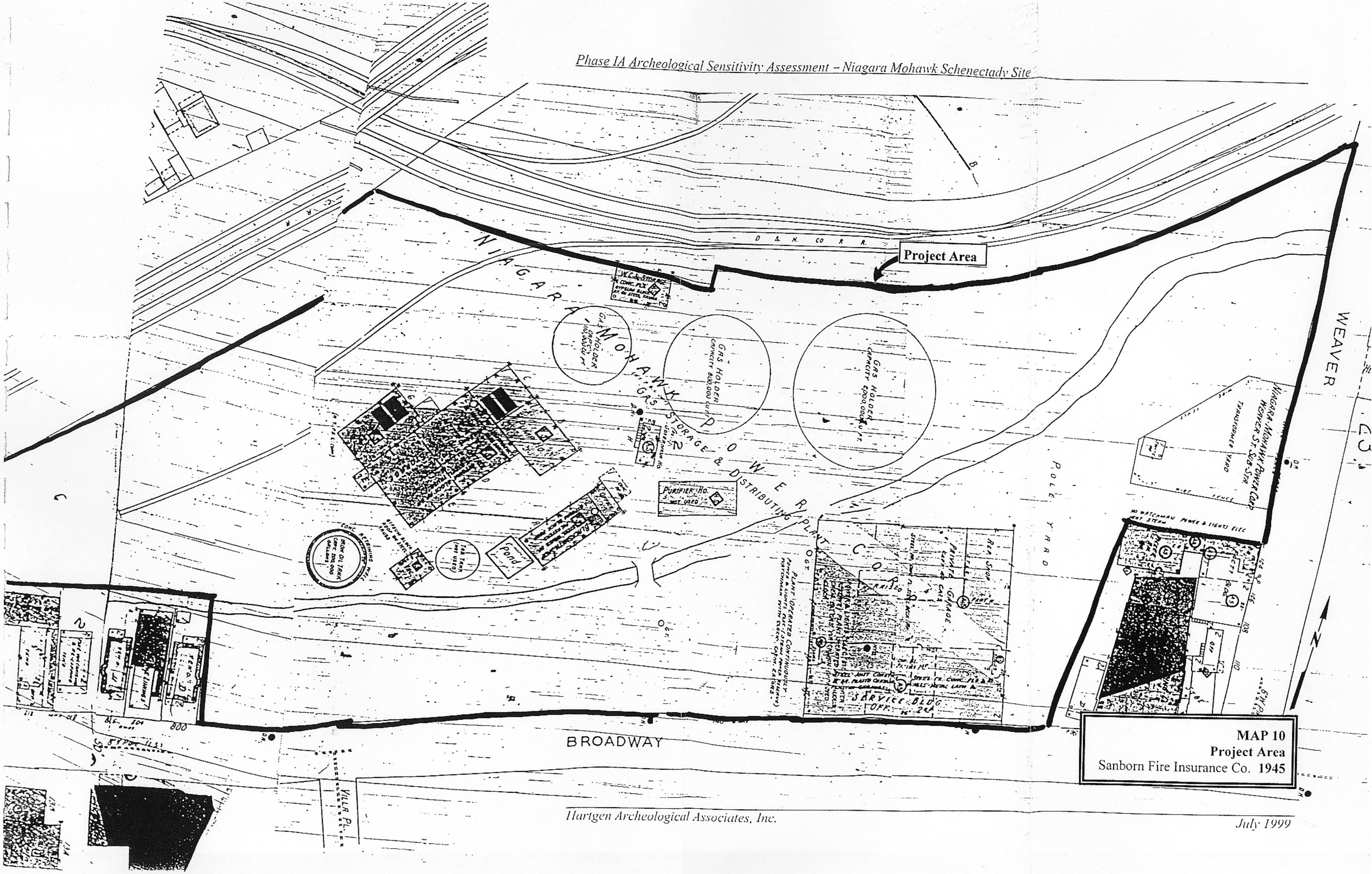
MAP 7
Project Location -- Schenectady 7.5'
NYSDOT 1974



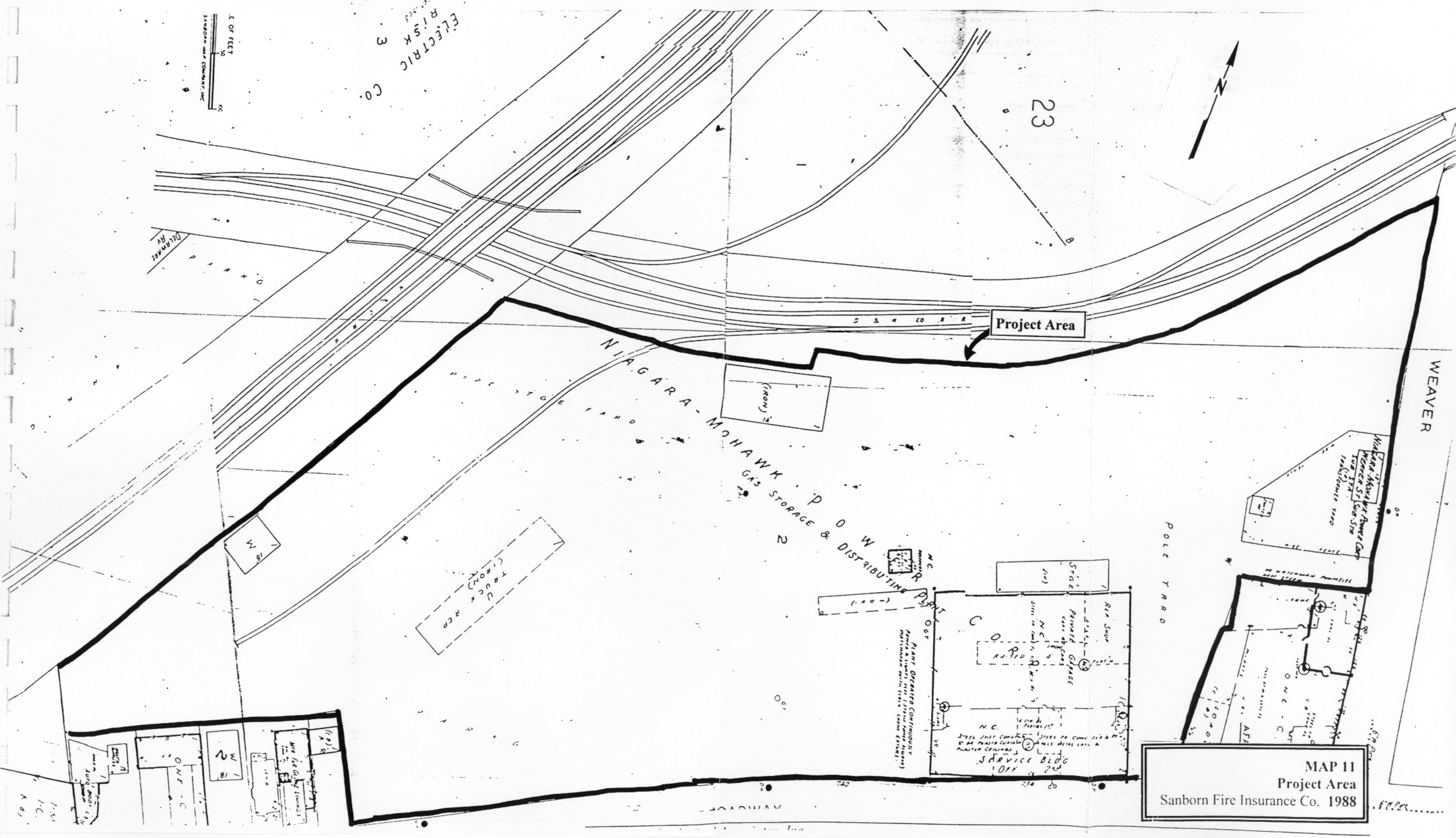
MAP 8
Project Area
Sanborn Fire Insurance Co. 1914



MAP 9
Project Area
Sanborn Fire Insurance Co. 1930



MAP 10
Project Area
Sanborn Fire Insurance Co. **1945**



MAP 11
Project Area
Sanborn Fire Insurance Co. 1988

PHOTOGRAPHS

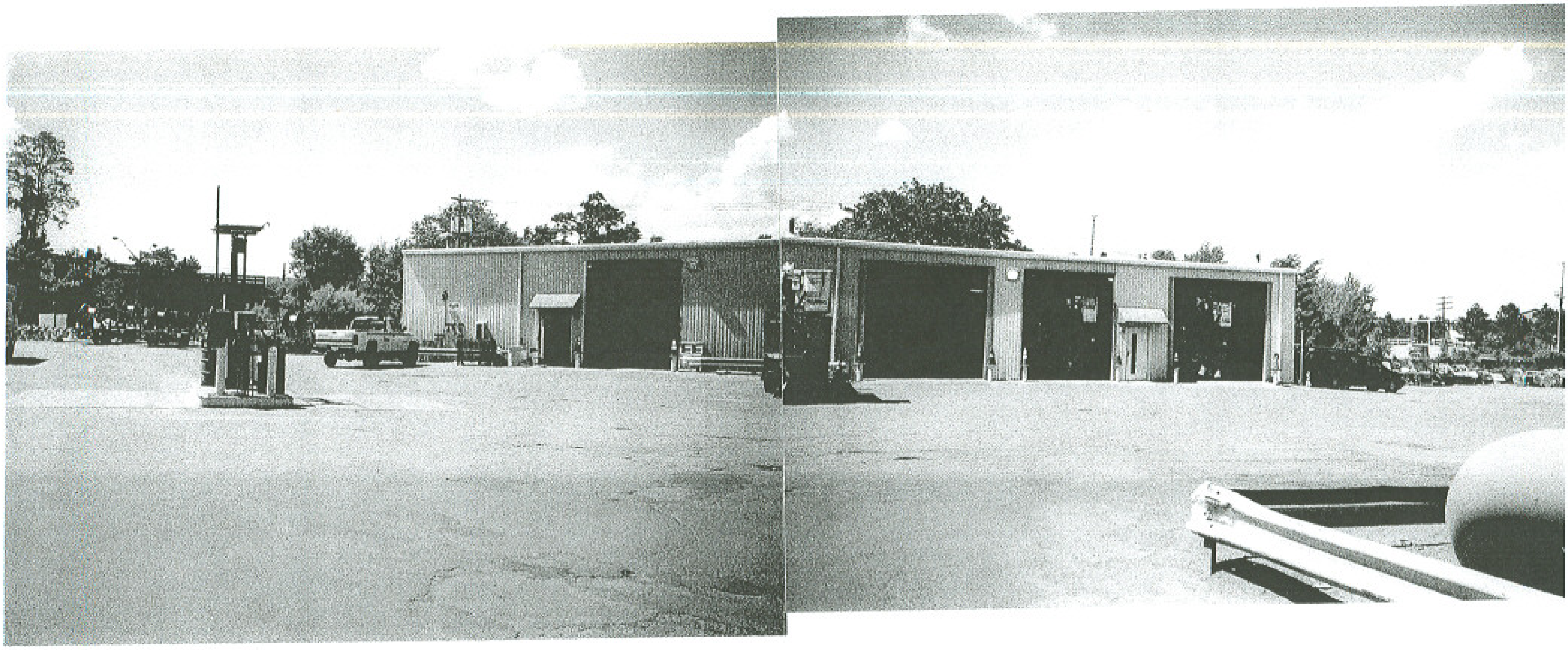


Photo 1: Looking north at a storage building. The gas holding tanks were in the area in front of the storage building.

Photo 2: Looking north at the open garage.

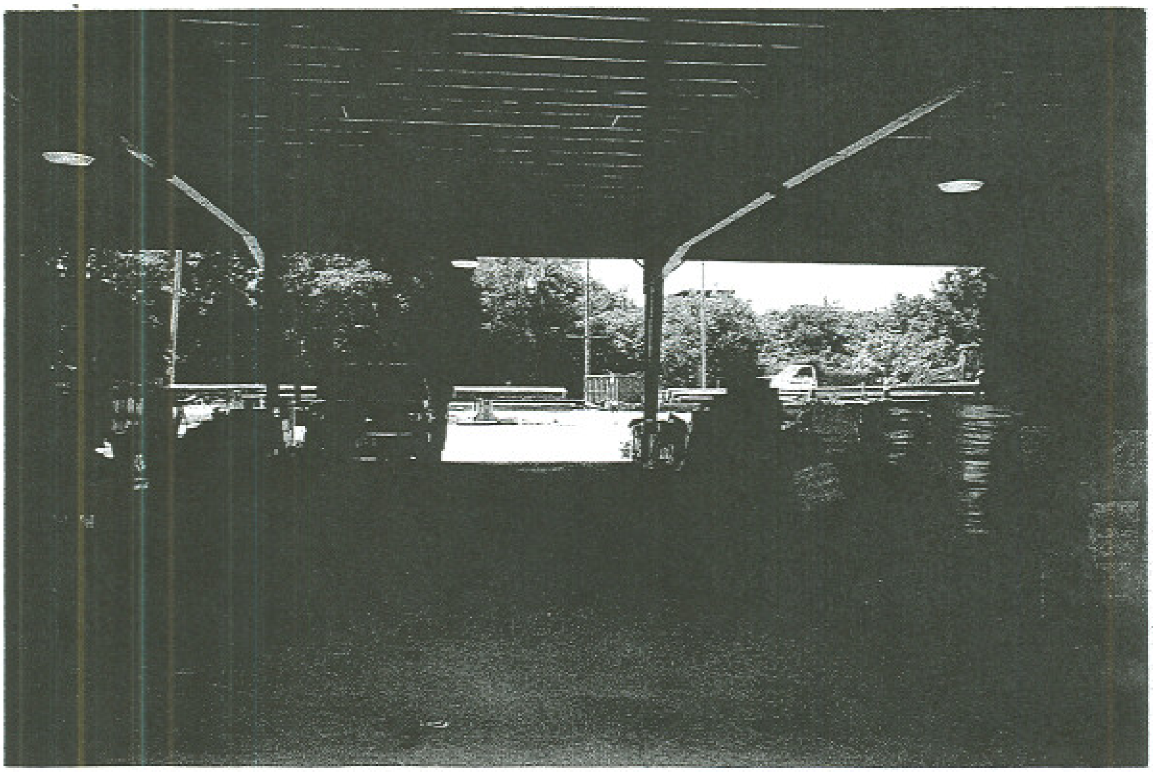


Photo 3: Looking west through the open garage.

Photo 4: Looking southwest at the undeveloped southwest corner of the project area. The soil in this area is a sandy fill indicating a prior disturbance.

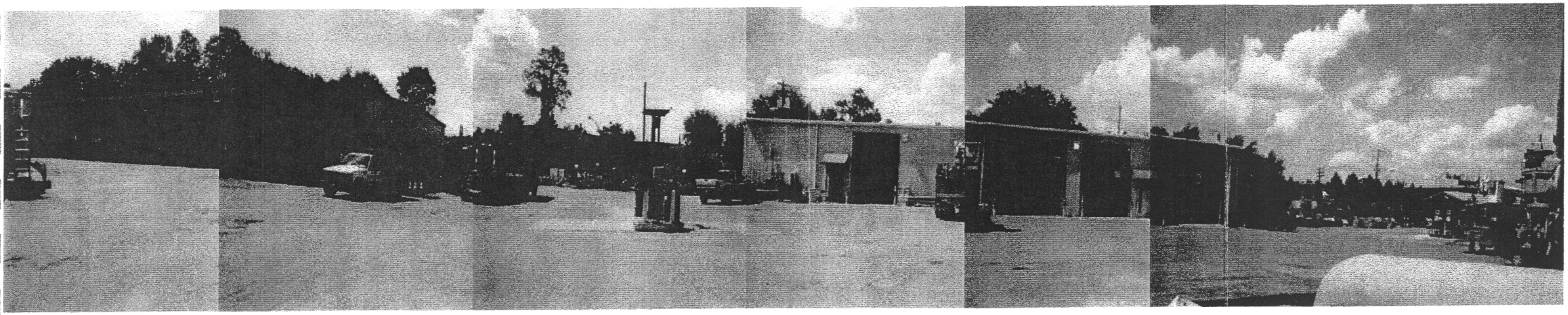


Photo 5: Looking north at the open garage (west) and the storage building (north).

Photo 6: Looking east from across Broadway at the garage/office building.

Photo 7: Looking north, a view of the transformer yard and sub station at the eastern entrance to the site.

APPENDIX 1:QUALIFICATIONS

Hartgen Archeological Associates, Inc.
Cultural Resource Specialists
1744 WASHINGTON AVENUE EXT. • RENSSELAER, NEW YORK 12144

KAREN S. HARTGEN

karen@hartgen.com

Qualifications: **36 CFR 61 qualified archeologist**
Registered Professional Archeologist

Experience:

March 1973 to Present :

President and Principal Investigator
Hartgen Archeological Associates, Inc.

I have directed the cultural resource management firm since 1973, completing over 2500 cultural resource projects in New York and New England. The firm currently has a full time staff of 25 and a trained seasonal staff of 40. Other specialists are available as needed. We provide services in historical documentation, site file searches, field reconnaissance, archeological survey and excavation, artifact preservation, collection management, cartography, CADD/GIS, historic structure survey, National Register nominations, Environmental Impact Evaluations as mandated under NEPA, NHPA, SHPA and SEQR. Archeological surveys include initial surveys to locate sites (Phase IA and IB), development of research designs and field methodologies to identify sites (Phase II), and subsequently data retrieval as mitigating measures (Phase III).

June 1974 to 1978 :

New York State Museum and Science Service
State Education Department, Albany
Assistant Highway Salvage Coordinator

Administration and coordination of the Highway Salvage Archeology Program for New York State during field seasons. Intermediary between various State agencies and cooperating institutions in the process of project evaluation and impact mitigation. Also prepared detailed financial reports for Federal reimbursement.

Education:

State University of New York at Albany
Master of Arts, Anthropology, December 1988

State University of New York at Albany
Bachelor of Arts, Anthropology, January 1970

Professional Affiliations:

Registered Professional Archaeologist (RPA)
President, New York State Archaeological Association (NYSAA)
Board Member, American Cultural Resource Association (ACRA)
Board Member, Rensselaer County Historic Society (RCHS)
Board Member, Cornell Cooperative Extension of Rensselaer County
Former President, New York Archaeological Council (NYAC)
Chair, RCHS Preservation Committee
State Plan for Historic Resources Steering Committee Member, for Office of Parks, Recreation and Historic Preservation
Historic Albany Foundation
Society of American Archaeology
Society of Historic Archeology
Preservation League of New York State
Council for Northeast Historic Archaeology
Northeastern Anthropological Association
National Trust for Historic Preservation
Society for Industrial Archeology
Eastern States Archeological Federation
Hudson-Mohawk Industrial Gateway
Women in Transportation
Greenbush Historical Society

Appendix C

Groundwater / Stormwater Volume Management Calculations

APPENDIX C1

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

GROUNDWATER / STORMWATER VOLUME MANAGEMENT CALCULATIONS
SOIL ALTERNATIVE 3

Area inside the containment Wall (ft2)=	115000				
Infiltration rate through sealed asphaltic concrete cap (inch/year)=	1	ft/year=	0.0833	9580	ft3/year
				71664	gal/year
				196	**gpd**
				0.1	**gpm**

Notes:

1. Groundwater levels within the containment barrier wall would be expected to equilibrate to the approximate groundwater potentiometric surface elevation of the till unit (which is at or slightly below the current water level elevation). Infiltration through the sealed asphaltic concrete cap is expected to be minimal (approximately 1 inch per year or 0.1 gpm for the entire capped area). Therefore no groundwater management is anticipated to be necessary in order to maintain an inward gradient from the area outside the containment barrier wall to the area within the containment barrier wall.

APPENDIX C2

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

GROUNDWATER / STORMWATER VOLUME MANAGEMENT CALCULATIONS
SOIL ALTERNATIVE 5

Area inside the sheetpile wall (ft2) = 157000 | Infiltration rate (inch/year)= 1 | ft/year= 0.0833 | 13078 ft3/year
97837 gal/year
268 gpd
0.19 gpm

(per year over 4 years) Sheetpile Perimeter in 4 equal areas (ft)= 1200 (Provided by JDB 10/5/05)

ΔH= 16 | Area/4 (ft2)= 39250 | Sy= 0.3
(ΔH based on 22' excavation depth minus average depth to water table [May '05] of ~ 6' bgs)

ΔH = saturated soil thickness
Sy = soil porosity
$V_{Drainage=}$ ΔH (Area)Sy

$V_{Drainage=}$ 188400 ft3

1) Flow from Sand Unit (Cut off by Sheetpile Wall):

$Q_{transient}$=$V_{Drainage}$/Time of excavation

Time= 250 days
$Q_{transient}$= 753.6 ft3/day | **5637.7 gpd** | **3.9 gpm**

2) Flow from Till Unit into Sand Unit:

Kv(Till)= 1.73E-07 cm/s = 4.90E-04 ft/day | dh/dL=16/30= 0.53333

Q_{bottom}=Kv(Till) x A x dh/dL

Q_{bottom}= 10.25 f3/day = | **76.7 gpd** | **0.05 gpm**

3) Flow Through Sheetpile Wall:

K= 1.00E-08 cm/s | 2.84E-05 ft/day | Area 55'x1200= 66000 | dh/dL=16/0.375"= 512

Q_{Sides}= K*A*(dh/dL)

Q_{Sides}= 9.58E+02 ft3/day | **7166.8 gpd** | **5.0 gpm**

100 year average as reported by
National Oceanic & Atmosphere Administration (inches) 36.6

Total storm water volume removed (4 years/40,000 SF) =
488000 cubic-feet 3,650,240 gallons

Qtotal max w/o precipitation (per year) =
1 + 2 + 3 12881.2 gpd 8.9 gpm

Total volume removed w/o precipitation (4 years) =
12,881,174 gallons

Total volume removed over 4 years =
16,531,414 gallons

APPENDIX C3

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

GROUNDWATER / STORMWATER VOLUME MANAGEMENT CALCULATIONS
SOIL ALTERNATIVE 6

Area inside the sheetpile wall (ft2)= 324000 Infiltration rate (inch/year)= 1 ft/year= 0.0833 26989 ft3/year
(Provided by JDB 9/20/05) 201906 gal/year
553 gpd
0.38 gpm

(per year over 9 years) Sheetpile Perimeter in 9 equal areas (ft) = 800 (Provided by JDB 9/20/05)

ΔH= 24 Area/9 (ft2)= 36000 Sy= 0.3
(?H based on 30' average excavation depth provided by JDB 9/16/05 minus average depth to water table [May '05] of ~ 6' bgs)

ΔH = saturated soil thickness
Sy = soil porosity
$V_{Drainage}$= ΔH (Area)Sy

$V_{Drainage}$= 259200 ft3

1) Flow from Sand Unit (Cut off by Sheetpile Wall):

$Q_{transient}=V_{Drainage}$/Time of excavation

Time= 250 days
$Q_{transient}$= 1036.8 ft3/day **7756.3 gpd** **5.4 gpm**

2) Flow from Till Unit into Sand Unit:

Kv(Till)= 1.73E-07 cm/s = 4.90E-04 ft/day dh/dL=24/30= 0.8

Q_{bottom}=Kv(Till) x A x dh/dL

Q_{bottom}= 14.10 f3/day = **105.5 gpd** **0.1 gpm**

3) Flow Through Sheetpile Wall:

K= 1.00E-08 cm/s 2.84E-05 ft/day Area 55'x800'= 44000 dh/dL=24/0.375"= 768

Q_{Sides}= K*A*(dh/dL)

Q_{Sides}= 9.58E+02 ft3/day **7166.8 gpd** **5.0 gpm**

4) Precipitation:

100 year average as reported by
National Oceanic & Atmosphere Administration (inches) = 36.6

Total storm water volume removed (9 years/36,000 SF) =
988200 cubic-feet 7,391,736 gallons

Qtotal max w/o precipitation (per year) =
1 + 2 + 3 15028.6 gpd 10.4 gpm

Total volume removed w/o precipitation (9 years) =
33,814,364 gallons

Total volume removed over 9 years =
41,206,100 gallons

Appendix D

Slurry Wall Bench-Scale Testing Summary Report

Memorandum from Geo-Solutions

Date: 8/8/05
To: Jason Brien, BB&L
From: Steve Day, Geo-Solutions
Via: email

Report: Soil-Bentonite Backfill Permeability, and Compatibility Testing, Niagara Mohawk, Schenectady (Broadway), NY

1.0 Introduction

This report presents the results of laboratory tests performed on potential slurry wall materials for the proposed installation of a slurry cutoff wall at the Broadway Site in Schenectady, NY (Site). The work described in this report was completed in accordance with our agreement with Blasland, Bouck and Lee Inc. (BB&L) and Geo-Solution's (GSI) own judgment and our expertise in this area.

1.1 Objectives

The objective of the testing program was to develop a Site-specific, soil-bentonite (SB) slurry wall mixture that is compatible with Site groundwater such that it is appropriate for use in containing and/or diverting contaminated groundwater at the Site. Later, we determined that a cement-bentonite (CB) mixture was a better solution to the particular challenges of this Site. Any successful slurry wall design mix program should demonstrate the following:

- Select materials (commercial and local) that are acceptable, workable, and cost effective for use in the construction of a slurry wall;
- Formulate slurry (bentonite/water or cement/bentonite/water) with adequate workability that will provide stability for the slurry trench excavation;
- Formulate a backfill mixture (SB or CB) from materials with adequate workability and low permeability;
- Test and demonstrate gross compatibility of the Site groundwater with bentonite and bentonite slurry;
- Test and demonstrate long-term compatibility and low permeability of the backfill with Site groundwater; and
- Minimize cost to the owner with maximum effectiveness.

As previously stated, the laboratory design mix program was modified and truncated during the work to better address the specific problems of the Site with CB backfill.

1.2 Scope of Testing Program

The scope of the testing program is defined in our proposal to BB&L of February 4, 2005 and includes a phased program as follows:

- Field Phase: Retrieve representative samples of the Site soils, local mixing water, and Site groundwater. This phase was completed by BB&L and samples were sent by BB&L directly to our sub-contract laboratory (Geotechnics) for analysis and testing.
- Laboratory Phase I: Develop bentonite slurries and test for gross compatibility with groundwater.
- Laboratory Phase II: Develop backfill soils and mix with bentonite to create trial SB mixtures. Test SB trial mixtures for permeability to water in flexible wall permeameters.
- Laboratory Phase III: Test the long-term permeability of selected backfill mixtures to Site groundwater. This phase was terminated in favor of future testing with CB backfill.

1.3 Laboratory

Laboratory testing was performed by Geotechnics Laboratory of East Pittsburgh, PA, under the direction and supervision of GSI. GSI visited the laboratory several times during the project and was in regular communication with the laboratory staff and supervisor.

1.4 Organization of Report

This report presents details on the materials, test methods, and test results. Appendices are attached with photographs of selected tests, summaries of raw data, and copies of laboratory data sheets. Data and pictures related to significant decisions made during the testing program are included in the text of this report, and in certain cases are also provided in the appendix.

2.0 Methods and Materials

2.1 Materials

The source of materials used in the laboratory testing program are as follows:

TABLE 1

Material	Source
Mix water	Municipal water from Schenectady, NY, sampled by BB&L, spring 2005
Groundwater	Site monitoring well MW-26, sampled by BB&L, spring 2005
On-site soils	Soil borings: MW-28 and BB-149, sampled by BB&L, spring 2005
Bentonite clays	Fed-Jel 90, Federal Bentonite, Houston, TX Hydrogel 90, Wyo-Ben Inc., Billings, MT SW101, Wyo-Ben Inc., Billings, MT

2.2 Standards

The following standard methods and references were relied upon in testing the materials in the laboratory:

TABLE 2

Materials/Mixture	Property	Standard Method
Water	pH	API RP 13B-1 (test strip)
	Total Chlorine	Hach (test strip)
	Total Hardness & Alkalinity	Hach (test strip)
Soils	Water Content	ASTM D 2216
	Grain Size	ASTM D 422
	Atterberg Limits	ASTM D 4318
	Classification	ASTM D2487 (USCS)
Bentonite	Material Standard	API 13A (Section 4)
Bentonite Slurry	Viscosity	API RP 13B-1
	Density	API RP 13B-1
	Filtrate Loss	API RP 13B-1
	pH	API RP 13B-1 (test strip)
Bentonite Compatibility	Filter Press Permeability	D'Appolonia (1980)
	Cake Desiccation	Alter, et. al (1985)
	Sedimentation	Ryan (1987)
SB backfill	Grain Size	ASTM D 1140
	Atterberg Limits	ASTM D 4318
	Slump	ASTM C 143 (Mini slump method)
	Flex Wall Permeability	ASTM D 5084

2.3 Phase I Testing Methods

In Phase I, bentonite/water slurries were made and tested. Rheologic properties were tested to develop stable and workable bentonite slurries. Workable slurries were then tested for compatibility with the groundwater from the Site. Three bentonite clay products were blended with mix water to produce slurries with a Marsh Funnel (MF) viscosity of approximately 40 seconds. Premium API 13A (90 bbl/ton) bentonite clay slurries (about 6% bentonite, 94% water) were made from the Hydrogel and Fed-Jel bentonite clays and mix water. A bentonite clay treated to resist certain salts and contaminates, SW101 bentonite, was tested at a concentration of 4.0% bentonite, 96% water. The lesser amount of bentonite in the SW101 slurry is due to the higher viscosity, which results from the manufacturer’s inclusion of additives in the SW101.

Compatibility tests were performed to assess the gross compatibility of the key slurry wall ingredient, bentonite, under worst-case conditions. These tests are not standardized, but are in common use in the industry and referenced in engineering literature (Day, 1994). Most tests start with a standard bentonite trenching slurry (6% bentonite), which is then diluted with, mixed with, and/or permeated with site groundwater to model potential field conditions. Further details of the different compatibility tests are presented with the results, below.

2.4 Phase II Testing Methods

In Phase II, soil-bentonite (SB) mixtures were formulated and tested for water content, workability, grainsize, and permeability to water. A composite of soils from two borings was made to be representative of soils from the Site. This composite backfill soil was used to model the soil for the SB backfill.

SB mixtures were made in the laboratory to simulate field-blended backfill. The SB backfill was composed of bentonite slurry; composite backfill soils; and "dry" bentonite powder, as required. Fixed amounts of soil and dry bentonite were mixed with a variable amount of bentonite slurry. Bentonite slurry was added to the mixture until a slump of 4 to 6 inches was measured.

Flexible wall permeability tests were performed on the SB mixtures using municipal water as the permeant. Flexible wall permeability tests were performed at an effective confining stress of 10 psi and a hydraulic gradient less than 30.

3.0 Materials Testing

3.1 Characterization of Soils

The composite soils obtained from soil borings advanced at the Site by BB&L were delivered to the laboratory in sealed 5 gallon buckets, labeled, tested, and classified as follows:

TABLE 3

ANALYTICAL PARAMETER	Unit	SOIL COMPOSITES BB-150	SOIL COMPOSITES MW-28 & BB-149
Description		2 - 5 gal SSM soil sample soft gray more odor	2 - 5 gal SW soil sample soft gray
Total Density	pcf	100-120	100-120
Moisture Content	%	31.9	32.8
Bucket Densiy (Dry PCF)		97.7	93.8
Soil pH	units	7	7
Gradation			
- Gravel (>0.5 inch)	%	0	2.84
- Coarser Sand (>#4)	%	0.35	4.48
- Finer Sand (>#40)	%	8.81	11.2
- Fines (<#200)	%	66.75	69.65

Atterberg Limits			
- Plastic Limit	%	17	18
- Liquid Limit	%	25	25
- Plasticity Index	%	8	7
Organic Content			
- Loss on Ignition	%	1.9	2.5
USCS Classification	-	CL	CL-ML

There are two soil composites were obtained in the soil borings: 1) soils representative of of the slurry wall alignment, and 2) soil representative of the area to be treated by SSM (shallow soil mixing). The soils in the slurry wall alignment appear well-suited for SB backfill with their high fines content and plasticity. Portions of the till, which will serve as the foundation for the slurry wall, were not included due to its relatively small volume in the SB mixture and to add a conservative bias.

3.2 Characterization of Waters

Samples of a potential mix water (City of Schenectady tap water) and site groundwater (MW-26) were obtained and tested for index properties. Index properties of the waters are as shown below.

TABLE 4

ANALYTICAL PARAMETER	Unit	WATER COMPOSITES MW-26	Muni Water
Description		2 - 2.5 gal Groundwater	4 - 2.5 gal Mix Water rusty
pH	units	7.2	8
Total Hardness	ppm	120	120
Total Alkalinity	ppm	120	120
Total Chlorine	ppm	0	0

The properties of the tap waters appear reasonable and acceptable for the use in a bentonite slurry. Analytical testing of the groundwater was performed by BB&L and is not included in this report. Based on our testing there is nothing unusual about the groundwater, except that it is contaminated.

4.0 Test Results

4.1 Bentonite Slurry Testing

The proportion and rheologic properties of the bentonite slurries are as shown the following table:

TABLE 5

Property	Bentonite Clays		
	Fed Jel 90	**HydroGel 90**	**SW101**
B/W	0.064	0.061	0.040
Marsh Funnel (sec.)	44	40	44
600 rpm	42	36	38
300 rpm	30	27	26
3 rpm (10 sec)	5	6	26
AV (cP)	21	18	19
Density (pcf)	64.0	64.0	63.0
Temp. (^{o}C)	22.0	22.0	19.0
Filtrate (ml / 30 min.)	18.0	20.0	14.0
pH	9.3	8.0	9.0

These slurries were designed to produce a viscosity of approximately 40 MF seconds, which is typically the minimum slurry viscosity used in the field. The SW101 produced a higher viscosity at a lower concentration, but also a lower density and filtrate. The lower filtrate of SW101 is typical of treated bentonite products.

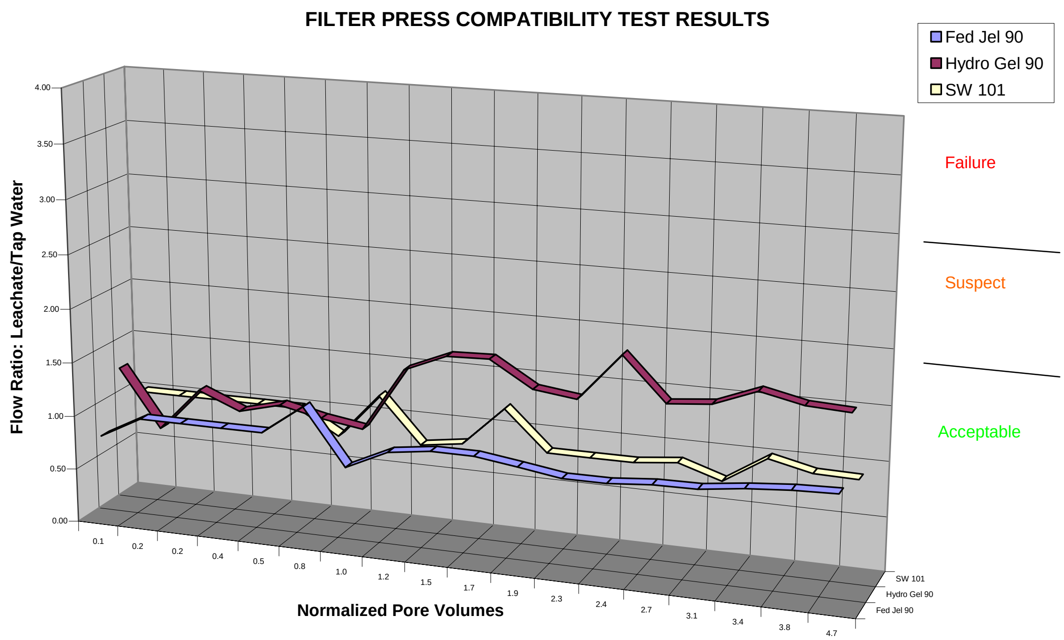
4.2 Bentonite / Groundwater Compatibility

A summary of compatibility test results is presented in Table 6.

TABLE 6

Test	Units	Bentonite Clays		
		Fed Jel 90	**HydroGel 90**	**SW101**
Modified Filter Press				
K (tap water)	cm/sec	2.60E-07	2.50E-07	2.00E-07
K (grdwtr)	cm/sec	2.50E-07	2.70E-07	2.90E-07
K_{grdwtr}/ K_{tap}	Ratio	0.96	1.08	1.45
Chemical Dessication				
Result w/ Groundwater	observation	OK	OK	OK
Sedimention				
Result w/ Groundwater	observation	OK	minor bleed	OK
Summary		OK	delete	OK

Filter press permeability tests were performed by first completing two standard filtrate tests (30 minutes at 100 psi) with bentonite slurry made from mix water and each bentonite clay. Next, the supernate from each test was decanted and two separate cells (with filter cakes still intact) were refilled with either mix water or groundwater. The test cells were again pressurized (at 100 psi) and the test continued for about 3 hours while the flow rate of the waters through the two filter cakes was monitored. The flow rates can be compared as the ratio of the filtrate of the groundwater (or leachate) to the filtrate of the tap water verses the pore volumes of flow. The graphs below presents the results. As can be seen in the graph, the ratio of flow of leachate/ flow of tap water is low (about 1) and thus there are no indications of an incompatibility in these tests.



	0.1	0.2	0.2	0.4	0.5	0.8	1.0	1.2	1.5	1.7	1.9	2.3	2.4	2.7	3.1	3.4	3.8	4.7
Fed Jel 90	0.80	1.00	1.00	1.00	1.00	1.28	0.76	0.95	1.00	1.00	0.95	0.89	0.89	0.92	0.93	0.98	1.01	1.03
Hydro Gel 90	1.33	0.80	1.20	1.04	1.14	1.06	1.00	1.59	1.75	1.76	1.53	1.48	1.92	1.52	1.56	1.71	1.63	1.61
SW 101	1.00	1.00	1.00	1.00	1.00	0.78	1.20	0.78	0.83	1.20	0.83	0.83	0.83	0.88	0.75	1.00	0.91	0.90

Figure 1. Modified Filter Press Test Results

Chemical desiccation tests are performed by mixing a standard (6% clay) bentonite slurry at a 1:1 ratio (by volume) with tap water, and groundwater. These mixtures are poured onto glass plates and allowed to dry. The cracking pattern of the dried slurry is then examined for any unusual patterns. Pictures of the dried Fed Jel 90 slurry is shown below. Pictures of all desiccation tests are shown in the appendix. There were no indications of unusual cracking patterns and therefore, no apparent incompatibility.

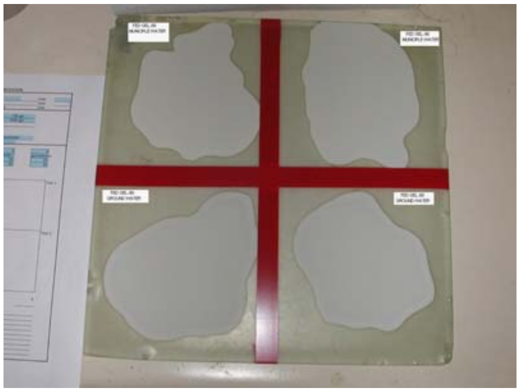


Figure 2.: Chemical Desiccation Test Result with Fed Jel 90 Bentonite

Sedimentation/flocculation tests were also performed to help determine whether the bentonite will fall out of suspension in the presence of the groundwater during construction. Slurries were made with each of the three different bentonite clays, as previously described, and diluted 1:1 (by volume) with distilled water, tap water, and groundwater, and observed for at least 7 days. All of the bentonite products appeared to perform normally, expect the Hydrogel 90, which exhibited a separation or produced water over the top of the slurry with both the tap water and the groundwater. Pictures of the tests are shown on Figures 4, 5, and 6, with a detail of Hydrogel 90 on Figure 7 (shown below). The separation observed with the Hydrogel is considered unusual.

A photograph of sedimentation test on Hydrogel 90 (a.k.a.Wyo Ben 90) is shown below.

Figure 3: Sedimentation/Flocculation Test Result with Hydrogel 90 Bentonite

Based on the results of the compatibility tests, Hydrogel 90 was excluded from further testing. Based on cost, SW 101 was excluded from further testing and Fed Jel 90 was selected for further testing.

4.3 SB Proportions and Permeability

Six SB mixtures were made with the composite Site soil, dry bentonite and bentonite slurry. The proportions of the SB mixtures tested are as follows:

TABLE 7

Mix No.	Bentonite Brand	Bentonite Added Via Slurry (%)	Bentonite Added Dry (%)	Total Bentonite Added (%)	Initial Water Content (%)	Slump* (inch)	Mud Bal. Density (pcf)
1	None	0.00	0.00	0.00	28.5	5.9	119
2	Fed Jel 90	0.00	0.31	0.31	28.7	5.9	119
3	Fed Jel 90	1.00	0.31	1.31	29.5	5.1	118
4	Fed Jel 90	2.00	0.31	2.31	29.0	4.0	117
5	Fed Jel 90	2.80	0.52	3.32	30.7	4.5	117
6	SW 101	0.00	0.31	0.31	31.3	5.1	115

*Slurry bentonite added until a slump of 4 to 6 inches was measured.

All of the mixtures were considered workable. The amount of dry bentonite added was selected to span the range typically employed on similar projects. Mix No. 1 was proportioned to provide a control, i.e. no bentonite added. Mix No. 6 used SW101 bentonite. The initial water content of the Site soil was unusually high at 27% so an unusually low amount of bentonite was added via slurry.

The results of the flexible wall permeability tests with an effective confining stress of 10 psi and a hydraulic gradient of 30 or less using mix water as the permeant are presented in the Table 8, below:

TABLE 8

Mix No.	Bentonite Brand	Total Bentonite Added (%)	Initial Water Content (%)	Final Water Content (%)	Final Total Density (pcf)	Permeability (cm/sec)
1	None	0.00	28.5	20.7	126.0	1.4.E-07
2	Fed Jel 90	0.31	28.7	20.7	126.0	3.0.E-07
3	Fed Jel 90	1.31	29.5	21.8	126.0	2.5.E-07
4	Fed Jel 90	2.31	29.0	22.2	126.0	1.7.E-07
5	Fed Jel 90	3.32	30.7	22.8	125.0	1.4.E-07
6	SW 101	0.31	31.3	22.9	129.0	3.7.E-07

None of the SB mixes meet the typical limit of $k < 1 \times 10^{-7}$ cm/sec. There seems to be no clear trend in the data. Furthermore, the mixes with the least and most bentonite added achieved essentially the same permeability. We believe that a suitable SB mixture could be made by employing one or more of the following approaches:

- Dry the soils so that much more bentonite slurry is absorbed.
- Add much more dry bentonite, and/or
- Add a borrow soil to dry the soil and alter its grainsize distribution.

All of the above approaches will require more costs, require more space for construction and potentially generate more soils for disposal. At this point an alternate approach using CB for the slurry wall backfill was given more serious consideration.

5.0 CB Slurry Walls

CB slurry walls are an established technology that has been used on hundreds of sites to contain contaminated water or divert clean groundwater. With the Cement-Bentonite (CB) method, cement is added to the bentonite-water slurry just prior to introduction into the trench. In addition to serving as the stabilizing fluid to maintain an open trench, the CB slurry remains to set up and form the permanent backfill. The CB slurry generally provides several important advantages including:

- The backfill is not dependent on the suitability of the site soils. Since the soils on the Site are problematic as SB backfill, this is a definite advantage.
- The CB method provides superior trench stability due to its higher density and is self-hardening.
- No area is needed for mixing the SB. This makes the CB method more applicable to sites with limited working room. The CB is mixed in a grout plant and pumped to the trench. The excess soils are hauled away to disposal.
- The CB construction sequence is much more flexible than with SB. It is possible to move from area to area, whereas with SB, generally the trench must be constructed from start to finish in a continuous fashion. This can be very useful when buried utilities are encountered or when working around active facilities or traffic.
- It is possible to formulate CB mixtures with a permeability of less than 1×10^{-7} cm/sec. A mixture of blast furnace slag cement, Portland cement, and bentonite is used to provide the low permeability. Similar mixtures were tested in the SSM laboratory testing program for the Site.

CB construction is generally more expensive than SB construction and generates more soils for disposal. However, at the Broadway Site the lack of space for construction and the limitations of the Site soils make CB an attractive option.

6.0 Summary of Testing Program

Although SB does not appear to be a cost-effective material for the Site, this laboratory testing program (and the accompanying SSM laboratory testing program) demonstrates several important facts. The following is a list of facts demonstrated by this testing program:

- Bentonite slurry can be made with the available Site mixing water (Municipal water) and commercial bentonite products.
- Bentonite is compatible with the Site groundwater.
- The Site soils are unusually wet and require additional costs and measures to be used in SB backfill.
- CB backfill provides significant advantages for construction on the Site. CB-type mixes, similar to the type commonly used in CB slurry walls were tested in the SSM testing program and produced acceptable results. Additional testing may be required to optimize the CB mixture for construction.

7.0 Conclusions

Careful planning and a comprehensive quality control program are recommended to minimize field problems and promote the success of the construction.

Sincerely,

Geo-Solutions Inc.

Christopher R. Ryan
President

Steven R. Day
Vice President

REFERENCES

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Appendix E

ISS Bench-Scale Testing Summary Report

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Memorandum from Geo-Solutions

Date: 8/12/05
To: Jason Brien, BB&L
From: Steve Day & Chris Ryan, Geo-Solutions
Via: email

Report: SSM Treatment of MGP Contaminated Soils Testing, Niagara Mohawk, Schenectady (Broadway), NY

1.0 Introduction

This report presents the results of laboratory tests performed on potential Shallow Soil Mixing (SSM) materials for the proposed treatment of MGP (manufactured gas plant) impacted soils at the Broadway Site in Schenectady, NY (Site). The work described in this report was completed in accordance with our agreement with Blasland, Bouck and Lee Inc. (BB&L).

1.1 Objectives

The objective of the testing program was to develop a Site-specific mixture of materials that can be blended with site soils to stabilize and solidify (S/S) in situ using the Shallow Soil Mixing (SSM) technique. A successful SSM laboratory testing program should demonstrate the following:

- Select materials (commercial and local) that are acceptable, workable, and cost effective for SSM construction;
- Formulate and test grouts (cement/clay/water) with adequate workability that will can be injected and mixed in situ using SSM;
- Formulate and test mixtures of Site soils and grouts that provide adequate strength, low permeability, and reduce the mobility of MGP contaminates;
- Optimization of the mixtures for minimum cost and best results. The optimization phase of the project was not implemented.
- Minimize cost to the owner for maximum effectiveness.

1.2 Laboratory

Geotechnical and mixture testing was performed by Geotechnics Laboratory of East Pittsburgh, PA, under the direction and supervision of GSI. GSI visited the laboratory several times during the project and was in regular communication with the laboratory staff and supervisor. Chemical testing was performed by CompuChem Laboratory of Cary, NC under a separate contract with BB&L.

1.3 Organization of Report

This report presents details on the materials, test methods, and test results. Appendices are attached with photographs of selected tests, summaries of raw data, and copies of laboratory data sheets. Data and pictures related to significant decisions made during the testing program are included in the text of this report, and in certain cases are also provided in the appendix.

2.0 Methods and Materials

2.1 Site Materials

The Site soils, as received, were very wet and odorous silts and clays. Upon receipt, materials were handled with stainless steel utensils and the materials at a temperature of 4^{o}C. The table below summarizes the results of our tests on the physical properties of the untreated soils for both SSM and slurry wall testing.

TABLE 1: Untreated Soils - Physical Characterization

ANALYTICAL PARAMETER	Unit	SOIL COMPOSITES	
		BB-150	MW-28 & BB-149
Description		2 - 5 gal pails SSM soil sample Soft gray, w/ more odor	2 – 5 gal pails SW soil sample soft gray w/odor
Moisture Content	%	31.9	32.8
Bulk Dry Density	Pcf	97.7	93.8
Soil pH	Units	7	7
Gradation			
- Gravel (>0.5 inch)	%	0	2.84
- Coarser Sand (>#4)	%	0.35	4.48
- Finer Sand (>#40)	%	8.81	11.2
- Fines (<#200)	%	66.75	69.65
Atterberg Limits			
- Plastic Limit	%	17	18
- Liquid Limit	%	25	25
- Plasticity Index	%	8	7
Organic Content			
- Loss on Ignition	%	1.9	2.5
USCS Classification	-	CL	CL-ML

The soils were very wet and soft and easily mixed in the bucket with a spoon, when received. The percentage of gravel and sand in the soil was very limited. These soils seem well suited for SSM treatment with conventional drilling equipment. A representative sub-sample (300 to 500 gm) of the SSM soil was sent to the chemical laboratory for analysis.

Samples of the waters from the site were also received and tested. The table below summarizes the properties of these waters, as received.

TABLE 2: Site Waters – Basic Characterization			
ANALYTICAL PARAMETER	Unit	WATER COMPOSITES	
		MW-26	Municipal Water
Description		2 - 2.5 gal Groundwater	4 - 2.5 gal Mix Water Rusty
PH	units	7.2	8
Total Hardness	ppm	120	120
Total Alkalinity	ppm	120	120
Total Chlorine	ppm	0	0

The municipal water is Schenectady tap water and is intended to serve as the mixing water for slurries and grouts used in both the slurry wall and SSM testing. The tap water seems typical and easily usable as mixing water. The rust in the water is probably due to limited flushing of the source hydrant when sampled and does not appear to be problematic. The water from MW-25 was used as the leachate in the slurry wall testing. BB&L has previously analyzed the waters from MW-26 and other monitoring wells.

2.2 Reagents

Commercial sources have been located for a variety of potential reagents for the SSM and slurry wall treatments. Estimated prices of these materials delivered to the site have also been obtained. The following table identifies the potential reagents and estimated delivered costs.

TABLE 3: Potential Reagents

Material	Source	Estimated Cost ($/ton)
Portland Cement (PC)		
Type I	Lab source	$100.00
Type I-II	Lafarge	$100.00
Blast Furnace Slag (BFS)		
Grade 120	Lafarge	$100.00
Sodium Bentonite		
API 13A - 90 bbl	Wyo-Ben	$180.00
SW 101	Wyo-Ben	$356.00
API 13A - 90 bbl	Federal	$190.00
Activated Carbon		
WPX	Calgon	$850.00
Zero Valent Iron (ZVI)		
Minus #50 screen	Peerless	$750.00

2.3 Testing Methods

The following standard methods and references were relied upon in testing the materials in the laboratory:

TABLE 4: Test Standards		
Materials/Mixture	**Property**	**Standard Method**
Water	pH	Hach test strip
	TDS	Hach test strip
	Hardness	Hach test strip
Soils	Water Content	ASTM D 2216
	Grain Size	ASTM D 422
	Atterberg Limits	ASTM D 4318
	Classification	ASTM D 2487 (USCS)
	Organic content (LOI)	ASTM D 2974
	pH	Hach test strip
Grout	Viscosity	API RP 13B-1
	Density	API RP 13B-1
	pH	Hach test strip
SSM mixtures	Mixture preparation	ASTM D 4832
	Wet Density	API RP 13B-1
	Slump	ASTM C 143 (Mini slump method)
	Penetration Resistance	ASTM D 1558
	Slake	ASTM D 4644 mod
	UCS (unconfined compressive strength)	ASTM D 2166
	Permeability	ASTM D 5084
	VOC	EPA 8260B
	Semi VOC	EPA 8270C
	RCRA Metals (8)	EPA 6010B/7471
	SPLP Extract Preparation	EPA Method 1312

3.0 <u>SSM Trial Mixtures</u>

SSM mixtures were made with Site soil and grout. The stabilization of soils with SSM creates a mixture that must meet workability criteria, as well as the stabilization criteria. The grout serves as both a drilling fluid and as the stabilization reagent. The grout must be pumpable and have an extended set time for the proper application of the soil mixing reagents. The amount of reagents (including mixing water) added in the grout increases the volume of the treated soils creating an increase in soil volume called “swell” and therefore the amount added must be controlled.

The soils at the Schenectady site are very wet and soft and therefore well suited for drilling and in situ mixing. Since the water content of the soils are so high, less water can be used in the SSM grout. In the laboratory it is difficult to accurately gauge the amount of water needed for mixing in the field, so we estimate the potential water need by measuring the slump and density of the trial mixtures. Further optimization of the water needs for drilling and mixing may be needed in the field, either during a pilot project or during SSM production.

Eight SSM design mixtures were made and tested. The proportions and properties of the SSM trial mixtures are shown in the table below.

TABLE 5: SSM Trial Mixtures

TRIAL MIX No.	REAGENT TYPE	REAGENT ADDED (%)	WATER ADDED (%)	Theo Swell (%)	Grout Visc (cP)	Grout Dens (pcf)	SSM Dens (pcf)	SSM Slump (inch)	SSM pH
	Silty Clay Soil								
1	PC / Bentonite	7 / 0.35	14	26	17.5	77.4	112	7.5	12
2	PC / Bentonite	7 / 0.35	10	20	34	84.2	117	5.5	12.2
3	PC / Bentonite	12 / 0.35	12	26	44	91.1	116	6.3	12.3
4	PC / BFS / Bentonite	3 / 3 / 0.35	10	19	25	82.4	119	4.8	12.1
5	PC / BFS / Bentonite	4 / 4 / 0.35	10	20	33	87.4	120	5.0	12.1
6	PC / BFS / Bentonite	2.5 / 7.5 / 0.35	10	22	37	87.4	118	4.8	12.2
7	PC / Bentonite / Carbon	7 / 0.35 / 1	12	24	28.5	84.2	115	5.5	12.1
8	PC / BFS / Bentonite / Carbon / ZVI	3 / 3 / 0.35 / 1 / 1	12	24	21	86.1	114	6	12

The mixtures were all workable, but appeared wetter than mixtures used on some other sites, due to the high water content of the untreated soils. The slumps of the mixtures are also relatively high, indicating less water could be used, but the water added (about 10 to 14%) and the theoretical swell are already quite low and probably near the lower limit for effective drilling. Good mixing should be easily obtained in the field with these mixtures.

The pH of the mixtures is high, but typical. The pH of soil-cement mixtures including SSM mixtures typically decreases as the mixtures cure and the cement continues to hydrate. The density of the mixtures is typical of SSM mixtures. Usually, the SSM density is similar to the in situ total density of the untreated soils.

3.1 SSM Strength and Set

The SSM mixtures harden with time as the cement hydrates, with hardening often continuing for at least three months. Test results of the set and strength of the mixtures are shown in the table below.

TRIAL MIX No.	REAGENT TYPE	Penetrometer 1 day (tsf)	Penetrometer 3-4 day (tsf)	Penetrometer 5-6 day (tsf)	UCS 7 day (psi)	UCS 28 day (psi)
	Silty Clay Soil					
1	PC / Bentonite	1.0	2.25	2.5	23	39
2	PC / Bentonite	1.75	>4.5	4.5	33	57
3	PC / Bentonite	3.5	4.5	>4.5	82	148
4	PC / BFS / Bentonite	1	2.5	3.5	31	100
5	PC / BFS / Bentonite	1.5	>4.5	>4.5	64	186
6	PC / BFS / Bentonite	1.25	>4.5	>4.5	261	767
7	PC / Bentonite / Carbon	1	3.25	3.75	25	35
8	PC / BFS / Bentonite / Carbon / ZVI	0.5	1	1.25	14	51

The set time of the mixtures (based on penetration resistance) seems adequate for SSM construction. Most of the mixtures bracket a range in strength between 20 and 60 psi at 7 days. For these mixtures about 8 or 9% cement is near the optimum. However, mix #6 is much stronger. The replacement of PC with BFS tends to increase strength at a constant addition rate. An optimum mixture for strength probably includes BFS at the PC/BFS ratios of mix #6 with an application rate nearer 6 to 8%.

3.2 SSM Stability

The SSM mixtures were immersed in water after 8 days of curing to gauge their stability when immersed in water, which is also known as slake. The mixtures were tested for penetration resistance after 8 days (immediately prior to immersion) and again at 15 days (after 1 week of immersion). A decrease in penetration resistance after immersion tends to indicate that the mixture is not stable. The mixtures were also photographed when immersed. A photograph of a test specimen is shown below.

As can be seen in the photograph, the water remained crystal clear and the SSM mixtures did not breakdown or flake apart when immersed in water. Any sediment flaking off the specimens and deposited on the bottom of the jars during immersion was minimal. The table below summarizes these results and our conclusions after the slake tests.

TABLE 7: Results of Slake Tests

TRIAL MIX No.	**Penetomete Day 5-6 (tsf)**	**SLAKE Pene. - Day 8 (tsf)**	**Pene. – Day 15 (tsf)**	**Improve ? (y/n)**	**Sedimentation**	**Observations**
	Prior to Slake	Prior to Slake	After Slake			
1	2.5	2.75	3.75	Yes	Slight	Good
2	4.5	>4.5	>4.5	No change*	Slight	Good
3	>4.5	>4.5	>4.5	No change*	Slight	v. good
4	3.5	>4.5	>4.5	No change*	Slight	v. good
5	>4.5	>4.5	>4.5	No change*	slight	v. good
6	>4.5	>4.5	>4.5	No	slight	v. good

				change*		
7	3.75	4.25	>4.5	Yes	slight	Good
8	1.25	3.75	>4.5	Yes	slight	Good

*No measurable change due to maximum instrument reading of 4.5 tsf.

Performance in slake and strength are strongly related, but good slake performance is also a function of adhesion and resistance to water penetration, as wells as chemical and physical stability. In general, our mixtures performed well.

3.3 SSM Leachate Generation

SPLP (synthetic precipitation leaching procedure) tests were performed on each SSM mixture after 2 weeks of curing. The SPLP test is similar to the TCLP (toxicity characteristic leaching procedure) except that in the SPLP test the model used is acid rain precipitation instead of landfill leachate. In the SPLP test, the specimen in broken into small pieces, immersed in an acid extract solution, and agitated to encourage the generation of the worst case chemical leachates. In practice, the SSM monolithic is never purposely broken up into pieces so the SPLP test contains a considerable degree of conservatism. Also, chemical stability of the monolithic SSM mass is known to improve with time and continued curing of the cement.

A summary of the SPLP results for each SSM mixture is shown in the table below.

Table 8: SPLP Results

Analyte	SPLP Analysis (mg/L)							
Trial Mix No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
VOCs								
Acetone	0.063 U	0.022	0.023	< 0.125	< 0.179	< 0.078	< 0.125	< 0.078
2-Butanone	0.063 U	0.021	< 0.031	0.125	< 0.179	< 0.078	< 0.125	< 0.078
Benzene	< 0.030 U	< 0.008	< 0.013	< 0.050	< 0.071	< 0.031	0.040 J	0.048
4-Methyl-2-pentanone	0.063 U	< 0.008	< 0.013	< 0.125	< 0.179	< 0.078	< 0.125	< 0.078
Toluene	0.111	0.009	0.023	0.069	0.176	0.084	0.436	0.508
2-Hexanone	0.063 U	0.021	< 0.031	< 0.125	0.179	< 0.031	< 0.125	< 0.078
Ethylbenzene	0.969	0.284	0.380	1.060	1.480	0.904	1.080	1.070
Styrene	0.475	0.216	0.240	0.500	0.695	0.651	0.255	0.252
Isopropylbenzene	0.052	0.027	0.025	0.060	0.072	0.049	0.030 J	0.031 J
Xylene (total)	1.740	0.674	0.820	1.860	2.420	1.790	1.400	1.410
BETX Total	**2.82**	**0.97**	**1.22**	**2.99**	**4.08**	**2.78**	**2.92**	**2.99**
VOCs Total	**3.6**	**1.3**	**1.5**	**3.7**	**5.0**	**3.5**	**3.2**	**3.3**
SVOCs								
Naphthalene	1.400 D	1.600 D	1.600 D	1.300 D	1.800 D	1.400 D	0.350	0.320
2-Methylnaphthalene	0.400	0.450	0.440	0.330	0.450	0.380	0.051	0.044 J
1,1'-Biphenyl	0.032 J	0.035 J	0.034 J	0.025 J	0.033 J	0.029 J	< 0.050	< 0.050
Acenaphthylene	0.015	0.018 J	0.017 J	0.013 J	0.018 J	0.015 J	< 0.050	< 0.050
Acenaphthene	0.100	0.100	0.096	0.069	0.093	0.078	0.011 J	0.009 J
Dibenzofuran	0.010 J	0.010 J	0.010 J	0.007 J	0.010 J	0.008 J	< 0.050	< 0.050
Fluorene	0.046 J	0.044 J	0.042 J	0.030 J	0.038 J	0.033 J	< 0.050	< 0.050
Phenanthrene	0.056	0.052	0.049 J	0.033 J	0.040 J	0.036 J	< 0.050	< 0.050

Anthracene	0.011 J	0.011 J	0.010 J	0.007 J	0.009 J	0.008 J	< 0.050	< 0.050
Carbazole	0.010 J	0.011 J	0.010 J	0.008 J	0.011 J	0.009 J	< 0.050	< 0.050
Bis(2-ethylhexyl) phthalate	< 0.050	< 0.050	0.007 J	0.006 J	0.006 J	< 0.050	< 0.050	0.008 J
Total SVOCs	**2.1**	**2.3**	**2.3**	**1.8**	**2.5**	**2.0**	**0.4**	**0.4**
RCRA METALS								
Barium	0.258	0.195 B	0.392	0.363	0.418	0.552	0.212	0.450
Total RCRA Metals	**0.3**	**0.2**	**0.4**	**0.4**	**0.4**	**0.6**	**0.2**	**0.5**

Notes:
1. < = Compound was not detected at a concentration exceeding the presented laboratory detection limit. Hits only 10 ppb and greater shown.
2. J = Indicates an estimated concentration.
3. B = Indicates that the compound was detected in the laboratory sample was well as the associated laboratory blank.
4. D = Indicates sample was diluted due to concentration level.
5. Concentrations reported in milligrams per liter (mg/L) or parts per million (ppm).

The SPLP test results indicate a very low level of leachate generation. Ethylbenzene, styrene, xylene, naphthalene, methylnaphthalene, and barium are the primary anayltes detected, but in general these total less than about 6 ppm. The inclusion of special additives (carbon and ZVI) did little to improve SPLP performance. The SPLP test results indicate that the SSM mixtures are stable and limit contaminant mobility.

3.4 SSM Permeability

A positive method to limit contaminant mobility is to reduce the permeability of the stabilized monolith. The permeability of our SSM mixtures was measured after 14 days of curing in the flexible wall permeameter. The samples were tested at an effective confining pressure of 6.25 psi and a maximum hydraulic gradient of 30. The results of the tests are shown in the table below.

Table 9: Permeability Test Results

TRIAL MIX No.	REAGENT TYPE	REAGENT ADDED (%)	WATER ADDED (%)	Density (pcf)	Water Content (%)	Hydraulic Conductivity (cm/sec)
	Sand					
1	PC / Bentonite	7 / 0.35	14	108	38.6	1.90E-06
2	PC / Bentonite	7 / 0.35	10	113	35.9	7.90E-07
3	PC / Bentonite	12 / 0.35	12	111	34.8	9.10E-07
4	PC / BFS / Bentonite	3 / 3 / 0.35	10	114	32.5	7.70E-07
5	PC / BFS / Bentonite	4 / 4 / 0.35	10	115	30.4	9.30E-07
6	PC / BFS / Bentonite	2.5 / 7.5 / 0.35	10	116	30.5	5.80E-07
7	PC / Bentonite / Carbon	7 / 0.35 / 1	12	109	40.6	1.10E-06
8	PC / BFS / Bentonite / Carbon / ZVI	3 / 3 / 0.35 / 1 / 1	12	109	40.8	7.50E-07

All permeability test results are less than 1 x 10^{-5} cm/sec, with most results less than 1 x 10^{-6} cm/sec. These are low permeability results and capable of limiting contaminate mobility.

4.0 Conclusions

The testing of SSM mixtures for the Broadway site has demonstrated the following;

- The Site soils are wet and soft and well suited to treatment by SSM.
- The addition of about 8% cement produces a mixture with adequate strength and workability.
- SSM mixtures tested for use on the Site are stable and limit contaminant mobility.
- Permeability tests of SSM mixtures produced low values, generally less than 1×10^{-6} cm/sec.
- Further optimization of the SSM mixtures is recommended prior to construction.
- Careful planning and a comprehensive quality control program are recommended to minimize field problems and promote the success of the construction.

Please feel free to call me if you have any questions.

Appendix F

ISS Case Study

an ARCADIS company

In-Situ Stabilization of MGP-Contaminated Soils, Columbus, GA

BY

N.Darahyl Dennis
Georgia Power

FOR

GEI Compendium

1999

In-Situ Stabilization of MGP-Contaminated Soils

Columbus, GA

By N. Darahyl Dennis
Remediation Projects Manager
Georgia Power

GEORGIA POWER
A SOUTHERN COMPANY

June 1999

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In-Situ Stabilization of MGP-Contaminated Soils Columbus, GA

Georgia Power Company elected to perform in-situ stabilization of soils at the site of a former manufactured gas plant (MGP) in Columbus, Georgia. This was the largest deep-auger, in-situ stabilization project performed in the United States, and also the first MGP site to be cleaned up using this technology.

Project Background

The site is located in the central business district of Columbus, Georgia. The waterfront site, bounded to the west by the Chattahoochee River, was acquired by the City of Columbus as part of a downtown waterfront revitalization and restoration plan. The land was designated to be redeveloped by the City as a park and riverfront walk.

The first MGP operations were conducted on the site in the 1850s. Manufactured gas was initially produced by distillation of wood and later produced by a coal and a carbureted gas process. The production of manufactured gas ceased in 1931 when the site was converted to a natural gas storage and metering facility.

The four-acre site had been filled extensively since the 1930s (especially along the west side) to raise the riverbank. Site assessments revealed pockets of coal tar in the fill. The primary MGP-affected soils, however, were encountered below the water table in the alluvium underlying the fill. Analytical results indicated the presence of chemical constituents characteristic of MGP processes, including volatile organic analytes (VOAs) and polynuclear aromatic hydrocarbons (PAHs). The reported maximum total VOA and PAH concentrations were 263 ppm and 2,386 ppm, respectively.

Site Cleanup Plan

The primary objectives of site cleanup were to minimize and control the MGP materials, control off-site migration of contaminants, and protect human health and the environment. Many other unique criteria were factored into selection of the cleanup approach.

The project was large, with an estimated 90,000 cubic yards of soils affected by constituents of the MGP processes. The goal was an effective solution—one requiring no long-term maintenance or handling of groundwater and the associated discharge permitting. The urban setting presented a challenge due to tight space constraints and high public profile, with corresponding concerns regarding noise, odors, and other potential by-produces of an MGP cleanup. Cost was also an issue.

All applicable cleanup alternatives that had been used on MGP sites were considered. These included excavation and removal (landfilling), on-site and off-site thermal treatment, in-situ stabilization, and encapsulation. In-situ stabilization was selected as the technology that would most effectively meet project objectives and criteria. In-place treatment would preclude the expense and complication of material transport and minimize the potential for worker and public exposure to contaminants. The site soil characteristics were amenable to in-situ stabilization, and the comparative cost was favorable.

The cleanup plan specified in-situ stabilization to directly treat and immobilize MGP-affected materials below the water table. Existing clean fill above the water table would be excavated and stockpiled for reuse; pockets of MGP-affected materials within the fill would be stabilized together with the in-situ soils. The plan also included the addition of an extra-rich soil/cement mixture along the west side of the site, parallel to the river. The extra-rich mixture provided a necessary barrier to groundwater flow and gave the in-situ material the freestanding capabilities to allow excavation on the west side. Upon completion of the stabilization process, a synthetic liner would be placed over the stabilized area and clean fill placed to final park grades.

The in-situ stabilization would be performed on MGP-affected fill soils and approximately 15 feet of alluvial material above the saprolite, or weathered bedrock. The affected soils would be mixed with a cement additive. The in-situ mixing involved auger drilling from the excavated surface through the soil and keying 1 to 2 feet into the saprolite. Cement additives would be injected and mixed with the affected soils in each auger hole to create a homogeneous column of stabilized material. Quality control testing would be performed throughout the process to ensure that engineering design parameters would be achieved.

The stabilization subcontractor performed a treatability study to determine the appropriate stabilization dosage of Type I Portland cement additive. Test mixes were evaluated for their ability to achieve design values of unconfined compressive strength, permeability, and PAH content of TCLP extract (see Table 1). Based on the results of the study, a design mix of 10 percent by weight addition of cement was specified for the stabilization, with a rich mix of 25 percent to be used for the western soil/cement wall.

Site Cleanup

A detailed Work Plan was developed as a guidance document covering all elements of the stabilization project. Mobilization to the Columbus site began in November 1991, and a Notice to Proceed was received from the potentially responsible party (PRP) in early December. The main components of the site operations are listed below. The site layout is shown in Figure 1.

- Mobilization and demolition
- Excavation
- In-situ stabilization
- Site restoration
- Post-cleanup monitoring

All site operations were performed in compliance with the project Health and Safety Plan which mandated safe and controlled working conditions and practices in accordance with federal regulations and City of Columbus ordinances. Work was performed in Level D and modified Level C personal protective equipment (PPE). Real-time monitoring and historical exposure assessment data formed the basis for any upgrade or downgrade of PPE level.

Mobilization and Demolition

The prime contractor mobilized the required personnel and equipment, set up trailers and associated facilities, installed temporary fencing and erosion control measures, and established a new traffic pattern on busy Bay Avenue (the eastern site boundary). The river protection system was installed during initial site set-up to control any seepage from the site during construction/cleanup activities. The protective system consisted of a floating boom and absorbents to contain any floating contaminants.

Existing facilities on the site were demolished and the debris hauled off site for disposal.

Excavation

The excavation sequence had to be carefully planned and coordinated on this tightly confined site. It was necessary to maintain continued truck access for hauling and concurrently accommodate in-situ stabilization operations. Excavation proceeded initially in strips across the site from east to west as the surface was lowered in 2½-foot lifts. When required, an aqueous film-forming foam concentrate had to be sprayed on the uncovered material to suppress odors.

The overburden fill soils were excavated from the general site elevation of 234 to approximate elevations 224 and 212, a maximum of 22 feet. After placement of the western soil cement wall, the riverbank west of the wall was further lowered to approximately elevation 193. Georgia Power, in cooperation with the Corps of Engineers, maintained the river level below elevation 190 during this excavation. All excavation was above the groundwater level. About 86,000 cubic yards of soil were removed in the excavation phase.

It was critical to segregate MGP-affected from non-affected soils during this phase. Before excavation of each lift, the fill surface was visually inspected. In some cases, the soil could be identified as affected, based on odor or marked discoloration. In the absence of clear visual indications, the site was divided into sections, and composite grab samples were taken from each section. The samples were analyzed for TPH, PAH, and BTEX content. The criteria for classification of the fill as affected material are listed on Table 2.

Affected soils, removed to an off-site storage area, were returned to the site for stabilization. Unaffected soils were hauled to an off-site storage area for later use as a cover material for the Columbus sanitary landfill. Some unaffected material was returned to the site for use as clean backfill material. Because some contaminated material was discovered under the buildings, which were demolished, the volume of affected soils was greater than originally anticipated. Some of the affected soils were transported to a double-lined special waste landfill at the discretion of Georgia Power Company.

In-Situ Stabilization

The in-situ stabilization process at the Columbus MGP site used an auger system to drill into affected soils and uniformly mix the soils with cement additive. This approach was selected over more conventional solidification/stabilization methods which use mechanical mixers or backhoe buckets. The methods had limited applicability to the relatively deep in-situ mixing required for this project and may also necessitate the capture and treatment of organic vapors and dust released in the mixing process.

A batch plant and additive storage tank were set up in the southeastern corner of the site. The mix design specified 10 percent by weight addition of Type I Portland cement and a 25 percent addition for the western soil/cement wall. The depth of each auger hole was projected, based on the extensive site assessment data, and the shaft volume calculated. The required amount of additive for each hole could then be determined and regulated. The water-to-cement ratio varied across the site, but was typically about 1½ to 1. It was desirable to use the least amount of water that would allow hydration of the cement.

The treatment equipment included an 8-foot-diameter auger capable of in-situ soil-mixing down to a 40-foot depth. Cement additive was introduced through the hollow stem auger to three exit ports in the bottom of the auger. The in-situ stabilization system is shown schematically in Figure 2. Stabilization was performed by Geocon, Inc.

In-situ stabilization operations began along the western site boundary. The rich soil/cement mix wall along the western side of the site was completed first to provide a necessary barrier to groundwater flow and to give the in-situ material free-standing capabilities to allow excavation of affected material on the west side. The wall was approximately 450 feet long, with each overlapping 8-foot-diameter auger hole keyed 3 feet into the saprolite. Once the wall was stabilized, affected soils west of the wall (between the wall and the river) were excavated and placed on the eastern side of the wall for subsequent stabilization with the in-situ soils. Shotcrete was sprayed on the lower portion of the exposed river side of the wall to ensure sealing of the saprolite/bed rock interface.

Stabilization then progressed across the site. Treatment extended, in different site areas, from elevations 224 and 212 down to approximately evaluation 190, the deepest auger holes were about 35 feet.

More than 1,800 overlapping 8-foot-diameter auger holes were drilled and stabilized in 20 weeks. This duration included mobilization and demobilization. The total amount of stabilized material was over 90,000 cubic yards.

Quality control testing of the stabilized shafts verified achievement of the specified performance criteria relative to unconfined compressive strength (UCS), permeability, and PAH content of TCLP extract (see Table 1). A total of 333 shafts were sampled; the shaft numbers and sample depths were randomly selected. Samples of freshly-mixed stabilized soil were collected using a sampling tube device. All samples were subjected to UCS testing. A penetration resistance at one day was used as an early indicator that the required 28-day strength of 60 psi had been achieved. Permeability and leachable PAH analyses were performed on 10 percent of the samples. All analytical results have met or exceeded design specifications.

Site Restoration

Upon completion of the in-situ stabilization operations, the stabilized area was covered with 1 foot of non-affected soil, sloped to drain to the north and south, and the subgrade compacted. A 60-mil HDPE liner was then placed over the entire stabilized area.

Nonaffected soils previously excavated and stored off site were returned to the site for use as backfill. Backfill was placed over the liner in lifts and compacted to 90 percent of the Standard Proctor maximum dry density. The fill extended from the approximate excavated elevation 212 to about elevation 232, within 2 feet of planned park grades. The City of Columbus completed the area fill with topsoil to the final grade. The remaining surplus of non-affected soil was used as daily cover at the City's municipal landfill.

Post-cleanup Monitoring

Georgia Power Company implemented a Post-cleanup monitoring plan to confirm and document the effectiveness of the cleanup action and monitor for potential releases of MGP-related constituents from the site. Eight monitoring wells were installed around the site periphery. Seven of these were screened in the water table aquifer above the saprolite and the remaining well penetrated the underlying bedrock. The wells were sampled regularly and the groundwater samples analyzed for volatile organic compounds (VOCs), PAHs, and total cyanide. The wells were also checked visually for the presence of nonaqueous-phase liquids.

The sampling occurred quarterly in 1992 and 1993 and semiannually for the next three years. All organic constituents sampled were non-detectable. Cyanide results were below the federal MCL levels.

Summary

In addition to being the largest deep-auger in-situ stabilization ever undertaken in the United States, this project also marked the first use of in-situ stabilization to clean up MGP-affected soils. The applicability of this technology to MGP sites depends on many variables, including the nature of contamination and the intended future use of the property. Georgia Power Company has proven (for appropriate sites) that in-situ stabilization is a viable and effective cleanup alternative for MGP sites.

Tables

Table 1

In-Situ Stabilization Performance Criteria

Parameter	General Stabilization (10% Design Mix)	Soil/Cement Wall (25% Design Mix)
Unconfined Compressive Strength at 28 Days (psi)	60	60
Permeability (cm/sec)	1×10^{-5}	1×10^{-6}
PAH Content of TCLP Extract (mg/L)	10	10

Table 2

Criteria For Affected Soils

Total PAH Content	> 200 ppm
Carcinogenic PAH Content	> 100 ppm
BTEX Content	> 100 ppm
Total TPH Content	> 500 ppm

Figures

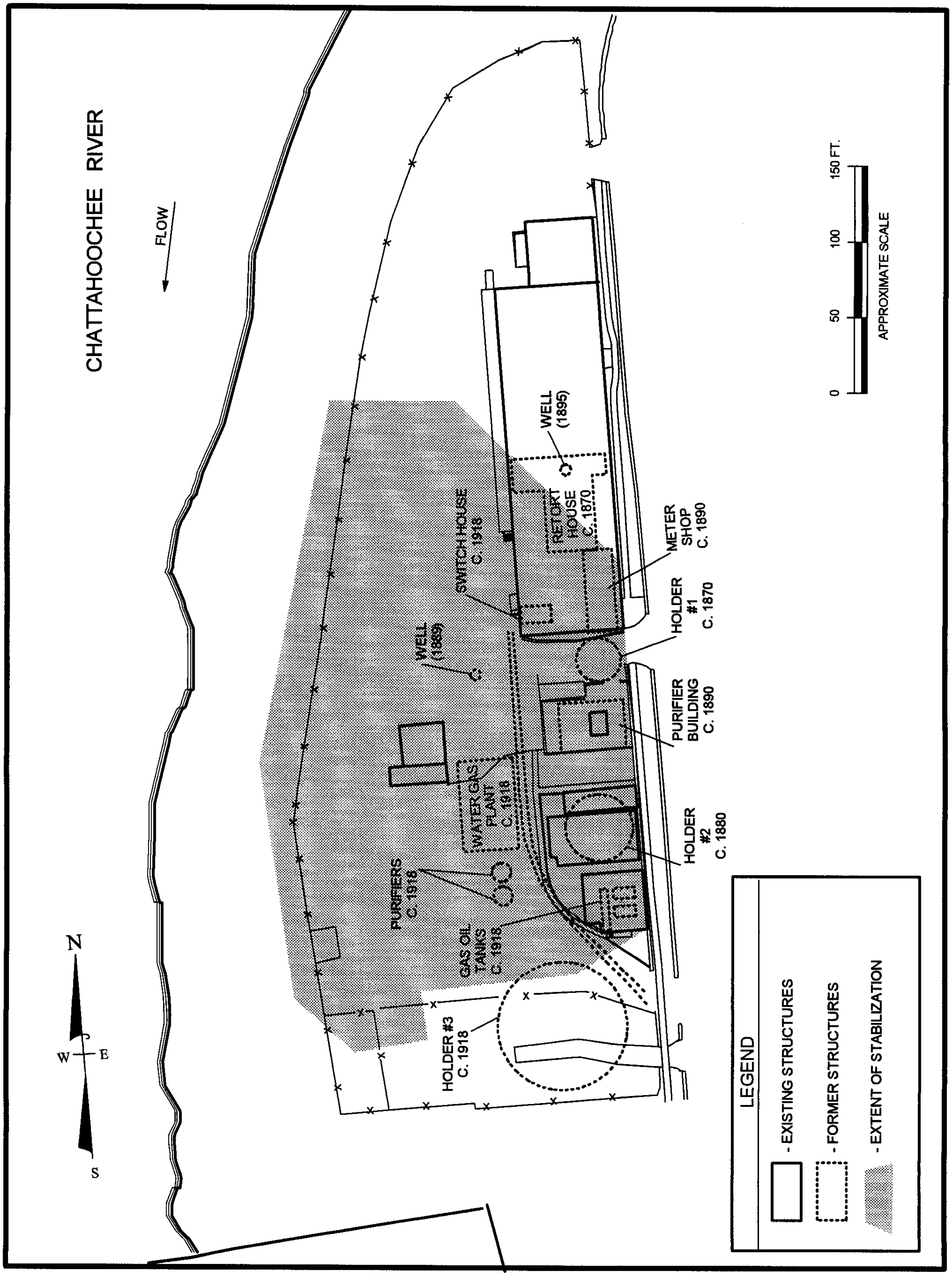

Figure 1. Site Layout

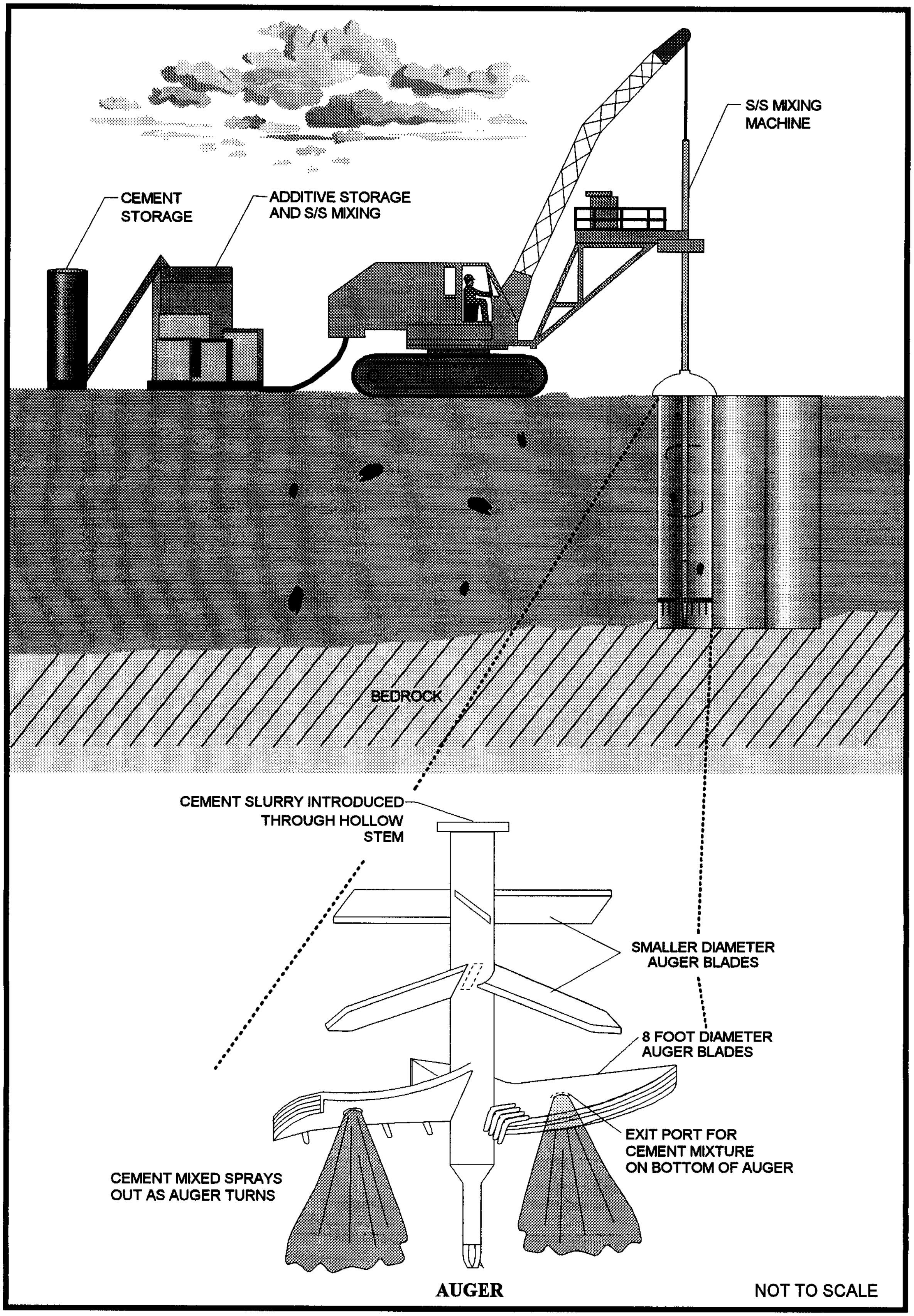

Figure 2. In-Situ Stabilization System

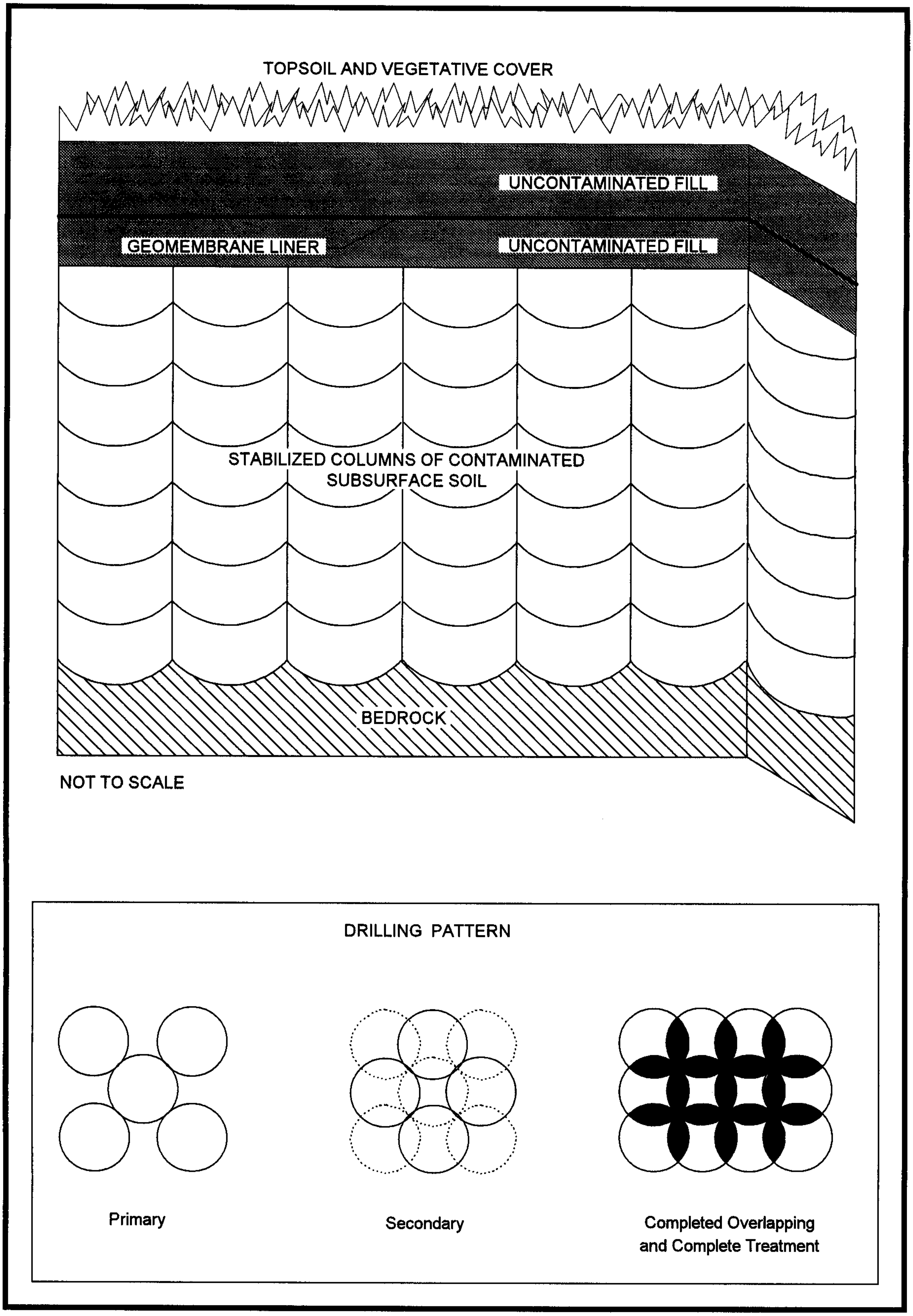

Figure 3. Sectional View of IN-SITU Soil Stabilization Area

Appendix G

Schermerhorn Creek Isolation Alternatives Analysis

BBL®
an ARCADIS company

Schermerhorn Creek Isolation Alternatives Analysis

nationalgrid

National Grid
Schenectady, New York

December 2006

BBL®
an ARCADIS company

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Figures

1. Introduction

This appendix presents a summary of alternatives reviewed by BBL, an ARCADIS Company (BBL) for isolation of the Schermerhorn Creek (the creek) from groundwater at the National Grid Schenectady (Broadway) Service Center property located in Schenectady, New York (Service Center property). This alternatives review was conducted in parallel with the preparation of the revised *Feasibility Study Report* (FS Report) (BBL, 2006) for the Schenectady (Broadway) Former MGP site. As described in the FS Report, isolation of the creek is required to achieve Groundwater Remedial Action Objective (RAO) #2: "Prevent future discharge of impacted groundwater to surface water in Schermerhorn Creek to the extent practicable."

The recommended site-wide remedial alternative will likely result in changes in the groundwater flow patterns (of both impacted and non-impacted groundwater) in the vicinity of the site. Due to the complex hydrostratigraphy beneath and surrounding the site (e.g., strong vertical gradients between hydrostratigraphic units, numerous regional hydraulic influences), fully understanding current groundwater flow conditions or predicting the effect of implementing the selected site-wide remedial alternative cannot be achieved with an acceptable degree of certainty. Based on the selected site remedy, the following statements can be made regarding on-site/off-site groundwater flow patterns:

1. The containment barrier will be designed and constructed to enclose impacted groundwater (but not all potentially-impacted groundwater) such that the groundwater stays within the barrier and does not discharge to the creek; and

2. The resulting groundwater flow patterns outside the containment barrier may include groundwater discharge (including potentially impacted groundwater in the vicinity of the gas regulator station located outside the proposed containment barrier) to the Schermerhorn Creek, if this creek is not isolated.

Therefore, isolation of the Schermerhorn Creek is required to fully meet groundwater RAO #2.

To evaluate potential alternatives for the isolation of the creek, BBL conducted a technical design review in October 2004 to assess current conditions. The technical design review consisted of the following activities:

- Conducting a site visit on October 7, 2004 to observe current creek conditions on the Service Center property, as well as upstream and downstream from the property;

- Reviewing the following design reports and associated drawings prepared by Stearns & Wheeler, Inc. (S&W) for National Grid: Alternatives Evaluation (April 1998); Basis of Design Report (April 1998); Army Corps of Engineers Permit Application (September 1998); and Final Design (December 1998);

- Conducting a review of existing hydrologic information (i.e., potentiometric surface maps, hydraulic gradients, etc.) at the site; and

- Assessing surface water hydrology/pipe hydraulics to evaluate relative impacts of the proposed design alternatives.

Following completion of the technical design review, potential conceptual alternatives to isolate the portion of the creek on the Service Center property were evaluated. In addition, a cost estimate was developed to construct the proposed creek modification.

The remainder of this appendix presents relevant background information relating to the creek, including a description of creek conditions, followed by a summary and review of the alternatives considered for the isolation of the creek.

2. Background

Schermerhorn Creek, which primarily serves as a conduit for stormwater runoff in the area (including runoff from the National Grid property), crosses the Service Center property in a general southwest to northeast direction prior to discharging to the Mohawk River (located approximately 4,000 feet north of the Service Center property). The setting of the creek relative to the property is indicated on Figure G-1. The creek daylights in the southwestern portion of the Service Center property from an approximately 90-inch diameter reinforced concrete pipe (RCP) and re-enters an approximately 72-inch diameter RCP culvert at the northeastern property boundary at Weaver Street.

Due to frequent flooding, the City of Schenectady (the City) received funding from the Federal Emergency Management Agency (FEMA) in 1996 to implement drainage improvements to the creek. Drainage improvements consisted of enclosing a portion of the creek upstream from the Service Center property in a culvert and removing sediment upstream and downstream from the Service Center property. Due to the presence of impacted sediment (i.e., sediment containing elevated concentrations of polychlorinated biphenyls [PCBs] and/or polynuclear aromatic hydrocarbons [PAHs]) within a portion of the creek on the Service Center property, sediment removal was not conducted for the onsite portion of the creek.

2.1 October 2004 Creek Observations

BBL conducted a site visit on October 7, 2004 to observe current conditions of the creek, extending approximately 0.25 miles upstream and approximately 0.3 miles downstream from the property. On the day of the site visit, the weather in the vicinity was clear and dry (there was no precipitation recorded in the site vicinity). Precipitation in the vicinity of the site was previously recorded on October 2, 2004 (CBS6Albany.com). BBL's creek observations were conducted from the top of the creek bank. BBL did not conduct sediment probing during the October 2004 site visit. Thicknesses of sediment observed during BBL's creek walk were estimated and are referenced at the locations of culverts relative to the percentage that the sediment filled the culverts at the culvert openings. The creek observations were conducted in order to:

- observe current creek conditions, including approximate depth of sediment (below top of water), depth of water in the creek, sizes of culverts, approximate locations of bridges, and approximate locations of utility crossings;

- assess potential causes/sources of the sediment observed in the creek and creek culverts (e.g., abrupt changes in hydraulic conditions, signs of significant erosion); and

- identify the locations and types of flow control structures (e.g., dams, weirs, sluice gates) and potential obstructions upstream and downstream from the Service Center property (if any).

Observations noted during the site visit are summarized below. The observations may be cross referenced to the points [1] through [4] as referenced on Figure G-2. The visual observations noted during the site visit (from downstream to upstream) are presented below followed by a summary of existing groundwater-creek interaction.

Offsite Downstream (from points [1] to [2])

- The inlet end of a 96-inch diameter RCP culvert located approximately 1,250 feet north (downstream) from the property showed no visible signs of accumulated sediment within the culvert, and appears to be flowing freely.

- The 96-inch diameter RCP culvert at Edison Avenue (approximately 800 feet downstream from the property) appeared to be approximately 50% filled with sediment.

- The 72-inch diameter Weaver Street culvert appeared to be approximately 50% filled with sediment at the downstream end, and approximately 10% filled with sediment at the upstream end.

Onsite (from points [2] to [3])

- At the time of BBL's field visit, the top of sediment within the onsite portion of the creek appeared to be approximately 3 feet below the top of the creek bank, and the creek appeared to have an average flow depth of approximately 10 to 14 inches.

- Portions of the onsite creek banks showed signs of erosion, likely from surface runoff (as evidenced by deep furrowing and irregularity of the ground surface in a direction perpendicular to the centerline of the creek).

- Existing mapping indicates the presence of two storm sewer drains that discharge from Broadway to the creek. The discharge points of these storm drains have not been observed by BBL.

Offsite Upstream (from point [3] to upstream of point [4])

- The 90-inch diameter RCP culvert that discharges to the Service Center property appeared to be approximately 80-90% filled with sediment.

- The creek banks through former Fuller's Pond located immediately west (i.e., upstream) of Congress Street showed signs of significant amounts of both past and present erosion and sloughing and appear to contain little to no vegetative growth in many areas. An outlet structure consisting of an overflow weir and a 30-inch diameter sluice gate leading to a 90-inch diameter RCP culvert was located at the downstream end of the former pond. The 90-inch diameter culvert appeared to be clear of sediments and flowing freely.

Potential causes/sources for the substantial sediment deposition (similar to the existing conditions) in the portion of the creek located on the Service Center property include the following:

- a significant decrease in downstream flow capacity (i.e., flow constriction);

- sloughing of unstable onsite creek banks;

- a change in upstream hydraulic conditions;

- a change in downstream hydraulic conditions (e.g., 72-inch RCP culvert) that could cause reduced upstream flow velocities, facilitating sediment deposition; and

- upstream erosion (i.e., Fuller's Pond) resulting in downstream propagation and deposition of sediment.

2.2 Existing Groundwater-Creek Interactions

As part of the *Site Remedial Investigation Report, Schenectady (Broadway) Site* (BBL, 2005), a water table elevation map indicating the current interaction between the creek and groundwater at the property was presented. The water table elevation map is included in this appendix as Figure G-3. Generally, the pattern of contours indicates that shallow groundwater beneath the property and surrounding areas flows northwest toward the Mohawk River. As indicated on the figure, Schermerhorn Creek is a losing stream in the vicinity of the site, meaning that surface water is discharging to the groundwater and that locally, groundwater flow is away from the creek. Based on the observed depth of sediment in the creek as well as depths previously reported by S&W, the water table appears to be within the layer of deposited sediment. Based on the current groundwater elevation data, if the sediment were removed to restore the creek bed to its original depth, the stream would likely become a gaining stream (i.e., impacted groundwater would recharge the surface water within the creek and the groundwater flow in the localized area surrounding the creek would be toward the creek). In addition, implementation of the selected site remedy (installation of a barrier wall) may further affect groundwater flow patterns in the vicinity of the creek, as described in the FS Report. As discussed in Section 1, the impact of the selected site remedy on groundwater (outside the containment barrier) cannot be readily predicted. Therefore, to meet groundwater RAO #2, the Schermerhorn Creek needs to be isolated.

3. Development and Evaluation of Creek Isolation Alternatives

Based on BBL's review of existing creek conditions, consideration of the proposed site remedy, and the previous technical design prepared by S&W, BBL has identified the following alternative measures for isolating the creek from site groundwater:

- Alternative 1 – Reinforced Concrete Culvert;
- Alternative 2 – Closed 90-inch High Density Polyethylene (HDPE) or Reinforced Concrete Pipe;
- Alternative 3 – Rip Rap Lined Open Channel; and
- Alternative 4 – Concrete Lined Open Channel with Removable Covers.

Presented below is a technical description of each alternative, along with identification of the likely advantages and disadvantages of each alternative. Each of the alternatives were developed using an assumed peak flow rate of 350 cubic-feet per second (cfs).

3.1 Alternative 1 – Reinforced Concrete Culvert

This alternative consists of installing a 6-foot tall by 8-foot wide pre-cast box concrete culvert to replace the current open channel section of the creek on the Service Center property. Under this alternative, the existing 90-inch RCP culvert that discharges to the Service Center property would be transitioned into the 6-foot by 8-foot box culvert using a pre-cast concrete catch basin. To allow surface water runoff to enter the creek, catch basins would be installed along the creek alignment.

In addition to conveying the creek flow, the concrete culvert would be water tight, thus mitigating the potential for impacted groundwater to come in contact with the surface waters of the Schermerhorn Creek. Installation of a concrete culvert and associated backfill would also stabilize the eastern creek bank which is currently eroding, specifically in the vicinity of the Weaver Street electrical substation.

Advantages and disadvantages of this alternative are presented below:

Reinforced Concrete Culvert	
Advantages	**Disadvantages**
• Provides an effective barrier to surrounding groundwater, effectively isolating the Schermerhorn Creek from on-site- or off-site-related impacts. • Monitoring of the culvert (for groundwater intrusion) is readily implemented. • The smooth interior of the box culvert would facilitate higher flow velocities than the current open channel, minimizing sediment deposition within the new culvert, thus limiting long-term operation and maintenance requirements. • Easy to install except where utilities cross the	• Three known gas utility crossings and one known electrical utility crossing would need to be relocated beneath or over the box culvert (routing utilities through the box culvert could substantially reduce flow capacity and cause debris accumulation and blockage). • Would not provide a riparian habitat. • A closed culvert system will reduce the in-stream storage capacity during higher flows; however, the culvert could be designed to convey major storm events.

Reinforced Concrete Culvert	
Advantages	**Disadvantages**
creek. • Relatively small area of disturbance during installation. • Limits potential for future bank erosion and undermining in area of the Weaver Street Substation.	

3.2 Alternative 2 – 90-inch HDPE or Reinforced Concrete Pipe

Under this option, a 90-inch diameter HDPE or RCP (90-inch pipe) could be used similar to the box culvert to isolate the onsite portion of the creek. To allow surface water runoff to enter the creek, catch basins would be installed along the creek alignment.

In addition to conveying the creek flow, the pipe would be water tight, thus mitigating the potential for impacted groundwater to come in contact with the surface waters of the Schermerhorn Creek. Installation of a 90-inch pipe and associated backfill would also stabilize the eastern creek bank which is currently eroding, specifically in the vicinity of the Weaver Street electrical substation.

Advantages and disadvantages of this alternative are presented below:

90-inch HDPE or Reinforced Concrete Pipe	
Advantages	**Disadvantages**
• Provides an effective barrier to surrounding groundwater, effectively isolating the Schermerhorn Creek from on-site- or off-site-related impacts. • Monitoring of the pipe (for groundwater intrusion) is readily implemented. • The smooth interior of the pipe would facilitate higher flow velocities, minimizing sediment deposition, thus limiting long-term operation and maintenance requirements. • Easy to install except at utility crossings. • Relatively small area of disturbance during installation. • If HDPE can be used (based on size availability) the material costs would be less expensive than concrete.	• Three known gas utility crossings and one known electrical utility crossing would need to be relocated beneath or over the culvert (routing utilities through the 90-inch pipe could substantially reduce flow capacity and cause debris accumulation and blockage). • Would not provide a riparian habitat. • A pipe system will reduce the in-stream storage capacity during higher flows; however, the pipe could be designed to convey major storm events.

90-inch HDPE or Reinforced Concrete Pipe	
Advantages	**Disadvantages**
• Additional creek crossings could be designed given sufficient clearance to backfill over the pipe or by installing reinforcement around sections of the culvert. • Limits potential for future bank erosion and undermining in area of the Weaver Street Substation.	

3.3 Alternative 3 – Riprap-Lined Open Channel

Under this option, riprap could be used to create a stable, open-channel creek on the Service Center property. Underneath the riprap would be a multi-component liner system (such as geo-composite liner, HDPE, select fill) that would isolate the creek from the site groundwater. In addition, the creek channel would be lined with an impermeable material to isolate surface water from impacted groundwater at the site. The riprap would need to be sized to accommodate specific design storm flows.

Advantages and disadvantages associated with a riprap-lined open channel include the following:

Riprap-Lined Open Channel	
Advantages	**Disadvantages**
• Provides a barrier to surrounding groundwater.	• The creek would need to be frequently maintained by the City of Schenectady to limit accumulation of sediment or other debris. • Effectiveness of barrier is directly proportional to frequent and regular maintenance by the City of Schenectady. • Difficult to monitor liner system under riprap for groundwater intrusion/infiltration into the creek. • The liner system would need to be sufficiently weighted to resist buoyant forces from the surrounding groundwater. • Would not provide a riparian habitat. • Liner system, if damaged, would be difficult to replace. • Riprap would need to be laid back on a maximum slope of 2:1 (horizontal:vertical) which would be difficult to install and maintain. Installation of a “flatter” slope (3:1 or less) may not be practicable in the areas

Riprap-Lined Open Channel	
Advantages	**Disadvantages**
	of existing buildings, substations or site bridges. • Adequate physical and visual barriers would need to be installed to limit the potential for site personnel and visitors to accidentally enter or otherwise fall into the creek.

3.4 Alternative 4 – Concrete-Lined Open Channel with Removable Covers

Under this option, an open-top cast-in-place or pre-cast concrete-lined channel would be used to isolate the creek. The concrete-lined channel would be constructed with vertical side walls and removable grating or solid steel plating to facilitate creek crossing and protect site personnel and visitors from potentially falling into the creek at the site. Open grating would allow surface water runoff from the site to enter the creek. The grating/plates would be removable to facilitate maintenance activities within the channel.

Advantages and disadvantages associated with a concrete lined channel include the following:

Concrete-Lined Open Channel with Removable Covers	
Advantages	**Disadvantages**
• Provides an effective barrier to surrounding groundwater, effectively isolating the Schermerhorn Creek from on-site- or off-site-related impacts. • Monitoring of the culvert (for groundwater intrusion) is readily implemented. • Easy access to creek for maintenance by the City of Schenectady. • The smooth concrete lining would facilitate higher flow velocities, reducing the potential for sediment deposition.	• Could be labor-intensive to cast in place. • Would not provide a riparian habitat. • May require substantial amount of in-creek work which would increase the period of time required to divert creek flow. • Potential maintenance to the gas utilities would be very difficult if they are conveyed beneath the concrete liner. • May be difficult to construct a smooth transition from the 90-inch culvert to the concrete-lined channel. An abrupt transition could create an area prone to debris accumulation and blockage. • “Open top” configuration could result in accumulation of debris (from the surface), which would require frequent maintenance by the City of Schenectady.

3.5 Additional Data Needs

Isolation of the existing creek, under any of the above-listed four alternatives would present certain considerations that would need to be addressed during remedial design, as listed below:

1. Gas and electrical utilities that currently cross the creek would need to be relocated, removed or replaced. Gas lines are known to cross the creek at three locations and two electrical conduits currently cross over the creek in the vicinity of the electrical substation. In addition, two onsite gas lines run parallel to the western edge of the creek in the southern portion of the Service Center property. Overhead electrical service lines also cross over the creek at several locations and must be assessed for potential obstruction with construction equipment. All nearby utilities and utility crossings need to be identified and mapped (utility type, size, depth, minimum relocation requirements, buffer requirements, etc.) prior to preparation of a final design or construction of the drainage improvements.

2. The existing lateral storm sewer drain(s) from Broadway would need to located and tied into the selected creek modification. Construction and/or maintenance associated with offsite drainage may require additional coordination with the City of Schenectady.

3. Based on BBL's site visit in October 2004, sediment is likely present at a volume between 10 and 50% of capacity within the 72-inch culvert. The extent of sediment within the 90-inch culvert is unknown, but at the downstream end of the culvert, sediment is currently present in approximately 80-90% of the visible portion of the culvert outfall. The sediment within these culverts would need to be removed in order to minimize the potential for redistribution of the sediment following construction of the selected creek modification. Currently, analytical data for sediment within the existing culverts is not available.

4. Invert elevations of the existing drainage structures.

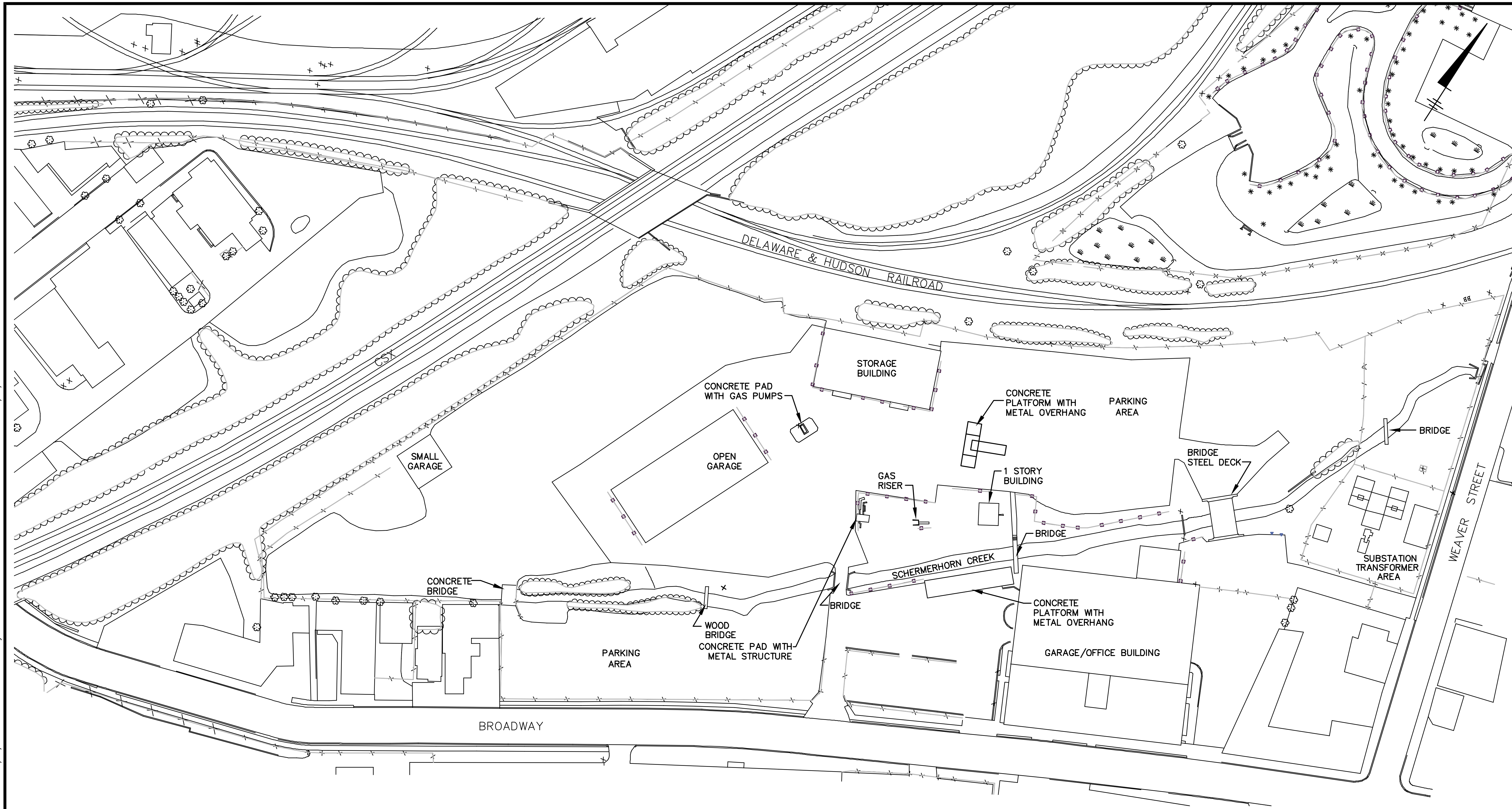
5. A backwater analysis during design storm events (i.e., 25 yr., 50 yr., and/or 100 yr.) will need to be conducted. Because of the potential for the 72-inch Weaver Street culvert to act as a flow constriction during high flow events, this analysis would be conducted to determine if the selected creek modification will have sufficient flood storage, and what the flood area would be for given design storms.

6. An assessment of the Schermerhorn Creek watershed to determine peak design flows as well as to determine creek diversion requirements.

3.6 Selected Creek Isolation Alternative

Based on the analysis conducted by BBL, all alternatives provide some form of isolation of the Schermerhorn Creek. Alternatives 1, 2, and 4 provide a more effective barrier than Alternative 3. Alternative 3 has no advantages to its construction and would require the most extensive amount of maintenance by the City of Schenectady. Alternative 4 also would require more maintenance by the City of Schenectady (as compared to Alternatives 1 and 2). In addition, although not included in this evaluation, the City of Schenectady has, in meetings with National Grid, indicated they would support installation of a culvert for the on-site reach of the Schermerhorn Creek. The City of Schenectady's acceptance of this alternative could be included in the evaluation of Community Acceptance of the selected site-wide remedy by the NYSDEC. In consideration of the long-term maintenance concerns and the need to provide an effective barrier, a closed culvert (either the reinforced concrete box culvert or the 90 inch pipe) has been selected as the method for inclusion into the FS Report for the isolation of the creek and to achieve (in part) groundwater RAO #2. For costing analysis, the concrete box culvert was identified within the FS Report; however, either the box culvert or 90-inch pipe constructed of reinforced concrete or HDPE will be effective in attaining the creek isolation goals.

Figures



NOTES:

1. BASE MAP PROVIDED BY NIAGARA MOHAWK POWER CORPORATION ON 5/21/99, FROM NIAGARA MOHAWK POWER CORPORATION SURVEY REFERENCE FILE DRAWING 3277.DGN, DATED 10/26/94 AT A SCALE OF 1"=100'.
2. ALL LOCATIONS ARE APPROXIMATE.

LEGEND:

—X— FENCE LINE

0 100' 200'

GRAPHIC SCALE

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK
SCHERMERHORN CREEK ISOLATION ALTERNATIVES ANALYSIS

SITE MAP

BBL® an ARCADIS company

FIGURE
G-1

LEGEND:

[1] CROSS REFERENCE CREEK OBSERVATION LOCATION

SCHERMERHORN CREEK

SITE PROPERTY LINE

NOTE:

BASE MAPPING FROM A DRAWING BY PARSONS ENGINEERING SCIENCE, INC. ENTITLED "BTEX, PAHs AND CYANIDE IN SURFACE SOIL, SEDIMENT AND SURFACE WATER, FILE TRACER: H:CAD\725727\25727G06.DWG, @ A SCALE OF 1" = 80', DATED 6/24/97.

0 400' 800'

GRAPHIC SCALE

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK

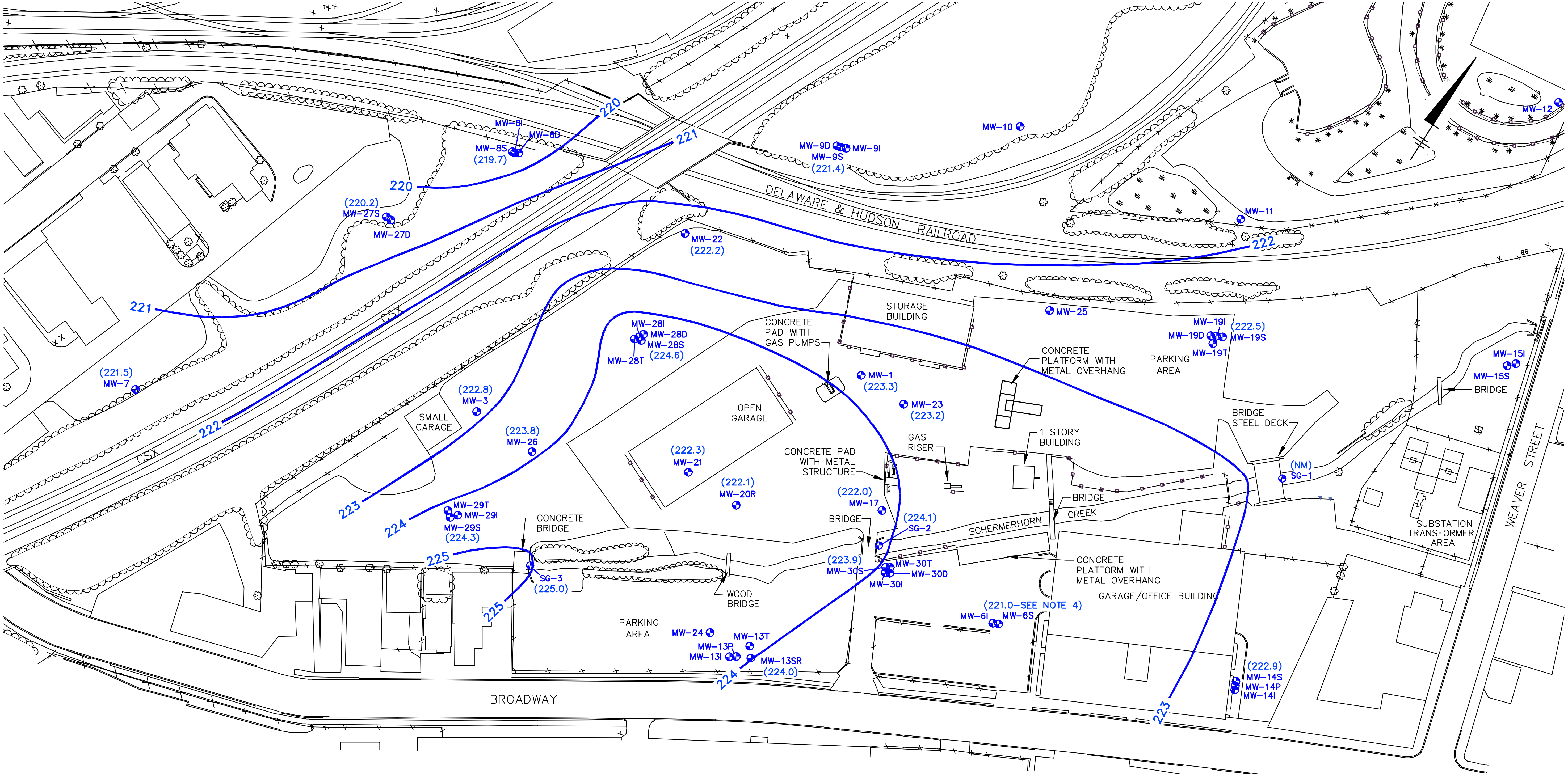
SCHERMERHORN CREEK ISOLATION ALTERNATIVES ANALYSIS

CREEK OBSERVATION LOCATION MAP

BBL® an ARCADIS company

FIGURE **G-2**

SYR-85-PGL L: ON=*, OFF=REF, (FRZ)
F:\ACTIVE\-DWG\ACT\36657018\36657B46.DWG SAVED:11/14/2006 4:38 PM LAYOUT:Layout1 PAGESETUP:---- PENTABLE:PLTFULL.CTB PRINTED:11/14/2006 4:38 PM BY:PLISTER
PROJECTNAME:----
XREFS: IMAGES:



0 100' 200'

GRAPHIC SCALE

NOTES:

1. BASE MAP PROVIDED BY NIAGARA MOHAWK POWER CORPORATION ON 5/21/99, FROM NIAGARA MOHAWK POWER CORPORATION SURVEY REFERENCE FILE DRAWING 3277.DGN, DATED 10/26/94 AT A SCALE OF 1"=100'.
2. MONITORING WELL LOCATIONS SURVEYED BY BBL.
3. HORIZONTAL DATUM IS NEW YORK STATE PLANE OF 1983, EAST ZONE.
4. WATER LEVEL MEASURED AT MW-6S APPEARS ANOMALOUS AND WAS NOT USED FOR CONTOURING.
5. MONITORING WELLS MW-17, MW-20R, AND MW-21 WERE INSTALLED SUCH THAT THEIR SCREENS STRADDLE THE SHALLOW AND INTERMEDIATE HYDROSTRATIGRAPHIC ZONES. THEREFORE THE WATER LEVELS MEASURED AT THESE LOCATIONS ARE NOT INDICATIVE OF THE WATER LEVELS FOR EITHER OF THESE ZONES AND WERE NOT USED FOR CONTOURING.
6. MONITORING WELLS MW-20R, REPLACED MONITORING WELL MW-20; MW-21 REPLACED MW-5; MW-22 REPLACED MW-4; MW-23 REPLACED MW-18; AND MW-26 REPLACED MW-16.

LEGEND:

MW-15S	MONITORING WELL
—X—	FENCE LINE
	APPROXIMATE LOCATION OF EXISTING SITE FEATURE
224	INFERRED GROUNDWATER ELEVATION CONTOUR
(224.0)	GROUNDWATER ELEVATION
(NM)	NOT MEASURED

NATIONAL GRID
SCHENECTADY (BROADWAY) SERVICE CENTER
SCHENECTADY, NEW YORK
SCHERMERHORN CREEK ISOLATION ALTERNATIVES ANALYSIS

WATER TABLE ELEVATION CONTOUR MAP - MAY 2005

BBL® an ARCADIS company

FIGURE **G-3**