National Grid

FEASIBILITY STUDY REPORT

Gloversville (Hill Street)
Former Manufactured Gas Plant
Gloversville, New York
Site No. 5-18-021

February 2017

Certification Statement

I, Jason D. Brien, P.E. certify that I am currently a NYS registered professional engineer and that this *Feasibility Study Report* was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER *Technical Guidance for Site Investigation and Remediation* (DER-10).

Date 2/14/17

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Former Manufactured Gas Plant Site

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ACRONYMS AND ABBREVIATIONS

AMSL	above mean sea level
Bss	below sediment surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CFR	Code of Federal Regulations
COC	constituent of concern
cy	cubic yard
CWA	Clean Water Act
DAR	Division of Air Resources
DER	Division of Environmental Remediation
DNAPL	dense non-aqueous phase liquid
DUS	dynamic underground stripping
ECL	Environmental Conservation Law
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
FWRIA	Fish and Wildlife Resource Impact Analysis
GJJWTF	Gloversville-Johnstown Joint Wastewater Treatment Facility
GRAs	general response actions
GRS	gas regulator station
HASP	health and safety plan
HDPE	high-density polyethylene
HHEA	Human Health Exposure Assessment
HPO	hydrous pyrolysis/oxidation
IRM	interim remedial measure
ISCO	in-situ chemical oxidation
ISS	in-situ solidification
LDRs	Land Disposal Restrictions
LTTD	low-temperature thermal desorption
mg/kg	milligrams per kilogram
MGP	manufactured gas plant
MNR	monitored natural recovery
NAPL	non-aqueous phase liquid

NYCRR	New York Code of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbons
POTW	publicly-owned treatment works
PPE	personal protective equipment
PRB	permeable reactive barrier
PSA	preliminary site assessment
RCRA	Resource Conservation and Recovery Act
RAO	remedial action objective
RI	Remedial Investigation
SCG	standards, criteria, and guidance
SCOs	soil cleanup objectives
SMP	site management plan
SPDES	State Pollutant Discharge Elimination System
SVI	soil vapor investigation
SVOC	semi-volatile organic compound
TCLP	toxicity characteristic leaching procedure
TOGS	Technical and Operational Guidance Series
UGI	United Gas Improvement Company
USACE	U.S. Army Corps of Engineers
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
UTSs	Universal Treatment Standards
UV	ultraviolet
VOC	volatile organic compound

EXECUTIVE SUMMARY

Introduction

This Feasibility Study Report (FS Report) presents an evaluation of remedial alternatives to address environmental impacts identified at the National Grid Gloversville (Hill Street) Former Manufactured Gas Plant (MGP) site (the site) located in Gloversville, New York (Site No. 5-18-021). This FS Report has been prepared in accordance with the November 7, 2003 multi-site Order on Consent (Index No. A4-0473-0000) between National Grid and the New York State Department of Environmental Conservation (NYSDEC).

The purpose of this FS Report is to identify and evaluate remedial alternatives that are:

- Appropriate for site-specific conditions.
- Protective of public health and the environment.
- Consistent with relevant sections of Title 6 of the New York Code of Rules and Regulations (6NYCRR) Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10) and Part 375.

The overall objective of this FS Report is to recommend a reliable and cost-effective remedy that achieves the site-specific remedial action objectives (RAOs) and the best balance of the NYSDEC evaluation criteria.

Background

The Gloversville (Hill Street) former MGP site is located at 20 Hill Street in a mixed residential, commercial, and industrial area south of downtown Gloversville, New York. The former MGP is bordered by Hill Street to the north, a wooded area to the south, South Boulevard and residences to the east, and a recreational walking/biking trail and Cayadutta Creek to the west. Additionally, a former bulk petroleum storage facility is located west of the site between the recreational trail and Cayadutta Creek.

The site currently operates as a National Grid service center. The site occupies an area of approximately 13 acres comprised of the service center area (approximately eight acres) and a wooded area south of the service center area (approximately five acres), referred to as the southern area. The service center operates as a base for natural gas and electrical transmission maintenance personnel and equipment. Service center features include an office/garage building (the service center building), multiple storage buildings and sheds, an open garage, a groundwater treatment system building, and various outdoor storage areas for utility maintenance equipment (e.g., poles, transformers, cable, piping, etc.).

Nature and Extent of Impacts

MGP-related impacts in the form of coal tar non-aqueous phase liquid (NAPL) and elevated concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX) compounds, polycyclic aromatic hydrocarbons (PAHs), and (to a lesser extent) cyanide have been identified as the constituents of concern (COCs) for the site. The site-related impacts are generally distributed as follows:

Visual Impacts

NAPL in the ground beneath the site (primarily coal tar dense-nonaqueous phase liquid [DNAPL]) is responsible for most of the environmental impacts resulting from the former MGP operations. DNAPL has been generally observed in the upper 20 feet of overburden (i.e., upper sand and gravel, peat, and fill materials), primarily within the first few feet above the top of the silt unit. Although DNAPL has generally not been able to penetrate the silt, the lower sand and gravel appears to contain minor amounts of DNAPL near/at areas where the silt is relatively thin or not present (i.e., north of the open garage and the "silt window" area in the southern area).

A former site drain system discharged collected groundwater and DNAPL into an unlined ditch near the southwestern corner of the service center area (i.e., near the current storm water detention basin). DNAPL has been observed along the eastern banks of the Cayadutta Creek near and south of this area. Minor quantities of DNAPL have also been observed above the silt in a few isolated areas beneath the western bank of Cayadutta Creek and in one isolated area further downstream beneath the eastern bank of Cayadutta Creek. Although NAPL has been observed at the bottom of the Cayadutta Creek in isolated sediment pockets adjacent to and downstream of the site, NAPL has not been observed in the creek since the 2007 Storm Sewer interim remedial measure (IRM).

An area of purifier waste placed as fill material is present along the eastern fence line of the service center area.

Soil Quality

Subsurface soil analytical results were compared to restricted industrial use and unrestricted soil cleanup objectives (SCOs) presented in 6 NYCRR Part 375-6, for soil samples collected within and outside the service center area, respectively. In addition, site-specific screening values of 10 milligrams per kilogram (mg/kg) total BTEX and 500 mg/kg total PAHs have been established to aid in the delineation of soil containing site-related impacts.

In general, soil samples containing individual BTEX compounds and total BTEX compounds at concentrations exceeding their respective criteria were collected near/at locations where NAPL has been observed. Additionally, soils samples containing cyanide at concentrations greater than the 6NYCRR Part 375-6 restricted use SCOs for the protection of ecological resources were generally collected at the eastern portion of the service center area, in areas containing NAPL or NAPL-impacted soil and within the area where purifier waste was placed as fill material.

Groundwater Quality

Groundwater analytical results were compared to the Class GA groundwater quality standards/guidance values presented in the NYSDEC's Division of Water, Technical and Operational Guidance Series 1.1.1: Ambient Water Quality Standards and Groundwater Effluent Limitations (TOGS 1.1.1) (NYSDEC, 2008).

The extent of groundwater impacts has a strong correlation to the observed DNAPL distribution across the site. Dissolved-phase BTEX, PAHs, and cyanide have been detected at concentrations greater than NYSDEC Class GA standards and guidance values in a majority of monitoring wells in the service center area installed within the upper sand-and-gravel/fill unit, with the exception of the wells north of the service center building. The groundwater impacts exceeding the NYSDEC Class GA standards and guidance values extend to the area along South Boulevard to the east, wells MW-14S and MW-31S to the west, and the northwestern corner of the southern area where NAPL has been observed and Cayadutta Creek to the south.

The vast majority of groundwater sampled from monitoring wells screened in the lower sand and gravel does not contain MGP-related constituents; however, a few localized areas of affected groundwater do exist where minor amounts of DNAPL have been observed in this unit. These areas are at/near the former relief holder and the silt window.

Sediment Quality

The greatest PAH concentrations in sediment have generally been detected in small depositional areas located in the vicinity of the right-angle bend in the creek near the site. Sheens resulting from the physical disturbance of some fine-grained sediments have been noted upstream, adjacent to, and downstream from the site, but their presence does not correlate well with high PAH concentrations. Additionally, sheens observed north of the right-angle bend in the creek are likely associated with other industries in the area and not related to the MGP or other activities conducted on the National Grid property.

Surface Water Quality

Dissolved-phase BTEX and PAHs have only been detected in surface water samples collected within or at the former drainage ditch that discharged to Cayadutta Creek at the southwest corner of the service center area. These surface water samples were collected prior to the 1995 and 2007 Storm Sewer IRMs, which served to improve the quality of the surface water discharging from the site to Cayadutta Creek. Based on the surface water analytical results for water samples collected from Cayadutta Creek, surface water in Cayadutta Creek does not contain detectable concentrations of BTEX and PAHs.

Remedial Action Objectives

RAOs are developed to address the specific COCs at the site, and to assist in developing goals for cleanup of COCs in each media that may require remediation. The RAOs presented in the following table have been developed based on the generic RAOs listed on NYSDEC's website (http://www.dec.ny.gov/regulations/67560.html).

Table ES.1 Remedial Action Objectives

RAOs for Soil
RAOs for Public Health Protection
1. Prevent, to the extent practicable, ingestion/direct contact with site-related COCs/ NAPL.
2. Prevent, to the extent practicable, inhalation of or exposure to site-related COCs from impacted soil.
3. Address, to the extent practicable, site-related COCs/NAPL in soil that could result in impacts to groundwater, surface water, or sediment.
4. Prevent, to the extent practicable, impacts to biota from ingestion/direct contact with soil containing site-related COCs.

RAOs for Groundwater
RAOs for Public Health Protection
1. Prevent, to the extent practicable, ingestion of groundwater containing site-related dissolved phase COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values.
2. Prevent, to the extent practicable, contact with or inhalation of volatile organic compounds (VOCs) from groundwater containing site-related COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values.
RAOs for Environmental Protection
1. Restore groundwater to pre-disposal/pre-release conditions, to the extent practicable.
2. Prevent the discharge of site-related COCs from groundwater to surface water and sediment, to the extent practicable.
3. Address the source of site-related groundwater impacts to the extent practicable.
RAOs for Soil Vapor
RAOs for Public Health Protection
1. Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at the site.
RAOs for Sediment
RAOs for Public Health Protection
1. Prevent, to the extent practicable, direct contact with impacted sediments.
2. Prevent, to the extent practicable, surface water impacts which may result in fish advisories.
RAOs for Environmental Protection
1. Prevent, to the extent practicable, releases of site-related COCs from sediments that would result in surface water levels in excess of ambient water quality criteria.
2. Prevent, to the extent practicable, impacts to biota from ingestion/direct contact with sediment containing site-related COCs in the sediment area identified to contain MGP residuals.
3. Restore sediments to pre-release/background conditions to the extent feasible.

Remedial Technology Screening and Development of Remedial Alternatives

The objective of the technology screening is to:

- Present general response actions (GRAs) and the associated remedial technology types and technology process options that have documented success at achieving similar RAOs at MGP sites.
- Identify options that are implementable and potentially effective at addressing site-specific concerns.

Based on this screening, remedial technology types and technology 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 NYSDEC DER DER-10.

Based on the results of the technology screening, the following potential remedial alternatives were developed:

- Alternative 1 – No Further Action
- Alternative 2 – Groundwater/NAPL Monitoring, monitored natural attenuation (MNR), and Institutional Controls
- Alternative 3 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment
- Alternative 4 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment
- Alternative 5 – Soil Removal to Unrestricted Use SCOs and Sediment Removal to Background Conditions

Detailed Evaluation of Alternatives

Following the development of the remedial alternatives, a detailed description of each alternative was prepared and each alternative was evaluated with respect to the following criteria presented in DER-10:

- Short-Term Impacts and Effectiveness
- Long-Term Effectiveness and Permanence
- Land Use
- Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment
- Implementability
- Compliance with standards, criteria, and guidelines (SCGs)
- Overall Protectiveness of Public Health and the Environment
- Cost Effectiveness

Comparative Analysis of Alternatives

Following the detailed evaluation of each alternative, a comparative analysis of the alternatives was completed using the evaluation criteria. The comparative analysis identified the advantages and disadvantages of each alternative relative to each other and with respect to the evaluation criteria. The results of the comparative analysis were used as a basis for recommending the preferred remedy for achieving the RAOs.

Preferred Remedial Alternative

The results of the comparative analysis were used as the basis for recommending a preferred remedial alternative for the site: Alternative 4. The primary components of the preferred remedial alternative consist of the following:

- Excavating 520 cubic yards (cy) of soil to facilitate the construction of a permeable NAPL barrier wall.
- Constructing a permeable NAPL barrier wall in the southern area perpendicular to the groundwater flow pathway to prevent potentially mobile NAPL in the service center property from migrating into Cayadutta creek. The NAPL barrier wall would include NAPL collection sumps installed within the wall to facilitate NAPL recovery.
- Excavating approximately 14,800 cy of material to address 4,100 cy of soil containing significant quantities of NAPL (i.e., greater than sheens and blebs) downgradient of the NAPL barrier wall and 3,000 cy of shallow purifier waste along the eastern boundary of the service center area.
- Removing surface soil (up to 2 feet below grade) located upgradient from the NAPL barrier wall and outside of the fenced service center area that contains COCs at concentrations greater than residential SCOs and installing a soil cover over this area.
- Removing an estimated 1,300 cy of sediment containing MGP-related impacts (i.e., visual indications of coal tar and/or material that generates sheens when disturbed).
- Transporting an estimated 16,500 tons of excavated material off-site for disposal as a non-hazardous solid waste.
- Transporting an estimated 10,800 tons of excavated material off-site for treatment/ disposal via low-temperature thermal desorption (LTTD).
- Installing up to seven NAPL recovery wells at locations in the service center property where recoverable quantities of NAPL have historically accumulated in groundwater monitoring wells.
- Conducting annual groundwater monitoring/NAPL recovery and MNR activities.
- Preparing an annual report to summarize annual groundwater sampling/NAPL recovery and MNR activities.
- Continuing operation and maintenance of the existing on-site drains and associated groundwater system.
- Establishing institutional controls in the form of deed restrictions and/or environmental easements for the properties that contain MGP-related impacts to limit the future development and use of the site and site groundwater, as well as to limit the permissible invasive (i.e., subsurface) activities that could result in potential exposures to subsurface soil, groundwater, and sediment containing MGP-related impacts. Additionally, the institutional controls would require compliance with the site management plan (SMP) (described below) that would be prepared as part of this alternative.

- Preparing an SMP to document the following:
  - The institutional controls that have been established and would be maintained for the site.
  - Known locations of remaining soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 industrial use SCOs.
  - Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities.
  - Protocols and requirements for conducting annual groundwater monitoring/NAPL recovery, and MNR.
  - Requirements for performing periodic site inspections, providing NYSDEC-required certifications, and submitting periodic reports to NYSDEC.

Alternative 4 would achieve the best balance of the NYSDEC evaluation criteria, while reducing the potential for future exposure to site-related impacts.

1 INTRODUCTION

This Feasibility Study Report (FS Report) presents an evaluation of remedial alternatives to address environmental impacts identified at the National Grid Gloversville (Hill Street) Former Manufactured Gas Plant (MGP) site (the site) located in Gloversville, New York (Site No. 5-18-021). This FS Report has been prepared in accordance with the November 7, 2003 multi-site Order on Consent (Index No. A4-0473-0000) between National Grid and the New York State Department of Environmental Conservation (NYSDEC).

1.1 Regulatory Framework

This FS Report has been prepared to evaluate remedial alternatives to address identified environmental impacts at the site in a manner consistent with the Order on Consent and with NYSDEC Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10) (NYSDEC, 2010a).

This FS Report has also been prepared in consideration of applicable provisions of the New York State Environmental Conservation Law (ECL) and associated regulations, including Title 6 of the New York Code of Rules and Regulations (NYCRR) Part 375-6 (6 NYCRR Part 375-6).

1.2 Purpose

The purpose of this FS Report is to identify and evaluate remedial alternatives that are:

- Appropriate for site-specific conditions.
- Protective of public health and the environment.
- Consistent with relevant sections of 6NYCRR DER-10 and Part 375.

The overall objective of this FS Report is to recommend a reliable and cost-effective remedy that achieves the site-specific remedial action objectives (RAOs) and the best balance of the NYSDEC evaluation criteria.

1.3 Report Organization

This FS Report is organized as presented in the following table.

Table 1.1 Report Organization

Section	Purpose
Section 1 – Introduction	Provides background information relevant to the development of remedial alternatives evaluated in this FS Report.
Section 2 – Identification of Standards, Criteria, and Guidance	Identifies standards, criteria, and guidance (SCGs) that govern the development and selection of remedial alternatives.
Section 3 – Development of Remedial Action Objectives	Presents the site-specific RAOs that have been developed to be protective of public health and the environment.

Section	Purpose
Section 4 – Technology Screening and Development of Remedial Alternatives	Presents the results of a screening process completed to identify potentially applicable remedial technologies and develops remedial alternatives that have the potential to meet the RAOs.
Section 5 – Detailed Evaluation of Remedial Alternatives	Presents a detailed description and analysis of each potential remedial alternative using the evaluation criteria presented in the referenced guidance documents.
Section 6 – Comparative Analysis of Alternatives	Presents a comparative analysis of the remedial alternatives using the evaluation criteria.
Section 7 – Preferred Remedial Alternative	Identifies the preferred remedial alternative for addressing the environmental concerns at the site.
Section 8 – References	Provides a list of references utilized to prepare this FS Report.

1.4 Background Information

This section summarizes site background information relevant to the development and evaluation of remedial alternatives, including site location and physical setting, MGP site history and operation, and a summary of previous investigations and interim remedial measures (IRMs) completed at the site.

1.4.1 Site Location and Physical Setting

The Gloversville (Hill Street) former MGP site is located at 20 Hill Street in a mixed residential, commercial, and industrial area south of downtown Gloversville, New York (Figure 1). As shown on Figure 2, the former MGP is bordered by Hill Street to the north, a wooded area to the south, South Boulevard to the east, and a recreational walking/biking trail and Cayadutta Creek to the west. Additionally, a former Agway petroleum storage facility is located west of the site between the recreational trail and Cayadutta Creek.

The site currently operates as a National Grid service center. The site covers an area of approximately 13 acres comprised of the service center area (approximately eight acres) and a wooded area south of the service center area (approximately five acres), referred as the southern area. The service center operates as a base for natural gas and electrical transmission maintenance personnel and equipment. Service center features include an office/garage building (the service center building), multiple storage buildings and sheds, an open garage, a groundwater treatment system building, and various storage areas for utility maintenance equipment (e.g., poles, transformers, cable, piping, etc.). Current site features are shown on Figure 2.

During an unknown period in (or prior to) the late 1800s/early 1900s, the southern portion of the service center area (the area currently occupied by the open garage and equipment storage areas) was backfilled to the approximate existing lines and grades. The wooded southern area was not backfilled (or was backfilled to a lesser extent) and remains lower in elevation compared to the fenced service center.

1.4.2 Site History and Operation

The former MGP was constructed by the United Gas Improvement Company (UGI) in 1898 to serve both the Johnstown and Gloversville communities. UGI sold the company to the Fulton County Gas and Electric Company in 1900. In 1907, the facility was producing gas (via the water gas process). In 1927, the Fulton County Gas and Electric Company (controlled by the Mohawk Power Company) was consolidated with other utility companies to form New York Power and Light Corporation. Gas production at the site continued on a full-time basis until 1929-1930 when a gas main from a Troy, New York facility was constructed. Approximate locations of former MGP structures present at the site in 1907, 1927, and 1937 are shown on Figure 3. Additionally, a trench used for tar disposal was reportedly located along the eastern site boundary south of the gas holders.

Based on a review of Sanborn maps, during the early 1900s, a lumber mill and leather mill operated in the southern area. The alignment of Cayadutta Creek was altered during the past century. Based on the 1912 and 1927 Sanborn maps, Cayadutta Creek consisted of meanders and oxbows south of the service center area near what is now South Boulevard and it appears that the creek was dammed in this area (potentially to harness hydro-mechanical/hydro-electric power for mill operations).

After 1930, gas was produced at the site on a seasonal basis only (i.e., during the winter months). In 1950, regional utility companies were consolidated to form Niagara Mohawk (now National Grid) and gas production at the site ceased during the winter of 1951/1952. Gas holders remained at the site and were used for emergency supplies until the late 1950s when the facility was shut down and a majority of the MGP structures were demolished. At that time, the site was converted to a service center. According to witness accounts, when the holders were demolished during the 1950s, the resulting subsurface openings were observed to contain water and tar. The above-grade gas production facilities were demolished and demolition debris was removed from the site. Solid waste (e.g., floor sweepings, metal, and wood) was disposed west of the north end of the open garage in an area that corresponds with the former water supply pond (see Figure 3).

1.4.3 Summary of Previous Investigations and Site Activities

The site has been subject to several environmental investigations and remedial measures including the following:

- 1983, Initial Site Survey – Ebasco Services Inc. (Ebasco) completed an initial site survey in July 1983 to characterize environmental impacts and potential risks from those impacts to human health and the environment. Investigation activities included installing monitoring wells and collecting soil and groundwater samples for laboratory analysis. Detailed results of the initial site survey are presented in the 1983 Initial Site Survey of the Former Gloversville Gas Plant Site report prepared by Ebasco (Ebasco, 1983).
- 1985, Supplemental Site Survey – Ebasco completed a supplemental site survey from October 1983 to October 1984 to further delineate the extent of MGP-related materials present at the site and to aid in an evaluation of potential remedial measures to address impacts identified by the initial site survey. Supplemental survey activities included installing monitoring wells; excavating test pits; conducting stream flow measurements; and collecting soil, groundwater, and surface water samples for laboratory analysis. Detailed results of the supplemental site survey are presented in the 1985

Supplemental Site Survey of the Former Gloversville Gas Plant Site report prepared by Ebasco (Ebasco, 1985a).

- 1985, Supplemental Cayadutta Creek Investigation – Ebasco completed a supplemental investigation of Cayadutta Creek in March 1985 to determine if MGP-related materials were affecting the chemical quality of Cayadutta Creek surface water and sediment. Supplemental creek investigation activities included collecting a surface water sample, three seep samples (i.e., groundwater seeping through the eastern creek bank), and 14 sediment samples for laboratory analysis. Detailed results of the supplemental creek investigation are presented in the 1985 Former Gloversville Gas Plant Site Study – Supplemental Cayadutta Creek Investigations report prepared by Ebasco (Ebasco, 1985b).
- 1992, PSA/IRM Study – Atlantic Environmental Services, Inc. (Atlantic) conducted a preliminary site assessment (PSA) during the spring and summer of 1992 and an engineering evaluation of potential IRMs to address environmental concerns identified by the investigation. The PSA/IRM evaluation activities included: reviewing historical site information; completing a soil gas survey; excavating 25 test pits; drilling 39 soil borings; installing a monitoring well; and collecting approximately 61 subsurface soil and groundwater samples for laboratory analysis. These activities were conducted to characterize and delineate the extent of MGP-impacted soil and groundwater at the site and to identify potential IRMs to address MGP-impacted site media. Detailed results of the PSA/IRM study are presented in the 1993 Preliminary Site Assessment/Interim Remedial Measure (PSA/IRM) Study report prepared by Atlantic (Atlantic, 1993).
- 1995, Purifier Waste Removal – Concurrent with site investigation activities completed in January 1995 (discussed below), approximately 370 tons of soil was removed from the eastern portion of the site (east of the former holders) to assess the potential for recycling/reusing purifier waste-containing soil as an additive for asphalt pavement.
- 1995, Storm Sewer IRM – Maxymillian Technologies, Inc. (Maxymillian) constructed a high-density polyethylene- (HDPE-) lined settling basin outside the southwest corner of the service center area to replace a portion of a drainage swale that received a combination of storm water and non-aqueous phase liquid- (NAPL-) impacted groundwater collected and conveyed by the on-site storm sewer system. A detailed account of the 1995 Storm Sewer IRM construction activities are presented in the 1996 Engineering Certification Report letter prepared by Arcadis (formerly BBL) (BBL, 1996).
- 1995 to 1997, Remedial Investigation – Parsons Engineering Science, Inc. (Parsons) conducted a remedial investigation of the site from July 1994 through August 1995 and March/April 1997 to evaluate the nature and extent of site impacts and potential human health and environmental risks; and to provide data to facilitate the preparation of a feasibility study. Remedial investigation activities included excavating six test pits; drilling 58 soil borings; installing 16 monitoring wells/pairs; hydraulic testing; and the collection and laboratory and/or geotechnical analysis of more than 180 soil, groundwater, surface water, and sediment samples. Detailed results of the remedial investigation activities are presented in the 1997 Remedial Investigation – NMPC Gloversville (Hill Street Site) report prepared by Parsons (Parsons, 1997).
- 2000, Monitoring Well MW-8 IRM – In August 2000, Stearns & Wheler LLC (Stearns & Wheler) installed an automated NAPL recovery pump at monitoring well MW-8 to recover NAPL that had been observed within the monitoring well. Over the course of the MW-8 IRM's operation, National Grid

estimates that more than 8,000 gallons of the NAPL and water mixture were recovered from the well. It has been estimated (by MW-8 IRM operation and maintenance contractors) that the NAPL/water mixture consists of more than 90% water. In addition, the recovered NAPL was in an apparent emulsified state (potentially caused by the recovery pump).

- 2000, Soil and Sediment Investigation – Stearns & Wheler completed a soil and sediment quality evaluation during 2000 in support of an assessment of natural physical, chemical, and biological attenuation processes that may potentially be occurring at the site or induced by an in-situ groundwater treatment remedy. Investigation activities included drilling 21 soil borings (three of which were completed as piezometers) and conducting a review of the previous site studies and investigations. Detailed results of the soil and sediment investigation activities are presented in the 2000 Soil and Sediment Quality Summary report prepared by Stearns & Wheler (Stearns & Wheler, 2000).
- 2000 to 2001, Former Holder No. 3 Removal – From September 2000 to May 2001, an IRM was completed at the site to remove the former 57,000 cubic feet relief holder. The removal activities were conducted to reduce the potential for migration of MGP-related material from within the holder. Approximately 7,900 tons of MGP-impacted material (i.e., coal tar and coal tar-impacted soil) was removed from within, immediately surrounding, and below the former holder and transported off-site for thermal treatment and disposal. Following excavation, the inside of the holder was backfilled with washed ¾- to 1-inch diameter gravel below the water table and with run-of-bank above the water table. The circular sheet pile and retaining walls were left in place following excavation. The circular sheet pile was cut-off below grade to allow for final site restoration (i.e., paving) and the retaining wall was left in place to protect existing gas lines behind the wall. Weep holes were drilled into the retaining wall to reduce the potential for groundwater mounding behind the wall. The weep holes drain groundwater into a gravel layer beneath the asphalt. A detailed account of the holder removal activities is presented in the 2001 Former Holder No. 3 Interim Remedial Measure Summary Report prepared by Foster Wheeler (Foster Wheeler, 2001).
- 2001, Cayadutta Creek Investigation – In July 2001, Arcadis (formerly BBL) conducted an investigation at the Cayadutta Creek to further delineate the extent of polycyclic aromatic hydrocarbons (PAHs) in creek sediment and bank soils. Creek investigation activities consisted of probing creek sediment to determine the type and depth of sediment and observe the presence/absence of MGP-related materials (e.g., sheen, coal tar) and collecting approximately 88 sediment and 71 soil bank samples for laboratory analysis. Detailed results of the 2001 creek investigation are presented in the 2002 Cayadutta Creek Investigation Summary Report prepared by Arcadis (BBL, 2002).
- 2001, Additional Investigation Activities – From April through July 2001, Stearns & Wheler conducted additional investigation activities to further delineate the extent of soil that would require management under various cleanup goals for remedies that may be implemented for the site. Investigation activities included excavating 40 test pits; drilling 77 soil borings; installing five monitoring wells, four piezometers, and four three-nested piezometers; completing hydraulic conductivity testing; and collecting numerous soil, groundwater, and NAPL samples for laboratory analysis. Detailed results of these additional investigation activities are presented in the 2002 Technical Memorandum prepared by Stearns & Wheler (Stearns & Wheler, 2002).
- 2003, GRS Upgrade – From August through December 2003, Niagara Mohawk installed new gas regulator station (GRS) equipment at the service center. A total of three excavations (one in the

northeast corner of the service center area, one along the eastern property boundary, and one along the western property boundary) were completed to facilitate the GRS modifications. A detailed account of the GRS upgrade activities is presented in the 2004 Gas Regular Station Modification Environmental Support Documentation Report prepared by Arcadis (formerly BBL) (BBL, 2004).

- 2006, Pre-Storm Sewer IRM Sediment Monitoring – At the request of NYSDEC, Arcadis conducted sediment monitoring activities within Cayadutta Creek in December 2006 to establish a baseline for creek conditions prior to the completion of the 2007 Storm Sewer IRM. Sediment monitoring activities consisted of probing and visual characterization of creek sediment and the collection and laboratory analysis of nine sediment samples. Detailed results of the pre-storm sewer IRM sediment monitoring activities are presented in the March 1, 2007 letter to NYSDEC (Arcadis, 2007a).
- 2006 to 2007, Storm Sewer IRM – From October 2006 through September 2007, a new storm sewer system was constructed to separately collect and convey surface water runoff from the service center area and impacted groundwater from service center building underdrains. Storm water is conveyed to a new storm water drainage ditch, storm water detention basins, and manholes (i.e., MH-1 and MH-6) prior to overflowing to Cayadutta Creek. Groundwater intercepted by the service center building underdrain system and French drain installed west of the open garage is conveyed to an on-site groundwater treatment system (constructed as part of the IRM) and then discharged to the Gloversville-Johnstown Joint Wastewater Treatment Facility (GJJWTF) for further treatment. A detailed account of the 2006/2007 Storm Sewer IRM construction activities is presented in the 2008 DRAFT Storm Sewer Interim Remedial Measure Engineering Certification Report prepared by Arcadis (Arcadis, 2008c).
- 2006, Monitoring Well MW-8 Investigation – Following the shutdown of the Monitoring Well MW-8 IRM in February 2006, Arcadis conducted an investigation in November and December 2006 to provide a basis for potential modifications to the MW-8 IRM. Investigation activities consisted of conducting an engineering evaluation of the monitoring well MW-8 recovery pump and drilling 28 soil borings in the vicinity of monitoring well MW-8 using the Tar-specific Green Optical Screening Tool (TarGOST™) technology. Detailed results of the monitoring well MW-8 investigation are presented in the March 15, 2007 letter to NYDSEC (Arcadis, 2007b).
- 2007, Post-Storm Sewer IRM Sediment Monitoring – Following construction of the 2007 Storm Sewer IRM, Arcadis conducted an additional round of sediment monitoring in November 2007 to compare the post-IRM creek conditions to the pre-IRM baseline conditions established by the December 2006 sediment monitoring activities. Similar to the 2006 monitoring, 2007 monitoring activities consisted of probing and visually characterizing creek sediment and collecting and submitting nine sediment samples (from approximately the same sampling locations as the December 2006 pre-IRM monitoring event) for laboratory analysis. Detailed results of the post-storm sewer IRM sediment monitoring activities are presented in the April 4, 2008 letter to NYSDEC (Arcadis, 2008a).
- 2007 to 2008, RI/FS Phase I Data Needs Investigation – Arcadis completed Phase I of the Remedial Investigation/Feasibility Study (RI/FS) Data Needs Investigation from May 2007 through March 2008 to obtain information and data necessary to complete the RI for the site and evaluate potential remedial alternatives to address environmental concerns at the site as part of a feasibility study. Investigation activities consisted of installing NAPL monitoring wells; conducting a hydraulic assessment of select monitoring wells; measuring groundwater levels; and conducting monthly NAPL

monitoring. Results of the RI/FS Phase I Data Needs Investigation activities are presented in the May 30, 2008 RI/FS Phase II Data Needs Work Plan letter (Arcadis, 2008b).

- 2008, RI/FS Phase II Data Needs Investigation – Arcadis completed Phase II of the RI/FS Data Needs Investigation from August through October 2008 to address several data gaps identified by the Phase I RI/FS Data Needs Investigation, further investigate observations of subsurface conditions made during construction of the 2007 Storm Sewer IRM, and confirm the results of previous site investigations. Investigation activities included drilling 40 soil borings, installing monitoring wells and piezometers, conducting creek flow gauging, and collecting groundwater samples for laboratory analysis. The RI/FS Phase II Data Needs Investigation activities are detailed in the Remedial Investigation Report prepared by Arcadis (Arcadis, 2009, revised in 2013).
- 2009, Soil Vapor Investigation – Arcadis conducted soil vapor investigation (SVI) activities to assess potential soil vapor impacts attributable to the former MGP. The SVI investigation activities were completed in three phases during August 2005, March 2009, and April 2009, and included collecting and analyzing a total of eight soil vapor samples (including four sub-slab samples), one indoor air sample and four ambient air samples. Based on the results obtained from the three SVI sampling phases, no additional sampling was deemed necessary relative to the MGP site as an exposure to constituents associated with the former MGP does not exist through soil vapor intrusion. In addition, based on the results of the indoor air sample collected during the April 2009 investigation, no further sampling was deemed necessary to evaluate potential vapor intrusion associated with non-MGP compounds. The SVI Investigation activities are detailed in the Remedial Investigation Report prepared by Arcadis (Arcadis, 2013).
- 2015, FS Data Needs Investigation – During September and November 2014, Arcadis completed a FS Data Needs Investigation to obtain information and site data to evaluate the technical and administrative feasibility of select remedial components that would be evaluated in the FS. The FS Data Needs Investigation activities consisted of a hydrogeologic evaluation, a wetland assessment, and an in-situ solidification (ISS) treatability study. Detailed results of the FS Data Needs Investigation activities are presented in the 2015 Feasibility Study Data Needs Investigation Summary Report prepared by Arcadis (Arcadis, 2015).

1.5 Site Characterization

This section presents an overall site characterization and a summary of the nature and extent of impacted media at the site based on the results obtained for the RI, site investigations, and observations of subsurface conditions made during interim remedial activities. The site characterization consists of a review of the site topography and drainage, an overview of the site geology and hydrogeology, and a summary of the nature and extent of impacts identified at the site.

1.5.1 Site Topography and Drainage

Site topography generally slopes downward from the northern to the southern portion of the site and from the eastern to the western portion of the site. The northern portion of the service center area (i.e., north of the open garage) is generally covered with impervious surfaces (i.e., buildings and pavement). The southern portion of the service center area is covered with gravel. Surface water runoff in the vicinity of the service center building is collected by the on-site storm sewer system catch basins, conveyed to a storm water drainage ditch that extends along the western portion of the site and to a storm water detention basin in the southwest corner of the service center area. The storm water drainage ditch and detention basin also receive surface water runoff via overland flow from the southern portion of the service center area. Storm water is subsequently discharged to Cayadutta Creek via a culverted pipe that overflows from the storm water detention basin. Cayadutta Creek is a tributary to the Mohawk River, which is located approximately six miles south of the site.

1.5.2 Geology

The overburden strata beneath the site are extremely heterogeneous as a result of the anthropogenic and geologic processes that deposited the soils. These strata, in descending order, consist of the following: fill; peat (where present); an upper sand, gravel, and cobble unit; silt; a lower sand-and-gravel unit; and bedrock or till (in some areas). Cross-section locations are shown on Figure 4 and geologic cross-sections are included on Figures 5 through 9. The character of these strata is briefly described below.

As the service center area was developed, up to 15 feet of fill was placed in the northern portion of the site. The southern area contains only a few feet of fill, if any. Fill materials in the service center area generally consist of tar, ash, cinder, coal, clinkers, slag, and construction and demolition debris. An area of purifier waste placed as fill material is present along the eastern fence line of the service center area.

A discontinuous deposit of peat is located beneath the fill or at ground surface where fill is not present (e.g., in the southern area). Underlying the peat (where present) is a heterogeneous deposit of alluvial fine-grained silt and rounded sands, gravels, cobbles, and boulders. These deposits, hereafter referred to as the upper sand and gravel, are observed to be as little as a few feet to as many as 15 feet thick. Both, the upper sand and gravel unit and the overlying fill materials are highly permeable.

A package of inter-layered silts and clays have been observed immediately beneath the upper sand and gravel. This layer, hereafter referred to as the silt unit, is continuous across the service center area; however, it appears to have been eroded away in a portion of the southern area. The region where the silt is absent is referred to as the “silt window”. The silt unit is approximately 5 to 20 feet thick in most areas of the site, but is generally thinner in the southern area.

A relatively thick (30 to 70 feet) deposit of permeable glacial outwash, hereafter referred to as the lower sand and gravel, is present below the silt unit. The silt unit “protects” the lower sand and gravel unit from impacts observed in the upper sand and gravel and fill, and with the exception of a few isolated areas, impacts have not been observed in this unit. Shale bedrock (Canajoharie Formation) lies directly under the lower sand and gravel unit in most of the site; however, a localized deposit of till is present below the outwash in the northern end of the site (near Hill Street).

1.5.3 Hydrogeology

Shallow groundwater in the service center area flows toward the southwest, in the direction of the two right angle bends in Cayadutta Creek. The water table across the service center area is typically found within the upper sand and gravel/fill materials at or near the ground surface to approximately 10 feet below grade. In the southern area, the water table is located at approximately 1 to 5 feet below grade.

The water table beneath the site fluctuates by several feet and at times expresses itself in the form of seeps at the ground surface along hill slopes, particularly following storm events. Several drain systems have been installed in the service center area to control these seeps. The drains are located near/beneath the open garage and under the service center building. These drains were once connected to a roughly north-south trending pipe that discharged collected groundwater to an unlined drainage ditch in the southwestern corner of the service center area. The drain system also inadvertently collected MGP-related tars and impacted groundwater, and as such, National Grid completed one Storm Sewer IRM in 1995 that consisted of constructing a settling basin at the southern end of the drainage ditch, and another Storm Sewer IRM in 2007 to divert groundwater from the drains to an on-site treatment system and to alleviate groundwater mounding west of the open garage. The treatment system treats and discharges this groundwater to the GJJWTF via an on-site sanitary sewer connection.

The City of Gloversville lies on/near a kame complex mapped to the immediate east and west of the site. The site lies in a notch in the kame complex likely formed by Cayadutta Creek as it eroded through the kame deposits. Kame deposits are generally very coarse, and therefore, highly permeable. As a result, precipitation falling on these deposits will readily reach the water table and, once below the water table, it begins to move toward areas of discharge (e.g., Cayadutta Creek). The majority of groundwater flow in the Gloversville area is expected to be through the kame deposits and glacial outwash deposits, both of which are observed beneath the site.

Groundwater flow beneath the site can be divided into two principal systems that are separated by the silt: flow in the upper sand and gravel/fill and flow in the lower sand and gravel. The average vertical permeability of the silt unit is estimated to be approximately 0.002 feet/day, and as such, groundwater flow within this unit is negligible compared to flow in the highly permeable sand and gravel units located above and below this unit. Hydraulic conductivity values for the upper sand and gravel/fill have been estimated to range from 0.004 to 630 feet/day with an average of approximately 2 feet/day. Groundwater flow within the upper sand and gravel and fill is dominated by highly permeable flow areas (i.e., preferential pathways) that are represented by the hydraulic conductivity values in the higher end of the range. These preferential pathways consist of the coarse-grained Cayadutta Creek-laid deposits and the drains that are present in several locations of the service center area; however, the exact location of the drains in the area of the open garage is not well known. Combining the high-end hydraulic conductivity value with a horizontal hydraulic gradient of approximately 0.03 for this unit yields groundwater flow velocities of approximately 60 feet/day for the preferential pathways. Given the coarse nature of the sand and gravel/fill materials and the presence of drains in the service center area, it is likely that groundwater flow velocities for the preferential pathways are appreciably higher than 60 feet/day in this unit.

The majority of the groundwater in the lower sand and gravel unit is derived from upgradient sources to the northeast and east. A small amount of groundwater discharges upward from the underlying bedrock and/or till and into this unit but this amount is expected to be relatively insignificant. The average estimated hydraulic conductivity of the lower sand and gravel is approximately 13 feet/day, with a range of 0.1 to 120 feet/day. Generally, groundwater flow patterns in the lower sand and gravel unit are controlled by the presence/absence of the silt unit. The silt separates the upper and lower sand-and-gravel units beneath most of the site, with the exception of the silt window in a portion of the southern area. Where the silt is present, the hydraulic head in the lower sand and gravel is generally 1 to 7 feet higher than the head measured in the upper sand and gravel. The magnitude and direction of vertical hydraulic gradient near the silt window is complicated by the presence of a perennial stream near this area. This stream can have a gaining or losing condition, depending on the elapsed time between a water-level measurement round and storm events. Groundwater flow in the lower sand and gravel is generally to the southwest or south converging towards the silt window. Groundwater that reaches the area of the silt window either moves slowly upward into the upper sand and gravel, and ultimately into Cayadutta Creek, or continues on to the south. A water table contour map and a potentiometric surface contour map for the lower sand and gravel are presented as Figures 10 and 11, respectively.

1.5.4 Nature and Extent of Impacts

MGP byproducts, typically dense non-aqueous phase liquids (DNAPLs) (i.e., coal tar), often account for the majority of the impacts at former MGP sites. Principal components of coal tar include benzene, toluene, ethylbenzene, and xylene (BTEX) compounds, which are volatile organic compounds (VOCs), and PAHs, which are semi-volatile organic compounds (SVOCs). Another MGP byproduct is gas purifier wastes, which often contains cyanide. As detailed below, coal tar, BTEX, PAHs, and (to a lesser extent) cyanide have been identified as the constituents of concern (COCs) for the site. The following subsections present a summary of the nature and extent of MGP-related environmental impacts identified for the site based on these COCs and the presence of coal tar NAPL.

1.5.4.1 Distribution of Visual Impacts and NAPL

NAPL in the ground beneath the site (primarily coal tar DNAPL) is responsible for most of the environmental impacts resulting from the former MGP operations. DNAPL has been generally observed in the upper 20 feet of overburden (i.e., upper sand and gravel, peat, and fill materials), primarily within the first few feet above the top of the silt unit. The topography of the silt unit influences the distribution of DNAPL observed across the site. DNAPL has moved downward from potential source areas (e.g., gas holders, possible tar disposal trench), due to gravitational forces, through the unsaturated zone (primarily fill) and reached the water table at several locations. Beneath the water table, DNAPL migration is driven by gravitational and hydraulic forces. These forces have caused DNAPL to move from assumed source areas in the service center area toward the south and southwest, in the direction of Cayadutta Creek. DNAPL migration was also influenced by the former drain system that collected both storm water and groundwater as part of the service center drain system and other miscellaneous drains that were installed to control groundwater expression at the site. NAPL observations are shown on the geologic cross-sections presented as Figures 5 through 9. In addition, Figure 12 indicates all locations where NAPL was observed in subsurface soil samples.

DNAPL has generally not been able to penetrate the silt due to its fine-grained nature and the strong upward hydraulic gradients that have been observed across this unit (between the upper and lower sand and gravel). There are, however, a few areas where the silt is relatively thin or not present: the silt was apparently excavated during construction of the 57,000 cubic-foot relief holder (located north of open garage; holder floor bottom approximately 20 feet below grade ~735 feet above mean sea level [AMSL]) and is only a few feet thick in this area or potentially not present; and the silt is not present in a region of the southern area (i.e., “silt window”). The lower sand and gravel appears to contain minor amounts of DNAPL near/at these areas, but these areas are isolated and the DNAPL is generally limited to the upper few feet of lower sand and gravel at the base of the silt. The upward gradients in the lower sand and gravel appear to be strong enough to keep DNAPL from moving vertically downward in these areas.

As indicated above, the former drain system discharged collected groundwater and DNAPL into an unlined ditch near the southwestern corner of the service center area. The soils surrounding the former ditch (i.e., near the current storm water detention basin) are still a likely source of DNAPL. DNAPL has been observed along the eastern banks of the creek near and south of this area.

Minor quantities of DNAPL have also been observed above the silt in a few isolated areas beneath the western bank of Cayadutta Creek and in one isolated area further downstream beneath the eastern bank of Cayadutta Creek. The presence of DNAPL below the western bank can potentially be the result of the historical usage of the creek near the site. As discussed above, based on review of historical mapping, the creek alignment has been altered and the creek was once dammed in at least two locations near the site. Although NAPL has been observed at the bottom of the Cayadutta Creek in isolated sediment pockets adjacent to and downstream of the site, NAPL has not been observed in the creek since the 2007 Storm Sewer IRM.

An area of purifier waste placed as fill material is present along the eastern fence line of the service center area. Anecdotal information indicates that a tar disposal trench was once located near the eastern site boundary in the immediate area south of the holders. No direct evidence of a tar disposal trench was encountered during site investigation activities.

1.5.4.2 Soil Quality

Subsurface soil analytical results were compared to restricted industrial use and unrestricted soil cleanup objectives (SCOs) presented in 6 NYCRR Part 375-6, for soil samples collected within and outside the service center area, respectively. The industrial use SCOs are applicable to the site based on the current and anticipated future site use. In addition, site-specific screening values of 10 milligrams per kilogram (mg/kg) total BTEX and 500 mg/kg total PAHs have been established to aid in the delineation of soil containing site-related impacts. In general, the greatest concentrations of BTEX and PAHs were generally detected in soil samples that contained NAPL. Soil samples with total BTEX and PAH concentrations exceeding 10 mg/kg and 500 mg/kg, respectively, are shown on Figure 12. Soil impacts are distributed as follows:

- Individual BTEX compounds were not detected at concentrations exceeding industrial SCOs in any of the 180 soil samples collected from within the fenced service center area. However, individual PAHs were detected at concentrations greater than the industrial SCOs in 50 of the 180 soil samples collected from this area. Individual PAH exceedances were generally observed in subsurface soil samples collected from depths greater than 5 feet below grade.
- Individual BTEX compounds were detected at concentrations exceeding the unrestricted SCOs in 19 of 110 soil samples collected outside the fenced service center. In general, BTEX concentrations in more recent soil samples (collected in 2000 and 2001) were generally lower than concentrations observed in older samples (i.e., those collected in 1995 and earlier). Individual PAHs were detected at concentrations greater than unrestricted SCOs in 27 of the 110 soil samples collected outside the fenced service center. Soil samples containing individual BTEX and PAHs at concentrations exceeding unrestricted SCOs were generally collected from the northern portion of the offsite area (south of the fenced area) from depths greater than 5 feet below grade.

- With the exception of a small area along the eastern site boundary (GB-3 and TP-E), all soil samples that contained total BTEX and total PAHs at concentrations greater than 10 mg/kg and 500 mg/kg, respectively, were collected from locations where were visual impacts were observed.
- Soil samples collected from three isolated areas (at GB-14, GB-88, and PZ-434) below the silt unit contained total BTEX and total PAHs at concentrations greater than 10 mg/kg and 500 mg/kg, respectively, as the result of the presence of trace amounts of NAPL.

Soils samples containing cyanide at concentrations greater than the 6NYCRR Part 375-6 restricted use SCOs for the protection of ecological resources were generally collected at the eastern portion of the service center area, in areas containing NAPL or NAPL-impacted soil and within the area where purifier waste was placed as fill material.

1.5.4.3 Groundwater Quality

Analytical results for groundwater samples collected during the remedial investigation were compared to the Class GA groundwater quality standards/guidance values presented in the NYSDEC's Division of Water, Technical and Operational Guidance Series 1.1.1: Ambient Water Quality Standards and Groundwater Effluent Limitations (TOGS 1.1.1) (NYSDEC, 2008). The downgradient extent of dissolved-phase BTEX and PAHs is shown on Figure 13.

The extent of groundwater impacts has a strong correlation to the observed DNAPL distribution across the site. Dissolved-phase BTEX, PAHs, and cyanide have been detected at concentrations greater than NYSDEC Class GA standards in the service center area and southern area, but primarily within the upper sand-and-gravel/fill unit). MGP-related constituents at concentrations greater than NYSDEC Class GA standards and guidance values have been detected in a majority of monitoring wells in the service center area, with the exception of the wells north of the service center building. The eastern extent of groundwater impacts is delineated by groundwater samples collected from wells located along South Boulevard that did not contain constituents at concentrations greater than NYSDEC Class GA standards. MGP-related constituents have been detected in the two shallow wells (MW-14S and MW-31S) to the west of the service center area; however, detected concentrations are low enough to suggest that these wells are likely in the fringe of the plume. The extent of dissolved-phase constituents above standards and guidance values in the southern area is constrained to the northwestern corner where NAPL has been observed. It is anticipated that most of this shallow groundwater flows into Cayadutta Creek and, therefore, Cayadutta Creek is the downgradient boundary of dissolved-phase constituents associated with the former MGP site. Based on the observed presence of NAPL both north and south of the east-west flowing stream in the southern area, the stream does not have a significant impact on the migration of NAPL in this area. However, a fraction of the shallow groundwater in the southern area discharges into the east-west flowing stream, which in turn flows to Cayadutta Creek.

The upper few feet of silt may be affected by dissolved-phase constituents that have dissociated from DNAPL observed on top of and within the upper few feet of this unit in some areas. The vast majority of groundwater sampled from monitoring wells screened in the lower sand and gravel does not contain MGP-related constituents; however, a few localized areas of affected groundwater do exist where minor amounts of DNAPL have been observed in this unit. These areas are at/near the former relief holder and the silt window. Based on the minor amounts of NAPL observed in these areas, the dissolved-phase constituents associated with the DNAPL are anticipated to be isolated to the immediate vicinity of DNAPL-impacted soil. The localized areas of impacted groundwater in the lower sand and gravel are expected to move southward, remaining close to the bottom of the silt unit, and eventually degrade to low or non-detectable concentrations in a relatively short distance from the areas where DNAPL was observed.

1.5.4.4 Soil Vapor Quality

Based on the results of the SVI investigation activities conducted at the site (included in the Remedial Investigation Report [Arcadis, 2013]), which concluded that exposures to constituents associated with the former MGP does not exist through soil vapor intrusion, no further action is warranted for either MGP- or non-MGP-related compounds in soil vapor.

1.5.4.5 Cayadutta Creek Sediment and Bank Soil Quality

Sediment investigations within Cayadutta Creek conducted prior to the Storm Sewer IRM indicated that PAHs are the primary constituents of interest associated with the former MGP. The greatest PAH concentrations have generally been detected in small depositional areas located in the vicinity of the right-angle bend in the creek near the site. Sheens resulting from the physical disturbance of some fine-grained sediments have been noted upstream, adjacent to, and downstream from the site, but their presence does not correlate well with high PAH concentrations. Additionally, sheens observed north of the right-angle bend in the creek are likely associated with other industries in the area and not related to the MGP or other activities conducted on the National Grid property. Some of the sediment deposits, which can create a sheen, are very limited and transient, and the sheen-creating material within the deposit is later dispersed or otherwise naturally attenuated.

As indicated above in Section 1.4.3, a storm sewer IRM was constructed between October 2006 through September 2007, to treat groundwater passively collected by the service center building underdrains and a French drain constructed in the southwest portion of the service center property. Results of a post-IRM sediment investigation conducted shortly following the IRM (November 2007) indicated decreasing total PAH concentrations relative to a pre-IRM investigation (December 2006). Additionally, visual inspections of the portion of the creek where NAPL had previously been observed to actively discharge to the creek (i.e., prior to the storm sewer IRM), have greatly improved since the IRM construction. No additional sediment investigations have been conducted since the November 2007 post-IRM event.

1.5.4.6 Surface Water Quality

Dissolved-phase BTEX and PAHs have only been detected in surface water samples collected within or at the former drainage ditch that discharged to Cayadutta Creek at the southwest corner of the service center area. These surface water samples were collected prior to the 1995 and 2007 Storm Sewer IRMs, which served to improve the quality of the surface water discharging from the site to Cayadutta Creek. Based on the surface water analytical results for water samples collected from Cayadutta Creek, surface water in Cayadutta Creek does not contain detectable concentrations of BTEX and PAHs.

1.5.5 Risk Evaluation

This evaluation assessed the potential risks posed to human health and the environment by MGP-related constituents at the site and in Cayadutta Creek. The risk evaluation consisted of a Fish and Wildlife Resource Impact Analysis (FWRIA) and a Human Health Exposure Assessment (HHEA).

The FWRIA concluded that potentially complete exposure pathways for fish and wildlife are present for surface soils in the southern area, Cayadutta Creek bank surface soils, Cayadutta Creek sediment and surface water (i.e., groundwater seeps), and sediment and surface water from the stream and wetland area in the southern portion of the site. These media contain potential MGP-related constituents at concentrations greater than applicable standards. However, potential ecological risks posed by exposure to these media is expected to be relatively low given that exceedances also exist in upstream (background) samples and considering a majority of collected samples did not contain any exceedances.

The HHEA concluded that potentially complete exposure pathways for humans (i.e., recreational users and trespassers) exist for Cayadutta Creek bank surface soils and surface soils outside the fenced service center. As indicated above, these media contain potential MGP-related constituents at concentrations greater than applicable standards. Subsurface soils do not represent a complete exposure pathway; however, construction workers involved in intrusive activities may be exposed to subsurface soils. Similarly, groundwater does not represent a complete exposure based on the depth to groundwater and because it is not used as a potable source.

2 IDENTIFICATION OF STANDARDS, CRITERIA, AND GUIDANCE

This section presents SCGs that have been identified at the site.

2.1 Definitions of Standards, Criteria, and Guidance

As defined in 6 NYCRR Part 375-1.8(f)(2), standards, criteria, and guidance values are defined as:

- "Standards and criteria" are 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 circumstance.
- "Guidance" is non-promulgated criteria, advisories and/or guidance 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 guidance documents that, based on professional judgment, are determined to be applicable to the project (6 NYCRR 375-1.8[f][2][ii]).

Per the regulations, standards, criteria and guidance will be applied so that the selected remedy will conform to standards and criteria that are generally applicable, consistently applied and officially promulgated; and that are either directly applicable, or that are not directly applicable but relevant and appropriate, unless good cause (as defined in 6 NYCRR 375-1.8 [f][2][i]) exists why conformity should be dispensed with.

2.2 Types of Standards, Criteria, and Guidance

Potential SCGs considered in this FS Report are categorized as follows:

- Chemical-Specific SCGs – These SCGs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values for each 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 technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste management and remediation of the site.
- 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.

2.3 Standards, Criteria, and Guidance

The SCGs identified for the evaluation of remedial alternatives are presented in the following subsections. These SCGs have been identified as potentially applicable; their actual applicability will be determined during the evaluation of a particular remedy, and further described during development of the remedial design (i.e., after the final site remedy has been selected). Each potential remedy will comply with the identified SCGs, or indicate why compliance with an SCG cannot or will not be obtained.

2.3.1 Chemical-Specific SCGs

The potential chemical-specific SCGs are summarized in Table 1. Chemical-specific SCGs are the criteria that typically drive the remedial efforts at former MGP sites because they are most directly associated with addressing potential human exposure. The primary chemical-specific SCGs that exist for impacted soil, groundwater, and sediment at the site are briefly summarized below.

The SCOs presented in 6 NYCRR Part 375-6 are chemical-specific SCGs that are relevant and appropriate to the site. Specifically, the SCOs for the protection of human health assuming a future industrial use (industrial SCOs) are applicable. Additionally, CP-51 Soil Cleanup Guidance (NYSDEC, 2010b) allows for a subsurface soil total PAH SCO of 500 mg/kg at non-residential sites (i.e., commercial and industrial use sites).

Chemical-specific SCGs that potentially apply to the waste materials generated during remedial activities are the Resource Conservation and Recovery Act (RCRA) and New York State regulations regarding identifying and listing hazardous wastes outlined in 40 Code of Federal Regulations (CFR) 261 and 6 NYCRR Part 371, respectively. Included in these regulations are the regulated levels for the Toxicity Characteristic Leaching Procedure (TCLP) constituents. The TCLP constituent levels are a set of numerical criteria at which solid waste is considered to be a hazardous waste by the characteristic of toxicity. In addition, the hazardous characteristics of ignitability, reactivity, and corrosivity may also apply, depending upon the results of waste characterization activities.

Another set of chemical-specific SCGs that may apply to waste materials generated at the site (e.g., soil that is excavated and determined to be a hazardous waste) are the United States Environmental Protection Agency (USEPA) Universal Treatment Standards/Land Disposal Restrictions (UTSs/LDRs), as listed in 40 CFR Part 268. These standards and restrictions identify hazardous wastes for which land disposal is restricted and define acceptable treatment technologies or concentration limits which may apply prior to land disposal.

Groundwater beneath the site is classified as Class GA in accordance with the New York State Groundwater Classification System presented in 6 NYCRR Part 701. Therefore, the New York State Groundwater Quality Standards (6 NYCRR Parts 700-705) and NYSDEC's TOGS 1.1.1 Class GA groundwater quality standards and guidance values are potentially applicable. These standards identify acceptable levels of constituents in surface water and groundwater based on potable use.

The section of the Cayadutta Creek at the site is classified as Class C fresh surface water per 6 NYCRR 876.4 and, as such, the New York State Surface Water and Groundwater Quality Standards (6 NYCRR Parts 700-705) are potentially applicable. Specifically, 6 NYCRR Part 703.2 identifies the surface water quality standards that need to be met during in-water activities, such as standards for turbidity and generation of sheens.

No cleanup standards, criteria, or limitations are currently promulgated under federal or state laws that specifically address concentrations of hazardous substances in sediment. However, the NYSDEC document Screening and Assessment of Contaminated Sediment (NYSDEC, June 2014) describes methodology for establishing screening criteria that provide a set of chemical-specific SCGs potentially applicable to site sediment.

2.3.2 Action-Specific SCGs

Potential action-specific SCGs are summarized in Table 2. Action-specific SCGs include general health and safety requirements, and general requirements regarding handling and disposal of waste materials (including transportation and disposal, permitting, manifesting, disposal, and treatment facilities), discharge of water generated during implementation of remedial alternatives, and air monitoring requirements (including permitting requirements for on-site treatment systems). Action-specific criteria will be identified for the selected site remedy in the remedial design work plan; compliance with these criteria will be required. Several action-specific SCGs that may be applicable to this site are briefly summarized below.

The NYSDEC Division of Air Resources (DAR) policy document DAR-1: Guidelines for the Control of Toxic Ambient Air Contaminants (formerly issued as Air Guide 1) (NYSDEC, 1997), incorporates applicable federal and New York State regulations and requirements pertaining to air emissions, which may be applicable for soil or groundwater alternatives that result in certain air emissions. Community air monitoring would be required in accordance with the New York State Department of Health (NYSDOH) Generic Community Air Monitoring Plan. New York Air Quality Standards provide requirements for air emissions (6 NYCRR Parts 257). Emissions from remedial activities will meet the air quality standards based on the air quality class set forth in the New York State Air Quality Classification System (6 NYCRR Part 256) and the permit requirements in New York Permits and Certificates (6 NYCRR Part 201).

The New York State hazardous waste management regulations presented in 6 NYCRR Parts 370-374 and 376 and the NYSDEC Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from Former Manufactured Gas Plants (DER-4) (NYSDEC, 2002) may be applicable to alternatives that include the disposal of impacted soil. LDRs that regulate the disposal of hazardous wastes may also be applicable to alternatives involving the disposal of hazardous waste (if any). In accordance with DER-4, thermal treatment of MGP-impacted material that only exhibits the hazardous characteristic of toxicity for benzene (D018) is conditionally exempt from the hazardous waste management requirements. If MGP-related hazardous wastes are destined for land disposal, the federal and New York State hazardous waste regulations apply, including LDRs and alternative LDR treatment standards for hazardous waste soil.

The NYSDEC no longer allows amendment of soil at MGP sites with lime kiln dust/ quick lime containing greater than 50% calcium and/or magnesium oxide (Ca/MgO) due to vapor issues associated with free oxides. Guidance issued in the form of a letter from the NYSDEC to the New York State utility companies, dated May 20, 2008, indicated that lime kiln dust/quick lime will not be permitted for use during future remedial activities.

The United States Department of Transportation (USDOT) and New York State rules for the transport of hazardous materials are provided in 49 CFR Parts 107 and 171.1 through 172.558 and 6 NYCRR 372.3, respectively. These rules include procedures for packaging, labeling, manifesting, and transporting hazardous materials. New York State requirements for waste transporter permits are included in 6 NYCRR Part 364, along with standards for collection, transport, and delivery of regulated wastes within New York State.

Section 404 of the Clean Water Act (CWA) establishes site-specific pollutant limitations and performance standards that are designed to protect surface water quality, and Section 401 of the CWA requires a 401

Water Quality Certification permit be obtained for those activities that may result in a discharge to a waters of the United States. The National Pollutant Discharge Elimination System (NPDES) program is also administered in New York by the NYSDEC as a State Pollutant Discharge Elimination System (SPDES). A temporary discharge approval, or SPDES Permit Equivalent, would be required for point source discharges of treated waste generated during the remedial activities. If the selected remedial alternative for the site results in discharges to a publicly-owned treatment works (POTW), discharge limits must be established with the local POTW.

Remedial alternatives conducted within the site must comply with applicable requirements outlined under the Occupational Safety and Health Administration (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 remediation are specified under 29 CFR 1926, and record keeping and reporting requirements are outlined under 29 CFR 1904.

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

2.3.3 Location-Specific SCGs

Potential location-specific SCGs are summarized in Table 3. Examples of potential location-specific SCGs include regulations and federal acts concerning activities conducted in floodplains, wetlands, historical areas, and activities affecting navigable waters and endangered/threatened or rare species.

Based on the Federal Emergency Management Agency (FEMA) National Flood Insurance Program Map Number 3602750002B dated September 30, 1983, the southern portion of the site is located within the limits of a 100-year floodplain. Because portions of the site are located within a 100-year floodplain, federal floodplain management laws and regulations are potential SCGs for remedial alternatives that involve excavation or backfilling within the floodplain. Federal requirements for activities conducted within floodplains are provided in 40 CFR Part 6.

Although the NYSDEC Freshwater Wetlands Map and the National Wetlands Inventory map for the Gloversville quadrangle did not show the presence of wetlands at the site, a formal wetland delineation identified the presence of a forested/scrub-shrub wetland complex at the southern portion of the site. Implementation of remedial activities to address environmental concerns on this area will require completing applications for U.S. Army Corps of Engineers (USACE) and NYSDEC permits to conduct activities in the wetland complex.

Location-specific SCGs also include local requirements, such as local building permit conditions for permanent or semi-permanent facilities constructed during the remedial activities (if any), influent/pre-treatment requirements for discharging water to the POTW, and local pollution requirements (e.g., air and noise).

3 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

This section presents the RAOs for impacted media (soil, groundwater, and sediment) identified at the site. These RAOs represent media-specific goals that are protective of public health and the environment that have been developed through consideration of the results of the site investigation activities and with reference to potential SCGs, as well as current and foreseeable future anticipated site uses.

RAOs are developed to address the specific COCs at the site, and to assist in developing goals for cleanup of COCs in each media that may require remediation. The RAOs presented in the following table have been developed based on the generic RAOs listed on NYSDEC's website (http://www.dec.ny.gov/regulations/67560.html).

Table 3.1 Remedial Action Objectives

RAOs for Soil
RAOs for Public Health Protection 1. Prevent, to the extent practicable, ingestion/direct contact with site-related COCs/ NAPL. 2. Prevent, to the extent practicable, inhalation of or exposure to site-related COCs from impacted soil. *RAOs for Environmental Protection* 3. Address, to the extent practicable, site-related COCs/NAPL in soil that could result in impacts to groundwater, surface water, or sediment. 4. Prevent, to the extent practicable, impacts to biota from ingestion/direct contact with soil containing site-related COCs.
RAOs for Groundwater
RAOs for Public Health Protection 1. Prevent, to the extent practicable, ingestion of groundwater containing site-related dissolved phase COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values. 2. Prevent, to the extent practicable, contact with or inhalation of VOCs from groundwater containing site-related COCs at concentrations exceeding NYSDEC groundwater quality standards or guidance values. *RAOs for Environmental Protection* 3. Restore groundwater to pre-disposal/pre-release conditions, to the extent practicable. 4. Prevent the discharge of site-related COCs from groundwater to surface water and sediment, to the extent practicable. 5. Address the source of site-related groundwater impacts to the extent practicable.
RAOs for Soil Vapor
RAOs for Public Health Protection 1. Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at the site.

RAOs for Sediment
RAOs for Public Health Protection 1. Prevent, to the extent practicable, direct contact with impacted sediments. 2. Prevent, to the extent practicable, surface water impacts which may result in fish advisories. *RAOs for Environmental Protection* 3. Prevent, to the extent practicable, releases of site-related COCs from sediments that would result in surface water levels in excess of ambient water quality criteria. 4. Prevent, to the extent practicable, impacts to biota from ingestion/direct contact with sediment containing site-related COCs in the sediment area identified to contain MGP residuals. 5. Restore sediments to pre-release/background conditions to the extent feasible.

Potential remedial alternatives are evaluated (in Section 5) based on their ability to meet the RAOs and be protective of public health and the environment.

4 TECHNOLOGY SCREENING AND ASSEMBLY OF REMEDIAL ALTERNATIVES

The objective of the technology screening is to:

- Present general response actions (GRAs) and the associated remedial technology types and technology process options that have documented success at achieving similar RAOs at MGP sites.
- Identify options that are implementable and potentially effective at addressing site-specific concerns.

This section identifies remedial alternatives to address impacted media at the site. GRAs potentially capable of addressing impacted media were identified as an initial step. GRAs are media-specific and describe actions that will satisfy the RAOs. GRAs may include various non-technology specific actions such as treatment, containment, institutional controls, and excavation, or any combination of such actions. Based on the GRAs, potential remedial technology types and technology process options were identified and screened to determine the technologies that were the most appropriate for addressing site impacts.

According to DER-10, the term “technology type” refers to general categories of technologies appropriate to the site-specific conditions and impacts, such as chemical treatment, immobilization, biodegradation, and capping. The term “technology process options” refers to specific processes within each remedial technology type. A series of remedial technology types and associated technology process options have been assembled for each GRA identified. Each remedial technology type and associated technology process options are briefly described and screened in accordance with DER-10 (on a medium-specific basis) to identify those that are technically implementable and capable of meeting the RAOs. This approach was used to determine if the application of a particular remedial technology type and technology process option is applicable, given site-specific conditions for remediation of the impacted media. Technologies/process options that were retained through the screening were used to assemble remedial alternatives. Detailed evaluation of these assembled remedial alternatives is presented in Section 5.

4.1 General Response Actions

Based on the RAOs identified in Section 3, the following GRAs have been established for soil, groundwater, and sediment:

- No Further Action
- Institutional Controls/Engineering Controls
- In-Situ Containment/Control
- In-Situ Treatment
- Removal
- Ex-Situ On-Site Treatment and/or Disposal
- Off-Site Treatment and/or Disposal

4.2 Identification of Remedial Technologies

Remedial technology types that are potentially applicable for addressing the impacted media were identified through a variety of sources, including vendor information, engineering experience, and review of various available literature, including DER-10.

Section 4.3 of DER-10 indicates that GRAs should be established such that they give preference to presumptive remedies. 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, although each former MGP site offers its own unique site characteristics. 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 to those with documented success in achieving similar RAOs.

4.3 Remedial Technology Screening Criteria

Potentially applicable remedial technology types and technology process options were identified for each of the GRAs, and were screened on a media-specific basis (i.e., separately for soil, groundwater, and sediment) to retain the technology types and process options that could be implemented and would potentially be effective at achieving the site-specific RAOs.

Technology process options were evaluated in relative terms to other technology process options of the same remedial technology type using the following criteria:

- Implementability – This criterion evaluates the ability to construct and reliably operate the technology process option as well as the availability of specific equipment and technical specialists to design, install, and operate and maintain the remedy.
- Effectiveness – This criterion is focused on the process option’s ability to meet the site-specific RAOs, either as a single technology or when used in combination with other technologies.

Groundwater flow modeling was conducted to support the screening of select technology process options (e.g., solidification, containment, permeable NAPL barrier wall). Ground flow modeling consisted of completing predictive simulations using a three-dimensional MODFLOW groundwater flow model (MODFLOW model) to assess changes to site hydraulics due to implementation of these technology process options. The results of MODFLOW model predictive simulations were used to evaluate potential hydrogeologic impacts of technology process options. A summary of the results of the MODFLOW model predictive simulations is included as Appendix A.

4.4 Remedial Technology Screening

This FS Report presents a brief overview of GRAs while focusing on the remedial technology types and associated process options that have documented success at achieving similar RAOs at former MGP sites. Summaries of the remedial technology screening to address impacted soil, groundwater, and sediment are presented in Tables 4, 5, and 6, respectively.

4.4.1 Soil

This section describes the basis for retaining representative soil remedial technology types and technology process options through the technology screening.

No Further Action

As required by DER-10, the “No Further Action” GRA has been included and retained through the screening evaluation. “No action” indicates that no remedial action would be implemented to address impacted soil. The “No Further Action” alternative is readily implementable and was retained to serve as a baseline against which other alternatives will be compared.

Institutional Controls

Remedial technology types associated with this GRA consist of non-intrusive controls focused on minimizing potential exposure to impacted media. The remedial technology type screened under this GRA consists of institutional controls. Technology process options screened under this remedial technology type include deed restrictions, environmental land use restrictions, enforcement and permit controls, and informational devices. Institutional controls would be utilized to limit permissible future site use, as well as establish health and safety requirements to be followed during subsurface activities that could result in construction worker exposure to impacted soil.

Institutional controls will not achieve the soil RAOs as a stand-alone process, as these measures would not treat, contain, or remove impacted soil. However, this process option was retained because institutional controls can be implemented in conjunction with other remedial technologies to reduce the potential for exposure to impacted soil.

In-Situ Containment/Control

Remedial technology types associated with this GRA consist of measures to address the impacted media by reducing mobility and/or the potential for exposure without removal or treatment. The remedial technology type evaluated under this GRA consists of capping. Technology process options screened under this remedial technology type include: soil cap, asphalt/concrete cap, and multi-media cap.

Soil and asphalt/concrete capping were retained for evaluation as these technology process options could be readily implemented in conjunction with other remedial technologies to limit the potential for exposures to impacted soil that would remain at the site. However, site operations in the service center area could compromise the integrity of the cap. An asphalt/concrete cap could be implemented at the service center area (generally covered with gravel, asphalt pavement, concrete, and/or buildings) to further reduce the potential for future exposures to impacted soil. A soil cap could be implemented on the southern area where wetland and wooded areas are present. However, the presence of a wetland and wooded areas in the southern area would limit the use of this technology option, as the vegetated areas would likely have to be maintained (or restored) following remedial activities.

Based on the current and anticipated future use of the service center area (i.e., industrial use), and the presence of a wetland and wooded areas in the southern portion of the site, a multi-media cap (i.e., a combination of clay or bentonite material and synthetic membrane[s] over impacted soil) was not retained for further evaluation. Site operations in the service center area and vegetation root structures in the southern area could compromise the integrity of the liners that would be used to construct the multi-media cap.

In-Situ Treatment

Remedial technology types associated with this GRA consist of those that treat impacted soil in-situ (i.e., without removal). These technologies would actively address site-related COCs in soil to achieve the RAOs. The remedial technology types evaluated under this GRA consist of immobilization, extraction/in-situ stripping, chemical treatment, biological treatment, and thermal treatment. Technology process options screened under these remedial technology types include:

- solidification (immobilization – e.g., in situ soil stabilization)
- dynamic underground stripping and hydrous pyrolysis/oxidation (DUS/HPO) (extraction/in-situ stripping)
- chemical oxidation and surfactant/co-solvent flushing (chemical treatment)
- biodegradation, enhanced biodegradation, and biosparging (biological treatment)
- in-situ thermal desorption and electrical resistance heating (thermal treatment)

Although solidification is an effective means to reduce the mobility of site-related COCs, eliminate free liquids, and reduce the hydraulic conductivity of NAPL-impacted soil, this technology process option was not retained for further evaluation. As discussed above, a MODFLOW model was used to evaluate the potential changes in site hydrogeology that would occur as the result of the implementation of this technology process option at select/localized areas of the site. Based on the results of the MODFLOW model predictive simulations, implementing solidification at the site (even in select areas) would cause significant groundwater mounding (i.e., flooding) above ground surface and adverse changes to groundwater flow patterns as a result of reduced soil permeability in areas targeted for treatment. These changes to site hydraulics could increase the potential for future exposures to impacted groundwater and the potential uncontrolled migration of site-related impacts to areas of the site where impacts have not been observed. A summary of the results of the MODFLOW model predictive simulations are included as Appendix A.

Based on the results of the screening, DUS/HPO, chemical oxidation, biodegradation, enhanced biodegradation, and biosparging were not retained for further evaluation due to known general ineffectiveness at addressing coal tar NAPL-impacted soil at MGP sites. Additionally, each of these processes would require long-term operation and monitoring due to the nature of impacts.

Specific concerns related to DUS/HPO include the potential for the uncontrolled migration of NAPL that could limit the effectiveness of the technology process option. DUS/HPO is typically more effective for addressing chlorinated solvents.

Pilot studies conducted at other former MGP sites have shown that in-situ chemical oxidation (ISCO) (including surfactant/co-solvent flushing) is only partially effective in the treatment of NAPL-impacted soil. ISCO has been shown to be effective at treating the dissolved phase impacts associated with the NAPL, but does not effectively treat soil containing NAPL. Multiple applications with large quantities of highly reactive oxidants would be required due to the nature and location of impacts. Based on the ineffectiveness in addressing impacted soil, oxidant would need to be administrated over a long period of time.

In-situ thermal treatment technologies were not retained as these technologies would present numerous implementability concerns associated with controlling groundwater flow into the treatment area that could limit the effectiveness of treatment, and utilities present within the treatment and surrounding areas.

Removal

Remedial technology types associated with this GRA consist of measures to remove impacted soil from the ground. The remedial technology type and technology process option evaluated under this GRA consists of excavation.

Excavation is a proven technology to address impacted material and would achieve several of the RAOs. When combined with proper handling of the excavated material, this technology process would be effective at minimizing potential future exposures. Excavation could be implemented (i.e., equipment and contractors needed to complete soil removal are readily available); however, excavation support (i.e., sheet pile) and extensive dewatering would be required when excavating below the water table, based on the nature of fill material present at the site and large volume of groundwater anticipated to be generated during excavation activities.

Ex-Situ On-Site Treatment and/or Disposal

Remedial technology types associated with this GRA consist of measures to treat impacted soil on-site after soil has been excavated or otherwise removed from the ground. The remedial technology types evaluated under this GRA consist of on-site ex-situ immobilization, extraction, thermal destruction, chemical treatment, and on-site disposal. Technology process options screened under these remedial technology types include:

- solidification/stabilization (immobilization)
- low-temperature thermal desorption (LTTD) (extraction)
- incineration (thermal destruction)
- chemical oxidation (chemical treatment)
- solid waste landfill and RCRA landfill (disposal)

Due to the current and anticipated future use of the service center area (i.e., industrial use) and the presence of wetland and wooded areas in the southern area, as well as space limitations, none of the ex-situ on-site treatment and/or disposal technology types and associated technology process options are considered practicable, technically implementable, or administratively feasible given lack of available space, public acceptance, and potential for exposures during on-site treatment/disposal. None of these process options were retained for further evaluation.

Off-Site Treatment and/or Disposal

Remedial technology types associated with this GRA consist of measures to treat/dispose of impacted soil at off-site locations after soil has been removed from the ground. The remedial technology types evaluated for this GRA consist of recycle/reuse, extraction, thermal destruction, and off-site disposal. Technology process options screened under these remedial technology types include:

- asphalt concrete batching, brick/concrete manufacturer, and fuel blending/co-burn in utility boiler (recycle/reuse)
- LTTD (extraction)

- incineration (thermal destruction)
- solid waste landfill and RCRA landfill (off-site disposal)

LTTD and off-site disposal at a solid waste landfill were retained for further evaluation. Disposal at an off-site solid waste landfill would be reserved for material that is not suitable for on-site reuse as subsurface fill, that does not contain visual impacts, and that is not appropriate for treatment via LTTD (e.g., concrete, debris). While each of these process options were retained, the final off-site treatment or disposal of waste materials will be evaluated as part of the remedial design for the selected remedy. This will allow for an evaluation of the costs associated with these potential off-site treatment/disposal processes, which can fluctuate significantly based on season, market conditions, and treatment/disposal facility capacity. In addition, multiple off-site treatment technologies could be utilized to treat or dispose of media with different concentrations of COCs. However, for the purpose of preparing this FS Report, LTTD and solid waste landfill are assumed as the off-site treatment/disposal technology process options for solid waste that may be excavated during remedial construction.

The asphalt concrete batch plant, brick/concrete manufacturer, and fuel blending/co-burn in utility boiler technology processes are not considered implementable. The number of facilities capable of implementing these processes and demand for raw materials are limited. Incineration and RCRA landfill technology processes were not retained through the technology screening. The relative cost for incineration is high and although incineration would be an effective means for treating soil containing site-related impacts, LTTD is equally effective for treating impacted soil at a lower cost. Disposal at a RCRA landfill was not retained, as material that is characteristically hazardous would still require pre-treatment to meet New York State UTSs/LDRs prior to disposal.

4.4.2 Groundwater

This section describes the basis for retaining representative groundwater remedial technology types and technology process options through the technology screening.

<u>No Further Action</u>

As required by DER-10, the “No Further Action” technology has been included and retained through the screening evaluation. “No action” indicates that no remedial efforts would be implemented to address impacted groundwater. The “No Further Action” alternative is readily implementable and was retained to serve as a baseline against which other alternatives will be compared.

<u>Institutional Controls</u>

Remedial technology types associated with this GRA generally consist of non-intrusive administrative controls used to reduce the potential for contact with, or use of site groundwater. The remedial technology type screened under this GRA consists of institutional controls. Technology process options for institutional controls include deed restrictions, groundwater use restrictions, enforcement and permit controls, and informational devices. This technology process is considered implementable and therefore, was retained for further evaluation. Because institutional controls would not treat, contain, or remove any COCs in groundwater, institutional controls alone would not achieve the RAOs established for the site. However, institutional controls would work toward meeting the RAO of preventing potential human exposures to groundwater containing COCs. Institutional controls could enhance the effectiveness of other technology types/technology process options when included as part of a remedial alternative.

In-Situ Containment/Control

Remedial technology types associated with this GRA involve addressing impacted groundwater and NAPL without removal or treatment. The remedial technology type evaluated under this GRA consists of containment. Technology process options screened under this remedial technology type consist of sheet pile walls, secant pile walls, and slurry/jet grout walls. Arcadis utilized the site-specific MODFLOW model to evaluate the feasibility of installing low-permeability containment wall around the majority of the NAPL-impacted area. Modeling efforts included evaluating scenarios that incorporated a highly conductive trench drain equipped with sump(s) to aid in water management upgradient from the containment area. The model output indicated:

- Mounded groundwater above grade north of the containment area.
- Increased heads (approximately 3 feet higher than the current-state calibrated model) inside the containment area below Service Center Building, suggesting good potential to flood building floor.
- Increased groundwater mounding east and west of site, suggest residential properties east of site could experience flooding.
- Groundwater heads in southern portion of containment area (south of open pole-barn) 3 to 5 feet higher than the current-state calibrated model, suggesting potential for downward gradient across silt.
- Water within the upper sand and gravel within and along the western portion of the containment area migrating downward through the silt and below the wall, eventually ending up in the highly conductive trench drain. This condition would present the potential for migration of impacts (NAPL and/or impacted groundwater) outside of the containment area.
- The highly conductive trench drain along western portion of containment area collects groundwater from the former Agway property that used to serve as a bulk petroleum storage site and is known to contain impacted materials associated with former operations at that facility.

Based on the results of the modeling, in situ containment/control technology process options were not retained for further evaluation. Additional groundwater modeling information is presented in Appendix A.

In-Situ Treatment

Remedial technology types associated with this GRA involve treating impacted groundwater and NAPL without removal. Remedial technology types evaluated under this GRA consist of biological treatment, chemical treatment, and extraction. Technology process options screened under these remedial technology types include:

- Groundwater monitoring, enhanced biodegradation, and phytoremediation (biological treatment)
- Chemical oxidation and permeable reactive barrier (PRB) (chemical treatment)
- DUS/HPO (Extraction)

Although groundwater monitoring will likely not achieve groundwater RAOs without source removal, this technology was retained as a measure to monitor and document groundwater conditions over time.

Enhanced biodegradation was not retained because this technology would not be a cost-effective means for addressing impacted groundwater over the long-term (i.e., significant amounts of oxygen would be required to enhance degradation over a long period of time). Based on previous site experience (i.e., during preliminary operation of the groundwater treatment system), the addition of oxygen to site groundwater could cause mineral fouling (i.e., precipitation of metals), potentially causing adverse changes to subsurface hydrogeological conditions and groundwater mounding above ground surface in areas targeted for treatment. This includes using ozone for in situ oxidation or adding oxygen as a means to enhance biodegradation to address dissolved-phase impacts. These changes to site hydraulics could increase the potential for future exposures to impacted groundwater.

Phytoremediation was not retained for further evaluation as this technology process option is typically more effective for addressing heavy metals than for treating organic constituents. Additionally, phytoremediation will likely not achieve groundwater RAOs without source removal and therefore, this technology process could only be implemented as a polishing mechanism and/or water control measure.

PRB was not retained because this technology process would not be an effective means for treating NAPL (i.e., the source for dissolved phase impacts) and furthermore, the presence of NAPL would inhibit the effectiveness of and could foul the barrier. Therefore, this technology would not be an effective means for addressing impacted groundwater over the long-term.

Chemical oxidation and DUS/HPO were not retained as these processes would not be a cost-effective means for achieving the RAOs and could result in NAPL and/or dissolved plume migration.

Removal

Remedial technology types associated with this GRA consist of removing groundwater containing site-related impacts for treatment and/or disposal. The remedial technology type evaluated under this GRA consists of hydraulic control. Technology process options screened under this remedial technology type include:

- vertical extraction wells and horizontal extraction wells (hydraulic removal)
- active removal, passive removal, and collection trenches/permeable NAPL barrier wall (NAPL removal)

In general, hydraulic control, by means of vertical or horizontal extraction wells would generate water that would require treatment over a long period of time. Equipment and tools necessary to install and operate vertical extraction wells are readily available. Installation of horizontal extraction wells includes use of specialized drilling equipment that requires a large amount of space, and subsurface site conditions (e.g., multiple obstructions, subsurface utilities, etc.) are not suitable for the installation of horizontal wells. Additionally, long-term pump-and-treat alternatives would not be an effective means to address dissolved phase impacts without the removal of potential source material (i.e., NAPL). Therefore, vertical and horizontal extractions wells were not retained for further evaluation.

As presented in Section 1, groundwater is currently collected passively by the service center building underdrain system and the French drain installed west of the open garage (herein referred to as the site drains). Groundwater collected by the site drains is conveyed to the existing on-site groundwater treatment system (constructed as part of the storm sewer IRM) for treatment. The site drains also limit groundwater expressions in the form of seeps on the ground surface that occur as the result of water table fluctuations (e.g., following storm events). The site drains and the on-site treatment system will be retained for inclusion in the remedial alternatives evaluated for the site.

Active and passive NAPL removal technology process options were also retained based on the potential effectiveness and implementability for recovering NAPL. Collection trenches/permeable NAPL barrier walls were retained as these technology process options can be a cost-effective means to collect, prevent further downgradient migration, and recover mobile NAPL when used in conjunction with active and passive NAPL removal options. As discussed above, a MODFLOW model was used to determine if site geologic conditions are suitable for the construction a NAPL barrier wall and to evaluate various barrier wall configurations. Based on the results of the MODFLOW model predictive simulations, constructing a NAPL barrier wall would be feasible if the barrier wall is constructed perpendicular to the groundwater flow pathway (e.g., along the eastern bank of Cayadutta Creek). However, groundwater modeling predicted that other NAPL barrier wall configurations (e.g., along the western portion of the National Grid property) could cause significant groundwater mounding (i.e., flooding) above ground surface and adverse changes to groundwater flow patterns as the barrier wall would work as a preferential pathway for groundwater due to the higher permeability of the barrier wall construction materials. These changes to site hydraulics could increase the potential for future exposures to impacted groundwater and management of impacted groundwater in areas of the site where impacts have not been previously observed. A summary of the MODFLOW model predictive simulation results is included as Appendix A.

Ex-Situ On-Site Treatment

The remedial technology type associated with this GRA consists of on-site treatment of impacted groundwater. The remedial technology types evaluated under this GRA consist of chemical treatment and physical treatment. Technology process options screened under these remedial technology types include:

- ultraviolet (UV) oxidation and chemical oxidation (chemical treatment)
- carbon adsorption, filtration, precipitation/coagulation/flocculation, and oil/water separation (physical treatment)

No groundwater extraction technology process options were retained through the technology screening. However, groundwater in the service center property is currently collected by the passive site drains requiring an ongoing treatment of collected groundwater. Therefore, select ex-situ on-site physical treatment process options were retained for further evaluation (collected water is currently treated at the on-site groundwater treatment system that was installed as part of the storm sewer IRM). Additionally, ex-situ on-site treatment technology process options could be used in support of other remedial technology processes during remedial construction (i.e., treatment of groundwater removed during excavation activities).

Off-Site Treatment and/or Disposal

Remedial technology types associated with this GRA consider the off-site treatment/disposal of extracted groundwater. The remedial technology type evaluated under this GRA consisted of groundwater disposal. Technology process options screened under this technology type consisted of: discharge to a local POTW, discharge to surface water, and discharge to a privately-owned and commercially operated treatment facility.

Although no groundwater extraction processes were retained through the technology screening, impacted groundwater/NAPL is currently collected by the site drains and conveyed to the existing groundwater treatment system for treatment. Treated water is subsequently discharged to the local POTW (i.e., the GJJWTF) for further treatment via a sanitary sewer connection. Off-site treatment and/or disposal technology process options were retained for further evaluation to support the on-going operation of the on-site groundwater treatment system.

4.4.3 Sediment

This section describes the basis for retaining representative sediment remedial technology types and technology process options through the technology screening.

No Further Action

As required by DER-10, the “No Further Action” technology has been included and retained through the screening evaluation. “No Further Action” indicates that no remedial efforts would be implemented to address impacted sediment. The “No Further Action” alternative is readily implementable and was retained to serve as a baseline against which other alternatives will be compared.

Institutional Controls

Remedial technology types associated with this GRA generally consist of non-intrusive administrative controls focused on minimizing potential exposure to impacted sediment. The remedial technology type screened under this GRA consists of institutional controls. Technology process options for institutional controls include deed restrictions, enforcement and permit controls, and informational devices. This technology process is considered implementable and therefore, was retained for further evaluation. Because institutional controls would not treat, contain, or remove any COCs in sediments, institutional controls alone would not achieve the RAOs established for the site. However, institutional controls would work toward meeting the RAOs of preventing potential human exposures impacted sediments. Institutional controls could enhance the effectiveness of other technology types/technology process options when included as part of a remedial alternative.

In-Situ Containment/Control

Remedial technology types associated with this GRA consist of measures to address the impacted media by reducing mobility and/or the potential for exposure without removal or treatment. The remedial technology type evaluated under this GRA consists of capping. Construction of an engineered cap was the only technology process option screened under this remedial technology type, and was retained for further evaluation. An engineered cap could consist of a combination of natural and/or synthetic materials and could be implemented in conjunction with other remedial technologies to limit the potential for exposures to impacted sediment that would remain within Cayadutta Creek.

In-Situ Treatment

Remedial technology types associated with this GRA would address impacted sediment without removal. These technologies would actively address site-related COCs in sediment to achieve the RAOs. Remedial technology types evaluated under this GRA consist of natural recovery and immobilization. Technology process options screened under these remedial technology types include monitored natural recovery (MNR) and solidification/stabilization, respectively.

Although MNR will likely not achieve sediment RAOs as a stand-alone technology (i.e., without source removal), this technology process option is considered implementable, and was retained as a measure to monitor and document sediment conditions over time, based on implementability. Solidification/stabilization was not retained as this technology process option is not considered implementable due the shallow thickness of impacted sediment in Cayadutta Creek.

Removal

Remedial technology types associated with this GRA consist of measures to remove sediments containing site-related impacts for treatment and/or disposal. The remedial technology type evaluated under this GRA consists of dredging. Technology process options screened under this remedial technology type include mechanical and hydraulic dredging.

Mechanical dredging was retained for further evaluation as this technology process option is a proven technology to address impacted sediment and is appropriate for the nature of the sediment and water body. When combined with proper handling of dredged material, this technology process option would be effective at meeting the RAOs. Based on the nature of sediment deposition (i.e., cobbles and rocks are present in Cayadutta Creek sediment deposits) and the relatively small volume of sediment that is anticipated to be removed, hydraulic removal would not be a cost-effective technology to remove impacted sediment from Cayadutta Creek and was not retained for further evaluation.

Ex-Situ On-Site Pre-Treatment, Treatment and/or Disposal

Remedial technology types associated with this GRA consist of measures to treat impacted sediment on-site following removal from Cayadutta Creek. The remedial technology types evaluated under this GRA consist of gravity drainage, immobilization, thermal extraction, thermal destruction, chemical extraction, chemical destruction, and on-site disposal. Technology process options screened under these remedial technology types include:

- dewatering (gravity drainage)
- solidification/stabilization (immobilization)
- LTTD (thermal extraction)
- incineration (thermal destruction)
- chemical extraction (chemical extraction)
- chemical reduction/oxidation (chemical destruction)
- RCRA landfill and solid waste landfill (on-site disposal)

Although dewatering alone will not meet sediment RAOs, this technology process option could be implemented in conjunction with other technologies (e.g., sediment disposal, water treatment) to help achieve the RAOs. Solidification/stabilization is a proven technology process option that can be used for stabilizing removed sediments prior to transportation and off-site disposal/treatment. However, a bench scale study is anticipated to be required to evaluate the appropriate materials and mixing ratios to stabilize excavated sediments. Both dewatering and solidification/stabilization were retained for further evaluation.

Due to the current and anticipated future use of the service center area (i.e., industrial use) and the presence of wetland and wooded areas in the southern area, as well as space limitations, the remaining ex-situ on-site treatment and/or disposal technology types and associated technology process options are not considered practicable, technically implementable, or administratively feasible given lack of available space, public acceptance, and potential for exposures during on-site treatment/disposal. None of these technology process options were retained for further evaluation.

Off-Site Treatment/Disposal

Remedial technology types associated with this GRA consist of measures to treat impacted sediment at off-site locations following removal from Cayadutta Creek. The remedial technology types evaluated under this GRA consist of recycle/reuse, extraction, thermal destruction, and off-site disposal. Technology process options screened under these technology types include:

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

LTTD and off-site disposal at a solid waste landfill were retained. Disposal at an off-site solid waste landfill would be appropriate for material that is not suitable for on-site reuse as subsurface fill and that is not appropriate for treatment via LTTD (e.g., cobbles and rocks). LTTD and solid waste landfill are assumed as the off-site treatment/disposal technology process options for hazardous (D018) and non-hazardous materials (respectively) that may be generated during remedial construction.

The asphalt concrete batch plant, brick/concrete manufacturer, and fuel blending/co-burn in utility boiler technology processes are not considered implementable. The number of facilities capable of implementing these processes and demand for raw materials are limited. Incineration and RCRA landfill technology processes were not retained through the technology screening. The relative cost for incineration is high and although incineration would be an effective means for treating sediment containing site-related impacts, LTTD is equally effective for treating impacted sediment at a lower cost. Disposal of hazardous materials at a RCRA landfill was not retained, as characteristically hazardous material from this site would be treated via LTTD.

4.5 Summary of Retained Technologies

Results of the remedial technology screening process for soil, groundwater, and sediment are presented in Tables 4, 5, and 6, respectively. Retained remedial technologies are summarized in the following tables.

Table 4.1 Retained Soil Technologies

GRA	Technology Type	Technology Process Option
No Further Action	No Further Action	No Further Action
Institutional Controls	Institutional Controls	Deed Restrictions, Environmental Land Use Restrictions, Enforcement and Permit Controls, Informational Devices
In-Situ Containment / Control	Capping	Soil Cap, Asphalt/Concrete Cap
Removal	Excavation	Excavation
Off-Site Treatment and/or Disposal	Extraction Disposal	Low-Temperature Thermal Desorption Solid Waste Landfill

Table 4.2 Retained Groundwater Technologies

GRA	Technology Type	Technology Process Option
No Further Action	No Further Action	No Further Action
Institutional Controls	Institutional Controls	Deed Restrictions, Enforcement and Permit Controls, Informational Devices
In-Situ Treatment	Biological Treatment	Groundwater Monitoring
Removal	NAPL Removal	Active Removal, Passive Removal, Collection Trench/Permeable NAPL Barrier Wall
Ex-Situ/On-Site Treatment	Physical Treatment	Carbon Adsorption, Filtration, Air Stripping, Precipitation/Coagulation/Flocculation, Oil/Water Separation
Off-Site Treatment and/or Disposal	Groundwater/NAPL Management	Discharge to a local POTW, Discharge to Surface Water via Storm Sewer, Discharge to a Privately-Owned Treatment/Disposal Facility

Table 4.3 Retained Sediment Technologies

GRA	Technology Type	Technology Process Option
No Further Action	No Further Action	No Further Action
Institutional Controls	Institutional Controls	Deed Restrictions, Enforcement and Permit Controls, Informational Devices
In-Situ Containment/ Controls	Capping	Engineered Cap
In-Situ Treatment	Natural Recovery	Monitored Natural Recovery
Removal	Dredging	Mechanical Removal
Ex-situ/On-Site Pre-Treatment, Treatment and/or Disposal	Gravity Drainage Immobilization	Dewatering Solidification/Stabilization
Off-Site Treatment and/or Disposal	Extraction Off-Site Disposal	Low-Temperature Thermal Desorption Solid Waste Landfill

4.6 Assembly of Remedial Alternatives

Retained remedial technology types and technology process options were combined into remedial alternatives that have the potential to achieve or work toward achieving site-specific RAOs. DER-10 requires an evaluation of the following alternatives:

- The “No Further Action” alternative.
- An alternative that would restore the site to pre-disposal conditions.

Additional alternatives were developed based on:

- Current, intended and reasonably anticipated future use of the site.
- Removal of source area(s) of site-related impact.
- Containment of source areas of site-related impacts.

These remedial considerations require varying levels of remediation, but provide protection of public health and the environment by:

- Preventing or minimizing exposure to the COCs through the use of institutional controls.
- Removing COCs to the extent possible thereby minimizing the need for long-term management.
- Treating COCs, to a degree that potentially requires long-term management in the form of treatment system operation and maintenance (O&M), institutional controls, engineering controls, etc.

Remedial alternatives that have been assembled and developed for addressing the impacted media are presented below. Unless otherwise indicated, the assembled remedial alternatives assume that the site drains will remain in place and that the on-site water treatment system will remain operational following remedial construction. Additionally, treated water from the on-site treatment system will continue to be discharged to the GJJWTF. Detailed technical descriptions of the remedial alternatives are presented in Section 5 as part of the detailed remedial alternative evaluations.

4.6.1 Alternative 1 – No Further Action

The “No Further Action” alternative was retained for evaluation as required by DER-10. No remedial activities would be completed to address site-related impacts to soil, groundwater, and/or sediment under this alternative. The “No Further Action” alternative serves as the baseline for comparison of the overall effectiveness of the other remedial alternatives.

4.6.2 Alternative 2 – Groundwater/NAPL Monitoring, MNR, and Institutional Controls

This alternative consists of annual groundwater monitoring using the existing monitoring well network to document the extent of dissolved phase impacts and the potential trends in COC concentrations in site groundwater, and monitoring for potential changes in groundwater flow direction. Passive removal of NAPL that accumulates into the existing monitoring wells would also be conducted as part of a long-term NAPL monitoring and recovery program. MNR would be conducted to assess sediment conditions and to document the attenuation of MGP-related constituents in surface sediments.

Alternative 2 also includes establishing institutional controls (i.e., deed restrictions and/or environmental easements, signs) for the properties that contain MGP-related impacts to limit the future development and use of the site and site groundwater, as well as limit the permissible invasive (i.e., subsurface) activities. For properties not owned by National Grid, implementation of institutional controls would require coordination between NYSDEC and the property owners. A Site Management Plan (SMP) would be prepared to document the extent of impacts at the site, long-term site monitoring requirements, and protocols for potential future site activities that may be conducted at the site.

4.6.3 Alternative 3 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment

Alternative 3 consists of the construction of a permeable NAPL barrier wall along the eastern bank of the Cayadutta Creek right-angle bend to address potentially mobile NAPL located upgradient from the barrier. The permeable NAPL barrier wall would be keyed into the silt unit and NAPL collection sumps would be installed within the barrier to facilitate NAPL recovery. Additionally, a series of NAPL recovery wells would be installed at locations where significant quantities of NAPL have been historically accumulated in site monitoring wells to collect potentially mobile NAPL that could remain on the National Grid property.

Alternative 3 also includes targeted removal to address soil containing significant quantities of NAPL (i.e., greater than sheens and blebs) downgradient of the NAPL barrier wall to depths up to 14 feet below grade. Additionally, Alternative 3 includes the targeted removal of shallow purifier waste along the eastern boundary of the service center area to depths up to 5 feet below grade.

Sediment containing MGP-related impacts (i.e., visual indications of coal tar and/or material that generates sheens when disturbed) would be capped in-place under Alternative 3. Shallow sediment (e.g., approximately 1 foot below sediment surface [bss]) would be removed to accommodate the design thickness of the engineered cap. This alternative also includes long-term cap monitoring to document the maintained effectiveness of the engineered cap.

Alternative 3 includes the same SMP, long-term groundwater/NAPL monitoring, MNR, and institutional control components as Alternative 2.

4.6.4 Alternative 4 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment

Alternative 4 includes the same soil removal and NAPL recovery well components as Alternative 3. Additionally, Alternative 4 includes the same SMP, long-term groundwater/NAPL monitoring, MNR, and institutional control components as Alternatives 2 and 3. However, Alternative 4 would also include removal and off-site disposal of sediment containing MGP-related impacts.

Alternative 4 includes the installation of a permeable NAPL barrier wall south of the service center area to address potentially mobile NAPL that would remain on the National Grid property. The permeable NAPL barrier wall would be keyed into the silt unit and NAPL recovery sumps would be installed within the permeable NAPL barrier wall to facilitate NAPL recovery similar to Alternative 3. Soil containing significant quantities of NAPL between the wall and Cayadutta Creek would be excavated for off-site treatment/disposal.

4.6.5 Alternative 5 –Soil Removal to Unrestricted Use SCOs and Sediment Removal to Background Conditions

Alternative 5 includes excavation of soil containing MGP-related COCs at concentrations greater than 6NYCRR Part 375-6 unrestricted use SCOs and removal of sediment containing PAHs at concentrations greater than background. Soil would be generally be removed to the top of the silt unit, located at depths ranging from 10 feet below grade up to more than 22 feet below grade. For the purpose of this FS, an assumed sediment removal area adjacent to and downstream from the upland soils containing visual indications of NAPL has been identified for removal. However, the extent of sediment removal would be assessed during the design phase if this alternative is selected. Alternative 5 does not include institutional controls and SMP components. Post-remediation groundwater/NAPL monitoring and MNR would also not be conducted. Alternative 5 assumes that on-site structures (e.g., the Service Center Building, pole-barn structure, groundwater treatment system) would be razed to facilitate the site wide excavation and the site would not be redeveloped. The existing groundwater treatment system would not be required following the completion of the remedial construction activities.

5 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

This section presents detailed evaluations of the remedial alternatives developed to address identified site impacts. Each of the retained remedial alternatives is evaluated with respect to the criteria presented in DER-10. The results of the detailed evaluation of remedial alternatives are used to support the recommendation of a preferred remedial alternative for addressing impacted site media.

5.1 Description of Evaluation Criteria

Consistent with DER-10, the detailed evaluation of remedial alternatives presented in this section consists of an evaluation of each assembled alternative (presented in Section 4.6) against the following criteria:

- Short-Term Impacts and Effectiveness
- Long-Term Effectiveness and Permanence
- Land Use
- Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment
- Implementability
- Compliance with SCGs
- Overall Protection of Public Health and the Environment
- Cost Effectiveness

Descriptions of the evaluation criteria are presented in the following sections. Additional criteria, including public and state acceptance, will be addressed following submittal of this FS Report.

Per DER-10, sustainability and green remediation will also be considered in the remedial evaluation with the goal of minimizing ancillary environmental impacts, such as greenhouse gas emissions during the implementation of remedial programs. The evaluation will consider the alternative's ability to; reduce energy use; reduce greenhouse gas and other emissions; maximize reuse of land and material recycling; and preserve, enhance, or create natural habitats, etc. Sustainability and green remediation will be discussed under the short-term impacts and effectiveness criterion.

5.1.1 Short-Term Impacts and Effectiveness

The short-term impacts and effectiveness criterion is used to evaluate the remedial alternative relative to its potential effect on public health and the environment during construction and/or implementation of the alternative. The evaluation of each alternative with respect to its short-term impacts and effectiveness will consider the following:

- Potential short-term adverse impacts and nuisances to which the public and environment 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.

- Amount of time required to implement the remedy and the time until the remedial objectives are achieved.
- The sustainability and use of green remediation practices during implementation of the remedy.

5.1.2 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 impacts to human receptors, ecological receptors, and the environment from untreated waste or treatment residuals remaining at the completion of the remedial alternative.
- The adequacy and reliability of institutional and/or engineering controls (if any) that will be used to manage treatment residuals or remaining untreated impacted media.

5.1.3 Land Use

The current and intended future use of this site is a mixture of commercial activities as a service center supporting electrical and gas transmission services as well as undeveloped land to be maintained and protected to the south of the fenced service center property. There are no current or anticipated future plans to develop the National Grid-owned property to the south of the fenced service center property. This criterion evaluates the current and anticipated future land use of the site relative to the cleanup objectives of the remedial alternative when commercial use cleanup levels would not be achieved. This evaluation considers local zoning laws, proximity to residential property, accessibility to infrastructure, and proximity to natural resources including groundwater drinking supplies.

5.1.4 Reduction of Toxicity, Mobility, and Volume of Contamination through Treatment

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 through treatment technologies.

5.1.5 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 will be considered during the implementability evaluation:

- Technical Feasibility – This factor considers the remedial alternative's constructability, as well as the ability to monitor the effectiveness of the remedial alternative.
- Administrative Feasibility – This factor refers to the availability of necessary personnel and material along with potential difficulties in obtaining approvals for long-term operation of treatment systems, access agreements for construction, and acquiring necessary approvals and permits for remedial construction.

5.1.6 Compliance with SCGs

This criterion evaluates the remedial alternative's ability to comply with SCGs that were identified in Section 2. Compliance with the following items is considered during evaluation of the remedial alternative:

- Chemical-specific SCGs
- Action-specific SCGs
- Location-specific SCGs

Potentially applicable chemical-, action-, and location-specific SCGs are presented in Tables 1, 2 and 3, respectively.

5.1.7 Overall Protection of Public Health and the Environment

This criterion evaluates whether the remedial alternative provides adequate protection of public health and the environment based on the following:

- How the alternative would eliminate, reduce, or control (through removal, treatment, containment, other engineering controls, or institutional controls) potentially complete exposure routes and other identified environmental impacts.
- The ability of the remedial alternative to meet the site-specific RAOs.
- A combination of the above-listed criteria including: long-term effectiveness and permanence; short-term impacts and effectiveness; and compliance with SCGs.

5.1.8 Cost Effectiveness

This criterion evaluates the overall cost of the assembled alternative relative to its effectiveness at meeting the RAOs.

The estimated total cost to implement the remedial alternative is based on a present worth analysis of the sum of the direct capital costs (i.e., materials, equipment, and labor), indirect capital costs (i.e., engineering, licenses/permits, and contingency allowances), and O&M costs. O&M costs may include future site management, operating labor, energy, chemicals, and sampling and analysis. These costs are estimated with an anticipated accuracy between -30% to +50%. A 20% contingency factor is included to cover unforeseen costs incurred during implementation of the remedial alternative. Present-worth costs are calculated for alternatives expected to last more than 2 years. A 4% discount (i.e., interest) rate is used to determine the present-worth factor.

5.2 Detailed Evaluation of Alternatives

This section presents the detailed analysis of each of the assembled remedial alternatives presented in Section 4.

- Alternative 1 – No Further Action
- Alternative 2 – Groundwater/NAPL Monitoring, MNR, and Institutional Controls

- Alternative 3 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment
- Alternative 4 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment
- Alternative 5 – Soil Removal to Unrestricted Use SCOs and Sediment Removal to Background Conditions

Each alternative is evaluated against the evaluation criteria described above (as indicated, public and state acceptance will be evaluated following submittal of this FS Report).

5.2.1 Alternative 1 – No Further Action

The “No Further Action” alternative was retained for evaluation as required by DER-10. The “No Further Action” alternative serves as the baseline for comparison of the overall effectiveness of the other remedial alternatives. The “No Further Action” alternative does not involve implementation of any additional remedial activities to address site-related impacts. The site would be allowed to remain in its current condition and no effort would be made to change or monitor the current site conditions. However, the existing site drains would remain in-place and the on-site groundwater treatment system would remain operational under this alternative. The site drains would continue passively collecting impacted groundwater and potentially mobile NAPL from the service center property. Collected groundwater would continue to be conveyed from the two pumping manholes (i.e., NMH-1 and NMH-6) for treatment at the existing on-site groundwater treatment system and then discharged to the GJJWTF. Collected NAPL would be periodically transported for off-site treatment/disposal. Potential groundwater treatment system modifications and treated water discharge alternatives would be considered during the remedial design phase.

5.2.1.1 Short-Term Impacts and Effectiveness – Alternative 1

No remedial actions would be implemented to address impacted environmental media. Therefore, no short-term environmental impacts or risks associated with remedial activities would be posed to the community. Potential exposures to field personnel as the result of activities related to the existing site drains and on-site groundwater treatment system (e.g., groundwater/NAPL collection, treatment of groundwater, off-site transportation of NAPL for treatment/disposal, system maintenance) would continue to be reduced through the use of proper training, personal protective equipment (PPE), and appropriate health and safety practices.

5.2.1.2 Long-Term Effectiveness and Permanence – Alternative 1

The “No Further Action” alternative does not include any additional actions (i.e., relative to current operations) to address the presence of COCs in impacted media and the potential for on-going migration of impacts. The existing on-site groundwater treatment system would remain in operation. This operation would provide some degree of long-term effectiveness in the form of limiting groundwater expressions (i.e., seeps) on the ground surface that occur as the result of water table fluctuations at the site (e.g., following storm events). This alternative does not effectively address the RAOs and would not provide a substantial degree of long-term effectiveness or permanence.

5.2.1.3 Land Use – Alternative 1

This alternative does not include any additional remedial actions and therefore the site would remain in its current condition. The "No Further Action" alternative would not alter the anticipated future intended use of the site.

5.2.1.4 Reduction of Toxicity, Mobility or Volume of Contamination through Treatment – Alternative 1

Groundwater passively collected by site drains would continue to be treated under the "No Further Action" alternative. The existing site drains would remain in-place and the on-site groundwater treatment system would remain operational as part of this alternative. No additional activities would be conducted to reduce the toxicity, mobility, or volume of contamination at the site.

5.2.1.5 Implementability – Alternative 1

The "No Further Action" alternative does not require construction of any additional remedial activities and therefore, is considered technically and administratively implementable.

5.2.1.6 Compliance with SCGs – Alternative 1

- Chemical-Specific SCGs – The existing groundwater treatment system treats groundwater that is passively collected by on-site drains and discharges to the GJJWTF for additional treatment. However, no additional removal or treatment of soil or groundwater is included as part of this alternative. Therefore, chemical-specific SCGs would not be met.
- Action-Specific SCGs – This alternative does not involve implementation of any remedial activities. Therefore, the action-specific SCGs are not applicable.
- Location-Specific SCGs – Location-specific SCGs are not applicable as no remedial activities would be conducted under this alternative.

5.2.1.7 Overall Protectiveness of the Public Health and the Environment – Alternative 1

The "No Further Action" alternative does not actively address the toxicity, mobility, or volume of impacted environmental media, and therefore, is not effective on a long-term basis for eliminating potential migration or potential exposure to impacts. However, impacted groundwater and potentially mobile NAPL are currently collected passively by the site drains. Collected groundwater is treated at the existing on-site groundwater treatment system and then discharged to the GJJWTF for further treatment, while collected NAPL is sent off-site for treatment/disposal. As the existing site drains would remain in-place and the on-site groundwater treatment system would remain operational under this alternative, the "No Further Action" would still work toward addressing potential sources of groundwater impacts (soil RAO #3 and groundwater RAO #5) and preventing discharge of contaminants from groundwater to surface water and sediment (groundwater RAO #4) through passive recovery and removal of NAPL and groundwater treatment via the on-site treatment system. However, for groundwater to be restored to pre-disposal/pre-release conditions (groundwater RAO #3), it would be over a prolonged period of time (i.e., through continued weathering of NAPL and dissociation of related COCs and natural attenuation of dissolved phase impacts), as the source of soil and groundwater impacts would remain at the site.

As presented in Section 1, exposures to constituents associated with the former MGP does not exist through soil vapor intrusion (soil vapor RAO #1).

5.2.1.8 Cost Effectiveness – Alternative 1

The estimated costs associated with Alternative 1 are presented in Table 7. The “No Further Action” alternative does not involve implementation of any additional remedial activities or monitoring; the only costs associated with this alternative are O&M costs for operating and maintaining the existing groundwater treatment system. The estimated 30-year present worth cost of O&M activities; including labor, treatment media replacement, and system maintenance/repair; is approximately $8,300,000.

5.2.2 Alternative 2 – Groundwater/NAPL Monitoring, MNR, and Institutional Controls

The major components of Alternative 2 consist of the following:

- Conducting long-term groundwater/NAPL monitoring
- Conducting long-term MNR of sediment
- Establishing institutional controls
- Developing a site management plan

<u>Groundwater/NAPL Monitoring</u>

Groundwater within the site contains BTEX, PAHs, and cyanide at concentrations greater than NYSDEC Class GA standards in both the service center and southern areas, as indicated in Section 1. Therefore, this alternative includes conducting annual groundwater monitoring to document potential changes in groundwater conditions. Annual groundwater monitoring activities would consist of collecting groundwater samples from the existing groundwater monitoring well network. Groundwater samples would be submitted for laboratory analysis for BTEX, PAHs, and cyanide. Analytical results would be used to document the extent of dissolved phase impacts and potential trends in COC concentrations. The specific wells to be sampled would be determined during the remedial design for this alternative.

During annual groundwater monitoring activities, potentially mobile NAPL that accumulates in the existing monitoring wells would be collected to reduce the volume/mass of NAPL at the site and reduce the potential for future NAPL migration to Cayadutta Creek. NAPL collection may be conducted passively by periodic manual bailing or by periodically pumping (with a portable pump) NAPL from the wells. If warranted based on the rate of NAPL recovery, NAPL could be removed via an automated pumping system. For the purpose of developing a cost estimate for this alternative, NAPL recovery activities are assumed to consist of passive NAPL collection in existing monitoring wells with manual recovery. The results of the groundwater/NAPL monitoring activities would be presented to NYSDEC in an annual report. Based on the results of the monitoring activities, National Grid may request to modify the quantity of wells sampled or the frequency of sampling events. However, for the purpose of developing a cost estimate for this alternative, it has been assumed that annual groundwater/NAPL monitoring activities would be conducted on an annual basis over a period of 30 years.

MNR of Sediment

Under Alternative 2, MNR activities would be conducted at Cayadutta Creek to qualitatively assess the effectiveness of naturally-occurring physical/chemical processes (e.g., biodegradation, sorption, sedimentation) to degrade residual visual impacts identified in sediment. A long-term sediment monitoring program would be implemented to document and monitor natural recovery of sediment in Cayadutta Creek. It is anticipated that sediment monitoring activities would consist of visual inspections of the MNR area. For the purposes of developing a cost estimate for this alternative, it has been assumed that sediment monitoring would be conducted annually for a period of over 30 years.

Institutional Controls and SMP

Alternative 2 also includes establishing institutional controls in the form of deed restrictions and/or environmental easements for the properties that contain MGP-related impacts to limit the future development and use of the site and site groundwater, as well as to limit the permissible invasive (i.e., subsurface) activities that could result in potential exposures to subsurface soil, groundwater, and sediment containing MGP-related impacts. Additionally, the institutional controls would require compliance with the SMP (described below) that would be prepared as part of this alternative. An annual report would be submitted to NYSDEC to document that institutional controls are maintained and remain effective, as well as summarize annual groundwater/NAPL monitoring and MNR activities.

As indicated above, this alternative includes the preparation of an SMP that would document the following:

- The institutional controls that have been established and would be maintained for the site.
- Known locations of soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 industrial use SCOs.
- Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities.
- Protocols and requirements for conducting annual groundwater monitoring/NAPL recovery, and MNR.
- Requirements for performing periodic site inspections, providing NYSDEC-required certifications, and submitting periodic reports to NYSDEC.

As with Alternative 1, under Alternative 2 the existing site drain system would remain in-place and the groundwater treatment system would remain operational. Potential groundwater treatment system modifications and treated water discharge alternatives would be considered during the remedial design phase.

5.2.2.1 Short-Term Impacts and Effectiveness – Alternative 2

As no remedial construction activities would be implemented under this alternative, short-term environmental impacts and risks posed to the community would be limited. Potential exposures to field personnel conducting groundwater/NAPL monitoring and MNR activities would be reduced through the use of proper training and PPE, as specified in a site-specific health and safety plan (HASP) that would be developed as part of the remedial design for this alternative. Potential risks to the community could occur during groundwater/NAPL monitoring and MNR activities via exposure to purged groundwater, groundwater samples, and NAPL (if any). Potential exposures to the community would be reduced by following appropriate procedures and protocols that would be described in the SMP.

Although this alternative does not employ green remediation practices, implementation of this alternative would utilize minimal non-renewable resources and is not anticipated to negatively impact the environment (i.e., consume non-renewable resources and energy). The relative carbon footprint of Alternative 2 (compared to the other alternatives) is considered minimal. The greatest contribution to greenhouse gases would occur as a result of traveling to and from the site to conduct groundwater/NAPL monitoring and MNR activities.

5.2.2.2 Long-Term Effectiveness and Permanence – Alternative 2

Under Alternative 2, soil, groundwater, and sediment containing MGP-related impacts would not be actively addressed. However, groundwater/NAPL are currently collected passively by the site drains. Collected groundwater is treated at the existing on-site groundwater treatment system and subsequently discharged to the GJJWTF, while NAPL is permanently sent off-site for treatment/disposal. The site drains also limit groundwater expressions in the form of seeps on the ground surface that could occur as the results of water table fluctuations at the site (e.g., following storm events), preventing the potential for exposures to impacted groundwater. The site drains would remain in-place and the groundwater treatment system would remain operational as part of Alternative 2.

Alternative 2 includes establishing institutional controls and developing an SMP to reduce the potential for exposures to impacted media (i.e., soil, groundwater, and sediment). The service center property is covered with gravel, asphalt pavement, concrete, and/or buildings, which provide a physical barrier to subsurface impacts. Based on the current and foreseeable future use of the site, employees do not conduct normal daily activities that could result in the potential for exposures to soil, groundwater, and sediment containing site-related impacts. However, because of the distribution of site-related impacts (i.e., a majority of the impacts generally located in the upper 20 feet of overburden), the potential for future invasive site construction activities to encounter the impacted media is relatively high. If subsurface activities (e.g., installation of new utilities) are to be conducted at the site, work activities (including handling potentially impacted material) would be conducted in accordance with the procedures described in the SMP.

Although groundwater is not currently used as a potable source at the site, institutional controls would prohibit potable uses of groundwater. Annual verification of the institutional controls would be completed via on-site inspection to document that the controls are being maintained and remain effective. Periodic groundwater monitoring would be conducted to document the extent of dissolved phase impacts and potential trends in COC concentrations. Additionally, NAPL that accumulates in the existing monitoring wells would be removed during groundwater monitoring activities to reduce the volume/mass of NAPL (if any) at the site and reduce the migration of potentially mobile NAPL to Cayadutta Creek. MNR would also be conducted to qualitatively assess (i.e., through periodic visual inspection and probing) the degradation of residual impacts observed in sediment via naturally-occurring processes. Potential exposures to field personnel and the community during long-term groundwater/NAPL monitoring and MNR activities would be reduced by following appropriate procedures and protocols that would be established in the SMP.

5.2.2.3 Land Use – Alternative 2

The current zoning for the site is listed as manufacturing, in accordance with the City of Gloversville Zoning Map dated April 1, 2013. Areas immediately surrounding the site are zoned for manufacturing, commercial, residential/commercial, and residential. The current and foreseeable future use of the area surrounding the site is commercial/residential. The site will continue to be used as a National Grid service center (i.e., a base for natural gas and electrical transmission maintenance personnel and equipment).

Alternative 2 would not affect the current or anticipated future land use at the site. Institutional controls would be placed on the site properties, and groundwater/NAPL and MNR activities would be conducted for an assumed 30 years. In the event that properties within the site are sold, future owners/operators would be required to comply with the SMP and institutional controls established based on the continued presence of soil, groundwater, and sediment containing site-related COCs.

5.2.2.4 Reduction of Toxicity, Mobility or Volume of Contamination through Treatment – Alternative 2

Alternative 2 does not include direct treatment or containment of impacted soil, groundwater, or sediment. However, the existing site drains would remain in-place and the on-site groundwater treatment system would remain operational as part of this alternative. Impacted groundwater is currently collected (i.e., mobility and volume) passively by the site drains and subsequently treated at the existing on-site groundwater treatment system (and then discharged to the GJJWTF for further treatment). Additionally, NAPL that is collected by the site drains is sent off-site for treatment/disposal (i.e., mobility and volume).The actual reduction of toxicity, mobility or volume for this alternative is limited as the only NAPL that would be addressed is through the groundwater treatment system. Although the groundwater treatment system treats groundwater, this alternative does not address the source of the dissolved phase impacts.

5.2.2.5 Implementability – Alternative 2

This remedial alternative would be both technically and administratively implementable. From a technical implementability aspect, equipment and qualified personnel to conduct groundwater/NAPL monitoring and MNR activities are readily available. From an administrative aspect, establishing institutional controls for properties not owned by National Grid would require coordination with state agencies (i.e., NYSDEC and NYSDOH) and the property owners. Access agreements would also be required, as select existing groundwater monitoring wells are located on properties not owned by National Grid.

5.2.2.6 Compliance with SCGs – Alternative 2

- Chemical-*Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 SCOs (i.e., industrial use) and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Additionally, CP-51 Soil Cleanup Guidance (NYSDEC, 2010b) provides a total PAH SCO of 500 mg/kg for subsurface soil at non-residential sites. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA Standards and Guidance Values. Potential chemical-specific SCGs for sediment include sediment screening levels established in the NSYDEC document Screening and Assessment of Contaminated Sediment (NYSDEC, June 2014).

Alternative 2 would not address soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 industrial use SCOs. Existing site soils would remain in place. Waste materials generated during periodic groundwater sampling activities would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 to determine off-site treatment/disposal requirements. New York State (NYS) LDRs would apply to any materials that are characterized as a hazardous waste.

As indicated in Section 1, BTEX, PAHs, and cyanide have been detected in groundwater at concentrations exceeding groundwater quality standards. This alternative could achieve groundwater SCGs over a prolonged period of time (i.e., through natural attenuation of dissolved phase impacts).

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Groundwater/NAPL monitoring and MNR activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

  Waste materials generated during groundwater/NAPL monitoring/recovery activities could be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following an NYSDEC-approved work plan and using licensed waste transporters and permitted disposal facilities.

- *Location-Specific SCGs* – Location-specific SCGs are presented in Table 3. As Alternative 2 does not include remedial construction activities, location-specific SCGs are not applicable.

5.2.2.7 Overall Protectiveness of the Public Health and the Environment – Alternative 2

Alternative 2 would mitigate the potential for long-term exposures to impacted soil, groundwater, and sediment by implementing institutional controls and developing an SMP. Site-related impacts would remain and would not be directly addressed. Additionally, the existing site drains would remain in place (collecting impacted groundwater/NAPL from the service center area) and the on-site water treatment system would remain operational (to treat groundwater collected by the site drains). Periodic groundwater/NAPL monitoring/recovery and MNR would be conducted to document site conditions.

This alternative would prevent exposures (i.e., direct contact, ingestion, and inhalation) to site-related impacts in soil, groundwater, and sediment (soil RAOs #1 and #2, groundwater RAOs #1 and #2, and sediment RAO #1) solely through the implementation of institutional controls and adherence to the procedures to be presented in the SMP. However, it would not prevent biota exposures (i.e., direct contact, ingestion) to site-related impacts in soil and sediment (soil RAO #4 and sediment RAO #4).

Although Alternative 2 does not address soil containing site-related impacts, this alternative would work toward addressing potential sources of groundwater impacts (soil RAO #3 and groundwater RAO #5) and preventing discharge of contaminants from groundwater to surface water and sediment (groundwater RAO #4) by removing impacted groundwater and NAPL via the site drains/on-site groundwater treatment system. However, if groundwater is restored to pre-disposal/pre-release conditions (groundwater RAO #3), it would occur over a prolonged period of time (i.e., through continued weathering of NAPL and dissociation of related COCs and natural attenuation of dissolved phase impacts).

Alternative 2 does not address sediment containing site-related impacts and therefore, does not address potential sources of surface water impacts (sediment RAOs # 2 and #3). If sediment is restored to pre-release/background conditions (sediment RAO #5), it would occur over a prolonged period of time through natural recovery of sediment impacts.

As presented in Section 1, exposures to constituents associated with the former MGP does not exist through soil vapor intrusion (soil vapor RAO #1).

5.2.2.8 Cost Effectiveness – Alternative 2

The estimated costs associated with Alternative 2 are presented in Table 8. The total estimated 30-year present worth cost for this alternative is approximately $10,080,000. The estimated capital cost, including costs for preparing an SMP and establishing institutional controls, is $160,000. The estimated 30-year present worth cost of O&M activities, including groundwater/NAPL monitoring and MNR, is approximately $9,920,000.

5.2.3 Alternative 3 – NAPL Barrier Wall, NAPL recovery wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment,

The major components of Alternative 3 include the following:

- Constructing a permeable NAPL barrier wall
- Installing NAPL recovery wells
- Implementing a NAPL recovery program
- Excavating NAPL-containing soil downgradient of the NAPL barrier wall
- Excavating surface soil and placing a soil cover outside of fenced service center upgradient from NAPL barrier wall
- Excavating shallow purifier waste
- Installing an engineered cap over sediments containing MGP-related impacts
- Conducting long-term cap monitoring and MNR of sediment
- Conducting long-term groundwater/NAPL monitoring
- Establishing institutional controls
- Developing a site management plan

NAPL Barrier Wall

A permeable NAPL barrier wall would be constructed along the eastern bank of Cayadutta Creek to prevent potentially mobile NAPL from migrating into Cayadutta creek. The NAPL barrier wall would include NAPL collection sumps installed within the wall to facilitate NAPL recovery.

The NAPL barrier wall would generally consist of an approximately 3-foot wide stone-filled trench that would be keyed into the confining silt unit (located 10 feet to 14 feet below grade along the alignment of the wall). Trench excavation would be conducted under a biopolymer slurry (typically food grade guar gum and stabilizers) to maintain excavation stability. Bench-scale laboratory testing would be required to evaluate the stability (i.e., viscosity, density, and pH) of various biopolymer slurry mixes when combined with the site groundwater, site soils, and NAPL collected from the site. Additionally, polymer degradation agents (i.e., “enzyme breakers”) would be evaluated for compatibility with the site-specific biopolymer mix designs.

Following completion of the trench excavation, a perforated pipe sloped to NAPL collection sumps would be installed at the bottom of the trench to facilitate NAPL collection and recovery. Stone would then be placed into the trench via slope displacement or a different controlled method (e.g., using a tremie pipe) to prevent damage to collection sumps (as necessary). During stone placement, enzyme breakers would be added to degrade the slurry and promote the free flow of groundwater through the wall. Following degradation of the slurry, the trench would be backfilled to restore the ground surface to match surrounding materials, lines, and grades. A minimum of two feet of granular fill consistent with existing materials will be placed over the stone fill. The approximate alignment of the NAPL barrier wall is shown on Figure 14.

NAPL Recovery Wells/NAPL Recovery Program

In addition to the NAPL collection sumps that would be installed within the NAPL barrier wall, NAPL recovery wells would be installed at locations in the service center property where recoverable quantities of NAPL have historically accumulated in groundwater monitoring wells. It has been assumed that up to seven NAPL recovery wells would be installed for the purpose of developing a cost estimate for this alternative. The NAPL recovery wells are assumed to consist of 6-inch diameter stainless steel wells, equipped with 5-foot long sumps, installed to an average depth of 16 feet below grade. The final number, location, and construction of the NAPL recovery wells would be evaluated as part of the remedial design phase of this alternative.

A long-term NAPL monitoring and recovery program would be established following installation of the wells to remove NAPL from the NAPL collection sumps (within the NAPL barrier wall) and NAPL recovery wells, reduce the volume/mass of NAPL at the site, and reduce the potential for future migration of NAPL to Cayadutta Creek. NAPL recovery may be conducted passively by periodic manual bailing or by periodically pumping (with a portable pump) NAPL from the sumps/wells. NAPL could also be removed via an automated pumping system (if warranted) based on the rate of NAPL recovery. For the purpose of developing a cost estimate for this alternative, NAPL recovery activities are assumed to consist of passive NAPL collection with manual recovery conducted on a quarterly basis during the first year following remedial construction, and on an annual basis following the first year for a total period of 30 years. National Grid may request to conduct NAPL monitoring/recovery activities less frequently or cease the program altogether if recoverable quantities of NAPL are not observed during multiple consecutive NAPL monitoring/recovery events (e.g., four consecutive annual monitoring events).

Soil Excavation

Alternative 3 includes targeted removal to address soil containing significant quantities of NAPL downgradient of the NAPL barrier wall, including:

- Approximately 900 cubic yards (cy) of soil to address an estimated 230 cy of NAPL-containing material at depths up to 12 feet below grade located on the west of Cayadutta Creek.
- Approximately 1,800 cy soil to address an estimated 450 cy of NAPL-containing material at depths up to 14 feet below grade located within the silt window, south of the alignment of the NAPL barrier wall.

Additionally, Alternative 3 also includes excavation activities to address approximately 3,000 cy of shallow purifier waste located along the eastern boundary of the service center area to depths up to 5 feet below grade. Shallow purifier waste will be removed to the extent possible based on the presence of potential obstructions/existing natural gas utilities. Excavation limits will be determined during the remedial design phase. The anticipated limits for areas to be targeted for excavation are shown on Figure 14.

Excavation sidewalls would be stabilized by sloping and benching (where possible) or using excavation support. Final excavation support system(s) would be further evaluated and developed as part of the remedial design phase of this alternative.

Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. An assumed 75% of the excavated soil would be transported off-site for disposal as a non-hazardous waste and 25% would be transported off-site for treatment/disposal via LTTD based on site characterization information from previous investigations and IRMs. Excavation areas would be restored with imported clean fill material to match previously existing lines and grades. Backfill materials and surface restoration details would be developed as part of the remedial design phase of this alternative.

Alternative 3 also includes excavation of surface soil (to a depth of approximately 2 feet below grade) containing COCs at concentrations greater than residential SCOs located outside of the fenced service center area and upgradient of the NAPL barrier wall. The area would be backfilled with imported fill to create a soil cover.

Excavations completed to depths below the water table would be dewatered to facilitate soil removal to targeted depths. For the purpose of developing this alternative, it has been assumed that water generated during remedial construction activities would be treated via a temporary on-site water treatment system, and treated water would be discharged to Cayadutta Creek under a temporary discharge authorization (meeting the substantive requirements of a NYSDEC SPDES Permit) or to the GJJWTF. Temporary water treatment system capacity and details would be evaluated as part of the remedial design phase of this alternative.

Sediment Capping

Alternative 3 includes placing an engineered cap over sediment containing MGP-related impacts to physically isolate the sediment and mitigate potential future exposure to MGP-related impacts. An approximately 12,000 square-foot area would be targeted for cap placement. The limits of the area to be capped and vegetation and existing habitat structures would be further investigated to support the design of this alternative. The anticipated sediment capping limits are shown on Figure 14.

Prior to capping, sediment would be removed to accommodate the cap placement without raising the existing creek bathymetry. For the purposes of developing a cost estimate for this alternative, it is assumed that 1 foot of sediment would be removed (approximately 450 cy) prior to placing the engineered cap. A temporary dam would be constructed upstream of the sediment removal areas in support of conducting sediment excavation activities in the dry. A bypass pumping system would be used to convey Cayadutta Creek flow downstream of the sediment removal areas. Sediment would be removed from the dewatered creek using an excavator. Removed sediment would be screened to remove gravel and cobbles that could be reused during site restoration activities to promote habitat restoration. Subsequently, removed sediment would be handled and processed on-site by dewatering and adding appropriate stabilization agents prior to transportation for off-site treatment/disposal via LTTD.

The engineered cap would be designed to provide a physical barrier to deeper impacts and protection against erosional forces, to the extent necessary. For the purposes of this FS, the engineered cap is assumed to consist of (from the bottom up) a synthetic layer (i.e., geotextile), overlain by a 12-inch silt/sand layer. The silt/sand materials would be designed to mimic the existing sediment characteristics and would meet the NYSDEC sediment quality guidelines. The actual cap thickness, materials, and configuration (including cap stability) would be evaluated during the remedial design phase of this alternative.

<u>O&M</u>

A long-term cap monitoring and maintenance program would be implemented to document and maintain the effectiveness of the engineered cap. Monitoring activities are anticipated to consist of visual inspections of the engineered cap. For the purposes of preparing a cost estimate for this FS, it has been assumed that cap monitoring would be conducted annually over a period of 30 years. Inspections of the cap may also be conducted following episodic events (e.g., extreme high flow events). Disturbance or damage to the cap observed during monitoring activities would be addressed appropriately to maintain the long-term effectiveness of the cap. For the purpose of developing a cost estimate, it has been assumed that approximately 20% of cap materials would require replacement and/or maintenance every 5 years.

Alternative 3 also includes the same long-term groundwater/NAPL monitoring, MNR, institutional control, and SMP components previously described under Alternative 2. The existing site drain system would remain in-place and the groundwater treatment system would remain operational under this remedial alternative. Potential groundwater treatment system modifications and treated water discharge alternatives would be considered during the remedial design phase.

5.2.3.1 Short-Term Impacts and Effectiveness – Alternative 3

Implementation of this alternative could result in short-term exposure of the surrounding community and workers to site-related COCs during NAPL barrier wall construction, soil excavation, sediment removal, sediment capping, and material handling and off-site transportation activities. Potential exposure mechanisms include ingestion and dermal contact with NAPL; impacted soil, groundwater, and/or sediment; and inhalation of volatile organic vapors or dust containing COCs during remedial construction.

Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design phase of this alternative. Air monitoring would be performed during excavation and backfilling activities to evaluate the need for additional engineering controls (e.g., use of water sprays to suppress dust, modify the rate of construction, etc.). Community access to the site would be restricted and the recreational walking/biking trail located west of the site would be closed (as appropriate) during portions of the remedial construction to reduce the potential for exposure to site-related COCs.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the site and delivery of fill, capping, or NAPL barrier wall construction materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices.

Potential short-term risks to the community could occur during periodic groundwater/ NAPL monitoring, MNR, and cap monitoring and maintenance activities via exposure to purged groundwater, groundwater samples, and recovered NAPL (if any). Potential exposures to the community would be reduced by following appropriate procedures and protocols that would be described in the SMP.

Off-site transportation of excavated material and importation of clean fill, capping, and NAPL barrier wall construction materials would result in approximately 860 truck round trips (assuming 35 tons per dump truck). Alternative 3 would have a moderate disruption to the nearby community due to the increased local truck traffic. Transportation activities would be managed appropriately to reduce risks to the community. Alternative 3 does not employ green remediation practices and the relative carbon footprint (as compared to the other alternatives) is considered moderate. The greatest contribution to greenhouse gas emissions would likely result from the off-site LTTD treatment of impacted soil/sediment.

Soil excavation, sediment capping, and installation of the NAPL barrier wall could be completed in approximately 7 months. Groundwater/NAPL monitoring, MNR, and sediment cap monitoring and maintenance activities would be conducted over an assumed 30-year period.

5.2.3.2 Long-Term Effectiveness and Permanence – Alternative 3

Approximately 5,700 cy of material would be excavated to address 680 cy of soil containing significant quantities of NAPL and 3,000 cy of purifier waste. The NAPL barrier wall would prevent the further migration of potentially mobile NAPL that would remain at the site to Cayadutta Creek. Excavation and disposal of the impacted materials downgradient from the NAPL barrier wall is a permanent process as the barrier wall would prevent future migration of NAPL to the imported fill materials.

A majority of the area where NAPL impacts would remain is covered with impervious surfaces (i.e., buildings and pavement) and/or gravel, which provide a physical vertical barrier to subsurface impacts. Alternative 3 also includes the installation of an engineered sediment cap to prevent exposures to sediment containing MGP-related impacts. These measures would rely on periodic inspection and maintenance to ensure that they remain effective at preventing potential exposure to impacted materials that would remain at the site.

Site workers do not routinely conduct activities that would potentially result in exposure to media (i.e., soil, groundwater, and sediment) containing site-related COCs. The long-term effectiveness to reduce the potential for exposures to remaining impacts during non-routine invasive work (e.g., utility installation) would be reduced by adhering to the protocols and requirements that would be presented in the SMP.

Surface soil (to approximately 2 feet below grade) located outside of the fenced service center area and upgradient from the NAPL barrier wall would be excavated and backfilled to create a soil cover addressing potential long term exposure to low level COCs in this material at concentrations greater than residential SCOs. Removal and disposal of these materials is a permanent process. Placement of a soil cover in this area would require periodic inspection and maintenance to ensure that the cover provides an effective barrier to remaining impacted soils.

The continued use of the site drains and existing groundwater treatment system would continue limiting groundwater expressions in the form of seeps on the ground surface that could result in the potential for exposures to impacted groundwater. This process provides long-term effectiveness and permanence as long as on-going O&M continues to be conducted for the treatment system.

Annual verification of the institutional controls would be completed to document that the controls are maintained and remain effective. Alternative 3 also includes periodic groundwater/NAPL monitoring and MNR activities to document site conditions.

5.2.3.3 Land Use – Alternative 3

The current zoning for the site is listed as manufacturing, in accordance with the City of Gloversville Zoning Map dated April 1, 2013. Areas immediately surrounding the site are zoned for manufacturing, commercial, residential/commercial, and residential. The current and foreseeable future use of the area surrounding the site is commercial/residential. The site will continue to be used as a National Grid service center (i.e., a base for natural gas and electrical transmission maintenance personnel and equipment).

Implementation of Alternative 3 is not anticipated to alter current or anticipated future site use. In the event that the property is sold, future owners/operators would be required to comply with the SMP and institutional controls established based on the continued presence of soil, groundwater, and sediment containing site-related COCs.

5.2.3.4 Reduction of Toxicity, Mobility or Volume of Contamination through Treatment – Alternative 3

Alternative 3 includes the removal and off-site treatment and/or disposal of approximately 5,700 cy of material to address 680 cy of soil containing significant quantities of NAPL and 3,000 cy of purifier waste. Alternative 3 also includes installation of a NAPL barrier wall and NAPL recovery wells to reduce the potential for future migration of NAPL from the site to Cayadutta Creek sediments. Periodic NAPL monitoring/recovery would be conducted to remove NAPL from collection sumps (within the NAPL barrier wall) and NAPL recovery wells. This would reduce the volume of material that is serving as a source for dissolved phase groundwater impacts.

Under Alternative 3, sediment containing MGP-related impacts would be capped in place limiting sediment mobility beneath the cap. Approximately 450 cy of sediment would be removed for off-site treatment/disposal to facilitate cap construction. MNR would also be conducted to document the extent and potential long-term reduction (i.e., toxicity and volume) of residual impacts in sediment.

The volume and mobility of impacted groundwater and NAPL would be reduced by maintaining the existing site drains and on-site groundwater treatment system. Impacted groundwater would continue to be collected passively by the site drains and subsequently treated at the existing on-site groundwater treatment system (and then discharged to the GJJWTF for further treatment). Additionally, NAPL collected via the site drains and on-site treatment system would be transported off-site for treatment/disposal.

5.2.3.5 Implementability – Alternative 3

Alternative 3 is both technically and administratively feasible. NAPL barrier wall construction, removal and off-site disposal of soil/sediment, engineered cap installation, groundwater/NAPL monitoring, and MNR are technically feasible and remedial contractors capable of performing the activities are readily available. Potential implementation challenges associated with this alternative include: conducting excavation activities where utilities may be present (e.g., electric and gas lines) and maintaining the stability of excavation support sidewalls/bottom. Site utilities, including overhead electric lines and subsurface electric and gas lines, are known to be present near the shallow purifier waste deposit along the eastern boundary of the service center area. Removal or relocation of the natural gas utilities is not anticipated and is considered impractical at this time. Soil will likely be removed to the extent possible and as close to the buried utilities as is deemed safe and the limits of remaining impacted materials will be visually demarcated. Removal of remaining impacted materials in the vicinity of the subsurface utilities will be reconsidered in the event that future subsurface work is required on the natural gas utility. Proposed methods for addressing soil near the natural gas utilities will be determined during the Remedial Design as appropriate.

This alternative assumes that excavation support, consisting of sheet piles, would be required at areas located downgradient of the NAPL barrier wall to facilitate excavation activities. However, excavation support systems would not be installed through the silt unit. As a result, excavation support systems would require multiple levels of internal bracing and/ or external tie-backs to maintain excavation stability, which would be evaluated during the remedial design phase of this alternative.

As presented in Section 1, the hydraulic head in the lower sand and gravel is generally 1 to 7 feet higher than the head measured in the upper sand and gravel, resulting in upward vertical gradients. Additional measures may be necessary to prevent upward groundwater seepage at the bottom of the excavation that could result in hydraulic ground failure (liquefaction, heaving, “boiling”). Detailed measures to prevent failure of the bottom of excavation areas will be evaluated during the remedial design phase of this alternative.

As presented in Section 1, surface water runoff from the service center area is currently collected by the on-site storm sewer system catch basins, and then conveyed to a storm water detention basin located at the southwest corner of the service center area via the storm water drainage ditch that extends along the western portion of the site. Surface water runoff is subsequently discharged to Cayadutta Creek via a culverted pipe that overflows from the storm water detention basin. As the culverted pipe would be removed to facilitate the construction of the NAPL barrier wall, the surface water that accumulates at the detention basin would need to be bypassed from the basin to Cayadutta Creek. The removed culverted pipe would need to be replace following the completion of remedial work. Options to bypass surface water runoff from the service center area will be evaluated during the remedial design phase of this alternative.

Logistically, limited space is available for equipment and material staging. Additionally, remedial construction activities would have to be coordinated with service center operations, as routine daily site operations would have to be (in part or completely) relocated to facilitate completion of the remedial construction activities. Administratively, implementation of Alternative 3 would require access agreements to work activities on properties not owned by National Grid. Access agreements would also be required to conduct long-term groundwater/NAPL monitoring and MNR on non-owned properties.

5.2.3.6 Compliance with SCGs – Alternative 3

- *Chemical-Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 SCOs (i.e., industrial use) and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Additionally, CP-51 Soil Cleanup Guidance (NYSDEC, 2010b) provides a total PAH SCO of 500 mg/kg for subsurface soil at non-residential sites. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA Standards and Guidance Values. Potential chemical-specific SCGs for sediment include sediment screening levels established in the NYSDEC document Technical Guidance for Screening Contaminated Sediment (NYSDEC, 1999).

  Alternative 3 would address potentially mobile NAPL upgradient of Cayadutta Creek via a NAPL barrier wall. Additionally, this alternative would address soil containing significant quantities of NAPL downgradient of the wall and shallow purifier waste along the eastern boundary of the service center area. Alternative 3 would also address surface soil (up to 2 feet below grade) in the southern area outside of the fenced service center property and upgradient from the NAPL barrier wall that contains COCs at concentrations greater than residential SCOs. However, a majority of soil remaining at the site would contain COCs at concentrations greater than the 6 NYCRR Part 375.6 industrial use SCOs. All excavated material and process residuals would be managed and characterized in accordance with 40 CFR Part 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. LDRs would apply to any materials that are characterized as a hazardous waste.

  Although this alternative includes construction of a NAPL barrier wall and NAPL recovery, a majority of impacted soil would remain at the site and therefore, Alternative 3 would likely not achieve groundwater SCGs within a determinate period of time.

  Placing a cap over sediment containing MGP-related impacts would isolate the impacted sediment and mitigate potential future exposure to MGP-related impacts. Additionally, this would provide a clean area of sediment (i.e., above the cap) that would meet the sediment SCGs. The NAPL barrier wall located along the Cayadutta Creek would prevent future migration of NAPL from impacted material upgradient of the wall to Cayadutta Creek sediments.

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Work activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

Excavated soil and sediment would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following an NYSDEC-approved remedial design and using licensed waste transporters and permitted disposal facilities. Per DER-4 (NYSDEC, 2002), excavated MGP-related material that is characteristically hazardous for benzene only (D018) is conditionally exempt from hazardous waste management requirements when destined for thermal treatment (e.g., LTTD). All excavated material would be disposed of in accordance with applicable LDRs (where applicable).

Placing cap materials into Cayadutta Creek would be subject to appropriate USACE and NYSDEC requirements for conducting activities within a water body of the United States/New York State.

- *Location-Specific SCGs* – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains and wetlands including conducting construction activities within a navigable waterway, which would require a joint permit with the Army Corps of Engineers and the NYSDEC. Other applicable location-specific SCGs generally include local building codes and construction permits. Remedial activities would be conducted in accordance with flood plain and wetland regulations, as well as City of Gloversville construction codes and ordinances. Local permits would be obtained prior to initiating the remedial activities.

5.2.3.7 Overall Protectiveness of the Public Health and the Environment – Alternative 3

Alternative 3 would address potentially mobile NAPL at the site via a NAPL barrier wall that would be constructed along the eastern bank of Cayadutta Creek, installation of NAPL recovery wells, and periodic NAPL monitoring/recovery. This alternative also includes excavation to address soil containing significant quantities of NAPL downgradient of the NAPL barrier wall and shallow purifier waste along the eastern boundary of the service center property as well as shallow soil excavation and installation of a soil cover outside of the fenced service center and upgradient from the NAPL barrier wall. Additionally, sediment containing MGP-related impacts would be addressed by placing an engineered cap. Exposures to remaining impacts would be addressed through the protocols and requirements that would be presented in the SMP.

Similar to Alternatives 1 and 2, the existing site drains would remain in place (collecting impacted groundwater/NAPL from the service center area) and the on-site water treatment system would remain operational (to treat groundwater collected by the site drains). Periodic groundwater/NAPL monitoring and MNR would be conducted to document site conditions.

Alternative 3 would work toward preventing exposures (i.e., direct contact, ingestion, and/or inhalation) to site-related impacts in soil (soil RAOs #1, #2, #4) and addressing the source of soil and groundwater impacts through the limited excavation of impacted soil (soil RAO #3 and groundwater RAOs #4 and #5) downgradient of the NAPL barrier wall and along the eastern boundary of the service center property. If future intrusive activities were conducted within the site, potential exposures to remaining soil and groundwater impacts would be prevented by adhering to the institutional controls and the procedures set forth in the SMP that would be developed as part this alternative (soil RAOs #1 and #2 and groundwater RAOs #1 and #2).

This alternative would work toward preventing the migration of site-related COCs that could result in impacts to groundwater, surface water and sediment (soil RAO #3 and groundwater RAO #4) through existing site drains/on-site groundwater treatment system (and associated groundwater treatment/NAPL recovery activities). Alternative 3 would also work toward addressing the source of soil and groundwater impacts (soil RAO # 3 and groundwater RAO #5) through the construction of a NAPL barrier wall, installation of NAPL recovery wells, and associated NAPL monitoring/recovery activities. However, if groundwater is to be restored to pre-disposal/pre-release conditions (groundwater RAO #3), it would occur over a prolonged period of time (i.e., through continued weathering of NAPL and dissociation of related COCs and natural attenuation of dissolved phase impacts), as the source of soil and groundwater impacts would remain upgradient of the barrier wall.

Under Alternative 3, exposures (direct contact and/or ingestion) to sediment containing MGP-related impacts would be prevented by placing an engineered cap and establishing institutional controls (Sediment RAOs #1 and #4). Alternative 3 would also prevent the release of MGP-related impacts that would result in fish advisories/ exceedances of ambient surface water quality criteria and impacts to biota from sediment containing MGP-related impacts (sediment RAOs #2 and #3) through a combination of the NAPL barrier wall, soil excavation, sediment, removal, and engineered cap construction. These same remedial components would work toward restoring sediment to pre-release/background conditions over time (sediment RAO #5).

As presented in Section 1, exposures to constituents associated with the former MGP does not exist through soil vapor intrusion (soil vapor RAO #1).

5.2.3.8 Cost Effectiveness – Alternative 3

The estimated costs associated with Alternative 3 are presented in Table 9. The total estimated 30-year present worth cost for this alternative is approximately $14,700,000. The estimated capital cost; including costs for conducting soil removal, NAPL barrier wall and NAPL monitoring well installation, and sediment capping activities; is $4,700,000. The estimated 30-year present worth cost of O&M activities, including groundwater/NAPL monitoring, MNR, and sediment cap inspection/maintenance, is approximately $10,000,000.

5.2.4 Alternative 4 – NAPL Barrier Wall, NAPL recovery wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment

The major components of Alternative 4 consist of the following:

- Constructing a permeable NAPL barrier wall
- Installing NAPL recovery wells
- Implementing a NAPL recovery program
- Excavating NAPL-containing soil downgradient from the NAPL barrier wall
- Excavating surface soil and placing a soil cover outside of fenced service center upgradient from the NAPL barrier wall
- Excavating shallow purifier waste

- Removing sediment containing MGP-related impacts
- Conducting long-term groundwater/NAPL monitoring
- Conducting long-term sediment monitoring
- Establishing institutional controls
- Developing a site management plan

NAPL Barrier Wall

Alternative 4 includes a NAPL barrier wall that would generally be constructed similarly, although more upgradient than the NAPL barrier wall described under Alternative 3. The NAPL barrier wall for Alternative 4 would be positioned in the southern area perpendicular to the groundwater flow pathway. The NAPL barrier wall would use similar construction methods as previously described under Alternative 3 (i.e., pre-trenching, trenching under a biopolymer slurry to maintain trench stability, installation of NAPL collection sumps, placing coarse fill, etc.). The approximate location and alignment of the proposed NAPL barrier wall is shown on Figure 15.

NAPL Recovery Wells/NAPL Recovery Program

Alternative 4 includes the same NAPL recovery well installation (i.e., installation of up to seven NAPL recovery wells) and long-term NAPL monitoring and recovery program components as Alternative 3. The long-term NAPL monitoring and recovery program under Alternative 4 would similarly be conducted on a quarterly basis during the first year following construction activities, and subsequently on an annual basis for a total period of over 30 years.

Soil Excavation

Alternative 4 also includes similar soil removal components as Alternative 3 (i.e., targeted removal of soil located west of Cayadutta Creek to address soil containing significant quantities of NAPL and removal of shallow purifier waste along the eastern boundary of the service center area). Additionally, Alternative 4 includes removal of approximately 10,900 cy of soil to address an estimated 3,800 cy of soil containing significant quantities of NAPL downgradient of the NAPL barrier wall to the top of the silt and clay unit (to depths up to 10 feet below grade).

Alternative 4 also includes excavation of surface soil (to a depth of approximately 2 feet below grade) containing COCs at concentrations greater than residential SCOs located outside of the fenced service center area and upgradient of the NAPL barrier wall. The area would be backfilled with imported fill to create a soil cover.

The anticipated excavation and soil cover limits for these areas are shown on Figure 15.

Excavation support systems would be required to complete soil removal activities downgradient of the NAPL barrier wall. For the purpose of developing this alternative, it has been assumed that sheet piles would be used as excavation support to facilitate these excavation activities. Multiple cells and internal bracing or tie backs may be required to facilitate soil removal. The final excavation support system(s) would be further evaluated and developed as part of the remedial design phase of this alternative.

Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. An assumed 65% of the excavated soil would be transported off-site for disposal as a non-hazardous waste and 35% would be transported off-site for treatment/disposal via LTTD based on site characterization information from previous investigations and IRMs. The excavation area would be backfilled with imported clean fill material to match the previously existing lines and grades. Backfill materials and surface restoration details would be developed as part of the remedial design phase of this alternative.

A long-term groundwater/NAPL monitoring program would be implemented downgradient from the NAPL barrier wall to monitor for NAPL breakthrough and dissolved phase concentrations in groundwater.

Excavations completed to depths below the water table would be dewatered to facilitate impacted soil removal to target depths. Water generated during remedial construction activities would be treated via a temporary on-site water treatment system and treated water would be discharged to Cayadutta Creek under a NYSDEC SPDES equivalent discharge permit or to the GJJWTF. Temporary water treatment system capacity and details would be evaluated as part of the remedial design phase of this alternative.

Sediment Removal

This alternative includes removal of approximately 1,300 cy of sediment containing MGP-related impacts (an approximately 12,000 square-foot area would be targeted for sediment removal to a depth of 3 feet bss). The limits of sediment meeting the removal criteria would be further evaluated during the remedial design phase of this alternative. The anticipated limits of sediment removal are shown on Figure 15.

A temporary dam would be constructed upstream of the sediment removal areas to facilitate bypass pumping to conduct sediment removal in the dry. Sediment would be removed from the dewatered creek using an excavator. Sediment would be removed from the dewatered creek using an excavator. Removed sediment would be screened to remove gravel and cobbles that could be reused during site restoration activities to promote habitat restoration. Removed sediment would be handled and processed on-site by dewatering and adding appropriate stabilizing agents prior to transportation to an off-site LTTD treatment facility. Sediment removal areas would be backfilled with imported fill material to restore the sediment surface to pre-existing lines and grades.

Alternative 4 includes the same long-term groundwater/NAPL monitoring, MNR, institutional control, and SMP components Alternatives 2 and 3. Alternative 4 also includes continued use of the existing site drains and on-site groundwater treatment system. Potential groundwater treatment system modifications and treated water discharge alternatives would be considered during the remedial design phase.

5.2.4.1 Short-Term Impacts and Effectiveness – Alternative 4

Implementation of this alternative could result in short-term exposure of the surrounding community and workers to site-related COCs as a result of NAPL barrier wall construction, soil excavation, sediment removal, and material handling and off-site transportation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL; impacted soil, groundwater, and/or sediment; and inhalation of volatile organic vapors or dust containing COCs during remedial construction.

Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design phase of this alternative. Air monitoring would be performed during excavation and backfilling activities to evaluate the need for additional engineering controls (e.g., use of water sprays to suppress dust, modify the rate of construction, etc.). Community access to the site would be restricted and the recreational walking/biking trail located west of the site would be closed (as appropriate) during remedial construction to reduce the potential for exposure to site-related COCs.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the site and delivery of fill or NAPL barrier wall construction materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices.

Potential short-term risks to the community could occur during periodic groundwater/ NAPL monitoring and MNR activities via exposure to purged groundwater, groundwater samples, and recovered NAPL (if any). Potential exposures to the community would be reduced by following appropriate procedures and protocols that would be described in the SMP.

Off-site transportation of excavated material and importation of clean fill and NAPL barrier wall construction materials would result in approximately 1,560 truck round trips (assuming 35 tons per dump truck). Alternative 4 would have a moderate disruption to the nearby community due to the increased local truck traffic. Transportation activities would be managed appropriately to reduce en-route risks to the community. Alternative 4 does not employ green remediation practices and the relative carbon footprint (as compared to the other alternatives) is considered moderate (although greater than Alternative 3). The greatest contribution to greenhouse gas emissions would likely result from the off-site LTTD treatment of impacted soil/sediment.

Soil/sediment removal and installation of the NAPL barrier wall could be completed in approximately 14 months. Groundwater/NAPL monitoring and MNR activities would be conducted over an assumed 30-year period.

5.2.4.2 Long-Term Effectiveness and Permanence – Alternative 4

Approximately 16,100 cy of material would be excavated to address approximately 4,100 cy of soil containing significant quantities of NAPL, 3,000 cy of purifier waste, and 1,300 cy of sediment containing MGP-related impacts. The NAPL barrier wall would prevent further migration of NAPL that would remain upgradient of the NAPL barrier wall to Cayadutta Creek. Excavation and disposal of the impacted materials downgradient from the NAPL barrier wall is a permanent process as the barrier wall would prevent future migration of NAPL to the imported fill materials.

The service center property is also covered with impervious surfaces (i.e., buildings and pavement) and/or gravel that provide a physical vertical barrier to subsurface impacts. These measures would rely on periodic inspection and maintenance to ensure that they remain effective at preventing potential exposure to impacted materials that would remain at the site.

Site workers do not routinely conduct activities that could result in exposure to media containing site-related COCs. The potential for exposures to remaining impacts during non-routine invasive work (e.g., utility installation) would be further reduced by adhering to the protocols and requirements that would be presented in the SMP.

The placement of the NAPL barrier wall under this alternative and associated soil removal downgradient from the wall would create a clean fill/buffer zone between the potential source materials (i.e., NAPL) and the sensitive receiving water body (i.e., Cayadutta Creek). Dissolved phase impacts would degrade via natural processes in this buffer zone prior to entering the creek. Degradation is a permanent and non-reversible process.

Surface soil (to approximately 2 feet below grade) located outside of the fenced service center area and upgradient from the NAPL barrier wall would be excavated and backfilled to create a soil cover addressing potential long-term exposure to low level COCs in this material at concentrations greater than residential SCOs. Removal and disposal of these materials is a permanent process. Placement of a soil cover in this area would require periodic inspection and maintenance to improve its effectiveness as a barrier to remaining impacted soils.

The continued use of site drains and existing groundwater treatment system would continue limiting groundwater expressions in the form of seeps on the ground surface that could result in the potential for exposures to impacted groundwater. This process provides long-term effectiveness and permanence as long as on-going O&M continues to be conducted for the treatment system.

Annual verification of the institutional controls would be completed to document that the controls are maintained and remain effective. Alternative 4 includes periodic groundwater/NAPL monitoring and MNR activities to document site conditions.

5.2.4.3 Land Use – Alternative 4

The current zoning for the site is listed as manufacturing, in accordance with the City of Gloversville Zoning Map dated April 1, 2013. Areas immediately surrounding the site are zoned for manufacturing, commercial, residential/commercial, and residential. The current and foreseeable future use of the area surrounding the site is commercial/residential. The site will continue to be used as a National Grid service center (i.e., a base for natural gas and electrical transmission maintenance personnel and equipment).

Implementation of Alternative 4 is not anticipated to alter current or anticipated future site use. In the event that the property is sold, future owners/operators would be required to comply with the SMP and institutional controls established based on the continued presence of soil, groundwater, and sediment containing site-related COCs.

5.2.4.4 Reduction of Toxicity, Mobility or Volume of Contamination through Treatment – Alternative 4

Alternative 4 includes the removal and off-site treatment and/or disposal of approximately 16,100 cy of material to address 4,100 cy of soil containing significant quantities of NAPL, 3,000 cy of purifier waste, and 1,300 cy of sediment containing MGP-related impacts. Alternative 4 also includes installation of a NAPL barrier wall and NAPL recovery wells to reduce the potential for further migration of NAPL upgradient of the NAPL barrier wall to Cayadutta Creek sediments (mobility and volume). Periodic NAPL monitoring/ recovery would be conducted to remove NAPL from collection sumps (within the NAPL barrier wall) and NAPL recovery wells. This would reduce the volume of material that is serving as a source for dissolved phase groundwater impacts.

Dissolved phase impacts remaining in groundwater downgradient from the NAPL barrier wall would attenuate via natural processes (e.g., dispersion, degradation, dilution, etc.) prior to entering Cayadutta Creek.

The volume and mobility of impacted groundwater and NAPL would be reduced by maintaining the existing site drains and on-site groundwater treatment system. Impacted groundwater would continue to be collected passively by the site drains and subsequently treated at the existing on-site groundwater treatment system (and then discharged to the GJJWTF for further treatment). Additionally, NAPL that is collected via the site drains would be sent off-site for treatment/disposal.

5.2.4.5 Implementability – Alternative 4

Alternative 4 is both technically and administratively feasible. NAPL barrier wall construction, removal and off-site disposal of soil/sediment, groundwater/NAPL monitoring, and MNR are technically feasible and remedial contractors capable of performing the activities are readily available. Potential implementation challenges associated with this alternative include: conducting excavation activities where utilities may be present (e.g., electric and gas lines), maintaining the stability of excavation support sidewalls/floor, and dewatering excavation areas/handling removed water. Site utilities, including overhead electric lines and subsurface electric and gas lines, are known to be present near the shallow purifier waste deposit along the eastern boundary of the service center area. Removal or relocation of the natural gas utilities is not anticipated and is considered impractical at this time. Soil will likely be removed to the extent possible and as close to the buried utilities as is deemed safe and the limits of remaining impacted materials will be visually demarcated. Removal of remaining impacted materials in the vicinity of the subsurface utilities will be reconsidered in the event that future subsurface work is required on the natural gas utility. Proposed methods for addressing soil near the natural gas utilities will be determined during the Remedial Design as appropriate.

This alternative assumes that excavation support, consisting of sheet piles, would be required at areas located downgradient of the NAPL barrier wall and the west side of Cayadutta Creek to facilitate excavation activities. However, excavation support systems would not be installed through the silt unit. As a result, excavation support systems may require multiple levels of internal bracing and/or external tie-backs to maintain excavation stability. Additionally, the area located downgradient of the NAPL barrier wall would be subdivided into smaller excavation cells to facilitate excavation activities based on the extent of excavation. Excavation support system options would be evaluated as part of the remedial design phase of this alternative.

As presented in Section 1, the hydraulic head in the lower sand and gravel is generally 1 to 7 feet higher than the head measured in the upper sand and gravel (where the silt unit is present), resulting in upward vertical gradients. Additional measures may be necessary to prevent upward groundwater seepage at the bottom of the excavation that could result in hydraulic ground failure (liquefaction, heaving, “boiling”). Detailed measures to prevent failure of the bottom of excavation areas will be evaluated during the remedial design phase of this alternative.

Significant quantities of water are anticipated to be generated during excavation activities based on the anticipated excavation depths, previous experience, and the site hydrogeologic conditions. This alternative assumes that water generated during remedial construction activities would be treated via a temporary on-site water treatment system and that treated water would be discharged to Cayadutta

Creek under a temporary discharge authorization. Dewatering systems/temporary water treatment system capacity and details would be evaluated as part of the remedial design phase of this alternative to ensure that there is adequate capacity at any given time to collect and treat the groundwater generated during the excavation activities.

As presented in Section 1, surface water runoff from the service center area is currently collected by the on-site storm sewer system catch basins, and then conveyed to a storm water detention basin located at the southwest corner of the service center area via the storm water drainage ditch that extends along the western portion of the site. Surface water runoff is subsequently discharged to Cayadutta Creek via a culverted pipe that overflows from the storm water detention basin. However, the detention basin and the culverted pipe would need to be removed to facilitate soil removal in the area located downgradient of the NAPL barrier wall. During excavation activities in this area, surface water runoff from the service center area would need to be bypassed from the storm water drainage ditch to Cayadutta Creek. The detention basin and culverted pipe would be replaced following the completion of remedial work. Options to bypass surface water runoff from the service center area will be evaluated during the remedial design phase of this alternative.

Logistically, limited space is available for equipment and material staging. Additionally, remedial construction activities would have to be coordinated with service center operations, as routine daily site operations would have to be (in part or completely) relocated to facilitate completion of the remedial construction activities. Administratively, implementation of Alternative 4 would require access agreements to work activities on properties not owned by National Grid. Access agreements would also be required to conduct long-term groundwater/NAPL monitoring and MNR on non-owned properties.

5.2.4.6 Compliance with SCGs – Alternative 4

- *Chemical-Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 SCOs (i.e., industrial use) and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Additionally, CP-51 Soil Cleanup Guidance (NYSDEC, 2010b) provides a total PAH SCO of 500 mg/kg for subsurface soil at non-residential sites. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA Standards and Guidance Values. Potential chemical-specific SCGs for sediment include sediment screening levels established in the NYSDEC document Technical Guidance for Screening Contaminated Sediment (NYSDEC, 1999).

  Alternative 4 would address potentially mobile NAPL in the service center property via a NAPL barrier wall. Additionally, this alternative would address soil containing significant quantities of NAPL downgradient of the wall and shallow purifier waste along the eastern boundary of the service center area. Alternative 4 would also address surface soil (up to 2 feet below grade) in the southern area outside of the fenced service center property and upgradient from the NAPL barrier wall that contains COCs at concentrations greater than residential SCOs. However, a significant quantity of soil remaining at the site would contain COCs at concentrations greater than the 6 NYCRR Part 375.6 industrial use SCOs. All excavated material and process residuals would be managed and characterized in accordance with 40 CFR Part 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. LDRs would apply to any materials that are characterized as a hazardous waste.

Although this alternative includes construction of a NAPL barrier wall, NAPL recovery, and removal of soil containing significant quantities of NAPL downgradient of the wall, impacted soil would remain at the service center area and therefore, Alternative 4 would likely not achieve groundwater SCGs within a determinate period of time.

Sediment containing MGP-related impacts would be removed and sediment removal areas would be backfilled with imported fill material meeting sediment SCGs. The NAPL barrier wall would prevent future migration of NAPL from impacted material upgradient of the wall to Cayadutta Creek sediments.

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Work activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

  Excavated soil and sediment would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following an NYSDEC-approved remedial design and using licensed waste transporters and permitted disposal facilities. Per DER-4 (NYSDEC, 2002), excavated MGP-related material that is characteristically hazardous for benzene only (D018) is conditionally exempt from hazardous waste management requirements when destined for thermal treatment (e.g., LTTD). All excavated material would be disposed of in accordance with applicable LDRs (where applicable).

- *Location-Specific SCGs* – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains and wetlands. Other applicable location-specific SCGs generally include local building codes and construction permits including conducting construction activities within a navigable waterway, which would require a joint permit with the Army Corps of Engineers and the NYSDEC. Remedial activities would be conducted in accordance with flood plain and wetland regulations, as well as City of Gloversville construction codes and ordinances. Local permits would be obtained prior to initiating the remedial activities.

5.2.4.7 Overall Protectiveness of the Public Health and the Environment – Alternative 4

Alternative 4 would address potentially mobile NAPL at the site via a NAPL barrier wall that would be constructed southwest of the service center area, installation of NAPL recovery wells, and periodic NAPL monitoring/recovery. Alternative 4 also includes excavation to address soil containing significant quantities of NAPL downgradient of the NAPL barrier wall and shallow purifier waste along the eastern boundary of the service center area, and shallow soil excavation and installation of a soil cover outside of the fenced service center and upgradient from the NAPL barrier wall. Additionally, sediment containing MGP-related impacts would be removed. Exposures to remaining impacts would be addressed through the protocols and requirements that would be presented in the SMP.

Similar to Alternatives 1 through 3, the existing site drains would remain in place (collecting impacted groundwater/NAPL from the service center area) and the on-site water treatment system would remain operational (to treat groundwater collected by the site drains). Periodic groundwater/NAPL monitoring and MNR would be conducted to document site conditions.

Alternative 4 would work toward preventing exposures (i.e., direct contact, ingestion, and/or inhalation) to site-related impacts in soil (soil RAOs #1, #2, #4) and would work toward addressing the source of soil and groundwater impacts through the targeted excavation of impacted soil (soil RAO #3 and groundwater RAOs #4 and #5). If future intrusive activities were conducted within the site, potential exposures to remaining soil and groundwater impacts would be prevented by adhering to the institutional controls and the procedures set forth in the SMP that would be developed as part this alternative (soil RAOs #1 and #2 and groundwater RAOs #1 and #2).

This alternative would work toward preventing migration of impacts that could result in impacts to groundwater, surface water, and sediment (soil RAO #3 and groundwater RAO #4) through the existing site drains/on-site groundwater system (and associated Groundwater treatment/NAPL recovery activities). Alternative 4 would also work toward addressing the source of soil and groundwater impacts (soil RAO # 3 and groundwater RAO #5) through the construction of a NAPL barrier wall, installation of NAPL recovery wells, and associated NAPL monitoring/recovery activities. However, if groundwater is to be restored to pre-disposal/pre-release conditions (groundwater RAO #3), it would occur over a prolonged period of time (i.e., through continued weathering of NAPL and dissociation of related COCs and natural attenuation of dissolved phase impacts), as the source of soil and groundwater impacts would remain upgradient of the barrier wall.

Under Alternative 4, exposures (direct contact and/or ingestion) to sediment containing MGP-related impacts would be prevented through removal and establishing institutional controls (Sediment RAOs #1 and #4). Additionally, Alternative 4 would prevent the release of MGP-related impacts that would result in fish advisories/exceedances of ambient surface water quality criteria and would also prevent impacts to biota from sediment containing MGP-related impacts (sediment RAOs #2 and #3) through backfilling sediment removal areas with imported clean fill. Furthermore, the NAPL barrier wall would prevent potentially mobile NAPL in the service center area from migrating to the Cayadutta creek sediment (Soil RAO #3). Therefore, this alternative would also work toward restoring sediment to pre-release/background conditions overtime (sediment RAO #5).

As presented in Section 1, exposures to constituents associated with the former MGP does not exist through soil vapor intrusion (soil vapor RAO #1).

5.2.4.8 Cost Effectiveness – Alternative 4

The estimated costs associated with Alternative 4 are presented in Table 10. The total estimated 30-year present worth cost for this alternative is approximately $18,100,000. The estimated capital cost, including costs for conducting soil/sediment removal and NAPL barrier wall and NAPL monitoring well installation activities, is $8,100,000. The estimated 30-year present worth cost of O&M activities, including groundwater/NAPL monitoring and MNR, is approximately $10,000,000.

5.2.5 Alternative 5 –Soil Removal to Unrestricted Use SCOs and Sediment Removal to Background Conditions

The major components of Alternative 5 consist of the following:

- Excavating soil containing COCs at concentrations greater than 6NYCRR Part 375-6 unrestricted use SCOs.
- Removing sediment containing PAHs at concentrations greater than background conditions.

Alternative 5 includes removal activities to address soil containing MGP-related COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs within the site. Additionally, Cayadutta Creek sediment containing PAHs at concentrations greater than background conditions would also be removed. Anticipated soil and sediment removal limits associated with Alternative 5 are shown on Figure 16.

For the purpose of developing this alternative, it is assumed that all above grade structures located on the service center property would be demolished and removed by others prior to remedial construction activities. Building demolition and removal activities are not a component of this alternative.

Alternative 5 does not include provisions or costs for any O&M activities following construction as the impacted media (soil, groundwater and sediment) would be removed. Under Alternative 5 the existing site drain system would be removed during excavation activities and the groundwater treatment system would be decommissioned.

<u>Soil Excavation</u>

This alternative includes excavation at depths ranging from 10 feet below grade up to more than 22 feet below grade (i.e., to the top of the silt unit) to remove approximately 180,000 cy of soil to address soil containing site-related COCs at concentrations greater than unrestricted use SCOs.

Excavation support systems would be required to complete soil removal activities to the top of the silt unit based on the anticipated excavation depths. For the purpose of developing this alternative, it has been assumed that sheet piles (keyed into the top of the silt unit) would be used as excavation support to facilitate these excavation activities. Multiple cells and internal bracing and tie backs may be required to facilitate soil removal. The final excavation support system(s) would be further evaluated and developed as part of the remedial design phase of this alternative.

Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. An assumed 50% of the excavated soil would be transported off-site for disposal as a non-hazardous waste and 50% would be transported off-site for treatment/disposal via LTTD, based on site characterization information from previous investigations and IRMs completed at the site. The excavation area would be backfilled with imported clean fill material to match the previously existing lines and grades. Backfill materials and surface restoration details would be developed as part of the remedial design phase of this alternative. Alternative 5 does not include costs for site redevelopment.

Excavations completed to depths below the water table (located at or near the ground surface to approximately 10 feet below grade) would be dewatered to facilitate impacted soil removal to target depths. Water generated during remedial construction activities would be treated via a temporary on-site water treatment system, and treated water would be discharged to Cayadutta Creek under a NYSDEC

SPDES equivalent discharge permit) or to the GJJWTF. Temporary water treatment system capacity and details would be evaluated as part of the remedial design phase of this alternative.

Sediment Removal

This alternative includes removal of approximately 2,200 cy of sediment containing PAHs at concentrations greater than background concentrations via dredging. The limits of sediment removal meeting the removal criteria would be further evaluated during the remedial design phase of this alternative. The anticipated limits of sediment removal are shown on Figure 16.

Sediment removal activities would be conducted using similar methods as previously described in Alternative 4, including:

- Installing a temporary dam with a bypass pump system upstream of the sediment removal areas to convey Cayadutta Creek flow downstream of the sediment removal areas (to facilitate conducting sediment excavation activities in the dry).
- Conducting sediment removal using an excavator.
- Screening removed sediment to remove desirable gravel and cobbles that could be reused during site restoration activities to promote habitat restoration.
- Dewatering removed sediment on-site by adding appropriate stabilizing agents prior to transportation to an off-site LTTD treatment facility.
- Backfilling sediment removal areas with imported fill material to restore the sediment surface to pre-existing lines and grades.

5.2.5.1 Short-Term Impacts and Effectiveness – Alternative 5

Alternative 5 presents significant short-term impacts to site workers and the surrounding community. Implementation of this alternative could result in short-term exposure of the surrounding community and workers to site-related COCs as a result of soil and sediment excavation, excavated material handling, and off-site transportation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL; impacted soil, groundwater and/or sediment; and inhalation of volatile organic vapors or dust containing COCs during remedial construction.

Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design phase of this alternative. Air monitoring would be performed during excavation and backfilling activities to evaluate the need for additional engineering controls (e.g., use of water sprays to suppress dust, modify the rate of construction, etc.). Community access to the site would be restricted and the recreational walking/biking trail located west of the site would be closed (as appropriate) during portions of the remedial construction to reduce the potential for exposure to site-related COCs.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the site and delivery of fill materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices. Transportation activities would need to be managed to minimize en-route risks to the community.

Off-site transportation of excavated material and importation of clean fill materials would result in approximately 15,900 dump truck round trips (assuming 35 tons per dump truck). Alternative 5 would have a significant disruption to the nearby community due to the increased local truck traffic. Alternative 5 does not employ green remediation practices and the relative carbon footprint resulting from the treatment of excavated materials via LTTD, as well as from transportation of excavated material and importation of clean fill materials, is considered to be significant (as compared to the other alternatives).

Soil/sediment excavation and backfilling activities could be completed in approximately 110 months, assuming all remedial activities are completed as one mobilization.

5.2.5.2 Long-Term Effectiveness and Permanence – Alternative 5

The potential for future long-term impacts from exposures to site-related COCs would be significantly reduced under this alternative. Soil containing COCs at concentrations greater than unrestricted use SCOs and sediments containing PAHs at concentrations greater than background conditions would be excavated and permanently transported off-site for treatment/disposal. Excavation and disposal is a permanent process for removing impacts from the site.

The vast majority (if not all) of impacted soil (i.e., the source of dissolved phase impacts) and sediments would be removed from the site under this alternative. Therefore, no groundwater monitoring, SMP, or institutional controls would be required to reduce the potential for exposures.

5.2.5.3 Land Use – Alternative 5

The current zoning for the site is listed as manufacturing, in accordance with the City of Gloversville Zoning Map dated April 1, 2013. Areas immediately surrounding the site are zoned for manufacturing, commercial, residential/commercial, and residential. The current and foreseeable future use of the area surrounding the site is commercial/residential. The site will continue to be used as a National Grid service center (i.e., a base for natural gas and electrical transmission maintenance personnel and equipment).

Implementation of Alternative 5 is not anticipated to alter current or anticipated future use of the site. Soil containing site-related COCs at concentrations greater than unrestricted use SCOs and sediments containing PAHs at concentrations greater than background conditions would be removed. Excavation areas would be backfilled with imported fill. There would be no limitations to the potential future use of the site. Dissolved phase concentrations of COCs in groundwater beyond the excavation limits would be expected to naturally attenuate over a relatively short time period.

5.2.5.4 Reduction of Toxicity, Mobility or Volume of Contamination through Treatment – Alternative 5

Alternative 5 includes the excavation of approximately 182,000 cy of material to address soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs and sediment containing PAHs at concentrations greater than background conditions. Excavated material would be permanently transported off-site for treatment via LTTD and/or disposal as a non-hazardous waste at a solid waste landfill. Alternative 5 would address a vast majority of soil containing site-related impacts, thereby reducing the flux of COCs from source material to groundwater and the toxicity and volume of residual dissolved phase groundwater impacts. Dissolved phase concentrations of BTEX and PAHs in groundwater downgradient of the excavation areas would be expected to naturally attenuate.

5.2.5.5 Implementability – Alternative 5

Removal of sediment containing PAHs at concentrations greater than background concentrations via dredging to depths up to 3 feet bss would be both technically and administratively implementable. Remedial contractors capable of conducting removal of sediment to these depths are readily available. However, soil removal to the top of silt (i.e., to depths ranging from approximately 10 feet below grade to 22 feet below grade) presents numerous challenges, including maintaining the stability of excavation support sidewalls/floors and dewatering excavation areas/handling removed water.

As discussed above, this alternative assumes that excavation support would consist of sheet pile walls. However, sheet piles would not be installed through the silt unit to prevent NAPL from migrating below the confining unit and therefore, sheet piles would not be cantilevered. Instead, the interior of the excavation area would be subdivided into smaller excavation cells to facilitate excavation activities and excavation support systems would require multiple levels of internal bracing/and or external tie-backs to maintain excavation stability. Excavation support systems associated with this alternative would be highly complex, soil loading conditions and other hydrologic forces (i.e., groundwater pressure) would be evaluated as part of the remedial design phase of this alternative.

As presented in Section 1, the hydraulic head in the lower sand and gravel is generally 1 to 7 feet higher than the head measured in the upper sand and gravel, resulting in upward vertical gradients. Additional measures may be necessary to prevent upward groundwater seepage at the bottom of the excavation that could result in hydraulic ground failure (liquefaction, heaving, "boiling"). Detailed measures to prevent failure of the bottom of the excavation walls will be evaluated during the remedial design phase of this alternative.

Based on the anticipated excavation depths, previous experience, and the documented site hydrogeologic conditions, significant quantities of water are anticipated to be generated during excavation activities. This alternative assumes that water generated during remedial construction activities would be treated via a temporary on-site water treatment system and that treated water would be discharged to Cayadutta Creek under a temporary discharge authorization. Dewatering systems/temporary water treatment system capacity and details would be evaluated as part of the remedial design phase of this alternative to ensure that there is adequate capacity at any given time to collect and treat the groundwater generated during excavation activities.

The extent of the excavation would also cause a severe disruption to the surrounding community. During the implementation of this remedial alternative, traffic patterns on public roads near the remedial construction activities would be disrupted for extended durations. Additionally, multiple treatment/disposal facilities and borrow sources capable of handling more than 182,000 cy of impacted material and providing an equal volume of fill material would have to be identified prior to the implementation of this alternative. Transportation planning would be conducted prior to commencing remedial construction activities.

Administratively, implementation of Alternative 5 would require relocating the service center operations and demolishing/relocating existing utility infrastructure. Additionally, access agreements would be required to conduct excavation activities on properties not owned by National Grid.

5.2.5.6 Compliance with SCGs – Alternative 5

- *Chemical-Specific SCGs* – Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 SCOs (i.e., unrestricted use) and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Additionally, CP-51 Soil Cleanup Guidance (NYSDEC, 2010b) provides a total PAH SCO of 500 mg/kg for subsurface soil at non-residential sites. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA Standards and Guidance Values. Potential chemical-specific SCGs for sediment include sediment screening levels established in the NYSDEC document Screening and Assessment of Contaminated Sediment (NYSDEC, June 2014).

  Alternative 5 includes the removal and off-site treatment/disposal of soil containing COCs at concentrations greater than unrestricted use SCOs and sediment containing PAHs at concentrations greater than background conditions. All excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

  As indicated in Section 1, BTEX, PAHs, and cyanide have been detected in groundwater at concentrations exceeding groundwater quality standards. As Alternative 5 would address the majority of source site-related impacts, this alternative would likely achieve groundwater SCGs.

- *Action-Specific SCGs* – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Work activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

  Excavated soil/sediment and process residuals would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following a NYSDEC-approved remedial design and using licensed waste transporters and permitted disposal facilities. Per DER-4 (NYSDEC, 2002), excavated material from a former MGP site that is characteristically hazardous for benzene only (D018) is conditionally exempt from hazardous waste management requirements when destined for thermal treatment (e.g., LTTD). All excavated material would be disposed of in accordance with applicable NYS LDRs.

- Location-*Specific SCGs* – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains and wetlands. Other applicable location-specific SCGs generally include local building codes and construction permits including conducting construction activities within a navigable waterway, which would require a joint permit with the Army Corps of Engineers and the NYSDEC. Remedial activities would be conducted in accordance with flood plain and wetland regulations, as well as City of Gloversville construction codes and ordinances. Local permits would be obtained prior to initiating the remedial activities.

5.2.5.7 Overall Protectiveness of the Public Health and the Environment – Alternative 5

Alternative 5 would address soil containing COCs at concentrations greater than unrestricted use SCOs and sediment containing PAHs at concentrations greater than background conditions. Excavated material would be permanently removed from the site. Therefore, Alternative 5 would eliminate potential exposures (i.e., direct contact, ingestion, and/or inhalation) to site-related impacts in soil and sediment (soil RAOs #1, #2 and #4, and sediment RAOs #1 and #4). Impacts to public health resulting from exposures to constituents associated with the former MGP via soil vapor intrusion would also be mitigated (soil vapor RAO #1).

Alternative 5 would address the migration of site-related COCs (soil RAO #3) and source of groundwater impacts (groundwater RAO #5) through the removal of soil containing COCs at concentrations greater than unrestricted use SCOs. Reduction in the extent and concentrations of dissolved phase COCs is anticipated following remedial construction activities, as a majority (if not all) impacted material located below the water table (i.e., the source for dissolved phase impacts) would be removed. Therefore, groundwater would eventually likely be restored to pre-disposal/pre-release conditions (groundwater RAO #3). Additionally, as residual dissolved phase impacts would naturally attenuate following soil removal, this alternative would eliminate exposures to impacted groundwater (groundwater RAOs #1 and #2) and prevent discharge of COCs from groundwater to surface water and sediment (groundwater RAO #4).

Alternative 5 would also address potential sources of surface water impacts (sediment RAOs # 2 and #3) through the removal of sediment containing PAHs at concentrations greater than background conditions. As the majority (if not all) sediments containing MGP-related impacts would be removed, sediment would likely be restored to pre-release/background conditions (sediment RAO #5).

5.2.5.8 Cost Effectiveness – Alternative 5

The estimated costs associated with Alternative 5 are presented in Table 11. The total estimated cost for this alternative, including costs for conducting soil/sediment removal and backfilling activities, is $67,900,000.

6 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents the comparative analysis of each remedial alternative using the evaluation criteria identified in Section 5. The comparative analysis identifies the advantages and disadvantages of each alternative relative to each other and with respect to the eight evaluation criteria.

6.1 Comparative Analysis

The alternatives evaluated in Section 5 consist of the following:

- Alternative 1 – No Further Action
- Alternative 2 – Groundwater/NAPL Monitoring, MNR, and Institutional Controls
- Alternative 3 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment
- Alternative 4 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment
- Alternative 5 – Soil Removal to Unrestricted Use SCOs and Sediment Removal to Background Conditions

The comparative analysis of these alternatives is presented in the following subsections.

6.1.1 Short-Term Impacts and Effectiveness

Alternative 1 does not include additional active remediation and subsequently would not present potential short-term impacts to the community. Potential exposures to field personnel as the result of on-going activities related to the existing site drains and on-site groundwater treatment system operation (e.g., groundwater/NAPL collection, treatment of groundwater, off-site transportation of NAPL for treatment/disposal, system maintenance) would continue to be reduced through the use of proper training, PPE, and appropriate health and safety practices.

As Alternative 2 does not include any intrusive activities, Alternative 2 would pose minimal potential short-term risks and potential disturbances to remedial workers and the surrounding community. Alternative 2 could result in short-term exposure to the surrounding community and field personnel during periodic groundwater/NAPL monitoring and MNR activities (conducted over an assumed 30 years). The potential exposures to field personnel would be reduced through the use of proper training and PPE as specified in a site-specific HASP. Potential exposures to the community would be reduced by following appropriate procedures and protocols that would be described in the SMP.

Alternatives 3 through 5 each include intrusive activities (i.e., installation of a NAPL barrier wall, soil excavation, and sediment removal and/or capping) to address site-related impacts. Each of these alternatives would pose potential short-term risks to remedial workers and the public from potential exposure to impacted soil, groundwater, sediment, and NAPL during soil excavation/sediment removal, and off-site transportation of excavated material. Additionally, the remedial construction activities conducted under these alternatives would pose short-term risks to site workers from the operation of construction equipment, and generation of noise and dust.

Nuisances to the surrounding community would include noise from installing excavation support systems (e.g., sheet pile) and operating construction equipment, as well as an increase in local truck traffic associated with importing backfill/capping materials and transportation of excavated materials for off-site treatment/disposal. Estimated durations to implement each of the alternatives and number of truck trips required for each alternative are presented below.

- Alternative 1 – no time required and no truck trips
- Alternative 2 – no time required and no truck trips
- Alternative 3 – 7 months and 860 truck trips
- Alternative 4 – 14 months and 1,560 truck trips
- Alternative 5 – 110 months and 15,900 truck trips

Potential exposures during remedial construction of these alternatives would be mitigated, to the extent practicable, by using appropriate PPE, implementing air and work space monitoring during remedial construction, implementing dust control and noise mitigation measures (as appropriate and/or necessary based on monitoring results), and proper planning and training of remedial workers.

Alternative 1 would have no carbon footprint and Alternative 2 is considered to have minimal foot print. While Alternatives 3 and 4 are considered to have moderate carbon footprints, Alternative 4 would have a greater carbon footprint, when compared to Alternative 3 based on the number of truck trips. Alternative 5 has the greatest carbon footprint compared to the other alternatives based on the significantly greater volume of soil/sediment excavated and backfilled under this alternative. The greatest contribution to greenhouse gases would occur as a result of treatment of excavated materials via LTTD, as well as from equipment operation during excavation, backfilling, and transportation activities.

Although each successive alternative includes the removal of a greater quantity of soil/sediment, and the potential for short-term impacts to the public and remedial workers inherently increases, Alternatives 3 and 4 would have a relatively equivalent short-term impact on the surrounding community and are anticipated to require similar timeframes to implement. Compared to the other remedial alternatives, Alternative 5 would be the most disruptive to the surrounding community, has the greatest potential for exposures to remedial workers and the public, would require the longest time to implement, and has the greatest carbon footprint.

6.1.2 Long-Term Effectiveness and Permanence

Alternative 1 does not include any remedial activities to address site-related impacts. However, groundwater/NAPL are currently collected passively by the site drains. The site drains also limit groundwater expressions in the form of seeps on the ground surface that could occur as the result of water table fluctuations at the site (e.g., following storm events), limiting the potential for exposures to impacted groundwater. The site drains and existing on-site groundwater treatment system would remain operational under Alternatives 2, 3, and 4.

Alternatives 2, 3, and 4 include groundwater/NAPL monitoring to document the extent and concentrations of dissolved phase impacts (i.e., to confirm that concentrations of dissolved phase COCs are stable or potentially decreasing through natural process), as well as to recover potentially mobile NAPL that accumulates in site wells. Additionally, MNR would be conducted under these alternatives to assess post-construction sediment conditions and to confirm and document the attenuation of MGP-related constituents in surface sediments. Alternatives 2, 3, and 4 also include establishing institutional controls and developing an SMP to limit the potential for future exposures to site-related impacts in soil, groundwater, and sediment (that would remain following remedial construction activities). However, Alternative 2 would solely rely more on the institutional controls and the SMP to mitigate future exposures.

Alternatives 3, 4, and 5 each rely on varying degrees of containment and/or removal to reduce the potential for long-term exposures to site-related impacts. Alternatives 3 and 4 rely on the construction of a permeable NAPL barrier wall to address further migration of potentially mobile NAPL to Cayadutta Creek. These alternatives also include excavation activities to address soil containing significant quantities of NAPL downgradient of the wall and shallow purifier waste along the eastern boundary of the service center area (Alternative 4 would include the removal of a greater quantity of impacted soil/sediment compared to Alternative 3). Alternative 4 has the advantage of creating a clean fill buffer zone between the permeable NAPL barrier wall and Cayadutta Creek. This buffer would facilitate attenuation of dissolved phase impacts via natural processes (e.g., degradation, dispersion, dilution, etc.). Alternative 3 and 4 also include the installation of an engineered sediment cap and sediment removal, respectively, to prevent exposure to sediment containing MGP-related impacts. Alternative 5 would eliminate long-term impacts by excavating soil containing COCs at concentrations greater than 6NYCRR Part 375-6 unrestricted use SCOs and removing sediment containing PAHs at concentrations greater than background conditions. Alternative 5 would have the greatest degree of long-term effectiveness and permanence based on the removal of the vast majority of impacted material.

Although Alternative 5 would have the highest degree of long-term effectiveness and permanence, Alternatives 3 and 4 are considered similarly effective as Alternative 5 as these alternatives include the construction of a NAPL barrier wall to address further migration of potentially mobile NAPL to Cayadutta Creek and removal soil to address soil containing significant quantities of NAPL downgradient of the wall. Alternative 3 and 4 also limit potential for future exposures to soil and groundwater containing MGP-related impacts (based on the current and intended future site use) by the presence of asphalt, concrete, buildings, and clean gravel covering the impacted materials.

6.1.3 Land Use

The current zoning for the site is listed as manufacturing, in accordance with the City of Gloversville Zoning Map dated April 1, 2013. Areas immediately surrounding the site are zoned for manufacturing, commercial, residential/commercial, and residential. The current and foreseeable future use of the area surrounding the site is commercial and residential. The site will continue to be used as a National Grid service center (i.e., a base for natural gas and electrical transmission maintenance personnel and equipment).

Implementation of Alternatives 1 through 5 is not anticipated to alter current or anticipated future use of the site. Alternative 1 does not include any remedial actions and therefore the site would remain in its current condition. Alternatives 2, 3, and 4, include establishing institutional controls on the site properties and conducting groundwater/ NAPL monitoring and MNR activities for an assumed 30 years. Additionally, Alternatives 3 and 4 include a combination of soil removal, NAPL recovery and containment and sediment capping to address site related-impacts. In the event that the property is sold, future owners/ operators would be required to comply with the SMP and established institutional controls based on the continued presence of soil, groundwater, and sediment containing site-related COCs. Under these alternatives, the service center property would likely be limited to commercial/industrial use, and the southern area would remain undeveloped.

As Alternative 5 would address a majority of site-related impacts by extensive excavation, there would likely be no limitations to the potential future use of the site. Dissolved phase concentrations of COCs in groundwater beyond the excavation limits would be expected to naturally attenuate over a relatively short time period.

6.1.4 Reduction of Toxicity, Mobility and Volume of Contamination through Treatment

The existing site drains would remain in-place and the on-site groundwater treatment system would remain operational as part of Alternatives 1 through 4 to address impacted groundwater/NAPL that passively enters the drains and is pumped to the treatment system. This would continue to reduce the volume and mobility of impacted groundwater and NAPL at the site.

Alternative 1 does not include additional activities to reduce the toxicity, mobility, or volume of contamination at the site, and therefore, is considered the least effective for this criterion. Alternatives 2, 3, and 4 include groundwater/NAPL monitoring to document the extent trends in concentrations of dissolved phase impacts), as well as to recover potentially mobile NAPL that accumulates in site wells. Additionally, MNR would be conducted under these alternatives to assess sediment conditions and to confirm and document the attenuation of MGP-related constituents in surface sediments.

Alternatives 3 and 4 include constructing a NAPL barrier wall and NAPL recovery wells to prevent further migration of potentially mobile NAPL from the site to Cayadutta Creek sediments. Periodic NAPL monitoring/recovery would be conducted to remove NAPL from collection sumps (within the NAPL barrier wall) and NAPL recovery wells. This would reduce the volume of material that is serving as a source for dissolved phase groundwater impacts.

For Alternatives 3 through 5, each successive alternative includes the excavation and off-site treatment and/or disposal of a greater quantity of soil/sediment. Alternative 3 and 4 include the removal of approximately 6,150 cy and 16,100 cy of material, respectively. Alternative 3 also includes placing an engineered cap to limit impacted sediment mobility beneath the cap. As described above, NAPL-impacted material that would remain (upgradient of the NAPL barrier wall) that is serving as a source for dissolved phase groundwater impacts going off site would be reduced under this alternative via the NAPL barrier wall/NAPL recovery wells. Additionally, the rate of dissolution of COCs will reduce as the NAPL continues to weather naturally overtime. Alternative 5 would remove the greatest volume of soil containing site-related impacts (approximately 182,000 cy of material).

A clean fill zone would be created under Alternative 4 between the permeable NAPL barrier wall and Cayadutta Creek. This would facilitate attenuation of dissolved phase impacts via natural processes (e.g., degradation, dispersion, dilution, etc.) following removal of NAPL in the NAPL barrier wall and prior to discharge to Cayadutta Creek.

Although Alternative 5 would remove a greater volume of soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs, Alternatives 3 and 4 would also be effective at reducing toxicity, mobility, and volume of MGP-related impacts via the NAPL barrier wall, NAPL recovery wells, and removal of soil/sediment.

6.1.5 Implementability

No additional remedial activities would be conducted as part of Alternative 1 and therefore, Alternative 1 is considered the most implementable. Alternatives 2, 3, and 4 include long-term groundwater/NAPL monitoring and MNR activities, preparation of an SMP, and implementation of institutional controls. From a technical implementability aspect, these activities do not require highly specialized equipment or personnel and could be easily implemented. Administratively, establishing institutional controls on properties not owned by National Grid would require coordination with state agencies (i.e., NYSDEC and NYSDOH) and the property owners. Additionally, access agreements would be required to conduct long-term groundwater/NAPL monitoring and MNR.

Alternatives 3, 4, and 5 include constructing a NAPL barrier wall, soil excavation, and sediment removal/capping and therefore, have similar implementation challenges. Alternative 5 would pose the following challenges making implementation much more difficult relative to Alternatives 3 and 4:

- Higher potential for excavation hydraulic ground failure (liquefaction, heaving, “boiling”).
- Significant disruption to surrounding community for an extended period of time (on the order of 5 to 10 years).
- Removal and/or relocation of significant regional gas distribution utilities.

6.1.6 Compliance with SCGs

- Chemical-Specific SCGs – Chemical-specific SCGs are presented in Table 1. Alternatives 1 and 2 do not include intrusive remedial construction activities and therefore, would not achieve chemical-specific SCGs for soil, groundwater, or sediment.

  Alternatives 3 and 4 would address potentially mobile NAPL at the site via a NAPL barrier wall Additionally, these alternatives would also address soil containing significant quantities of NAPL downgradient of the wall and shallow purifier waste along the eastern boundary of the service center area (Alternative 4 would include the removal of a greater quantity of soil/sediment compared to Alternative 3). Alternatives 3 and 4 both address surface soil (up to 2 feet below grade) located outside of the fenced service center that contains COCs at concentrations greater than residential SCOs. However, a majority of soil remaining at the site would contain COCs at concentrations greater than the 6 NYCRR Part 375.6 industrial use SCOs. Alternative 5 includes the removal and off-site treatment/disposal of all soils containing COCs at concentrations greater than unrestricted use SCOs. Under each alternative, excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

  As indicated in Section 1, BTEX, PAHs, and cyanide have been detected in groundwater at concentrations exceeding groundwater quality standards. Alternatives 1 and 2 do not address soil containing MGP-related impacts below the water table. Therefore, if these alternatives could achieve groundwater SCGs, the SCGs would be achieved over a prolonged period of time (i.e., through natural attenuation of dissolved phase impacts). Although Alternatives 3 and 4 include construction of a NAPL barrier wall, NAPL recovery, and varying degrees of soil removal downgradient of the wall, impacted soil would remain at the service center area and therefore, these alternatives would likely not achieve groundwater SCGs within a determinate period of time. As Alternative 5 would address the majority of source site-related impacts, this alternative would likely achieve groundwater SCGs.

Alternative 3 includes placing a cap over sediment containing MGP-related impacts to isolate the impacted sediment and mitigate potential future exposure to MGP-related impacts. The cap would also provide a clean area of sediment (i.e., above the cap) that would meet the sediment SCGs. Alternative 4 includes the removal of sediment containing MGP-related impacts and backfilling of sediment removal areas with imported fill material meeting sediment SCGs. The NAPL barrier wall that would be constructed as part of Alternatives 3 and 4 would prevent future migration of NAPL from impacted material upgradient of the wall to Cayadutta Creek sediments. Alternative 5 includes the removal and off-site treatment/disposal of sediment containing PAHs at concentrations greater than background conditions.

- *Action*-Specific SCGs – Action-specific SCGs are presented in Table 2. Potentially applicable action-specific SCGs include health and safety requirements and regulations associated with handling impacted media. Work activities would be conducted in accordance with OSHA requirements that specify general industry standards, safety equipment and procedures, and record keeping and reporting regulations. Compliance with these action-specific SCGs would be accomplished by following a site-specific HASP.

  Under Alternatives 2 through 5, excavated soil/sediment and/or process residuals would be subject to USDOT requirements for packaging, labeling, manifesting, and transporting hazardous or regulated materials. Compliance with these requirements would be achieved by following a NYSDEC-approved remedial design and using licensed waste transporters and permitted disposal facilities. Per DER-4 (NYSDEC, 2002), excavated material from a former MGP site that is characteristically hazardous for benzene only (D018) is conditionally exempt from hazardous waste management requirements when destined for thermal treatment (e.g., LTTD). All excavated material would be disposed of in accordance with applicable NYS LDRs.

  Placing cap materials into Cayadutta Creek as part of Alternative 3 would also be subject to appropriate USACE and NYSDEC requirements for conducting activities within a water body of the United States/New York State.

- Location-Specific SCGs – Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains and wetlands. Other applicable location-specific SCGs generally include local building codes and construction permits. Remedial activities would be conducted in accordance with flood plain and wetland regulations, as well as City of Gloversville construction codes and ordinances. Local permits would be obtained prior to initiating the remedial activities.

6.1.7 Overall Protection of Public Health and the Environment

Impacted groundwater and potentially mobile NAPL are currently collected passively by the site drains. Collected groundwater is treated at the existing on-site groundwater treatment system and then discharged to the GJJWTF for further treatment, while collected NAPL is sent off-site for treatment/disposal. The existing site drains would remain in-place and the on-site groundwater treatment system would remain operational under Alternatives 1 through 4.

The “No Further Action” alternative (i.e., Alternative 1) does not actively address the toxicity, mobility, or volume of impacted environmental media, and therefore, is not effective on a long-term basis for eliminating potential migration or potential exposure to impacts. However, this alternative would still work toward addressing potential sources of groundwater impacts (soil RAO #3 and groundwater RAO #5) and preventing discharge of contaminants from groundwater to surface water and sediment (groundwater RAO #4) through passive recovery and removal of NAPL and groundwater treatment via the on-site treatment system.

Alternatives 2 through 5 would prevent exposures (i.e., direct contact, ingestion, and inhalation) to site-related impacts in soil, groundwater, and sediment (soil RAOs #1 and #2, groundwater RAOs #1 and #2, and sediment RAO #1). Alternative 2 would solely rely on the site drains/on-site groundwater treatment system, implementation of institutional controls, and adherence to the procedures to be presented in the SMP, and would not prevent biota exposures (i.e., direct contact, ingestion) to site-related impacts in soil and sediment (soil RAO #4 and sediment RAO #4). Alternatives 3, 4, and 5 would rely on a combination of the site drains/on-site groundwater treatment system, varying amounts of excavation, NAPL recovery and containment, sediment capping/removal, institutional controls, and/or an SMP to prevent human and biota exposures to MGP-related impacts in soil and sediment (soil RAOs #1, #2, and #4, and sediment RAO #4).

Alternatives 2, 3, and 4 would work toward addressing potential sources of groundwater impacts and preventing migration of impacts that could result in impacts to groundwater, surface water, and sediment (soil RAO #3 and groundwater RAOs #4 and #5) through the existing site drains/on-site groundwater system. Alternatives 3 and 4 would also work toward addressing the source of soil and groundwater impacts (soil RAO # 3 and groundwater RAO #5) through the construction of a NAPL barrier wall, installation of NAPL recovery wells, and associated NAPL monitoring/recovery activities. However, if groundwater is to be restored to pre-disposal/pre-release conditions under this alternative (groundwater RAO #3), it would occur over a prolonged period of time (i.e., through continued natural weathering of NAPL and dissociation of related COCs and attenuation of dissolved phase impacts), as the source of soil and groundwater impacts would remain upgradient of the NAPL barrier wall. Only Alternative 5 would address the migration of site-related COCs (soil RAO #3) and source of groundwater impacts (groundwater RAO #5) through the removal of soil containing COCs at concentrations greater than unrestricted use SCOs. Groundwater would likely be restored to pre-disposal/pre-release conditions (groundwater RAO #3) as a majority (if not all) impacted material located below the water table (i.e., the source for dissolved phase impacts) would be removed. Additionally, as residual dissolved phase impacts would naturally attenuate following soil removal, Alternative 5 would also eliminate exposures to impacted groundwater (groundwater RAOs #1 and #2) and prevent discharge of COCs from groundwater to surface water and sediment (groundwater RAO #4).

Alternatives 1 and 2 do not address potential sources of surface water impacts (sediment RAOs # 2 and #3) and therefore, under these alternatives, sediment would only be restored to pre-release/background conditions (sediment RAO #5) over a prolonged period of time (i.e., through natural recovery of sediment impacts). Alternatives 3 and 4, would prevent exposures (direct contact and/or ingestion) to sediment containing MGP-related impacts (Sediment RAOs #1 and #4) through capping and/or removal, respectively. These alternatives would also prevent the release of MGP-related impacts that would result in fish advisories/exceedances of ambient surface water quality criteria and would also prevent impacts to biota from sediment containing MGP-related impacts (sediment RAOs #2 and #3) through capping/backfilling sediment removal areas with imported clean fill. Additionally, Alternatives 3 and 4 would prevent potentially mobile NAPL from migrating to the Cayadutta creek sediment (Soil RAO #3) through the construction of a NAPL barrier wall. Therefore, these alternatives would also work toward restoring sediment to pre-release/background conditions overtime (sediment RAO #5). Only Alternative 5 would address potential sources of surface water impacts (sediment RAOs # 2 and #3) through the removal of sediment containing PAHs at concentrations greater than background conditions. As the majority (if not all) sediments containing MGP-related impacts would be removed, sediment would likely be restored to pre-release/background conditions (sediment RAO #5).

As presented in Section 1, exposures to constituents associated with the former MGP does not exist through soil vapor intrusion (soil vapor RAO #1).

6.1.8 Cost Effectiveness

The following table summarizes the estimated costs associated with implementing each of the remedial alternatives.

Table 6.1 Estimated Costs

Alternative	Estimated Capital Cost	Estimated Present Worth Cost of O&M[1]	Total Estimated Cost
Alternative 1 – No Further Action	$0	$8,300,000	$8,300,000
Alternative 2 – Groundwater/NAPL Monitoring, MNR, and Institutional Controls	$160,000	$9,920,000	$10,080,000
Alternative 3 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment	$4,700,000	$10,000,000	$14,700,000
Alternative 4 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment	$8,100,000	$10,000,000	$18,100,000
Alternative 5 – Soil Removal to Unrestricted Use SCOs and Sediment Removal to Background Conditions	$67,900,000	$0	$67,900,000

Note:
1. Estimated present worth of O&M cost is over an assumed 30-year period.

The capital cost to implement Alternative 5 is significantly greater relative to the capital cost to implement the other alternatives (i.e., approximately three to six times the cost of Alternatives 2, 3, and 4). There are numerous implementation challenges/concerns associated with Alternative 5. The higher cost for Alternatives 5 corresponds to the large volume of excavation and backfilling associated with this alternative. Alternative 5 would address the greatest volume of soil. However, Alternative 5 corresponds to the greatest technical implementation difficulties and disruption to the surrounding community and has the greatest potential for exposures based on the extent of excavation and anticipated timeframe required to implement this remedial alternative. Therefore, Alternative 5 is considered the least cost-effective considering short-term effectiveness; reduction of toxicity, mobility, and volume; and long-term effectiveness.

The capital cost for implementing Alternative 2 is less than the capital cost to implement Alternatives 3 and 4; however, Alternative 2 does not include any active remedial activities to address site-related impacts. Therefore Alternative 2 is considered the less effective. Although the cost for implementing Alternative 4 is greater than Alternative 3, Alternative 4 addresses significantly more impacted site materials compared to Alternative 3. Alternative 4 would address approximately 160% more material (i.e., an additional 10,000 cy), for approximately 25% increase in cost (i.e., $3,400,000), compared to Alternative 3. Therefore, Alternative 4 is considered the most cost-effective.

6.2 Comparative Analysis Summary

The following table provides a summary of the remedial alternatives' abilities to meet the RAOs, as well as the volume of material addressed, relative short-term impacts, and estimated cost for each alternative.

Table 6.2 Comparative Analysis Summary

Criteria	Alternative No.				
	1	2	3	4	5
Overall Protection (RAOs)					
Soil RAO 1	No	Yes	Yes	Yes	Yes
Soil RAO 2	No	Yes	Yes	Yes	Yes
Soil RAO 3	Limited	Limited	Moderate	Moderate	Yes
Soil RAO 4	No	No	Moderate	Moderate	Yes
Groundwater RAO 1	No	Yes	Yes	Yes	Yes
Groundwater RAO 2	No	Yes	Yes	Yes	Yes
Groundwater RAO 3	Limited	Limited	Limited	Limited	Yes
Groundwater RAO 4	No	No	Moderate	Moderate	Yes
Groundwater RAO 5	Limited	Limited	Moderate	Moderate	Yes
Soil Vapor RAO 1	Yes	Yes	Yes	Yes	Yes
Sediment RAO 1	No	Yes	Yes	Yes	Yes
Sediment RAO 2	No	No	Yes	Yes	Yes
Sediment RAO 3	No	No	Yes	Yes	Yes
Sediment RAO 4	No	No	Yes	Yes	Yes
Sediment RAO 5	No	No	Moderate	Moderate	Yes

Criteria	Alternative No.				
	1	2	3	4	5
Reduction of Toxicity, Mobility, and Volume					
Soil/Sediment Removal Volume	0 cy	0 cy	6,150 cy	16,100 cy	182,000 cy
Short Term Impacts					
Length of Disruption	None	None	7 months	14 months	5-10 years*
Cost					
Total Cost	$8,300,000	$10,080,000	$14,700,000	$18,100,000	$67,900,000

Note:

* - Estimated time for Alternative 5 construction is based on an assumed production rate. The presented range attempts to bracket the potential for one or two excavation crews.

7 PREFERRED REMEDIAL ALTERNATIVE

This section presents a description of the preferred remedial alternative. The results of the comparative analysis conducted in Section 6 were used as a basis for recommending a preferred remedial alternative.

7.1 Summary of Preferred Remedial Alternative

Based on the comparative analysis of the remedial alternatives presented in Section 6, Alternative 4 is the preferred remedial alternative for the site. Alternative 4 would achieve the best balance of the NYSDEC evaluation criteria, while reducing the potential for future exposure to site-related impacts.

As described in Section 5 and presented in Table 10, the primary components of Alternative 4 consist of the following:

- Excavating 520 cy of soil to facilitate the construction of a permeable NAPL barrier wall.
- Constructing a permeable NAPL barrier wall in the southern area perpendicular to the groundwater flow pathway to prevent future migration of potentially mobile NAPL to Cayadutta creek. The NAPL barrier wall would include NAPL collection sumps installed within the wall to facilitate NAPL recovery.
- Excavating an estimated 14,800 cy of material to address 4,100 cy of soil containing significant quantities of NAPL downgradient of the NAPL barrier wall and 3,000 cy of shallow purifier waste along the eastern boundary of the service center area.
- Removing surface soil (up to 2 feet below grade) located upgradient from the NAPL barrier wall and outside of the fenced service center area that contains COCs at concentrations greater than residential SCOs and installing a soil cover over this area.
- Removing an estimated 1,300 cy of sediment containing MGP-related impacts.
- Transporting an estimated 16,500 tons of excavated material off-site for disposal as a non-hazardous solid waste.
- Transporting an estimated 10,800 tons of excavated material off-site for treatment/ disposal via LTTD.
- Installing up to seven NAPL recovery wells at locations in the service center property where recoverable quantities of NAPL have historically accumulated in groundwater monitoring wells.
- Continuing operation and maintenance of the existing on-site drains and associated groundwater system.
- Conducting annual groundwater monitoring/NAPL recovery and MNR activities.
- Preparing an annual report to summarize annual groundwater sampling/NAPL recovery and MNR activities
- Establishing institutional controls in the form of deed restrictions and/or environmental easements for the properties that contain MGP-related impacts to limit the future development and use of the site and site groundwater, as well as to limit the permissible invasive (i.e., subsurface) activities that could result in potential exposures to subsurface soil, groundwater, and sediment containing MGP-related

impacts. Additionally, the institutional controls would require compliance with the SMP (described below) that would be prepared as part of this alternative.

- Preparing an SMP to document the following:
    - The institutional controls that have been established and would be maintained for the site.
    - Known locations of remaining soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 industrial use SCOs.
    - Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities.
    - Protocols and requirements for conducting annual groundwater monitoring/NAPL recovery, and MNR.
    - Requirements for performing periodic site inspections, providing NYSDEC-required certifications, and submitting periodic reports to NYSDEC.

7.2 Preferred Remedy Selection Rationale

The primary components of the preferred alternative include a permeable NAPL barrier wall and soil excavation/sediment removal. These are proven technologies for addressing mobile NAPL and soil/sediment that contains MGP-related impacts, respectively. Additionally, these technologies have been successfully implemented at other MGP sites and are considered technically and administratively implementable. Remedial contractors capable of constructing the NAPL barrier wall and performing soil excavation/sediment removal activities are readily available. Potential implementation challenges associated with this alternative primarily include maintaining the stability of excavation support sidewalls/floor and dewatering excavation areas/handling removed water. Excavation support, consisting of sheet piles, would be used to facilitate excavation activities downgradient of the NAPL barrier wall. Excavation support systems may require multiple levels of internal bracing and/or external tie-backs to maintain excavation stability, as these systems would not be installed through the silt unit. Additionally, the excavation areas may be subdivided into smaller excavation cells to facilitate excavation activities. Additional measures may also be necessary to prevent upward groundwater seepage at the bottom of the excavation (resulting from existing upward vertical gradients) that could result in hydraulic ground failure (liquefaction, heaving, “boiling”). Excavation support system options and measures to prevent failure of the bottom of excavation areas would be evaluated as part of the remedial design phase of this alternative.

Significant quantities of water are anticipated to be generated during excavation activities based on the anticipated excavation depths, previous experience, and the site hydrogeologic conditions. Water generated during remedial construction activities would be treated via a temporary on-site water treatment system. Treated water would be discharged to Cayadutta Creek under a temporary discharge authorization. Dewatering systems/temporary water treatment system capacity and details would be evaluated as part of the remedial design.

Potential short-term impacts to the surrounding community and workers would include potential exposures to soil, groundwater, and sediment containing site-related COCs during NAPL barrier wall construction, soil excavation, sediment removal, and material handling and off-site transportation activities. The potential for exposure would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design phase of this alternative. Air monitoring would be performed during excavation and backfilling activities to evaluate the need for additional engineering controls (e.g., use of water sprays to suppress dust, odor control, modify the rate of construction, etc.). Community access to the site would be restricted and the recreational walking/biking trail located west of the site would be closed (as appropriate) during remedial construction.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transporting excavated material from the site and delivering fill and NAPL barrier wall construction materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices.

Potential short-term risks to the community could occur during periodic groundwater/ NAPL monitoring and MNR activities via exposure to purged groundwater, groundwater samples, and recovered NAPL (if any). Potential exposures to the community would be reduced by following appropriate procedures and protocols that would be described in the SMP.

Alternative 4 would work toward preventing exposures (i.e., direct contact, ingestion, and/or inhalation) to site-related impacts in soil through soil excavation and placing a soil cover in the portion of the southern area between the NAPL barrier wall and the service center fence (soil RAOs #1, #2, #4) and addressing the source of soil and groundwater impacts through the targeted excavation of impacted soil (soil RAO #3 and groundwater RAOs #4 and #5). Potential exposures to remaining soil and groundwater impacts would be prevented by adhering to the institutional controls and the procedures set forth in the SMP that would be developed as part this alternative (soil RAOs #1 and #2 and groundwater RAOs #1 and #2).

Alternative 4 would work toward preventing migration of impacts that could result in impacts to groundwater, surface water, and sediment (soil RAO #3 and groundwater RAO #4) through the existing site drains/on-site groundwater system (and associated groundwater treatment/NAPL recovery activities). Alternative 4 would also work toward addressing the source of soil and groundwater impacts (soil RAO # 3 and groundwater RAO #5) through the construction of the NAPL barrier wall, installation of NAPL recovery wells, and associated NAPL monitoring/recovery activities. However, groundwater would only be restored to pre-disposal/pre-release conditions (groundwater RAO #3), over a prolonged period of time (i.e., through continued natural weathering of NAPL and dissociation of related COCs and attenuation of dissolved phase impacts).

Alternative 4 would prevent exposures (direct contact and/or ingestion) to sediment containing MGP-related impacts through removal and establishing institutional controls (Sediment RAOs #1 and #4). Additionally, Alternative 4 would prevent releasing MGP-related impacts that would result in fish advisories/exceedances of ambient surface water quality criteria and would also prevent impacts to biota from sediment containing MGP-related impacts (sediment RAOs #2 and #3) through backfilling sediment removal areas with imported clean fill. Furthermore, the NAPL barrier wall would prevent potentially mobile NAPL in the service center area from migrating to Cayadutta creek sediment (Soil RAO #3). Therefore, this alternative would also work toward restoring sediment to pre-release/background conditions overtime (sediment RAO #5).

Generally, Alternative 4 is preferred over the other remedial alternatives based on the following:

- Alternative 4 includes the construction of a permeable NAPL barrier wall more upgradient from Cayadutta Creek as compared to Alternative 3.
- Alternative 4 would address more impacted material than Alternative 3 (8,400 cy versus 4,130 cy), with a similar timeframe as compared to Alternative 3.
- As opposed to Alternative 3, Alternative 4 creates a clean fill buffer zone down gradient from the permeable NAPL barrier wall that will facilitate dissolved phase COC attenuation via natural processes prior to discharge to Cayadutta Creek.
- Alternative 4 would address an estimated six times more NAPL-impacted material (i.e., 4,100 cy versus 680 cy), for approximately 25% increase in cost (i.e., $3,400,000), compared to Alternative 3.
- Remedial construction activities associated with Alternative 4 would require approximately 14 months to implement, compared to Alternative 5 which would require approximately 110 months to complete, and is thereby significantly less disruptive to the surrounding community.
- Alternative 5 is not a cost-effective alternative, given the duration of remedial construction activities, potential for exposure during remediation, and associated duration of disruption to the surrounding community.

7.3 Estimated Cost of Preferred Remedial Alternative

The total estimated cost associated with implementation of the preferred remedial alternative is summarized in the following table.

Table 7.1 Cost Estimate for Alternative 4

Alternative	Estimated Capital Cost	Estimated Present Worth of O&M Cost[1]	Total Estimated Cost
Alternative 4 – NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment	$8,100,000	$10,000,000	$18,100,000

Note:

1. Estimated present worth of O&M cost is over an assumed 30-year period.

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TABLES

Table 1
Summary of Chemical-Specific SCGs

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
National Primary Drinking Water Standards	40 CFR Part 141	S	Establishes maximum contaminant levels (MCLs) which are health-based standards for public water supply systems.	These standards are potentially applicable if an action involves future use of groundwater as a public supply source.
RCRA-Regulated Levels for Toxic Characteristics Leaching Procedure (TCLP) Constituents	40 CFR Part 261	S	These regulations specify the TCLP constituent levels for identification of hazardous wastes that exhibit the characteristic of toxicity.	Excavated materials may be sampled and analyzed for TCLP constituents prior to disposal to determine if the materials are hazardous based on the characteristic of toxicity.
Universal Treatment Standards/Land Disposal Restrictions (UTS/LDRs)	40 CFR Part 268	S	Identifies hazardous wastes for which land disposal is restricted and provides a set of numerical constituent concentration criteria at which hazardous waste is restricted from land disposal (without treatment).	Applicable if waste is determined to be hazardous and for remedial alternatives involving off-site land disposal.
Clean Water Act (CWA) - Ambient Water Quality Criteria	40 CFR Part 131; USEPA 440/5-86/001 “Quality Criteria for Water – 1986,” superseded by “National Recommended Water Quality Criteria: 2009”	S	Criteria for protection of aquatic life and/or human health depending on designated water use.	Potentially applicable to the evaluation of potential impacts to the Cayadutta Creek from site-related constituents.
CWA Section 136	40 CFR 136	G	Identifies guidelines for test procedures for the analysis of pollutants.	Potentially applicable to the evaluation of potential impacts to the Cayadutta Creek from site-related constituents.
New York State				
NYSDEC Guidance on Remedial Program Soil Cleanup Objectives	6 NYCRR Part 375	G	Provides an outline for the development and execution of the soil remedial programs. Includes soil cleanup objective tables.	These guidance values are to be considered, as appropriate, in evaluating soil quality.
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	S	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 6 NYCRR Parts 371-376.	Applicable for determining if materials generated during implementation of remedial activities are hazardous wastes. These regulations do not set cleanup standards, but are considered when developing remedial alternatives.
Soil Cleanup Guidance	CP-51	G	Provides the framework and policies for the selection of soil cleanup levels.	Guidance would be used to develop site-specific soil cleanup objectives (SCOs).
NYSDEC Ambient Water Quality Standards and Guidance Values	Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1	G	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 to be considered in evaluating groundwater and surface water quality.
New York State Surface Water and Groundwater Quality Standards	6 NYCRR Parts 700-705	S	Establishes quality standards for surface water and groundwater.	Potentially applicable for assessing water quality at the site during remedial activities.
Screening and Assessment of Contaminated Sediment	NYSDEC Division of Fish, Wildlife and Marine Resources Bureau of Habitat (June 24, 2014)	G	Describes the methodology for establishing numeric sediment cleanup standards. It also provides guidance when evaluating risk management options for contaminated sediment and when determining final contaminant concentrations that will be achieved through remedial efforts.	This guidance is potentially applicable for developing sediment cleanup goals.

Table 2
Summary of Action-Specific SCGs

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
Occupational Safety and Health Act (OSHA) - General Industry Standards	29 CFR Part 1910	S	These regulations specify the 8-hour time-weighted average concentration for worker exposure to various compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is not possible to maintain the work atmosphere below required concentrations. Appropriate training requirements will be met for remedial workers.
OSHA - Safety and Health Standards	29 CFR Part 1926	S	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 - Record-keeping, Reporting and Related Regulations	29 CFR Part 1904	S	These regulations outline record-keeping and reporting requirements for an employer under OSHA.	These regulations apply to the company(s) contracted to install, operate, and maintain remedial actions at hazardous waste sites.
RCRA - Preparedness and Prevention	40 CFR Part 264.30 - 264.31	S	These regulations outline requirements for safety equipment and spill control when treating, handling, and/or storing hazardous wastes.	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 Part 264.50 - 264.56	S	Provides requirements for outlining emergency procedures to be used following explosions, fires, etc. when storing hazardous wastes.	Emergency and contingency plans will be developed and implemented during remedial design. Copies of the plan will be kept on-site.
90 Day Accumulation Rule for Hazardous Waste	40 CFR Part 262.34	S	Allows generators of hazardous waste to store and treat hazardous waste at the generation site for up to 90 days in tanks, containers, and containment buildings without having to obtain a RCRA hazardous waste permit.	Potentially applicable to remedial alternatives that involve the storing or treating of hazardous materials on-site.
Land Disposal Facility Notice in Deed	40 CFR Parts 264 and 265 Sections 116-119(b)(1)	S	Establishes 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.
RCRA - General Standards	40 CFR Part 264.111	S	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 waste decomposition products. Also requires decontamination or disposal of contaminated equipment, structures, and soils.	Decontamination actions and facilities will be constructed for remedial activities and disassembled after completion.
Standards Applicable to Transporters of Applicable Hazardous Waste - RCRA Section 3003	40 CFR Parts 170-179, 262, and 263	S	Establishes the responsibility of off-site 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.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
United States Department of Transportation (USDOT) Rules for Transportation of Hazardous Materials	49 CFR Parts 107 and 171.1 - 172.558	S	Outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous materials.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
Clean Air Act-National Ambient Air Quality Standards	40 CFR Part 60	S	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.
USEPA-Administered Permit Program: The Hazardous Waste Permit Program	RCRA Section 3005; 40 CFR Part 270.124	S	Covers the basic permitting, application, monitoring, and reporting requirements for off-site hazardous waste management facilities.	Any off-site facility accepting hazardous waste from the site must be properly permitted. Implementation of the site remedy will include consideration of these requirements.
Land Disposal Restrictions	40 CFR Part 368	S	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes Universal Treatment Standards (UTSs) to which hazardous waste must be treated prior to land disposal.	Excavated materials that display the characteristic of hazardous waste or that are decharacterized after generation must be treated to 90% constituent concentration reduction capped at 10 times the UTS.
RCRA Subtitle C	40 U.S.C. Section 6901 et seq.; 40 CFR Part 268	S	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes UTSs to which hazardous wastes must be treated prior to land disposal.	Potentially applicable to remedial activities that include disposal waste material from the site.

Table 2
Summary of Action-Specific SCGs

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
CWA - Discharge to Waters of the U.S., and Section 404	40 CFR Parts 403, and 230 Section 404 (b) (1); 33 USC 1344	S	Establishes site-specific pollutant limitations and performance standards which are designed to protect surface water quality. Types of discharges regulated under CWA include: indirect discharge to a POTW and discharge of dredged or fill materials into U.S. waters.	Potentially applicable to remedial activities within and/or adjacent to the Cayadutta Creek
CWA Section 401	33 USC 1341	S	Requires that a 401 Water Quality Certification permit be provided to federal permitting agency (USACE) for any activity including, but not limited to, the construction or operation of facilities which may result in any discharge into jurisdictional waters of the U.S. and/or state.	Potentially applicable to remedial activities within and/or adjacent to the Cayadutta Creek.
Rivers and Harbors Act, Sections 9 & 10	33 USC 401 and 403; 33 CFR Parts 320- 330	S	Prohibits unauthorized obstruction or alteration of navigable waters of the U.S. (dredging, fill, cofferdams, piers, etc.). Requirements for permits affecting navigable waters of the U.S.	Potentially applicable to remedial activities within and/or adjacent to the Cayadutta Creek.
New York State				
NYSDEC's Monitoring Well Decommissioning Guidelines	NAPL Site Monitoring Well Decommissioning dated May 1995	G	This guidance presents procedure for abandonment of monitoring wells at remediation sites.	This guidance is applicable for soil or groundwater alternatives that require the decommissioning of monitoring wells onsite.
Guidelines for the Control of Toxic Ambient Air Contaminants	DAR-1 (Air Guide 1)	G	Provides guidance for the control of toxic ambient air contaminants in New York State and outlines the procedures for evaluating sources of air pollution.	This guidance may be applicable for soil or groundwater alternatives that result in certain air emissions.
New York Permits and Certificates	6 NYCRR Part 201	G	Provides instructions and regulations for obtaining a permit to operate air emission sources.	Permits are not required for remedial actions taken at hazardous waste sites; however, documentation for relevant and appropriate permit conditions would be provided to NYSDEC prior to and during implementation of the selected alternative.
New York State Air Quality Classification System	6 NYCRR Part 256	G	Outlines the air quality classifications for different land uses and population densities.	Air quality classification system will be referenced during the treatment process design.
New York Air Quality Standards	6 NYCRR Part 257	G	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.
Discharges to Public Waters	New York State Environmental Conservation Law, Section 71-3503	S	Provides that a person who deposits gas tar, or the refuse of a gas house or gas factory, or offal, refuse, or any other noxious, offensive, or poisonous substances into any public waters, or into any sewer or stream running or entering into such public waters, is guilty of a misdemeanor.	During the remedial activities, MGP-impacted materials will not be deposited into public waters or sewers.
New York Hazardous Waste Management System - General	6 NYCRR Part 370	S	Provides definitions of terms and general instructions for the Part 370 series of hazardous waste management.	Hazardous waste is to be managed according to this regulation.
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	S	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 6 NYCRR Parts 371-376.	Applicable for determining if solid wastes generated during implementation of remedial activities are hazardous wastes. These regulations do not set cleanup standards, but are considered when developing remedial alternatives.
Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities	6 NYCRR Part 372	S	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(s) contracted to do treatment work at the site or to transport or manage hazardous material generated at the site.
New York Regulations for Transportation of Hazardous Waste	6 NYCRR Part 372.3 a-d	S	Outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous waste.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
Waste Transporter Permits	6 NYCRR Part 364	S	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 Part 373.1.1 - 373.1.8	S	Provides requirements and procedures for obtaining a permit to operate a hazardous waste treatment, storage, and disposal facility. Also lists contents and conditions of permits.	Any off-site facility accepting waste from the site must be properly permitted.

Table 2
Summary of Action-Specific SCGs

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Land Disposal of a Hazardous Waste	6 NYCRR Part 376	S	Restricts land disposal of hazardous wastes that exceed specific criteria.	New York defers to USEPA for UTS/LDR regulations.
NYSDEC Guidance on the Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from Former Manufactured Gas Plants	DER-4	G	Outlines the criteria for conditionally excluding coal tar waste and impacted soils from former MGPs which exhibit the hazardous characteristic of toxicity for benzene (D018) from the hazardous waste requirements of 6 NYCRR Parts 370 - 374 and 376 when destined for thermal treatment.	This guidance will be used as appropriate in the management of MGP-impacted soil and coal tar waste generated during the remedial activities.
National Pollutant Discharge Elimination System (NPDES) Program Requirements, Administered Under New York State Pollution Discharge Elimination System (SPDES)	40 CFR Parts 122 Subpart B, 125, 301, 303, and 307 (Administered under 6 NYCRR 750-758)	S	Establishes permitting requirements for point source discharges; regulates discharge of water into navigable waters including the quantity and quality of discharge.	Removal activities may involve treatment/disposal of water. If so, water generated at the site will be managed in accordance with NYSDEC SPDES permit requirements.

Table 3
Summary of Location-Specific SCGs

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
National Environmental Policy Act Executive Orders 11988 and 11990	40 CFR 6.302; 40 CFR Part 6, Appendix A	S	Requires federal agencies, where possible, to avoid or minimize adverse impact of federal actions upon wetlands/floodplains and enhance natural values of such. Establishes the “no-net-loss” of waters/wetland area and/or function policy.	To be considered if remedial activities are conducted within the floodplain or wetlands.
Fish and Wildlife Coordination Act	16 USC 661; 40 CFR 6.302	S	Actions must be taken to protect fish or wildlife when diverting, channeling, or otherwise modifying a stream or river.	Potentially applicable to remedial activities within and/or adjacent to the Cayadutta Creek.
Historical and Archaeological Data Preservation Act	16 USC 469a-1	S	Provides for the preservation of historical and archaeological data that might otherwise be lost as the result of alteration of the terrain.	The National Register of Historic Places register would be consulted to determine the presence of historical sites in the immediate vicinity of the MGP site.
National Historic and Historical Preservation Act	16 USC 470; 36 CFR Part 65; 36 CFR Part 800	S	Requirements for the preservation of historic properties.	The National Register of Historic Places register would be consulted to determine the presence of historical sites in the immediate vicinity of the MGP site.
Hazardous Waste Facility Located on a Floodplain	40 CFR Part 264.18(b)	S	Requirements for a treatment, storage, and disposal (TSD) facility built within a 100-year floodplain.	Hazardous waste TSD activities (if any) will be designed to comply with applicable requirements cited in this regulation.
Endangered Species Act	16 USC 1531 et seq.; 50 CFR Part 200; 50 CFR Part 402	S	Requires federal agencies to confirm that the continued existence of any endangered or threatened species and their habitat will not be jeopardized by a site action.	Federal agencies would be consulted to determine if any wildlife species are identified on the USFWS list of Threatened, Endangered, Sensitive Species, or if any biota species are identify by the NHP as sensitive species in the vicinity of the site.
Floodplains Management and Wetlands Protection	40 CFR 6 Appendix A	S	Activities taking place within floodplains and/or wetlands must be conducted to avoid adverse impacts and preserve beneficial value. Procedures for floodplain management and wetlands protection provided.	To be considered if remedial activities are conducted within a 100-year floodplain or wetland.
New York State				
New York State Floodplain Management Development Permits	6 NYCRR Part 500	S	Provides conditions necessitating NYSDEC permits and provides definitions and procedures for activities conducted within floodplains.	Potentially applicable to remedial activities conducted within a 100-year flood plain.
New York State Freshwater Wetlands Act	ECL Article 24 and 71; 6 NYCRR Parts 662-665	S	Activities in wetlands areas must be conducted to preserve and protect wetlands.	Potentially applicable to remedial activities conducted within wetlands.
New York State Parks, Recreation, and Historic Preservation Law	New York Executive Law Article 14	S	Requirements for the preservation of historic properties.	The National Register of Historic Places register would be consulted to determine the presence of historical sites in the immediate vicinity of the MGP site.
Endangered & Threatened Species of Fish and Wildlife	6 NYCRR Part 182	S	Identifies endangered and threatened species of fish and wildlife in New York.	State agencies would be consulted to determine if any species in the vicinity of the site are identified on the list of Endangered, Threatened and Special Concern Fish & Wildlife Species of New York State.
Floodplain Management Criteria for State Projects	6 NYCRR Part 502	S	Establishes floodplain management practices for projects involving state-owned and state-financed facilities.	Portions of the area to be remediated are located within a 100-year floodplain. Therefore, activities conducted at these areas would be performed in accordance with this regulation.
Local				
Local Building Permits	N/A	S	Local authorities may require a building permit for any permanent or semi-permanent structure, such as an on-site water treatment system building or a retaining wall.	Substantive provisions are potentially applicable to remedial activities that require construction of permanent or semi-permanent structures.
Local Street Work Permits	N/A	S	Local authorities will require a permits for conducting work within and closing local roadways.	Street work permits will be required to conduct remedial activities within public roadways.

Table 4
Remedial Technology Screening Evaluation for Soil

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
No Action	No Action	No Action	Alternative would not include any 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 NYSDEC DER-10.	Implementable.	Would not achieve the RAOs for soil in an acceptable time frame.	Yes
Institutional Controls	Institutional Controls	Deed Restrictions, Environmental Land Use Restrictions, Enforcement and Permit Controls, Informational Devices	Institutional controls would include legal and/or administrative controls that mitigate the potential for exposure to impacted soils and/or jeopardize the integrity of a remedy. Examples of potential institutional controls include establishing land use restrictions, health and safety requirements for subsurface activities.	Implementable. Would require coordination between NYSDEC and property owners to establish institutional controls on properties not owned by National Grid.	When properly implemented and followed, this technology could reduce potential human exposures, and may be effective when combined with other technology processes. Would help to reduce human exposure to impacted soil. May not achieve RAOs for environmental protection.	Yes
In-Situ Containment/ Control	Capping	Soil Cap	Placing and compacting soil/gravel material over impacted soil to provide a physical barrier to human and biota exposure to impacted soil at the site.	Implementable for southern portion of the site but not a likely option for the northern portion of the site based on continued use as a service center. Equipment and materials necessary to construct the cap are readily available.	Could provide a physical barrier to site impacts. Not effective at directly addressing impacts.	Yes
		Asphalt/Concrete Cap	Application of a layer of asphalt or concrete over impacted soils.	Implementable for the northern portion of the site that would continue to be used as a service center. May require additional storm water controls. Not implementable for southern portion of the site based on presence of wetland areas.	May reduce the mobility of chemical constituents by reducing infiltration; would not reduce toxicity or volume of impacts. Long-term effectiveness requires ongoing maintenance. Addresses the RAOs for preventing exposure to impacted soil during future anticipated site activities, but alone does not address the potential for exposure during potential future invasive activities at the site.	Yes
		Multi-Media Cap	Application of a combination of synthetic membrane(s) over impacted soil.	Not implementable in the northern portion of the site based on continued use as a service center. Not Implementable for the southern portion of the site as wetland and wooded areas would be replaced following remedial construction and root structures could jeopardize the integrity of the membranes.	May reduce the mobility of chemical constituents by reducing infiltration; would not reduce toxicity or volume of impacts. Current and future use of site as an active service center could jeopardize the integrity/effectiveness of the cap. Addresses the RAOs for preventing exposure to impacted soil during future anticipated site activities, but alone does not address the potential for exposure during potential future invasive activities at the site.	No
In-Situ Treatment	Immobilization	Solidification	Addition of material to the impacted soil that limits the solubility and mobility of the NAPL and COCs in soil and groundwater. Involves treating soil to produce a stable material with low leachability of NAPL and associated COCs.	Based on the results of MODFLOW model predictive simulations, implementing this technology process option would cause groundwater mounding (i.e., flooding) above ground surface and changed groundwater flow patterns at the site.	Overall effectiveness of this process would need to be evaluated during a bench-scale treatability study. Assuming an effective solidification mix could be developed, this technology would effectively address each of the RAOs for soil.	No
	Extraction/In-Situ Stripping	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 on-site injection, collection and/or treatment systems.	Technically implementable. This option would require a pilot scale study to determine effectiveness. Process may result in uncontrolled NAPL migration. Not a preferred technology process due to risks and potential technical implementability issues.	Could potentially promote NAPL mobilization. Focused on saturated zone, not effective for soil/NAPL above the water table. Alone, this technology would not effectively address the RAO of preventing direct exposure to impacted soil. This option would require a pilot scale study to determine effectiveness.	No

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Remedial Technology Screening Evaluation for Soil

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
In-Situ Treatment (Cont.)	Chemical Treatment	Chemical Oxidation	Oxidizing agents are added to oxidize and reduce the mass of organic constituents in-situ chemical oxidation involves the introduction of chemicals such as ozone, hydrogen peroxide, magnesium peroxide, sodium persulfate or potassium permanganate. A pilot study would be required to evaluate/determine oxidant application requirements. May not effectively oxidize NAPL.	Implementable. Equipment and materials necessary to inject/apply surfactants are readily available. May require special provisions for storage of process chemicals.	Would require multiple treatments of chemicals to reduce COCs. Would not be effective at treating NAPL and NAPL-containing soil. Not effective for treating impacts in unsaturated zone.	No
		Surfactant/Cosolvent Flushing	A surfactant or cosolvent solution is delivered and extracted by a network of injection and extraction wells to flush the NAPL source area. Reduction of the NAPL mass occurs by increasing the dissolution of the NAPL or selected constituents or by increasing the NAPL mobility with reduction of the interfacial tension between the NAPL and groundwater and/or reduction of the NAPL viscosity. A bench-scale and treatability study would be required to determine surfactant/cosolvent solution	Implementable. Equipment and materials necessary to inject/apply oxidizing agents are readily available. May require special provisions for storage of process chemicals.	Overall effectiveness of this process would need to be evaluated during a bench- and field-scale pilot test to determine the site-specific design. Would not be effective at treating all NAPL and NAPL-containing soil.	No
	Biological Treatment	Biodegradation	Natural biological and physical processes that, under favorable conditions, act without human intervention to reduce the mass, volume, concentration, toxicity, and/or mobility of COCs. This process relies on long-term monitoring to demonstrate the reduction of impacts.	Implementable.	Less effective for PAHs; not effective for NAPLs; would not achieve RAOs in an acceptable time frame.	No
		Enhanced Biodegradation	Addition of amendments (e.g., oxygen, nutrients) and controls to the subsurface to enhance indigenous microbial populations to improve the rate of natural degradation.	Implementable.	Less effective for PAHs; not effective for NAPLs; would not achieve RAOs in an acceptable time frame.	No
		Biosparging	Air/oxygen injection wells are installed within the impacted regions to enhance biodegradation of constituents by increasing oxygen availability. Low-flow injection technology may be incorporated. This technology requires long-term monitoring.	Implementable.	Less effective for PAHs; not effective for NAPLs; would not achieve RAOs in an acceptable time frame.	No
	Thermal Treatment	In-Situ Thermal Desorption	Heat is injected into the subsurface via vacuum wells and heat transfer is completed via thermal conduction. COCs are destroyed via oxidation, pyrolysis, boiling, and volatilization. Vapor/water is recovered and treated.	Potentially implementable. Numerous concerns related to conducting thermal treatment in close proximity utilities, as well as concerns associated with controlling groundwater flow to facilitate treatment. Additionally, Limitations of space and public proximity concerns limits the implementability of this technology.	May not achieve RAOs for soil.	No
		Electrical Resistance Heating	Electrical current is applied to the subsurface via network of probes installed through standard drilling techniques. Electrical resistance is used to transfer heat via thermal conduction. COCs are destroyed via oxidation, boiling, and volatilization. Vapor/water is recovered and treated.			No
Removal	Excavation	Excavation	Physical removal of impacted soil. Typical excavation equipment would include excavators, backhoes, loaders, and/or dozers. Extraction wells and pumps or other methods may be used to obtain hydraulic control to facilitate use of typical excavation equipment to physically remove soil.	Implementable. Equipment capable of excavating the soil is readily available. Based on experience during construction of the Storm Sewer IRM, excavation below the water table may prove difficult given large amount of groundwater present and nature of fill material present at the site.	Would achieve RAOs. Proven process for effectively removing impacted soil.	Yes

See Note on Page 4.

Table 4
Remedial Technology Screening Evaluation for Soil

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
Ex-Situ On-Site Treatment and/or Disposal	Immobilization	Solidification	Addition of material to excavated soil that limits the solubility or mobility of the constituents present. Involves treating soil to produce a solidified material with low leachability, that physically and chemically locks the constituents within the solidified matrix.	Not implementable. Heavily impacted material that is solidified may still require treatment and/or disposal as a hazardous waste. Pilot study would be needed to verify implementability.	May achieve RAOs. Proven process for effectively reducing mobility and toxicity of NAPL and organic and inorganic constituents. Overall effectiveness of this process would need to be evaluated during a bench-scale study.	No
	Extraction	Low-Temperature Thermal Desorption	Process by which soils containing organics with boiling point temperatures less than 800° Fahrenheit are excavated, conditioned, and heated; 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. Treated soils are returned to the subsurface. Treatment is conducted in a thermal treatment unit that is mobilized or constructed on-site.	Not implementable. Potential emissions concerns based on site's location near residential area. Additionally, there is not sufficient space within the service center area and it is not feasible to construct the proper facility in the wooded/wetland area south of the service center.	Proven process for effectively removing organic constituents from excavated soil. The efficiency of the system and rate of removal of organic constituents would require evaluation during bench-scale and/or pilot-scale testing.	No
	Thermal Destruction	Incineration	Use of a mobile incineration unit installed on-site for high temperature thermal destruction of the organic compounds present in the media. Soils are excavated and conditioned prior to incineration. Treated soils are returned to the subsurface.	Not implementable. Potential emissions concerns based on site's location near residential area. Additionally, there is not sufficient space within the service center area and it is not feasible to construct the proper facility in the wooded/wetland area south of the service center.	Proven process for effectively addressing organic constituents. The efficiency of the system and rate of removal of organic constituents would need to be verified during bench-scale and/or pilot-scale testing.	No
	Chemical Treatment	Chemical Oxidation	Addition of oxidizing agents to degrade organic constituents to less-toxic by-products.	Implementable. Equipment and materials necessary to apply oxidizing agents are available. Large amounts of oxidizing agents may be required. May require special provisions for storage of process chemicals.	May not achieve RAOs for soil. Not known to be effective for NAPL.	No
	On-Site Disposal	RCRA Landfill	Construction of a landfill that would meet RCRA requirements.	Not implementable. Space limitations and intended future use as a service center make on-site landfilling infeasible. The site setting is not appropriate for a landfill.	This technology process would be effective at meeting the RAOs for soil. Excavated material would be contained in an appropriately constructed soil management cell. Long-term effectiveness requires ongoing maintenance and monitoring.	No
		Solid Waste Landfill	Construction of a landfill that would meet NYSDEC solid waste requirements.			No
Off-Site Treatment and/or Disposal	Recycle/ Reuse	Asphalt Concrete Batch Plant	Soil is used as a raw material in asphalt concrete paving mixtures. The impacted soil is transported to an off-site 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.	Not implementable. Based on the nature of the fill materials at the site, the soil would need excessive processing to make it usable/acceptable for this application. Permitted facilities and demand are limited.	Effective for treating organics and inorganics through volatilization and/or encapsulation. Thermal pretreatment may be required to prevent leaching. Limited number of projects to support comparison of effectiveness.	No
		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 in the product.		Effective for treating organics and inorganics through volatilization and/or vitrification. A bench-scale/pilot study may be necessary to determine effectiveness.	No
		Co-Burn in Utility Boiler	Soil is blended with feed coal to fire a utility boiler used to generate steam. Organics are destroyed.	Permitted facilities available for burning MGP soils are limited. Additional handling/ management and blending of material may be required.	Effective for treating organic constituents. Soil would be blended with coal prior to burning. Overall effectiveness of this process would need to be evaluated during a trial burn.	No

See Note on Page 4.

Off-Site Treatment and/or Disposal (Cont.)	Extraction	Low-Temperature Thermal Desorption	Process by which soils containing organics with boiling point temperatures less than 800° Fahrenheit are heated 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. Would be used on materials that are determined to be characteristically hazardous based on TCLP analysis.	Implementable. Treatment facilities are available.	Effective means for treatment of materials that are characteristically hazardous due to the presence of organic compounds (i.e., benzene).	Yes

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Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
	Thermal Destruction	Incineration	Soils are incinerated off-site for high temperature thermal destruction of the organic compounds present in the media. Soils are excavated and conditioned prior to incineration.	Implementable. Not a cost effective means for treating impacted soil. Limited number of treatment facilities. LTTD is a more appropriate technology process for thermally treating MGP-impacted media.	Proven process for effectively addressing organic constituents. The efficiency and effectiveness of the system and rate of removal of organic constituents would need to be verified during bench-scale and/or pilot-scale testing.	No
	Off-Site Disposal	Solid Waste Landfill	Disposal of non-hazardous soil and C&D debris in an existing permitted non-hazardous landfill.	Implementable.	Proven process that, in conjunction with excavation, can effectively achieve the RAOs.	Yes
		RCRA Landfill	Disposal of impacted soil in an existing RCRA permitted landfill facility.	Hazardous materials would not meet New York State LDRs and USTs without pre-treatment. Effective pre-treatment would be cost prohibitive when considering DER-4 exemption for permanent thermal treatment of D018 characteristically hazardous material.	Proven process that, in conjunction with excavation, can effectively achieve the RAOs.	No

Note:
1. Shading indicates that technology process has not been retained for development of a remedial alternative.

Table 5
Remedial Technology Screening Evaluation for Groundwater

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
No Action	No Action	No Action	Alternative would not include any 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 NYSDEC DER-10.	Implementable.	Would not achieve the RAOs for groundwater in an acceptable time frame.	Yes
Institutional Controls	Institutional Controls	Deed Restrictions, Groundwater Use Restrictions, Enforcement and Permit Controls, Informational Devices	Institutional controls would include legal and/or administrative controls that mitigate the potential for exposure to impacted materials and/or jeopardize the integrity of a remedy. Examples of potential institutional controls include establishing land use restrictions, health and safety requirements for subsurface activities, and restrictions on groundwater use and/or extraction.	Implementable. Would require coordination between NYSDEC and property owners to establish institutional controls on properties not owned by National Grid.	May be effective for reducing the potential for human exposure. This option would not meet the RAO for restoring groundwater, to the extent practicable, the quality of groundwater. This option may be effective when combined with other process options.	Yes
In-Situ Containment/ Control	Containment	Sheet Pile	Steel sheet piles are driven into the subsurface to contain groundwater and NAPLs. The sheet pile wall is typically keyed into a confining unit and could be permeable or impermeable to groundwater flow.	Not implementable for containment based on local groundwater flow. High potential to cause groundwater expressions and seepage at the ground surface if entire site is surrounded by a containment barrier wall.	Effective for reducing the groundwater flow to and from impacted areas. Would effectively limit the potential for future migration of NAPL. Could be used in conjunction with a low-permeability cap to effectively address soil RAOs.	No
		Secant Pile Wall	Wall is formed by a series of interlocking reinforced concrete piles. Technology used primarily with high water tables or unsuitable ground conditions. Minimal disturbance due to lack of noise and vibration.			No
		Slurry Walls/Jet Grout Wall	Involves excavating a trench and adding a slurry (e.g., soil/cement-bentonite mixture) to control migration of groundwater and NAPL from an area. Slurry walls are typically keyed into a low permeability unit (e.g., an underlying silt/clay layer).			No
In-Situ Treatment	Biological Treatment	Groundwater Monitoring	Natural biological, chemical, and physical processes that under favorable conditions, act without human intervention to reduce the mass, volume, concentration, toxicity, and mobility of chemical constituents. Long-term monitoring is required to demonstrate the reduction of COCs.	Easily implemented. Would require monitoring to demonstrate reduction of COCs.	May be effective if NAPL and impacted soil is addressed.	Yes
		Enhanced Biodegradation	Addition of amendments (e.g., nutrients, oxygen) to the subsurface to enhance indigenous microbial populations to improve the rate of natural biodegradation of constituents.	Would be difficult to sufficiently oxygenate the soil using amendments due to the thickness of the saturated zone and depth of impacts.	May not be effective if the subsurface conditions cannot be made and maintained aerobic. Would not be effective at restoring groundwater to pre-release/pre-disposal conditions unless MGP source materials are addressed (i.e., through excavation).	No
		Phytoremediation	Plants and/or algae are used to remove contaminants from soil and groundwater through uptake. Plants are periodically harvested and treated and/or disposed as appropriate.	Implementable, potentially as a groundwater polishing mechanism and/or water control measure for the southern portion of the site	Typically more effective for addressing heavy metals. Less effective for treating organic constituents. This option would not meet groundwater RAOs.	No

See Note on Page 4.

Table 5
Remedial Technology Screening Evaluation for Groundwater

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
In-Situ Treatment (Cont.)	Chemical Treatment	Chemical Oxidation	Oxidizing agents are added to oxidize and reduce the mass of organic constituents. In-situ chemical oxidation involves the introduction of chemicals such as ozone, hydrogen peroxide, magnesium peroxide, sodium persulfate, or potassium permanganate. Large amounts of oxidizing agents are needed to oxidize NAPL.	Implementable for areas containing dissolved-phase groundwater impacts and not source material. Equipment and materials necessary to inject/apply oxidizing agents are readily available. May require special provisions for storage of process chemicals. Access to areas that would require injection wells for this process option to be effective is limited.	Assuming removal of source materials, this technology could meet the RAOs for groundwater. However, may not be a cost effective means to achieve the RAOs. Not effective for NAPL. Dissolved-phase COCs concentrations would likely rebound following treatment if NAPL/source material for the dissolved-phase COCs is not removed.	No
		Permeable Reactive Barrier (PRB)	PRBs are installed in or downgradient 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.	Implementable. Pilot study would be required to evaluate appropriate design given site-specific hydraulic conditions.	NAPL in subsurface would inhibit effectiveness of PRB. Groundwater conditions may potentially encourage biological growth and fouling of PRB. Could meet the RAOs when combined with source removal.	No
	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 on-site injection, collection, and/or treatment systems.	This option would require a pilot scale study to determine effectiveness. Process may result in uncontrolled NAPL migration. Not a preferred technology process due to risks and potential technical implementability issues.	This option would require a pilot scale study to determine effectiveness. Process may result in NAPL and/or dissolved plume migration. Not certain in the ability of this alternative to meet the RAOs.	No
Removal	Hydraulic Control	Vertical Extraction Wells	Vertical wells are installed and utilized to recover groundwater for treatment/disposal and containment/migration control. Typically requires extensive design/testing to determine required hydraulic gradients and feasibility of achieving those gradients.	Equipment and tools necessary to install and operate vertical extraction wells are readily available. Would require operation for an extended period of time.	Would not meet RAOs as a stand alone technology. Would likely be used in conjunction with an ex-situ treatment system (i.e., pump and treat). Pumping would be required over a prolonged period of time.	No
		Horizontal Extraction Wells	Horizontal wells are utilized to replace conventional well clusters in soil and containment/migration control.	Requires specialized horizontal drilling equipment. Not implementable.	Proven process for effectively extracting groundwater. Not likely to meet RAOs in an acceptable amount of time.	No
	NAPL Removal	Active Removal	Process by which automated pumps are utilized to remove DNAPL from recovery wells.	Potentially implementable. Previous active removal systems at the site have been unsuccessful at removing significant quantities of NAPL. Removal pumps have emulsified NAPL. An appropriate pumping system would need to be identified/design to prevent NAPL emulsification and reliable system operation.	May be effective for removing potentially mobile NAPL.	Yes
		Passive Removal	NAPL is passively collected in vertical wells and periodically removed (i.e., via bottom-loading bailers, manually operated pumps, etc.).	Technically implementable.		Yes
		Collection Trenches/Permeable NAPL Barrier Wall	A zone of higher permeability material is installed within a trench hydraulically downgradient from the NAPL-impacted area. A perforated collection trench/pipe is placed laterally along the base of trench or permeable wall to direct NAPL to a collection sump for recovery and disposal.	Technically implementable. Would be used in conjunction with active or passive NAPL removal.		Yes

See Note on Page 4.

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Feasibility Study Report
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General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
Ex-Situ/On-Site Treatment	Chemical Treatment	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.	Potentially implementable. Limited space for a full-scale treatment system. Not typically used in MGP-impacted groundwater treatment train. Not effective on NAPL.	Proven process for effectively treating organic compounds. Use of this process may effectively achieve the RAOs. A bench-scale treatability study may be required to evaluate the efficiency of this process and to make project-specific adjustments to the process.	No
		Chemical Oxidation	Addition of oxidizing agents to degrade organic constituents to less-toxic byproducts.	Potentially implementable. Not typically used in MGP-impacted groundwater treatment train. Not effective on NAPL.	A bench-scale treatability study may be required to evaluate the efficiency of this process and to make project-specific adjustments to the process. Large amounts of oxidizing agents are needed to oxidize NAPL.	No
	Physical Treatment	Carbon Adsorption	Process by which organic constituents are adsorbed to the carbon as groundwater is passed through carbon units.	Implementable. Typically used in MGP-impacted groundwater treatment train.	Effective at removing organic constituents. Use of this treatment process may effectively achieve the RAOs when combined with groundwater extraction.	Yes
		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.	Implementable. Typically used in MGP-impacted groundwater treatment train.	Effective pre-treatment process to reduce suspended solids. Use of this process along with other processes (i.e., that address organic constituents) could effectively achieve the RAOs.	Yes
		Air Stripping	A process in which VOCs are removed through volatilization by increasing the contact between the groundwater and air.	Implementable, but not typically used in MGP-impacted groundwater treatment train.	This technology process would be effective at removing VOCs from water. Process would potentially be used as part of a temporary treatment train to treat groundwater removed from excavation areas. Has potential to be used as part of a treatment system to meet the RAOs.	Yes
		Precipitation/ Coagulation/ Flocculation	Process which precipitates dissolved constituents into insoluble solids and improves settling characteristics through the addition of amendments to water to facilitate subsequent removal from the liquid phase by sedimentation/filtration.	Implementable.	Process which transforms dissolved constituents into insoluble solids by adding coagulating agents to facilitate subsequent removal from the liquid phase by sedimentation/filtration. Has potential to be used as part of a treatment system to meet the RAOs.	Yes
		Oil/Water Separation	Process by which insoluble oils are separated from water via physical separation technologies, including gravity separation, baffled vessels, etc.	Implementable. Typically used in MGP-impacted groundwater treatment train.	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. Has potential to be used as part of a treatment system to meet the RAOs.	Yes

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National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
Off-Site Treatment and/or Disposal	Groundwater/NAPL Management	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.	Implementable. Equipment and materials necessary to extract, pretreat (if necessary), and discharge the water to the sewer system are readily available. Discharges to the sewer will require a POTW-issued discharge permit.	Proven process for effectively disposing of groundwater. Typically requires the least amount of pretreatment because the discharged water will be subjected to additional treatment at the POTW. May be used in support of excavation dewatering activities. However, permanent off-site treatment/disposal technologies are not required because groundwater removal technologies have not been	Yes
		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).	Discharges to surface water must meet substantive requirements of a SPDES permit. Cleanup objectives and sampling requirements may be restrictive.	This technology process would effectively dispose of groundwater. Impacted groundwater would require treatment to achieve water quality discharge limits. Helps in the management of treated water, but does not directly lend to achieving the RAOs for groundwater. May be used in support of excavation dewatering activities. However, permanent off-site treatment/disposal technologies are not required because groundwater removal technologies have	Yes
		Discharge to a privately-owned treatment/ disposal facility.	Treated or untreated water is collected and transported to a privately-owned treatment facility.	Equipment and materials to pretreat the water at the site are readily available on a commercial basis. Facilities capable of transporting and disposing of the groundwater are available. Treatment may be required prior to discharge.	Proven process for effectively disposing of groundwater. Typically requires the least amount of pretreatment because the discharged water will be subjected to additional treatment at the disposal facility. May be used in support of excavation dewatering activities. However, permanent off-site treatment/disposal technologies are not required because groundwater removal technologies have not been	Yes

Note:
1. Shading indicates that technology process has not been retained for development of a remedial alternative.

Table 6
Remedial Technology Screening Evaluation for Sediment

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
No Action	No Action	No Action	Alternative would not include any 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 NYSDEC DER-10.	Implementable.	Would not achieve the RAOs for sediment in an acceptable time frame.	Yes
Institutional Controls	Institutional Controls	Deed Restrictions, Enforcement and Permit Controls, Informational Devices	Institutional controls would include legal and/or administrative controls that mitigate the potential for exposure to impacted sediments and/or jeopardize the integrity of a remedy. Examples of potential institutional controls for sediments containing elevated concentrations of MGP-related COCs include posting of signs to mitigate potential exposure and actions that may disturb sediments and/or jeopardize the integrity of the remedy.	Implementable	This option could reduce the potential for human exposure, and may be effective when combined with other process options. May not achieve RAOs for environmental protection against potential exposure to sediments containing elevated concentrations of MGP-related COCs.	Yes
In-Situ Containment/ Control	Capping	Engineered Cap	Covering or encapsulating sediments with natural material (e.g., gravel, sand, organoclays), synthetic materials (aquablok ™ pellet , geotextile membranes), and/or armoring to physically, biologically, and/or chemically isolate sediments containing elevated site-related MGP constituents.	Implementable. Equipment and materials necessary to construct an engineered cap are readily available. May require that sediment removal first be implemented to minimize/prevent increase in river bottom elevation due to material placement.	May reduce the mobility of chemical constituents, and toxicity through reduced exposure. This option may be applied as a stand-alone alternative, or combined with other process options (e.g., removal).	Yes
In-Situ Treatment	Natural Recovery	Monitored Natural Recovery	Natural recovery would include the ongoing, naturally occurring degradation of elevated site-related MGP constituents in the sediments over time. Periodic visual observations and/or field sampling to monitor site conditions would be required over time.	Implementable	May achieve the RAOs over time when combined with source control activities. Would require monitoring to document the process.	Yes
	Immobilization	Solidification/ Stabilization	Mixing Portland cement into sediments containing elevated site-related MGP constituents.	Not implementable. Has not been successfully implemented full-scale for sediments. May require removal to address volume/river bottom elevation increase. May require cover to provide suitable habitat layer.	May reduce the mobility of chemical constituents, and toxicity through reduced exposure. Presence of rocks/cobbles may interfere with mixing process (most applicable for fine-grained, homogenous sediments). Bench-/pilot-scale testing required to identify suitable additive and mixing process.	No
Removal	Dredging	Mechanical Removal	Physical removal of impacted sediment using conventional earth moving equipment. Typical excavation equipment could include backhoes, loaders, and/or dozers. Temporary enclosures using cofferdams or sheet piling, and/or flow diversion (e.g., pump bypass system using temporary dams, pumps and piping) may be used to allow excavation to be conducted "in the dry".	Implementable. Equipment capable of excavating the sediment is readily available. Ability to perform removal "in the dry" dependent upon-site conditions (e.g., water depth, surface water velocities, sediment composition).	Proven process for effectively removing sediment. Can be implemented with other process options to help achieve RAOs (e.g., MNR, engineered cap).	Yes
		Hydraulic	Sediments are removed in liquid slurry form using pumps, suction hose, horizontal auger and/or cutterhead dredge.	Not implementable. Not appropriate for small volumes of sediment and/or coarse sized	Proven process for effectively removing sediment. Effectiveness may decrease with cobble creek bed.	No
Ex-Situ/On-Site Pre-Treatment, Treatment and/or Disposal	Gravity Drainage	Dewatering	Sediment is stockpiled and allowed to gravity dewater as a pre-treatment or pre-disposal step. Water is collected and treated prior to discharge/disposal.	Implementable.	Does not meet RAOs alone, but can be used in conjunction with other technologies (e.g., sediment disposal, water treatment) to help achieve the RAOs.	Yes
	Immobilization	Solidification/Stabilization	Addition of material to excavated sediment to stabilize (i.e., produce a stable, non-leachable material, that physically or chemically locks the constituents within the solidified matrix) the sediments.	Implementable. Solidification/stabilization materials are readily available.	Proven process for stabilizing sediments in preparation for transport over public roads (i.e., pass the paint filter test). Overall effectiveness of this process in stabilizing constituents in the sediments would need to be evaluated through a bench- and/or pilot-scale study.	Yes

See Note on Page 3.

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
Ex-Situ/On-Site Pre-Treatment, Treatment and/or Disposal (Cont.)	Thermal Extraction	LTTD	Process by which excavated sediments are heated and the organic compounds are desorbed from the sediments into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction. Treated sediments are subsequently disposed, unless some beneficial reuse endpoint can be identified.	Not implementable. Potential emissions concerns based on site's location near residential area and space required to conduct operations.	Proven process for effectively addressing organic constituents. The efficiency of the system and rate of removal of organic constituents would require evaluation during bench-scale and/or pilot-scale testing. Compliance with permit requirements for emission discharge would be required. No sites exist where material has been placed back in river bed after thermal treatment; treatment would likely be done in combination with a disposal option. Not appropriate for coarse sized material (i.e., cobbles and rocks).	No
	Incineration	Thermal Destruction	Use of a mobile incineration unit installed on-site for high temperature thermal destruction of the organic compounds present in the media. Sediments are excavated and conditioned prior to incineration. Treated sediments are returned to the subsurface.		Proven process for effectively addressing organic constituents. The efficiency of the system and rate of removal of organic constituents would need to be verified during bench-scale and/or pilot-scale testing. No sites exist where material has been placed back in river bed after thermal treatment; treatment would likely be done in combination with a disposal option. Not appropriate for coarse sized material (i.e., cobbles and rocks).	No
	Chemical Extraction	Chemical Extraction	Process by which excavated sediments are mixed with solvents/surfactants and organic compounds are desorbed from the sediments into a rinsate that is then treated. Treated sediments are subsequently disposed, unless some beneficial reuse endpoint can be identified.	Not appropriate for small volumes of sediment. Space constraints would exist for material processing and treatment equipment.	Proven process for effectively addressing organic constituents although it is commonly used with other treatment technologies (e.g., soil/sediment washing, incineration, solidification/stabilization). The efficiency of the extraction process and toxicity of the solvent in the treated sediments would require evaluation during bench-scale and/or pilot-scale testing. No sites exist where material has been placed back in the creek bed after chemical treatment; treatment would likely be done in combination with a disposal option.	No
	Chemical Destruction	Chemical Reduction/Oxidation	Process by which excavated sediments are mixed with oxidizing agents to reduce the mass of organic constituents. In-situ chemical oxidation involves the introduction of chemicals such as ozone, hydrogen peroxide, magnesium peroxide, sodium persulfate or potassium permanganate.	Implementable. Equipment and materials necessary to apply oxidizing agents are available. Large amounts of oxidizing agents may be required. May require special provisions for storage of process chemicals.	May not achieve RAOs for sediment. Not effective for NAPLs.	No
	On-Site Disposal	RCRA Landfill	Construction of a landfill that would meet RCRA requirements.	Not implementable. Space limitations and intended future use as a service center make on-site landfilling infeasible. Wetland area to the south of the service center is not appropriate for document as a landfill.	This technology process would be effective at meeting the RAOs for sediments. Excavated material would be contained in an appropriately constructed soil/sediment management cell. Long-term effectiveness requires ongoing maintenance and monitoring.	No
		Solid Waste Landfill	Construction of a landfill that would meet NYSDEC solid waste requirements.			No

See Note on Page 3.

Table 6
Remedial Technology Screening Evaluation for Sediment

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
Off-Site 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	Not implementable due to the coarse nature of the sediment at the site. Permitted facilities and demand are limited.	Effective for treating organics and inorganics through volatilization and/or encapsulation. Thermal pretreatment may be required to prevent leaching. Limited number of projects to support comparison of effectiveness. Coarse sized material (i.e., cobbles and rocks) are not utilized in asphalt concrete paving mixtures.	No
		Brick/Concrete Manufacture	Impacted sediment is transported off-site and used as a raw material in the manufacture of bricks or cement. Heating in ovens during the manufacturing process volatilizes organics and some inorganics.	Not implementable due to the coarse nature of the sediment at the site. The site does not have the adequate space necessary to conduct the significant amount of screening of the material required to be performed prior to being utilized in brick/concrete manufacture.	Effective for treating organics and inorganics through volatilization and/or vitrification. A bench-scale/pilot study may be necessary to determine effectiveness. Not appropriate for coarse sized material (i.e., cobbles and rocks are not utilized in the manufacturing of brick/concrete).	No
	Extraction	Low-Temperature Thermal Desorption	Process by which excavated sediments are heated and the organic compounds are desorbed from the sediments into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction. Treated sediments are subsequently disposed, unless some beneficial reuse endpoint can be identified. Would be used on materials that are determined to be characteristically hazardous based on TCLP analysis	Implementable. Treatment facilities are available.	Effective means for pre-treatment of materials that are characteristically hazardous due to the presence of organic compounds (i.e., benzene).	Yes
	Thermal Destruction	Incineration	Sediments are incinerated off-site for high temperature thermal destruction of the organic compounds present in the media. Sediments are excavated and conditioned prior to incineration.	Not implementable. Not a cost effective means for treating impacted sediment. Limited number of treatment facilities.	Proven process for effectively addressing organic constituents. The efficiency and effectiveness of the system and rate of removal of organic constituents would need to be verified during bench-scale and/or pilot-scale testing.	
	Off-Site Disposal	Solid Waste Landfill	Disposal of impacted sediment in an existing permitted non-hazardous landfill.	Implementable. Sediment excavated from Cayadutta Creek can be disposed at a solid waste landfill assuming disposal requirements are met or achieved through pre-treatment.	Proven process that can effectively achieve the RAOs for non-hazardous solid waste.	Yes
		RCRA Landfill	Disposal of impacted sediment in an existing RCRA permitted landfill facility.	Not implementable. Hazardous materials would not meet New York State LDRs and UTSs without pre-treatment. Effective pre-treatment would be cost prohibitive when considering DER-4 exemption for permanent thermal treatment of D018 characteristically hazardous material	Proven process that can effectively achieve the RAOs for hazardous waste.	No

Note:
1. Shading indicates that technology process has not been retained for development of a remedial alternative.

Table 7

Cost Estimate for Alternative 1 - No Further Action

Feasibility Study Report

National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
	No Capital Costs				$0
				Total Capital Cost	$0
Operation and Maintenance (O&M) Costs (Years 1 Through 30)					
1	Annual On-Site Groundwater Treatment System O&M	1	LS	$400,000	$400,000
				Subtotal O&M Cost	$400,000
				Contingency (20%)	$80,000
				Total Annual O&M Cost	$480,000
2				30-Year Total Present Worth Cost	$8,300,176
				Total Estimated Cost:	**$8,300,176**
				Rounded To:	**$8,300,000**

General Notes:

1. Cost estimate is based on Arcadis of New York's (Arcadis') past experience and vendor estimates using 2016 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. Arcadis 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.

3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. Annual on-site groundwater treatment system O&M cost estimate includes labor, equipment, and materials necessary to operate and conduct system maintenance/repairs on the existing site drains and on-site groundwater treatment system installed as part of the storm sewer interim remedial measure (IRM). Cost includes disposal of treated water at the Gloversville-Johnstown Joint Wastewater Treatment Facility (GJJWTF).

2. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2016.

Table 8

Cost Estimate for Alternative 2 - Groundwater/NAPL Monitoring, MNR, and Institutional Controls

Feasibility Study Report

National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
1	Site Management Plan	1	LS	$50,000	$50,000
2	Institutional Controls	1	LS	$80,000	$80,000
				Subtotal Capital Cost	$130,000
				Contingency (20%)	$26,000
				Total Capital Cost	$156,000
Operation and Maintenance (O&M) Costs (Years 1 Through 30)					
3	Annual On-Site Groundwater Treatment System O&M	1	LS	$400,000	$400,000
4	Annual Verification of Institutional Controls	1	LS	$10,000	$10,000
5	Annual Groundwater Sampling/NAPL Monitoring	1	EVENT	$20,000	$20,000
6	Laboratory Analysis of Groundwater Samples	66	EACH	$250	$16,500
7	Annual Monitored Natural Recovery	1	EVENT	$5,000	$5,000
8	Waste Disposal	2	DRUM	$700	$1,400
9	Annual Summary Report	1	LS	$25,000	$25,000
				Subtotal O&M Cost	$477,900
				Contingency (20%)	$95,580
				Total Annual O&M Cost	$573,480
10				30-Year Total Present Worth Cost	$9,916,635
				Total Estimated Cost:	**$10,072,635**
				Rounded To:	**$10,100,000**

General Notes:

1. Cost estimate is based on Arcadis of New York's (Arcadis') past experience and vendor estimates using 2016 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. Arcadis 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.

3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. Site management plan (SMP) cost estimate includes labor necessary to prepare a SMP to document: the institutional controls that have been established and will be maintained for the site; known locations of soil containing constituents of concern (COCs) at concentrations greater than 6NYCRR Part 375-6 industrial use Soil Cleanup Objectives (SCOs); protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities; protocols and requirements for conducting annual groundwater/non-aqueous phase liquid (NAPL) monitoring and monitored natural recovery (MNR) activities; and protocols for addressing significant changes in COC concentrations in groundwater based on the results of the annual monitoring activities.

2. Institutional controls cost estimate includes legal expenses to institute environmental easements and/or deed restrictions. Institutional controls would: limit intrusive (i.e., subsurface) activities that could result in potential exposures to remaining subsurface soil and groundwater containing site-related impacts at concentrations greater than applicable standards and guidance values; require compliance with the SMP; and prohibit the use of non-treated groundwater at the site.

3. Annual on-site groundwater treatment system O&M cost estimate includes labor, equipment, and materials necessary to operate and conduct system maintenance/repairs on the existing site drains and on-site groundwater treatment system installed as part of the storm sewer interim remedial measure (IRM). Cost includes disposal of treated water at the Gloversville-Johnstown Joint Wastewater Treatment Facility (GJJWTF).

4. Annual verification of institutional controls cost estimate includes administrative costs to confirm the status of institutional controls and prepare/submit a notification to the New York State Department of Environmental Conservation (NYSDEC) to demonstrate that the institutional controls are being maintained and remain effective.

5. Annual groundwater sampling/NAPL monitoring cost estimate includes labor, equipment, and materials necessary to conduct annual groundwater sampling/NAPL monitoring activities. Estimate includes costs for collecting groundwater samples from up to 60 groundwater monitoring wells using low-flow sampling procedures and removing NAPL (if any) that accumulates in the existing monitoring wells via manual bailing or using a portable peristaltic pump. Cost estimate assumes two workers will require 8 days to complete the groundwater sampling/NAPL monitoring activities. Estimate includes costs for field vehicle and equipment rental.

6. Laboratory analysis of groundwater samples cost estimate includes costs for analyzing of groundwater samples for benzene, toluene, ethylbenzene, and xylenes (BTEX); polycyclic aromatic hydrocarbons (PAHs); and cyanide. Estimate assumes laboratory analysis of groundwater samples from up to 60 groundwater monitoring wells and up to 6 quality assurance/quality control (QA/QC) samples per sampling event.

7. Annual monitored natural recovery (MNR) activities cost estimate includes labor, equipment, and materials necessary to conduct annual sediment monitoring to document the natural recovery of sediment in Cayadutta Creek. Cost estimate assumes sediment monitoring activities will consist of visual inspections of the MNR area. Estimate includes cost for field vehicle and equipment rental.

8. Waste disposal cost estimate includes off-site disposal of drummed personal protective equipment (PPE), disposable sampling equipment, and purge water generated/collected during groundwater sampling/NAPL monitoring activities.

9. Annual summary report cost estimate includes labor necessary to prepare and submit an annual report summarizing annual groundwater sampling/NAPL monitoring and MNR activities and results.

10. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2016.

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Table 9

Cost Estimate for Alternative 3 - NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
1	Pre-Design Investigation	1	LS	$120,000	$120,000
2	Permitting/Access Agreements	1	LS	$25,000	$25,000
3	Mobilization/Demobilization	1	LS	$250,000	$250,000
4	Utility Markout, Protection, Bypass, and/or Relocation	1	LS	$50,000	$50,000
5	Construct and Maintain Material Staging Area	1	LS	$30,000	$30,000
6	Decontamination Pad	1	LS	$15,000	$15,000
7	NAPL Barrier Wall Alignment Pre-Trenching	150	CY	$150	$22,500
8	NAPL Barrier Wall Trench Excavation	4,000	VSF	$80	$320,000
9	NAPL Barrier Wall Collection System	1	LS	$80,000	$80,000
10	NAPL Barrier Wall Stone Placement	370	CY	$20	$7,400
11	Install NAPL Recovery Wells	7	EACH	$7,000	$49,000
12	Install and Remove Temporary Sheet Pile Wall (w/ bracing)	6,900	VSF	$60	$414,000
13	Soil Excavation and Handling	5,700	CY	$45	$256,500
14	Surface Soil Excavation and Handling	3,300	CY	$45	$148,500
15	Temporary Dam and Bypass Pump System	1	LS	$390,000	$390,000
16	Sediment Excavation and Handling	450	CY	$60	$27,000
17	Temporary Water Treatment System	2	MONTH	$150,000	$300,000
18	Community Air Monitoring and Vapor/Odor Control	13	WEEK	$5,000	$65,000
19	Stabilization Admixture	120	TON	$115	$13,800
20	Backfill	5,800	SY	$25	$145,000
21	Soil Cover - Demarcation Layer	5,000	SY	$5	$25,000
22	Soil Cover - Backfill	3,300	CY	$25	$82,500
23	Engineered Sediment Cap - Geotextile	1,500	SY	$3	$4,500
24	Engineered Sediment Cap - Fill	450	CY	$35	$15,750
25	Solid Waste Characterization	30	EACH	$500	$15,000
26	Solid Waste Transportation and Disposal - Non-Hazardous Waste	10,700	TON	$55	$588,500
27	Solid Waste Transportation and Disposal - LTTD	4,200	TON	$85	$357,000
28	Site Management Plan	1	LS	$50,000	$50,000
29	Institutional Controls	1	LS	$80,000	$80,000
				Subtotal Capital Cost	$3,946,950
				Contingency (20%)	$789,390
				Total Capital Cost	$4,736,340
Operation and Maintenance (O&M) Costs (Year 1)					
30	Annual On-Site Groundwater Treatment System O&M	1	LS	$400,000	$400,000
31	Annual Verification of Institutional Controls	1	EVENT	$10,000	$10,000
32	Annual Groundwater Sampling/NAPL Recovery	1	EVENT	$20,000	$20,000
33	Quarterly NAPL Recovery	3	EVENT	$7,500	$22,500
34	Annual Soil Cover Inspection	1	EVENT	$2,000	$2,000
35	Annual Engineered Cap Monitoring	1	EVENT	$5,000	$5,000
36	Annual Monitored Natural Recovery	1	EVENT	$5,000	$5,000
37	Laboratory Analysis of Groundwater Samples	66	EACH	$250	$16,500
38	Waste Disposal	2	DRUM	$700	$1,400
39	Annual Summary Report	1	LS	$15,000	$15,000
				Subtotal O&M Cost	$497,400
				Contingency (20%)	$99,480
				Total Annual O&M Cost	$596,880
40				1-Year Total Present Worth Cost	$573,923
Operation and Maintenance Costs (Years 2 Through 30)					
41	Annual On-Site Groundwater Treatment System O&M	1	LS	$400,000	$400,000
42	Annual Verification of Institutional Controls	1	EVENT	$10,000	$10,000
43	Annual Groundwater Sampling/NAPL Recovery	1	EVENT	$20,000	$20,000
44	Annual Soil Cover Inspection	1	EVENT	$2,000	$2,000
45	Annual Engineered Cap Monitoring	1	EVENT	$5,000	$5,000
46	Annual Monitored Natural Recovery	1	EVENT	$5,000	$5,000
47	Laboratory Analysis of Groundwater Samples	20	EACH	$250	$5,000
48	Waste Disposal	4	DRUM	$700	$2,800
49	Annual Summary Report	1	LS	$25,000	$25,000
				Subtotal O&M Cost	$474,800
				Contingency (20%)	$94,960
				Total Annual O&M Cost	$569,760
50				30-Year Total Present Worth Cost	$9,304,463

Table 9

Cost Estimate for Alternative 3 - NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Operation and Maintenance Costs (Years 5, 10, 15, 20, and 25)					
51	Soil Cover Replacement/Maintenance	1	LS	$10,800	$10,800
52	Engineered Cap Replacement/Maintenance	1	LS	$4,100	$4,100
				Subtotal O&M Cost	$14,900
				Contingency (20%)	$2,980
				Total Annual O&M Cost	$17,880
53				30-Year Total Present Worth Cost	$57,083
				Total Estimated Cost:	**$14,671,809**
				Rounded To:	**$14,700,000**

General Notes:

1. Cost estimate is based on Arcadis of New York's (Arcadis') past experience and vendor estimates using 2016 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. Arcadis 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.

3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. Pre-design investigation (PDI) cost estimate includes labor, equipment, and materials necessary to conduct PDI activities in support of the remedial design of this alternative. PDI activities may include, but are not limited to, completing soil borings and test pits to refine excavation limits and collecting soil samples for geotechnical testing to support the NAPL barrier wall design, conducting creek flow measurements, and collecting sediment samples to refine capping limits. Cost estimate assumes sediment sampling will be for visual impacts only (no analytical testing).

2. Permitting/access agreements cost estimate includes costs to obtain appropriate permits and access agreements to construct this alternative.

3. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to construct this alternative. Estimate include costs for conducting clearing and grubbing of trees, shrubs, and stubs, as necessary, to facilitate the construction of this alternative. Estimate based on an assumed 10% of the total costs for this alternative, not including the pre-design investigations, permitting/access agreements, or waste transportation and disposal.

4. Utility markout, protection, bypass and/or relocation cost estimate includes labor, equipment, and materials necessary to temporarily bypass or relocate subsurface utilities within the anticipated excavation limits. Utilities anticipated to affected by remedial construction activities include, but are not limited to: overhead and below grade electric lines, storm and sanitary sewers, and natural gas lines.

5. Construct and maintain material staging area cost estimate includes labor, equipment, and materials necessary to construct a 100-foot by 50-foot material staging area for staging excavated material to facilitate waste characterization sampling and material handling/stabilization. The staging area would consist of a 6-inch gravel sub-base equipped with a 12-inch berm and sloped to a sump and covered with non-woven geotextile, 40-mil high-density polyethylene (HDPE) liner, and a 6-inch layer of gravel. Maintenance includes inspecting and repairing staging area as necessary. Estimate assumes a cost of approximately $6 per square-foot of pad.

6. Decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 50-foot by 20-foot decontamination pad and appurtenances. The decontamination pad would consist of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil high-density polyethylene (HDPE) liner and a 6-inch layer of gravel.

7. NAPL barrier wall alignment pre-trenching cost estimate includes labor, equipment, and materials necessary to conduct excavation activities along the non-aqueous phase liquid NAPL barrier wall alignment to a depth of 4 feet below grade to identify potential obstructions. Cost estimate assumes excavation activities will be conducted using a backhoe and hand digging, and excavation will be backfilled following removal of obstructions. Cost estimate assumes that the excavation will be approximately 3 feet wide.

8. NAPL barrier wall trench excavation cost estimate includes labor, equipment, and materials necessary to excavate a three-foot wide trench to facilitate the construction of a passive NAPL barrier wall. Cost estimate assumes the NAPL barrier wall trench will be excavated along the eastern bank of Cayadutta Creek to an average depth of 12 feet below grade (i.e., to the top of silt). Cost estimate assumes trench excavation would be conducted under biopolymer slurry using conventional excavation equipment.

9. NAPL collection system cost estimate includes labor, equipment, and materials necessary to install a NAPL collection system along the NAPL barrier wall consisting of up to twelve NAPL collection sumps installed to an average depth of 12 feet below grade (i.e., to the top of silt) at an spacing of approximately 30 feet. Cost estimate assumes the collection sumps will be constructed using 6-inch diameter stainless steel wells equipped with minimum 4-foot long sumps. Cost estimate assumes the NAPL barrier wall collection system will also include a pipe at the bottom of the trench sloped to the NAPL collection sumps to facilitate NAPL collection and recovery.

10. NAPL barrier wall stone placement cost estimate includes labor, equipment, and materials necessary to import and place pea gravel into the NAPL barrier wall trench. Cost estimate assumes that the NAPL barrier wall trench will be backfilled to a depth of two feet below grade (i.e., to the water table). Cost estimate is based on in-place gravel volume.

Table 9

Cost Estimate for Alternative 3 - NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Capping of MGP-Impacted Sediment

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

11. Install NAPL recovery wells cost estimate includes labor, equipment, and materials necessary to install NAPL recovery wells to the top of the silt unit (i.e., approximately 16 feet below grade) at locations in the service center property where recoverable quantities of NAPL have been historically accumulated in groundwater monitoring wells. Cost estimate includes oversight by a geologist and a drill rig and crew. Cost estimate assumes an average 20-foot long, 6-inch diameter stainless steel well, including minimum 4-foot long sumps.

12. Install and remove temporary sheet pile cost estimate includes labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile will be installed to an average depth of 14 feet bgs (i.e., to the top of silt). Cost estimate includes two rows of internal bracing and/or lateral supports. Sheet pile to be removed following excavation and backfilling activities.

13. Soil excavation and handling includes labor, equipment, and materials necessary to excavate soil containing significant quantities of NAPL (i.e., greater than sheens and blebs) and purifier waste. Cost estimate assumes excavation activities would be completed to depths up to 14 feet below grade using conventional construction equipment. Cost estimate is based on in-place soil volume.

14. Surface soil excavation and handling includes labor, equipment, and materials necessary to excavate surface soil (i.e., to a depth of 2 feet below grade) containing constituents of concern (COCs) at concentrations greater than 6 NYCRR Part 375-6 residential use Soil Cleanup Objectives (SCOs). Cost estimate assumes excavation activities would be completed using conventional construction equipment. Cost estimate is based on in-place soil volume.

15. Temporary dam and bypass pump system cost estimate includes labor, equipment, and materials necessary to construct a temporary dam and bypass pump system upstream of the sediment removal area in support of conducting sediment excavation activities in the dry. Cost estimate assumes the bypass pump system will consist of three pumps capable of operating at 8,000 gallons per minute (gpm) (to accommodate an estimated creek flow of up to 50 cubic feet per second), conveyance piping and hoses, and a flow meter.

16. Sediment excavation and handling includes labor, equipment, and materials necessary to remove sediment to accommodate the engineered cap placement without raising the existing creek bathymetry. Estimate includes costs to screen removed sediment to remove gravel and cobbles that could be reused during site restoration activities to promote habitat restoration. Cost estimate assumes excavation activities would be completed in the dry to depths up to 1 foot below sediment surface using conventional construction equipment. Cost estimate is based on in-place sediment volume.

17. Temporary water treatment system cost estimate includes installation of sumps and associated pumps to dewater excavation areas and rental and operation of a portable water treatment system capable of operating at 100 gpm. Cost estimate assumes water treatment system includes pumps, influent piping and hoses, frac tanks, carbon filters, bag filters, discharge piping and hoses, and flow meter. Cost estimate assumes that treated water would be discharged to Cayadutta Creek under a New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) Permit Equivalent.

18. Community air monitoring and vapor/odor control cost estimate includes labor, equipment, and materials necessary to monitor vapor/odor emissions during intrusive site activities and to apply vapor/odor suppressing foam to open excavations.

19. Stabilization admixture cost estimate includes purchasing and importing stabilizing agents to amend sediment and material excavated from below the water table. Cost estimate assumes stabilization admixture (e.g., Portland cement) will be added at ratio of 10% of the weight of material to be stabilized.

20. Backfill cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact general fill in excavation areas to match previously existing surrounding grades. Cost estimate is based on in-place soil volume. Cost estimate assumes 95% compaction based on standard proctor testing and includes survey verification and compaction testing.

21. Soil cover - demarcation layer cost estimate includes labor, equipment, and materials necessary to place a woven, light-weight, non-biodegradable, high-visibility demarcation layer within the soil excavation area footprints.

22. Soil cover - backfill cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact general fill in surface soil excavation areas to match previously existing surrounding grades. Cost estimate is based on in-place soil volume. Cost estimate assumes 95% compaction based on standard proctor testing and includes survey verification and compaction testing.

23. Engineered cap - geotextile cost estimate includes labor, equipment, and materials to purchase and install non-woven geotextile within the engineered cap footprints. Estimate includes an additional 10% for material overlap and waste.

24. Engineered cap - fill cost estimate includes labor, equipment, and materials necessary to install a 12-inch silt/sand layer within the engineered cap footprint to provide a physical barrier to deeper impacts and protect against erosional forces. Estimate includes costs to reuse screened gravel and cobbles (from removed sediment) during site restoration activities to promote habitat restoration. Cost estimate is based on in-place sediment volume.

25. Solid waste characterization cost estimate includes laboratory analysis of soil and sediment samples (including, but not limited to, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and Resource Conservation and Recovery Act-(RCRA-) regulated metals). Cost assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.

26. Solid waste transportation and disposal - non-hazardous waste cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated material not requiring low-temperature thermal desorption (LTTD) treatment at a non-hazardous solid waste landfill. Cost estimate assumes that 75% of material excavated to address soil containing significant quantities of NAPL and purifier waste and to facilitate the installation of the NAPL barrier wall will be treated/disposed of via LTTD. Cost assumes excavated soil and sediment will be disposed as non-hazardous waste. Cost estimate includes transportation and disposal of excavated soil and sediment at an assumed density of 1.5 tons per cubic-yard. Cost estimate includes disposal fee, transportation fuel surcharge, and spotting fees.

27. Solid waste transportation and disposal - LTTD cost estimate includes labor, equipment, and materials necessary to transport and treat excavated soil and sediment at a thermal treatment facility. Cost estimate assumes that sediment removed to facilitate the installation of the engineered cap and 35% of material excavated to address soil containing significant quantities of NAPL and purifier waste and to facilitate the installation of the NAPL barrier wall will be treated/disposed of via LTTD. Cost assumes excavated soil and sediment will be treated/disposed of via LTTD. Cost assumes excavated soil and sediment will be treated/disposed of via LTTD at an estimated density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees. Cost estimate assumes thermally treated soil does not require subsequent treatment or disposal.

28. Site management plan (SMP) cost estimate includes labor necessary to prepare a site management plan to document: the institutional controls that have been established and will be maintained for the site; known locations of soil containing constituents of concern (COCs) at concentrations greater than 6NYCRR Part 375-6 industrial use Soil Cleanup Objectives (SCOs); protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities; protocols and requirements for conducting annual groundwater/NAPL recovery, monitored natural recovery (MNR), and engineered cap inspection; and requirements for performing periodic site inspections, providing NYSDEC-required certifications, and submitting periodic reports to NYSDEC.

29. Institutional controls cost estimate includes legal expenses to institute environmental easements and/or deed restrictions. Institutional controls would: limit intrusive (i.e., subsurface) activities that could result in potential exposures to remaining subsurface soil, groundwater, and sediment containing MGP-related impacts at concentrations greater than applicable standards and guidance values; require compliance with the SMP; and prohibit use of groundwater at the site.

30. Annual on-site groundwater treatment system O&M cost estimate includes labor, equipment, and materials necessary to operate and conduct system maintenance/repairs on the existing site drains and on-site groundwater treatment system installed as part of the storm sewer interim remedial measure (IRM). Cost includes disposal of treated water at the Gloversville-Johnstown Joint Wastewater Treatment Facility (GJJWTF).

31. Annual verification of institutional controls cost estimate includes administrative costs to confirm the status of institutional controls and prepare/submit a notification to the New York State Department of Environmental Conservation (NYSDEC) to demonstrate that the institutional controls are being maintained and remain effective.

32. Annual groundwater sampling/NAPL recovery cost estimate includes labor, equipment, and materials necessary to conduct annual groundwater sampling/NAPL recovery activities. Estimate includes costs for collecting groundwater samples from up to 60 groundwater monitoring wells using low-flow sampling procedures and removing NAPL (if any) that accumulates in monitoring wells and the NAPL collection sumps (within the NAPL barrier wall) via manual bailing or using a portable peristaltic pump. Cost estimate assumes two workers will require 8 days to complete the groundwater sampling/NAPL monitoring activities. Estimate includes costs for field vehicle and equipment rental.

33. Quarterly NAPL recovery cost estimate includes labor, equipment, and materials necessary to conduct quarterly NAPL recovery activities. Estimate includes costs for collecting NAPL (if any) that accumulates in site monitoring wells and the NAPL collection sumps (within the NAPL barrier wall) via manual bailing or using a portable peristaltic pump. Cost estimate assumes two workers will require 4 days to complete NAPL recovery activities. Estimate includes costs for field vehicle and equipment rental.

34. Annual soil cover inspection cost estimate includes labor, equipment, and materials necessary to verify the integrity of the soil cover. Estimate includes costs to visually inspect the soil cover.

35. Annual engineered cap monitoring cost estimate includes labor, equipment, and materials necessary to verify the integrity of the engineered cap. Estimate includes costs to visually inspect the engineered cap.

36. Annual monitored natural recovery (MNR) activities cost estimate includes labor, equipment, and materials necessary to conduct annual sediment monitoring to document the natural recovery of sediment in Cayadutta Creek. Cost estimate assumes sediment monitoring activities will consist of visual inspections of the MNR area. Estimate includes cost for field vehicle and equipment rental.

37. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for benzene, toluene, ethylbenzene, and xylenes (BTEX); polycyclic aromatic hydrocarbons (PAHs); and cyanide. Estimate assumes laboratory analysis of groundwater samples from up to 60 groundwater monitoring wells and up to 6 quality assurance/quality control (QA/QC) samples per sampling event.

38. Waste disposal cost estimate includes off-site disposal of drummed personal protective equipment (PPE), disposable sampling equipment, and purge water generated/collected during groundwater sampling/NAPL monitoring activities.

39. Annual summary report cost estimate includes labor necessary to prepare and submit an annual report summarizing annual groundwater sampling/NAPL recovery and MNR activities and results.

40. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2016.

41. See note 30.

42. See note 31.

43. See note 32.

44. See note 34.

45. See note 35.

46. See note 36.

47. See note 37.

48. See note 38.

49. See note 39.

50. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2016 and present worth is calculated for O&M costs associated with years 2 through 30.

51. Soil cover replacement/maintenance cost estimate includes labor, equipment, and materials necessary to replace and/or maintain soil cover materials to maintain the cover's integrity and effectiveness. Cost estimate assumes 10% of the cover materials (Items 21 and 22) would require replacement and/or maintenance every 5 years (until year 30). Actual maintenance frequency and requirements will be determined based on post-construction monitoring events.

52. Engineered cap replacement/maintenance cost estimate includes labor, equipment, and materials necessary to replace and/or maintain cap materials to maintain the engineered cap's integrity and effectiveness. Cost estimate assumes 20% of the cap materials (Items 23 and 24) would require replacement and/or maintenance every 5 years (until year 30). Actual maintenance frequency and requirements will be determined based on post-construction monitoring events.

53. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2016.

ARCADIS Design & Consultancy for natural and built assets

Table 10
Cost Estimate for Alternative 4 - NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
1	Pre-Design Investigation	1	LS	$150,000	$150,000
2	Permitting/Access Agreements	1	LS	$25,000	$25,000
3	Mobilization/Demobilization	1	LS	$420,000	$420,000
4	Utility Markout, Protection, Bypass, and/or Relocation	1	LS	$50,000	$50,000
5	Construct and Maintain Material Staging Area	1	LS	$30,000	$30,000
6	Decontamination Pad	1	LS	$15,000	$15,000
7	NAPL Barrier Wall Alignment Pre-Trenching	170	CY	$150	$25,500
8	NAPL Barrier Wall Trench Excavation	4,700	VSF	$80	$376,000
9	NAPL Barrier Wall Collection System	1	LS	$90,000	$90,000
10	NAPL Barrier Wall Stone Placement	430	CY	$20	$8,600
11	NAPL Recovery Wells	7	EACH	$7,000	$49,000
12	Install and Remove Temporary Sheet Pile Wall (w/ bracing)	16,300	VSF	$60	$978,000
13	Soil Excavation and Handling	14,800	CY	$45	$666,000
14	Surface Soil Excavation and Handling	1,400	CY	$45	$63,000
15	Temporary Dam and Bypass Pump System	1	LS	$390,000	$390,000
16	Sediment Excavation and Handling	1,300	CY	$60	$78,000
17	Temporary Water Treatment System	5	MONTH	$150,000	$750,000
18	Community Air Monitoring and Vapor/Odor Control	23	WEEK	$5,000	$115,000
19	Stabilization Admixture	260	TON	$115	$29,900
20	Backfill - Excavation Areas	14,900	CY	$25	$372,500
21	Soil Cover - Demarcation Layer	2,100	SY	$5	$10,500
22	Soil Cover - Backfill	1,400	CY	$25	$35,000
23	Backfill - Sediment Removal Area	1,300	CY	$35	$45,500
24	Solid Waste Characterization	60	EACH	$500	$30,000
25	Solid Waste Transportation and Disposal - Non-Hazardous Waste	16,500	TON	$55	$907,500
26	Solid Waste Transportation and Disposal - LTTD	10,800	TON	$85	$918,000
27	Site Management Plan	1	LS	$50,000	$50,000
28	Institutional Controls	1	LS	$80,000	$80,000
				Subtotal Capital Cost	$6,758,000
				Contingency (20%)	$1,351,600
				Total Capital Cost	$8,109,600
Operation and Maintenance (O&M) Costs (Year 1)					
29	Annual On-Site Groundwater Treatment System O&M	1	LS	$400,000	$400,000
30	Annual Verification of Institutional Controls	1	EVENT	$10,000	$10,000
31	Annual Groundwater Sampling/NAPL Recovery	1	EVENT	$20,000	$20,000
32	Quarterly NAPL Recovery	4	EVENT	$7,500	$30,000
33	Annual Soil Cover Inspection	1	EVENT	$2,000	$2,000
34	Annual Monitored Natural Recovery	1	EVENT	$5,000	$5,000
35	Laboratory Analysis of Groundwater Samples	66	EACH	$250	$16,500
36	Waste Disposal	4	DRUM	$700	$2,800
37	Annual Summary Report	1	LS	$25,000	$25,000
				Subtotal O&M Cost	$511,300
				Contingency (20%)	$102,260
				Total Annual O&M Cost	$613,560
38				30-Year Total Present Worth Cost	$589,962
Operation and Maintenance Costs (Years 2 Through 30)					
39	Annual On-Site Groundwater Treatment System O&M	1	LS	$400,000	$400,000
40	Annual Verification of Institutional Controls	1	EVENT	$10,000	$10,000
41	Annual Groundwater/NAPL Recovery	1	EVENT	$20,000	$20,000
42	Annual Soil Cover Inspection	1	EVENT	$2,000	$2,000
43	Annual Monitored Natural Recovery	1	EVENT	$5,000	$5,000
44	Laboratory Analysis of Groundwater Samples	66	EACH	$250	$16,500
45	Waste Disposal	4	DRUM	$700	$2,800
46	Annual Summary Report	1	LS	$25,000	$25,000
				Subtotal O&M Cost	$481,300
				Contingency (20%)	$96,260
				Total Annual O&M Cost	$577,560
47				30-Year Total Present Worth Cost	$9,431,841
Operation and Maintenance Costs (Years 5, 10, 15, 20, and 25)					
48	Soil Cover Replacement/Maintenance	1	LS	$4,600	$4,600
				Subtotal O&M Cost	$4,600
				Contingency (20%)	$920
				Total Annual O&M Cost	$5,520
49				30-Year Total Present Worth Cost	$17,623
				Total Estimated Cost:	**$18,149,025**
				Rounded To:	**$18,100,000**

Table 10

Cost Estimate for Alternative 4 - NAPL Barrier Wall, NAPL Recovery Wells, Targeted Soil Removal, and Dredging of MGP-Impacted Sediment

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

General Notes:

1. Cost estimate is based on Arcadis of New York's (Arcadis') past experience and vendor estimates using 2016 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. Arcadis 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.

3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. Pre-design investigation (PDI) cost estimate includes labor, equipment, and materials necessary to conduct PDI activities in support of the remedial design of this alternative. PDI activities may include, but are not limited to, completing soil borings and test pits to refine excavation limits and collecting soil samples for geotechnical testing to support the NAPL barrier wall design, conducting creek flow measurements, and collecting sediment samples to refine removal limits. Cost estimate assumes sediment sampling will be for visual impacts only (no analytical testing).

2. Permitting/access agreements cost estimate includes costs to obtain appropriate permits and access agreements to construct this alternative.

3. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to construct this alternative. Estimate include costs for conducting clearing and grubbing of trees, shrubs, and stubs, as necessary, to facilitate the construction of this alternative. Estimate based on an assumed 10% of the total costs for this alternative, not including the pre-design investigations, permitting/access agreements, or waste transportation and disposal.

4. Utility markout, protection, bypass and/or relocation cost estimate includes labor, equipment, and materials necessary to temporarily bypass or relocate subsurface utilities within the anticipated excavation limits. Utilities anticipated to affected by remedial construction activities include, but are not limited to: overhead and below grade electric lines, storm and sanitary sewers, and natural gas lines.

5. Construct and maintain material staging area cost estimate includes labor, equipment, and materials necessary to construct a 100-foot by 50-foot material staging area for staging excavated material to facilitate waste characterization sampling and material handling/stabilization. The staging area would consist of a 6-inch gravel sub-base equipped with a 12-inch berm and sloped to a sump and covered with non-woven geotextile, 40-mil high-density polyethylene (HDPE) liner, and a 6-inch layer of gravel. Maintenance includes inspecting and repairing staging area as necessary. Estimate assumes a cost of approximately $6 per square-foot of pad.

6. Decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 50-foot by 20-foot decontamination pad and appurtenances. The decontamination pad would consist of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil HDPE liner and a 6-inch layer of gravel.

7. NAPL barrier wall alignment pre-trenching cost estimate includes labor, equipment, and materials necessary to conduct excavation activities along the non-aqueous phase liquid NAPL barrier wall alignment to a depth of 4 feet below grade to identify potential obstructions. Cost estimate assumes excavation activities will be conducted using a backhoe and hand digging, and excavation will be backfilled following removal of obstructions. Cost estimate assumes that the excavation will be approximately 3 feet wide.

8. NAPL barrier wall trench excavation cost estimate includes labor, equipment, and materials necessary to excavate a three-foot wide trench to facilitate the construction of a passive NAPL barrier wall. Cost estimate assumes the NAPL barrier wall trench will be excavated along the eastern bank of Cayadutta Creek to an average depth of 12 feet below grade (i.e., to the top of silt). Cost estimate assumes trench excavation would be conducted under biopolymer slurry using conventional excavation equipment.

9. NAPL collection system cost estimate includes labor, equipment, and materials necessary to install a NAPL collection system along the NAPL barrier wall consisting of up to 14 NAPL collection sumps installed to an average depth of 12 feet below grade (i.e., to the top of silt) at an spacing of approximately 30 feet. Cost estimate assumes the collection sumps will be constructed using 6-inch diameter stainless steel wells equipped with minimum 4-foot long sumps. Cost estimate assumes the NAPL barrier wall collection system will also include a pipe at the bottom of the trench sloped to the NAPL collection sumps to facilitate NAPL collection and recovery.

10. NAPL barrier wall stone placement cost estimate includes labor, equipment, and materials necessary to import and place pea gravel into the NAPL barrier wall trench. Cost estimate assumes that the NAPL barrier wall trench will be backfilled to a depth of two feet below grade (i.e., to the water table). Cost estimate is based on in-place gravel volume.

11. Install NAPL recovery wells cost estimate includes labor, equipment, and materials necessary to install NAPL recovery wells to the top of the silt unit (i.e., approximately 16 feet below grade) at locations in the service center property where recoverable quantities of NAPL have been historically accumulated in groundwater monitoring wells. Cost estimate includes oversight by a geologist and a drill rig and crew. Cost estimate assumes 6-inch diameter stainless steel well construction and wells equipped with minimum 4-foot long sumps.

12. Install and remove temporary sheet pile cost estimate includes labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile will be installed to an average depth of 14 feet bgs (i.e., to the top of silt). Cost estimate includes two rows of internal bracing and/or lateral supports. Sheet pile to be removed following excavation and backfilling activities.

13. Soil excavation and handling includes labor, equipment, and materials necessary to excavate soil containing significant quantities of NAPL (i.e., greater than sheens and blebs) and purifier waste. Cost estimate assumes excavation activities would be completed to depths up to 12 feet below grade using conventional construction equipment. Cost estimate is based on in-place soil volume.

14. Surface soil excavation and handling includes labor, equipment, and materials necessary to excavate surface soil (i.e., to a depth of 2 feet below grade) containing constituents of concern (COCs) at concentrations greater than 6 NYCRR Part 375-6 residential use Soil Cleanup Objectives (SCOs). Cost estimate assumes excavation activities would be completed using conventional construction equipment. Cost estimate is based on in-place soil volume.

15. Temporary dam and bypass pump system cost estimate includes labor, equipment, and materials necessary to construct a temporary dam and bypass pump system upstream of the sediment removal area in support of conducting sediment excavation activities in the dry. Cost estimate assumes the bypass pump system will consist of three pumps capable of operating at 8,000 gallons per minute (gpm) (to accommodate an estimated creek flow of up to 50 cubic feet per second), conveyance piping and hoses, and a flow meter.

16. Sediment excavation and handling includes labor, equipment, and materials necessary to excavate sediment containing manufactured gas plan- (MGP-) related impacts (i.e., visual indications of coal tar and/or material that generates sheens when disturbed). Estimate includes costs to screen removed sediment to remove gravel and cobbles that could be reused during site restoration activities to promote habitat restoration. Cost estimate assumes excavation activities would be completed in the dry to depths up to 3 feet below sediment surface using conventional construction equipment. Cost estimate is based on in-place sediment volume.

17. Temporary water treatment system cost estimate includes installation of sumps and associated pumps to dewater excavation areas and rental and operation of a portable water treatment system capable of operating at 100 gpm. Cost estimate assumes water treatment system includes pumps, influent piping and hoses, frac tanks, carbon filters, bag filters, discharge piping and hoses, and flow meter. Cost estimate assumes that treated water would be discharged to Cayadutta Creek under a New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) Permit Equivalent.

18. Community air monitoring and vapor/odor control cost estimate includes labor, equipment, and materials necessary to monitor vapor/odor emissions during intrusive site activities and to apply vapor/odor suppressing foam to open excavations.

19. Stabilization admixture cost estimate includes purchasing and importing stabilizing agents to amend sediment and material excavated from below the water table. Cost estimate assumes stabilization admixture (e.g., Portland cement) will be added at ratio of 10% of the weight of material to be stabilized.

20. Backfill - excavation areas cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact general fill in excavation areas to match previously existing surrounding grades. Cost estimate is based on in-place soil volume.

21. Soil cover - demarcation layer cost estimate includes labor, equipment, and materials necessary to place a woven, light-weight, non-biodegradable, high-visibility demarcation layer within the soil excavation area footprints.

22. Soil cover - backfill cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact general fill in surface soil excavation areas to match previously existing surrounding grades. Cost estimate is based on in-place soil volume. Cost estimate assumes 95% compaction based on standard proctor testing and includes survey verification and compaction testing.

23. Backfill - sediment removal area cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact general fill in the sediment removal area to match previously existing lines and grades. Estimate includes costs to reuse screened gravel and cobbles (from removed sediment) during site restoration activities to promote habitat restoration. Cost estimate is based on in-place sediment volume.

24. Solid waste characterization cost estimate includes laboratory analysis of soil and sediment samples (including, but not limited to, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and Resource Conservation and Recovery Act- (RCRA-) regulated metals). Cost assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.

25. Solid waste transportation and disposal - non-hazardous waste cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated soil not requiring low-temperature thermal desorption (LTTD) treatment at a non-hazardous solid waste landfill. Cost estimate assumes 65% of material excavated to address soil containing significant quantities of NAPL and purifier waste and to facilitate the installation of the NAPL barrier wall will be treated/disposed of via LTTD. Cost assumes excavated soil and sediment will be disposed as non-hazardous waste. Cost estimate includes transportation and disposal of excavated soil and sediment at an assumed density of 1.5 tons per cubic-yard. Cost estimate includes disposal fee, transportation fuel surcharge, and spotting fees.

26. Solid waste transportation and disposal - LTTD cost estimate includes labor, equipment, and materials necessary to transport and treat excavated soil and sediment at a thermal treatment facility. Cost estimate assumes that sediment removed to address MGP-related impacts and 35% of material excavated to address soil containing significant quantities of NAPL and purifier waste and to facilitate the installation of the NAPL barrier wall will be treated/disposed of via LTTD. Cost assumes excavated soil and sediment will be treated/disposed of via LTTD at an estimated density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees. Cost estimate assumes thermally treated soil does not require subsequent treatment or disposal.

27. Site management plan (SMP) cost estimate includes labor necessary to prepare a site management plan to document: the institutional controls that have been established and will be maintained for the site; known locations of soil containing constituents of concern (COCs) at concentrations greater than 6NYCRR Part 375-6 industrial use Soil Cleanup Objectives (SCOs); protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities; protocols and requirements for conducting annual groundwater/NAPL recovery, monitored natural recovery (MNR), and engineered cap inspection; and requirements for performing periodic site inspections, providing NYSDEC-required certifications, and submitting periodic reports to NYSDEC.

28. Institutional controls cost estimate includes legal expenses to institute environmental easements and/or deed restrictions. Institutional controls would: limit intrusive (i.e., subsurface) activities that could result in potential exposures to remaining subsurface soil and groundwater containing site-related impacts at concentrations greater than applicable standards and guidance values; require compliance with the SMP; and prohibit the use of groundwater at the site.

29. Annual on-site groundwater treatment system O&M cost estimate includes labor, equipment, and materials necessary to operate and conduct system maintenance/repairs on the existing site drains and on-site groundwater treatment system installed as part of the storm sewer interim remedial measure (IRM). Cost includes disposal of treated water at the Gloversville-Johnstown Joint Wastewater Treatment Facility (GJJWTF).

30. Annual verification of institutional controls cost estimate includes administrative costs to confirm the status of institutional controls and prepare/submit a notification to the New York State Department of Environmental Conservation (NYSDEC) to demonstrate that the institutional controls are being maintained and remain effective.

31. Annual groundwater sampling/NAPL recovery cost estimate includes labor, equipment, and materials necessary to conduct annual groundwater sampling/NAPL recovery activities. Estimate includes costs for collecting groundwater samples from up to 60 groundwater monitoring wells using low-flow sampling procedures and removing NAPL (if any) that accumulates in monitoring wells and the NAPL collection sumps (within the NAPL barrier wall) via manual bailing or using a portable peristaltic pump. Cost estimate assumes two workers will require 8 days to complete the groundwater sampling/NAPL monitoring activities. Estimate includes costs for field vehicle and equipment rental.

32. Quarterly NAPL recovery cost estimate includes labor, equipment, and materials necessary to conduct quarterly NAPL recovery activities. Estimate includes costs for collecting NAPL (if any) that accumulates in site monitoring wells and the NAPL collection sumps (within the NAPL barrier wall) via manual bailing or using a portable peristaltic pump. Cost estimate assumes two workers will require 4 days to complete NAPL recovery activities. Estimate includes costs for field vehicle and equipment rental.

33. Annual soil cover inspection cost estimate includes labor, equipment, and materials necessary to verify the integrity of the soil cover. Estimate includes costs to visually inspect the soil cover.

34. Annual monitored natural recovery (MNR) activities cost estimate includes labor, equipment, and materials necessary to conduct annual sediment monitoring to document the natural recovery of sediment in Cayadutta Creek. Cost estimate assumes sediment monitoring activities will consist of visual inspections of the MNR area. Estimate includes cost for field vehicle and equipment rental.

35. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for benzene, toluene, ethylbenzene, and xylenes (BTEX); polycyclic aromatic hydrocarbons (PAHs); and cyanide. Estimate assumes laboratory analysis of groundwater samples from up to 60 groundwater monitoring wells and up to 6 quality assurance/quality control (QA/QC) samples per sampling event.

36. Waste disposal cost estimate includes off-site disposal of drummed personal protective equipment (PPE), disposable sampling equipment, and purge water generated/collected during groundwater sampling/NAPL monitoring activities.

37. Annual summary report cost estimate includes labor necessary to prepare and submit an annual report summarizing annual groundwater sampling/NAPL recovery and MNR activities and results.

38. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2016.

39. See note 29.

40. See note 30.

41. See note 31.

42. See note 33.

43. See note 34.

44. See note 35.

45. See note 36.

46. See note 37.

47. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2016 and present worth is calculated for O&M costs associated with years 2 through 30.

48. Soil cover replacement/maintenance cost estimate includes labor, equipment, and materials necessary to replace and/or maintain soil cover materials to maintain the cover's integrity and effectiveness. Cost estimate assumes 10% of the cover materials (Items 21 and 22) would require replacement and/or maintenance every 5 years (until year 30). Actual maintenance frequency and requirements will be determined based on post-construction monitoring events.

49. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2016.

ARCADIS Design & Consultancy for natural and built assets

Table 11
Cost Estimate for Alternative 5 - Soil Removal to Unrestricted Use SCOs and Sediment Removal to Background Conditions

Feasibility Study Report
National Grid - Gloversville (Hill Street) Former Manufactured Gas Plant Site - Gloversville, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs					
1	Above Grade Structure Demolition	1	LS	$500,000	$500,000
2	Pre-Design Investigation	1	LS	$200,000	$200,000
3	Permitting/Access Agreements	1	LS	$25,000	$25,000
4	Mobilization/Demobilization	1	LS	$1,700,000	$1,700,000
5	Utility Markout, Protection, Bypass, and/or Relocation	1	LS	$100,000	$100,000
6	Construct and Maintain Material Staging Area	1	LS	$30,000	$30,000
7	Decontamination Pad	1	LS	$15,000	$15,000
8	Install and Remove Temporary Sheet Pile Wall (w/bracing)	169,800	VSF	$60	$10,188,000
9	Soil Excavation and Handling	180,000	CY	$45	$8,100,000
10	Install Temporary Dam and Bypass Pump System	1	LS	$390,000	$390,000
11	Sediment Excavation and Handling	2,200	CY	$60	$132,000
12	Temporary Water Treatment System	54	MONTH	$150,000	$8,100,000
13	Community Air Monitoring and Vapor/Odor Control	243	WEEK	$5,000	$1,215,000
14	Stabilization Admixture	10,000	TON	$115	$1,150,000
15	Backfill - Excavation Areas	180,000	CY	$25	$4,500,000
16	Backfill - Sediment Removal Area	2,200	CY	$35	$77,000
17	Solid waste Characterization	570	EACH	$500	$285,000
18	Solid Waste Transportation and Disposal - Non-Haz	140,000	TON	$55	$7,700,000
19	Solid Waste Transportation and Disposal - LTTD	143,000	TON	$85	$12,155,000
				Subtotal Capital Cost	$56,562,000
				Contingency (20%)	$11,312,400
				Total Capital Cost	$67,874,400
				Total Estimated Cost:	**$67,874,400**
				Rounded To:	**$67,900,000**

General Notes:

1. Cost estimate is based on Arcadis of New York's (Arcadis') past experience and vendor estimates using 2016 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. Arcadis 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.

3. All costs assume construction field work to be conducted by non-unionized labor.

Assumptions:

1. Above-grade structure demolition cost estimate includes labor, equipment, and materials necessary to remove existing above grade structures located on the service center property prior to the remedial construction activities, including an office/garage building (the service center building), multiple storage buildings and sheds, an open garage, a groundwater treatment system building, and various storage areas for utility maintenance equipment (e.g., poles, transformers, cable, piping, etc.).

2. Pre-design investigation (PDI) cost estimate includes labor, equipment, and materials necessary to conduct PDI activities in support of the remedial design of this alternative. PDI activities may include, but are not limited to, completing soil borings and test pits to refine excavation limits and collecting and conducting chemical/geotechnical analysis of soil samples, conducting creek flow measurements, and collecting and conducting chemical analysis of sediment samples to refine removal limits.

3. Permitting/access agreements cost estimate includes costs to obtain appropriate permits and access agreements to construct this alternative.

4. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to construct this alternative. Estimate include costs for conducting clearing and grubbing of trees, shrubs, and stubs, as necessary, to facilitate the construction of this alternative. Estimate based on an assumed 5% of the total costs for this alternative, not including the pre-design investigations, permitting/access agreements, or waste transportation and disposal.

5. Utility markout, protection, bypass and/or relocation cost estimate includes labor, equipment, and materials necessary to temporarily bypass or relocate subsurface utilities within the anticipated excavation limits. Utilities anticipated to affected by remedial construction activities include, but are not limited to: overhead and below grade electric lines, storm and sanitary sewers, natural gas lines, and telecommunication lines.

6. Construct and maintain material staging area cost estimate includes labor, equipment, and materials necessary to construct a 100-foot by 50-foot material staging area for staging excavated material to facilitate waste characterization sampling and material handling/stabilization. The staging area would consist of a 6-inch gravel sub-base equipped with a 12-inch berm and sloped to a sump and covered with non-woven geotextile, 40-mil high-density polyethylene (HDPE) liner, and a 6-inch layer of gravel. Maintenance includes inspecting and repairing staging area as necessary. Estimate assumes a cost of approximately $6 per square-foot of pad.

7. Decontamination pad cost estimate includes labor, equipment, and materials necessary to construct and remove a 50-foot by 20-foot decontamination pad and appurtenances. The decontamination pad would consist of a 12-inch gravel fill layer bermed and sloped to a sump and covered with a 40-mil high-density polyethylene (HDPE) liner and a 6-inch layer of gravel.

8. Install and remove temporary sheet pile cost estimate includes labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile will be installed at an average depth of 12 feet bgs (i.e., to the top of silt). Cost estimate includes two rows of internal bracing and/or lateral supports. Sheet pile to be removed following excavation and backfilling activities.

9. Soil excavation and handling includes labor, equipment, and materials necessary to excavate soil to up to 18.5 feet below grade (i.e., to the top of silt) to address soil containing constituents of concern (COCs) at concentrations greater than 6 NYCRR Part 375-6 unrestricted use Soil Cleanup Objectives (SCOs). Cost estimate assumes excavation activities would be completed using conventional construction equipment. Cost estimate is based on in-place soil volume.

10. Temporary dam and bypass pump system cost estimate includes labor, equipment, and materials necessary to construct a temporary dam and bypass pump system upstream of the sediment removal area in support of conducting sediment excavation activities in the dry. Cost estimate assumes the bypass pump system will consist of three pumps capable of operating at 8,000 gallons per minute (gpm) (to accommodate an estimated creek flow of up to 50 cubic feet per second), conveyance piping and hoses, and a flow meter.

11. Sediment excavation and handling includes labor, equipment, and materials necessary to excavate sediment containing polycyclic aromatic hydrocarbons (PAHs) at concentrations greater than background conditions. Cost estimate assumes excavation activities would be completed in the dry to depths up to 3 feet below sediment surface using conventional construction equipment. Cost estimate is based on in-place sediment volume.

12. Temporary water treatment system cost estimate includes installation of sumps and associated pumps to dewater excavation areas and rental and operation of a portable water treatment system capable of operating at 100 gpm. Cost estimate assumes water treatment system includes pumps, influent piping and hoses, frac tanks, carbon filters, bag filters, discharge piping and hoses, and flow meter. Cost estimate assumes that treated water would be discharged to Cayadutta Creek under a New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) Permit Equivalent.

13. Community air monitoring and vapor/odor control cost estimate includes labor, equipment, and materials necessary to monitor vapor/odor emissions during intrusive site activities and to apply vapor/odor suppressing foam to open excavations.

14. Stabilization admixture cost estimate includes the purchasing and importing stabilizing agents to amend sediment and material excavated from below the water table. Cost estimate assumes stabilization admixture (e.g., Portland cement) will be added at ratio of 10% of the weight of material to be stabilized.

15. Backfill - excavation areas cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact general fill in excavation areas to match previously existing surrounding grades. Cost estimate is based on in-place soil volume. Cost estimate assumes 95% compaction based on standard proctor testing and includes survey verification and compaction testing.

16. Backfill - sediment removal area cost estimate includes labor, equipment, and materials necessary to import, place, grade and compact general fill in the sediment removal area to match previously existing lines and grades. Estimate includes costs to reuse screened gravel and cobbles (from removed sediment) during site restoration activities to promote habitat restoration. Cost estimate is based on in-place sediment volume.

17. Solid waste characterization cost estimate includes laboratory analysis of soil and sediment samples (including, but not limited to, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and Resource Conservation and Recovery Act- (RCRA-) regulated metals). Cost assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.

18. Solid waste transportation and disposal - non-hazardous waste cost estimate includes labor, equipment, and materials necessary to transport and dispose of excavated soil and sediment not requiring low-temperature thermal desorption (LTTD) treatment at a non-hazardous solid waste landfill. Cost estimate assumes that 50% of excavated material will be disposed as non-hazardous waste. Cost estimate includes transportation and disposal of excavated soil and sediment at an assumed density of 1.5 tons per cubic-yard. Cost estimate includes disposal fee, transportation fuel surcharge, and spotting fees.

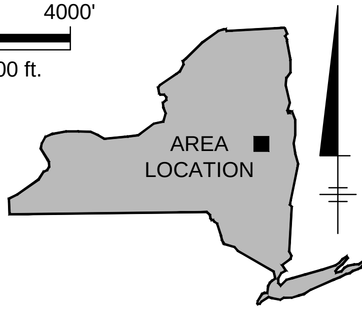
19. Solid waste transportation and disposal - LTTD cost estimate includes labor, equipment, and materials necessary to transport and thermally treat excavated soil and sediment exhibiting toxicity characteristic for benzene at a thermal treatment facility. Cost estimate assumes that 50% of excavated material will be treated/disposed of via LTTD. Cost assumes excavated soil and sediment will be treated/disposed of via LTTD at an estimated density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees. Cost estimate assumes thermally treated soil does not require subsequent treatment or disposal.

FIGURES

REFERENCE: BASE MAP USGS 7.5. MIN. TOPO. QUAD., GLOVERSVILLE, NEW YORK, 2013.

0 2000' 4000'

Approximate Scale: 1 in. = 2000 ft.



NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

SITE LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

CITY: SYRACUSE, NY DIV/GROUP: ENV-CAD DB:K.SARTORI LD:K.SARTORI PIC/PM/TM: D.RODRIGUEZ LYR:(Opt)ON=*;OFF=*REF*
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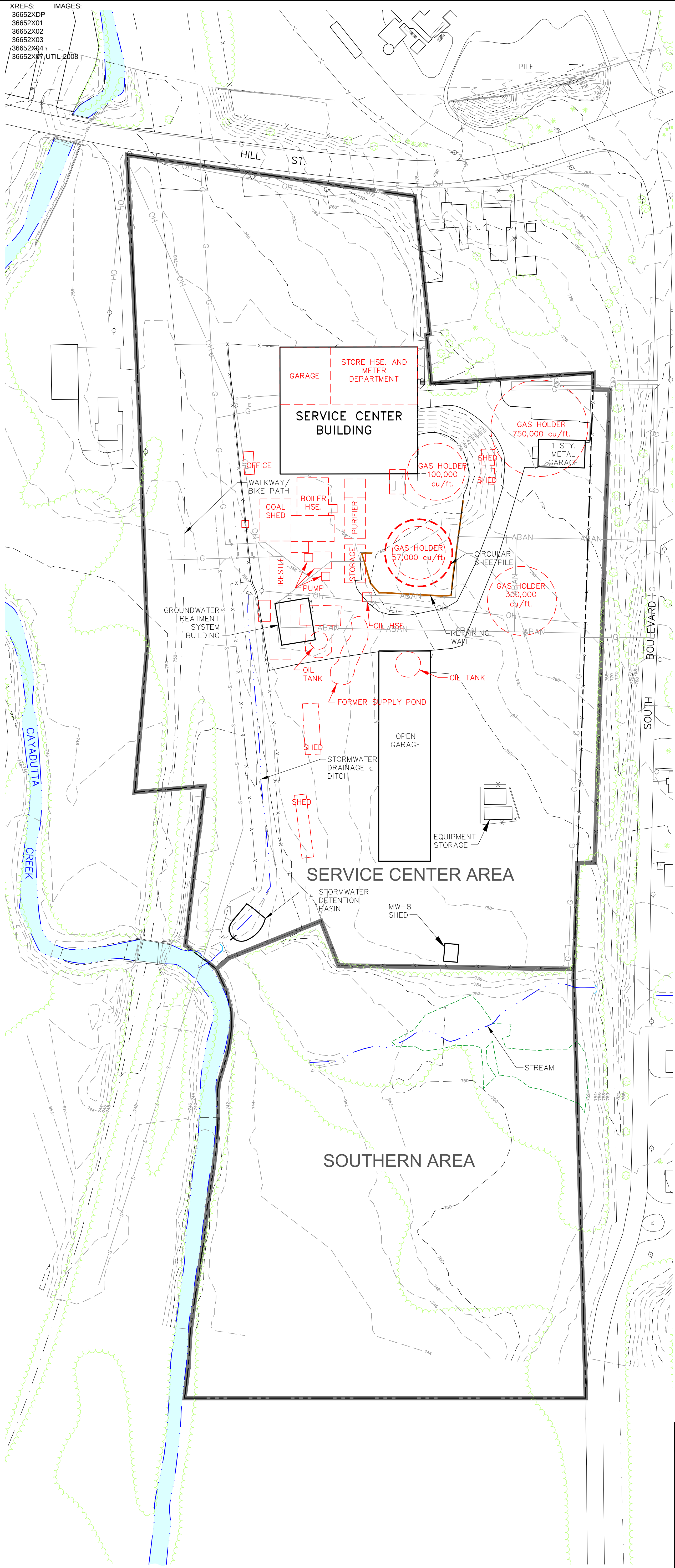


LEGEND:

- APPROXIMATE PROPERTY LINE
- HISTORICAL MGP STRUCTURE
- TOPOGRAPHIC ELEVATION CONTOUR
- WATER STREAM
- TREE LINE
- FENCE
- SANITARY LINE
- NATURAL GAS DISTRIBUTION LINE
- ELECTRICAL
- OVERHEAD
- ABANDONED
- UTILITY POLE
- IDENTIFIED WETLAND

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
5. EXISTING SITE FEATURES BASED ON "ASBUILT SURVEY" PROVIDED BY STANTEC ON 7/18/08.
6. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2-4 & 2-5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.

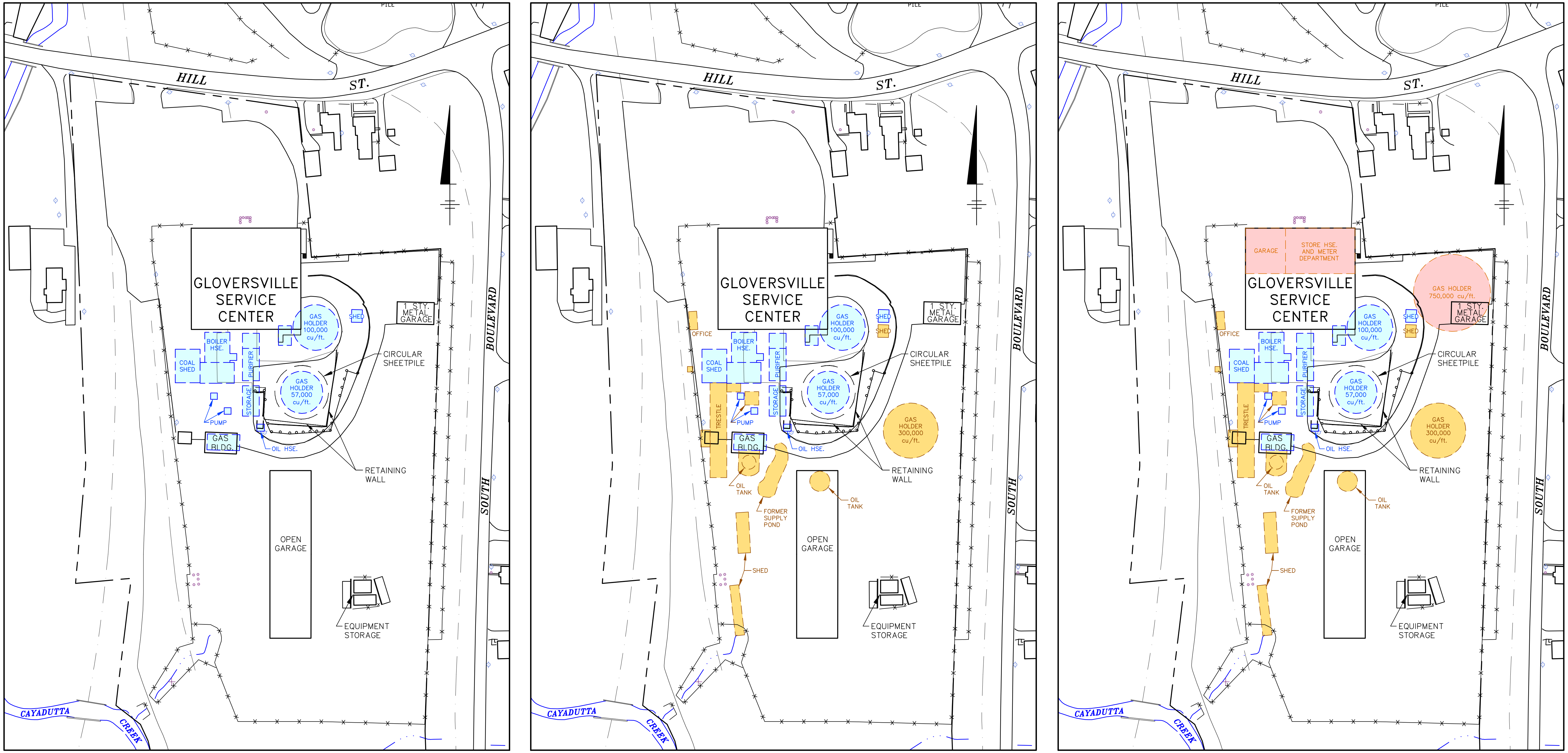
0 60' 120'
GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

SITE PLAN

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2



1907 1927 1937

LEGEND:

- SANBORN 1907 FEATURE
- SANBORN 1927 FEATURE
- SANBORN 1937 FEATURE

NOTES:

1. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
2. THE NIAGARA MOHAWK PROPERTY LINE SHOWN IS APPROXIMATE.
3. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2-4 & 2-5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.

0 150' 300'

GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

HISTORICAL SITE FEATURES LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

XREFS: IMAGES:
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36652X02
36652X03
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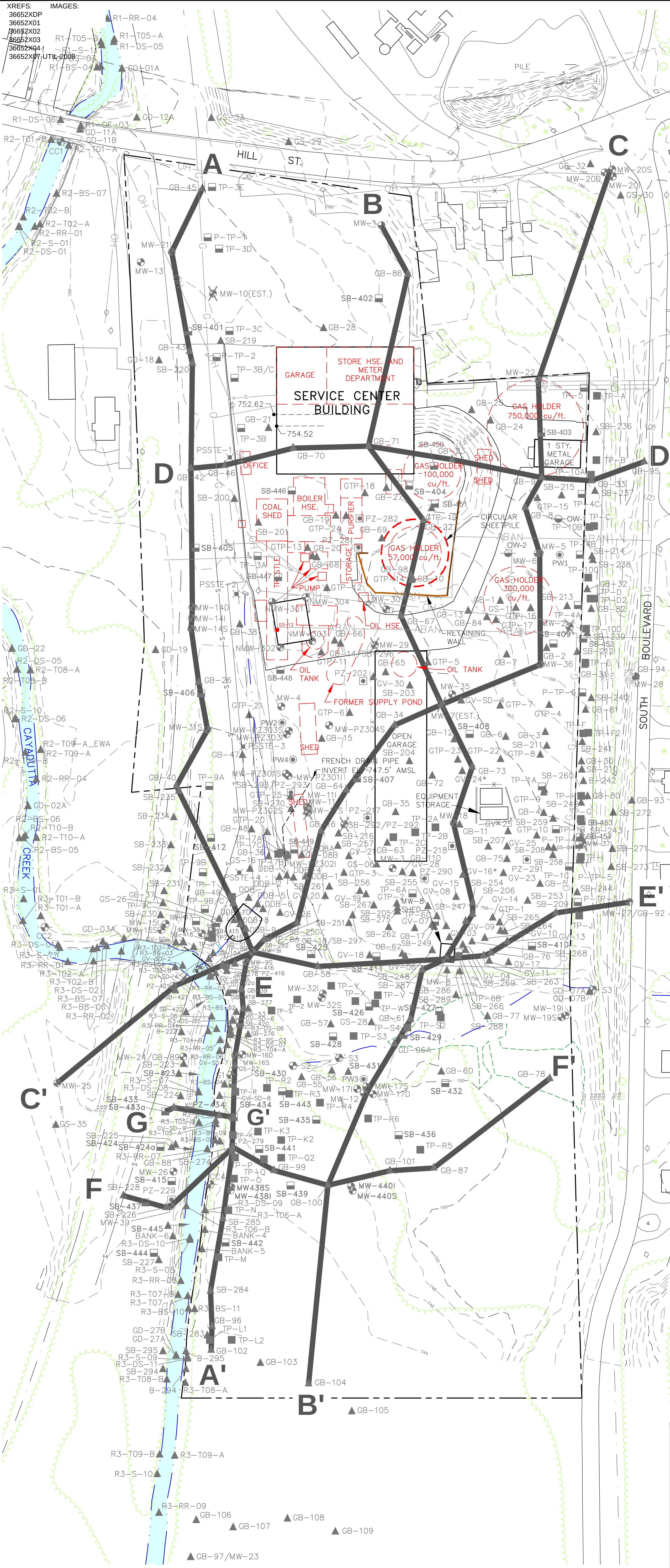


LEGEND:

- APPROXIMATE PROPERTY LINE
- HISTORICAL MGP STRUCTURE
- TOPOGRAPHIC ELEVATION CONTOUR
- WATER STREAM
- TREE LINE
- FENCE
- SANITARY LINE
- NATURAL GAS DISTRIBUTION LINE
- ELECTRICAL
- OVERHEAD
- ABANDONED
- UTILITY POLE
- IDENTIFIED WETLAND
- OW-2 OBSERVATION WELL
- PW1 PUMPING WELL
- NMW-301 MONITORING WELL
- PZ-290 PIEZOMETER
- SB-445 ANGLED SOIL BORING, ARROW INDICATES DIRECTION OF ANGLE
- GB-61 SOIL BORING
- DDB-1 DRAINAGE DITCH SOIL BORING
- GV-25 TARGOST PROBING LOCATION
- * CONFIRMATION BORING COMPLETED AT THIS LOCATION
- PSSTE-4 TEST EXCAVATION LOCATION
- TP-G, TP-1B, GTP-10 TEST PIT
- CC1 STREAM GAUGE
- MW-2 MONITORING WELL OR PIEZOMETER DESTROYED OR OTHERWISE INACCESSIBLE
- A—A' LINE OF CROSS SECTION

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETRIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
5. EXISTING SITE FEATURES BASED ON "ASBUILT SURVEY" PROVIDED BY STANTEC ON 7/18/08.
6. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2-4 & 2-5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.

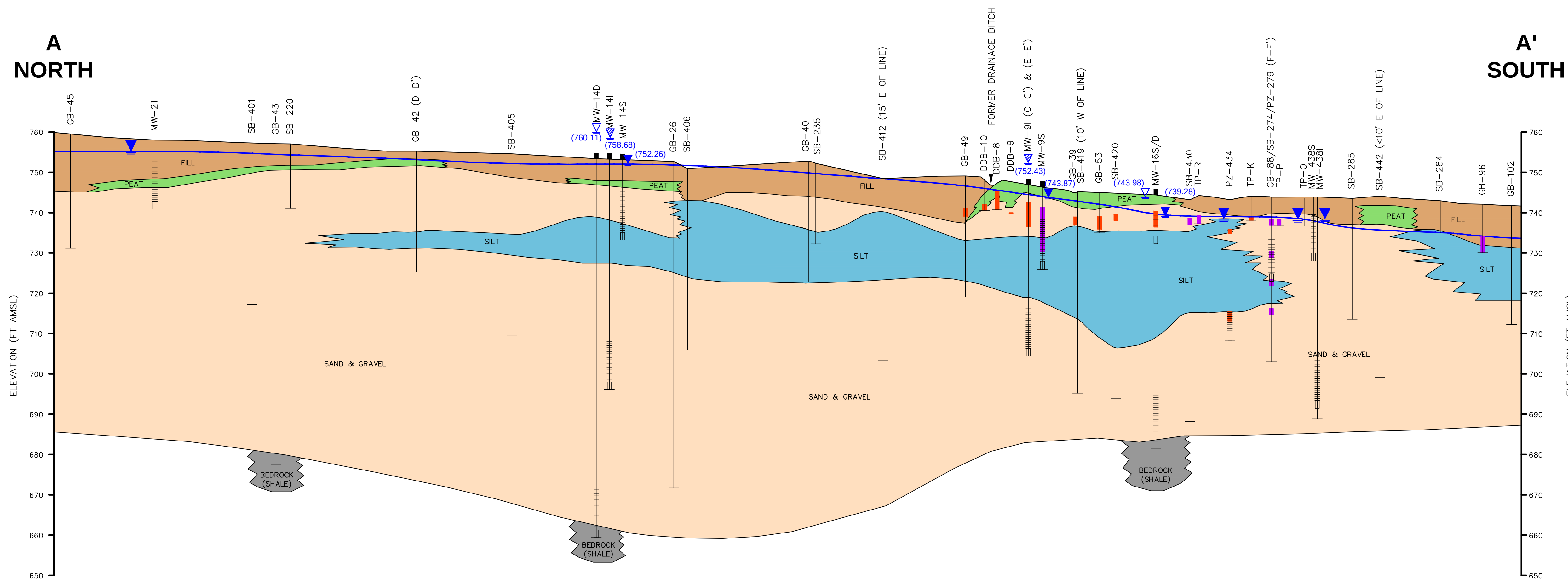
0 60' 120'
GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

CROSS SECTION LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4



LEGEND:

- WELL/BORING ID
- WELL PROTECTOR
- GROUND SURFACE
- WATER TABLE
- MONITORING WELL
- (752.26) GROUNDWATER ELEVATION – SHALLOW WELL
- (758.68) GROUNDWATER ELEVATION – INTERMEDIATE WELL
- (760.11) GROUNDWATER ELEVATION – DEEP WELL
- SOIL BORING
- SCREENED INTERVAL
- SUMP
- LITHOLOGIC CONTACT
- TRACE TO LITTLE NAPL
- NAPL
- BOTTOM OF BORING

(Legend example IDs: SB-220, MW-14)

- FILL
- PEAT
- SAND AND GRAVEL
- SILT AND CLAY
- BEDROCK

NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. COORDINATES ARE BASED ON THE NORTH AMERICAN DATUM OF 1983, NEW YORK EAST ZONE.
3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
4. STRATIGRAPHIC CONTACTS BETWEEN SUBSURFACE INVESTIGATION LOCATIONS ARE INFERRED. SOIL DESCRIPTIONS, STRATIGRAPHIC CONTACTS, AND PRESENCE/ABSENCE OF NAPL ARE BASED ON REVIEW/INTERPRETATION OF THE AVAILABLE SUBSURFACE LOGS.
5. GROUNDWATER ELEVATIONS MEASURED ON JANUARY 14, 2008.

0 15' 30'
VERTICAL SCALE

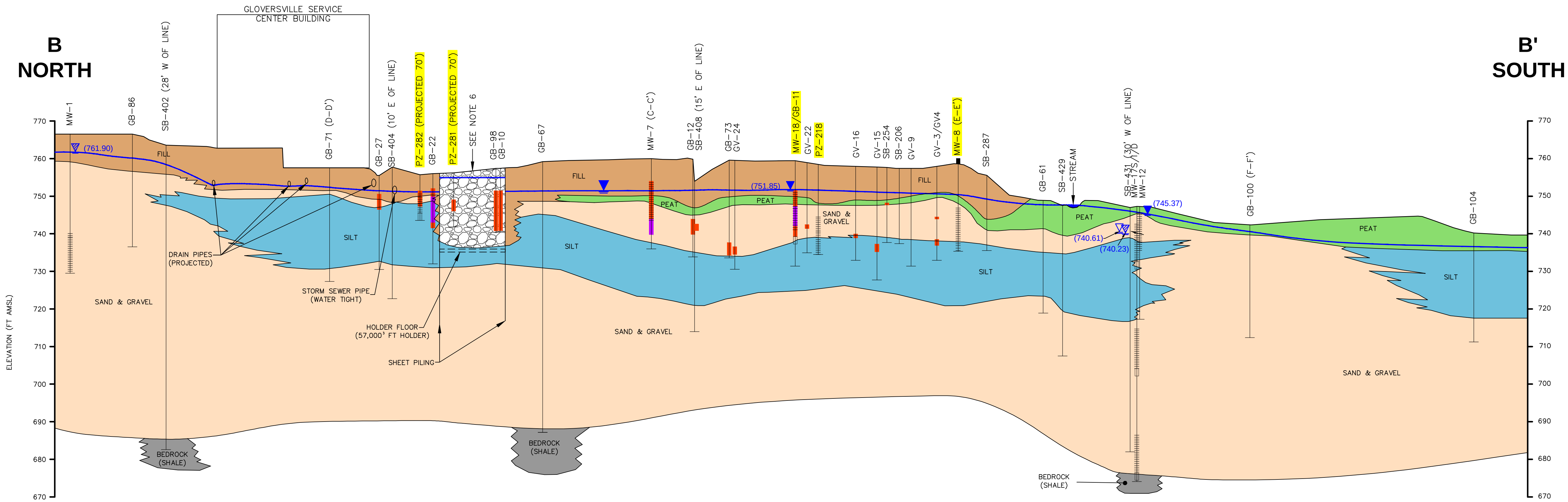
0 60' 120'
HORIZONTAL SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

GEOLOGIC CROSS SECTION A - A'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
5



LEGEND:

- SB-206, MW-17S/I/D — WELL/BORING ID
- WELL PROTECTOR
- GROUND SURFACE
- WATER TABLE
- MONITORING WELL
- (740.64) GROUNDWATER ELEVATION – SHALLOW WELL
- (740.23) GROUNDWATER ELEVATION – INTERMEDIATE WELL
- (740.61) GROUNDWATER ELEVATION – DEEP WELL
- SOIL BORING
- SCREENED INTERVAL
- SUMP
- LITHOLOGIC CONTACT
- TRACE TO LITTLE NAPL
- NAPL
- BOTTOM OF BORING

- FILL
- GRAVEL
- PEAT
- SAND AND GRAVEL
- SILT AND CLAY
- BEDROCK

PZ-218 — MONITORING WELL/PIEZOMETER WHERE RECOVERABLE AMOUNTS OF NAPL HAVE BEEN ENCOUNTERED

NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. COORDINATES ARE BASED ON THE NORTH AMERICAN DATUM OF 1983, NEW YORK EAST ZONE.
3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
4. STRATIGRAPHIC CONTACTS BETWEEN SUBSURFACE INVESTIGATION LOCATIONS ARE INFERRED. SOIL DESCRIPTIONS, STRATIGRAPHIC CONTACTS, AND PRESENCE/ABSENCE OF NAPL ARE BASED ON REVIEW/INTERPRETATION OF THE AVAILABLE SUBSURFACE LOGS.
5. GROUNDWATER ELEVATIONS MEASURED ON JANUARY 14, 2008.
6. FORMER HOLDER NO. 3 IRM DETAILS OBTAINED FROM DOCUMENT ENTITLED, "FORMER HOLDER NO. 3 INTERIM REMEDIAL MEASURE (IRM) SUMMARY REPORT" (FOSTER WHEELER, OCTOBER 2001).
7. NO VISIBLE INDICATIONS OF NAPL WERE NOTED ON THE BORING LOG FOR MONITORING WELL MW-8 (INSTALLED 1984). HOWEVER, A NAPL RECOVERY IRM WAS CONSTRUCTED AT THIS WELL IN 2000 AND HAS RECOVERED NAPL SINCE ITS INSTALLATION.
8. RECOVERABLE QUANTITIES OF NAPL HAVE BEEN NOTED IN MONITORING WELLS MW-8, MW-18 ND MW-30 (LOG NOT AVAILABLE) AND PIEZOMETERS PZ-218, PZ-281 AND PZ-282.

0 15' 30' VERTICAL SCALE

0 60' 120' HORIZONTAL SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

GEOLOGIC CROSS SECTION B - B'

ARCADIS Design & Consultancy for natural and built assets

FIGURE 6

CITY: SYRACUSE, N.Y. GROUP: ENVCAD-141 DB: A. SCHILLING, P. LISTER, R.ALLEN PM: J. BRIEN TM: J. BRIEN TR: D.RODRIGUEZ LYR: ON=*;OFF=REF, (FRZ) PAGESETUP: LD2B-PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 5/24/2016 10:53 AM BY: ALLEN, ROYCE
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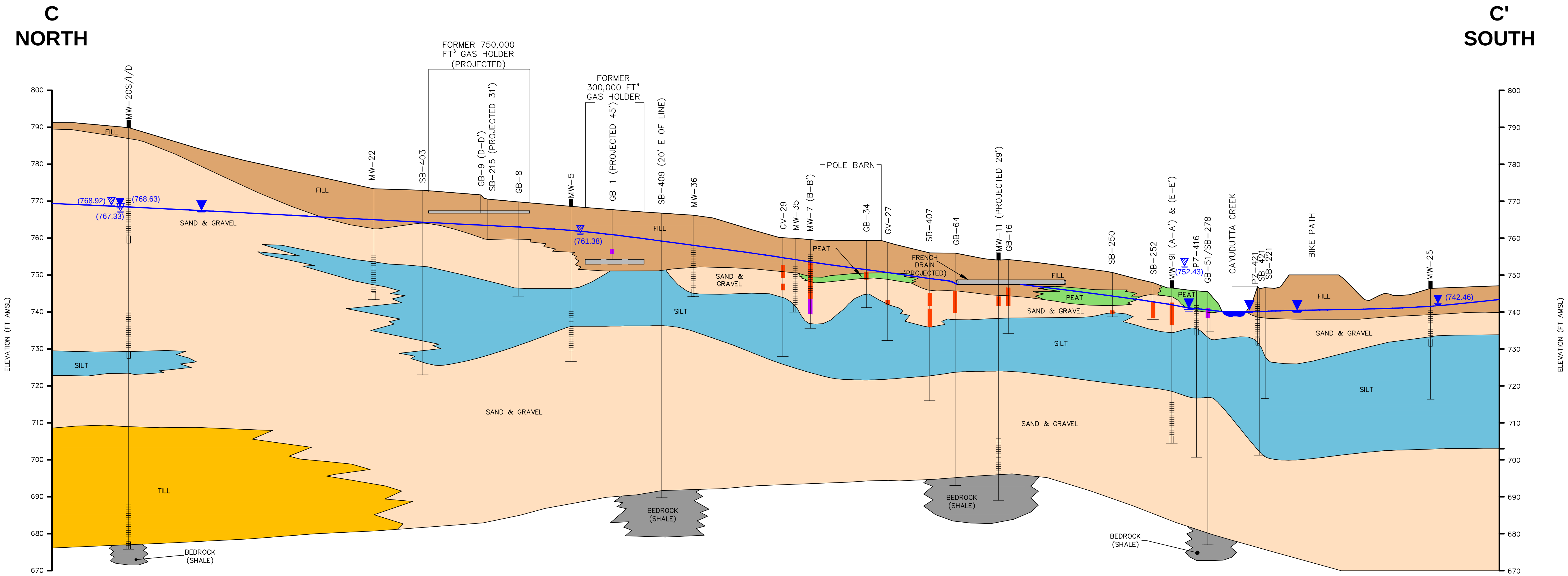

LEGEND:

SB-250
MW-20S/I/D

- WELL/BORING ID
- WELL PROTECTOR
- GROUND SURFACE
- WATER TABLE
- MONITORING WELL
- (768.63) GROUNDWATER ELEVATION – SHALLOW WELL
- (768.92) GROUNDWATER ELEVATION – INTERMEDIATE WELL
- (767.33) GROUNDWATER ELEVATION – DEEP WELL
- SOIL BORING
- SCREENED INTERVAL
- SUMP
- LITHOLOGIC CONTACT
- TRACE TO LITTLE NAPL
- NAPL
- BOTTOM OF BORING

- FILL
- PEAT
- SAND AND GRAVEL
- SILT AND CLAY
- TILL
- BEDROCK

NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. COORDINATES ARE BASED ON THE NORTH AMERICAN DATUM OF 1983, NEW YORK EAST ZONE.
3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
4. STRATIGRAPHIC CONTACTS BETWEEN SUBSURFACE INVESTIGATION LOCATIONS ARE INFERRED. SOIL DESCRIPTIONS, STRATIGRAPHIC CONTACTS, AND PRESENCE/ABSENCE OF NAPL ARE BASED ON REVIEW/INTERPRETATION OF THE AVAILABLE SUBSURFACE INVESTIGATION LOGS.
5. GROUNDWATER ELEVATIONS MEASURED ON JANUARY 14, 2008.
6. GROUNDWATER NEAR FRENCH DRAIN WAS BEING CONTROLLED VIA PUMPING AT MANHOLE NMH-6 ON JANUARY 14, 2008.

0 15' 30'
VERTICAL SCALE

0 60' 120'
HORIZONTAL SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

GEOLOGIC CROSS SECTION C - C'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
7

CITY: SYRACUSE, N.Y. GROUP: ENVCAD-141 DB: A. SCHILLING, P. LISTER, R.ALLEN PM: J. BRIEN TM: J. BRIEN TR: D.RODRIGUEZ LYR: ON=*;OFF=REF (FRZ) PAGESETUP: LD2B-PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 5/24/2016 11:06 AM BY: ALLEN, ROYCE
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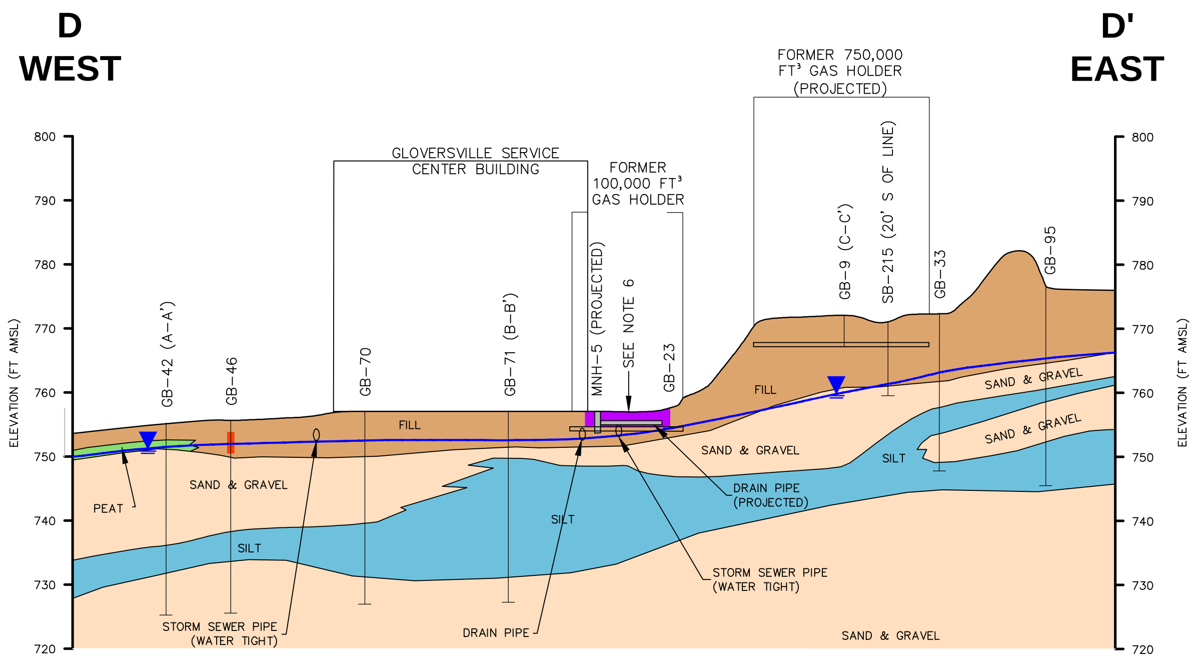

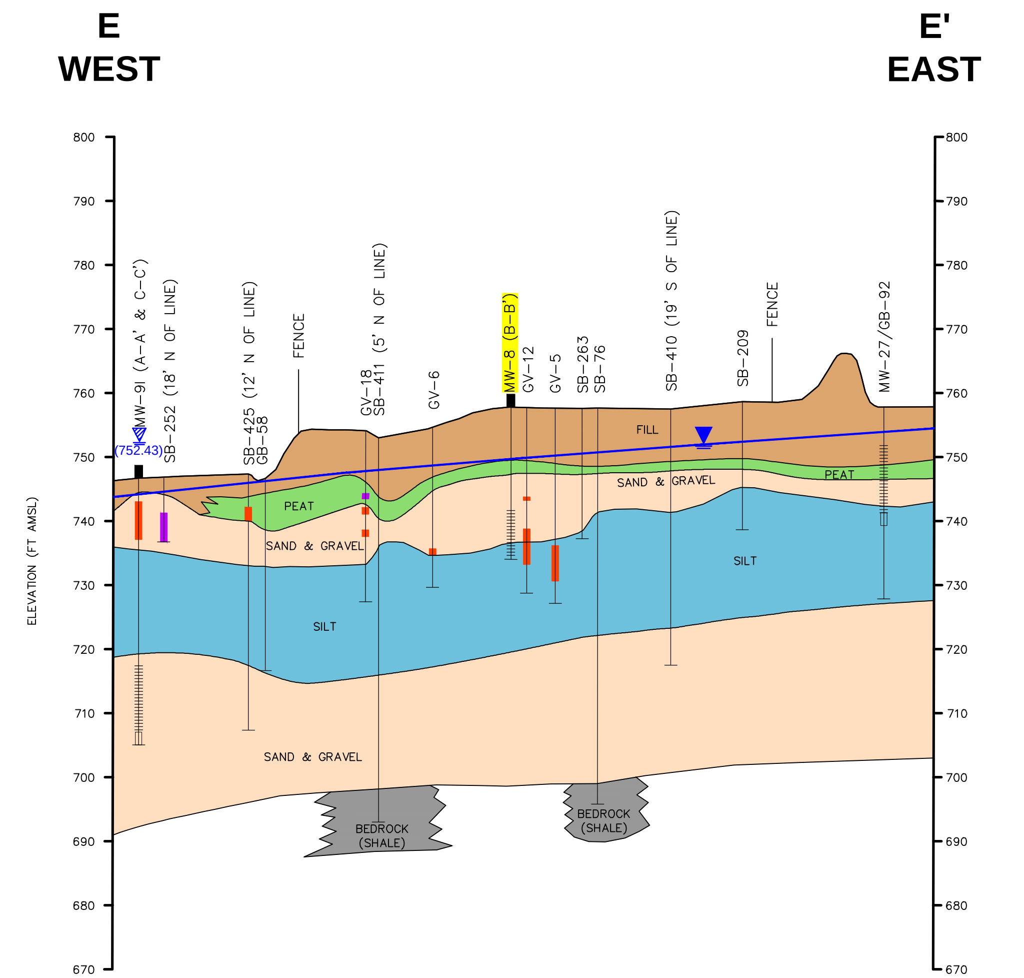

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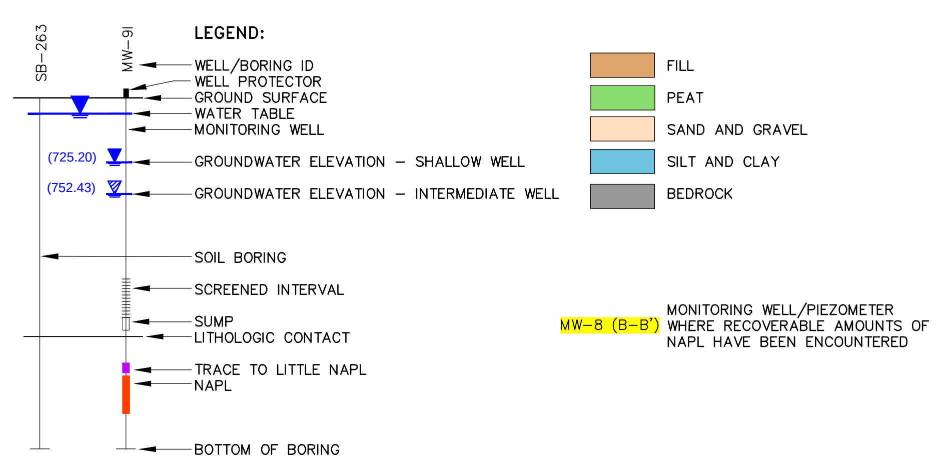

NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. COORDINATES ARE BASED ON THE NORTH AMERICAN DATUM OF 1983, NEW YORK EAST ZONE.
3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
4. STRATIGRAPHIC CONTACTS BETWEEN SUBSURFACE INVESTIGATION LOCATIONS ARE INFERRED. SOIL DESCRIPTIONS, STRATIGRAPHIC CONTACTS, AND PRESENCE/ABSENCE OF NAPL ARE BASED ON REVIEW/INTERPRETATION OF THE AVAILABLE SUBSURFACE LOGS.
5. GROUNDWATER ELEVATIONS MEASURED ON JANUARY 14, 2008.
6. APPROXIMATELY 3-INCH DIAMETER ANGULAR STONE FILL ENCOUNTERED ABOVE FORMER 100,000 FT³ HOLDER FOUNDATION WITH MODERATE TO HEAVY NAPL PRESENT.

0 15' 30'
VERTICAL SCALE

0 60' 120'
HORIZONTAL SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

GEOLOGIC CROSS SECTIONS D - D' AND E - E'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
8

CITY: SYRACUSE, NY GROUP: ENVCAD DB: A. SCHILLING, K.SARTORI, R. ALLEN PM/TM: J. BRIEN TR: D.RODRIGUEZ LYR: ON=*;OFF=REF (FRZ)
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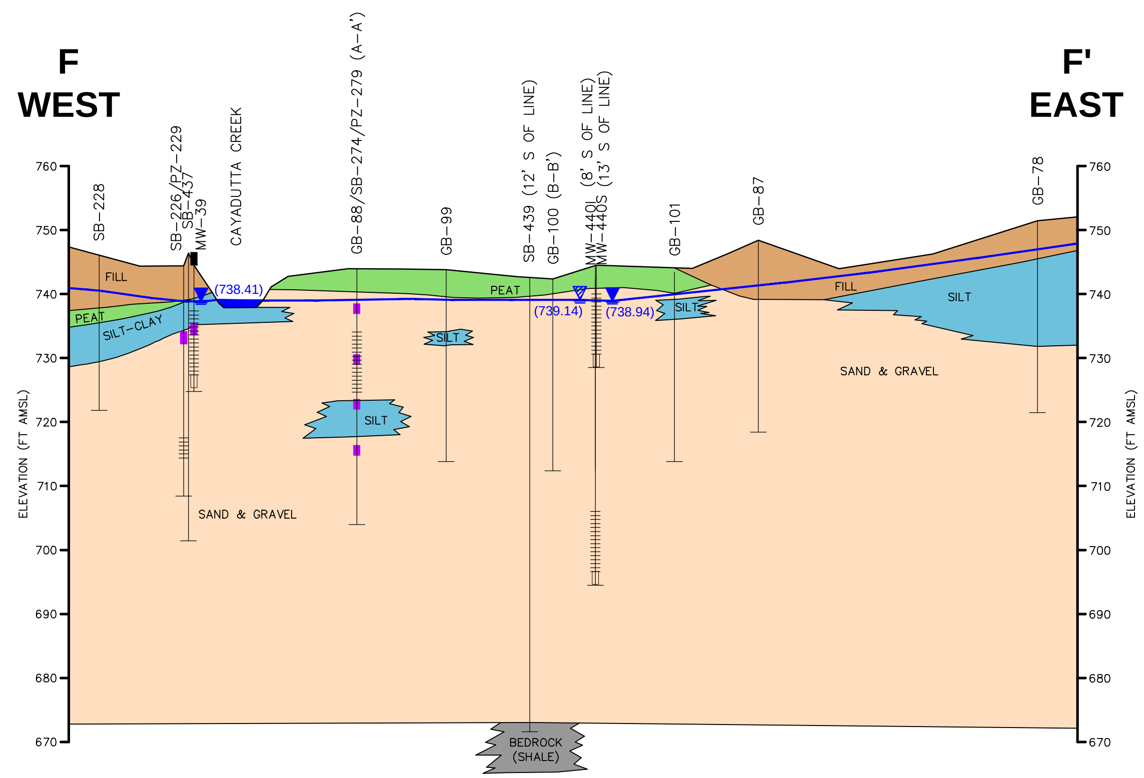

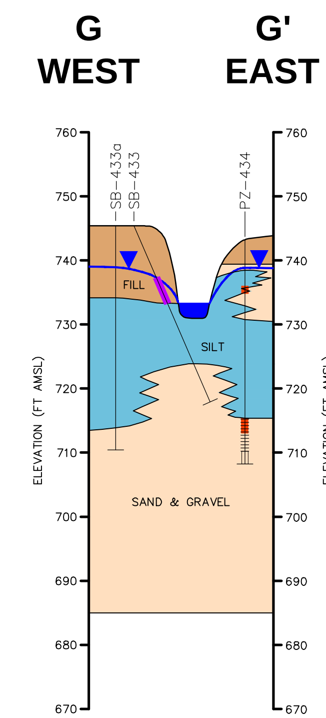

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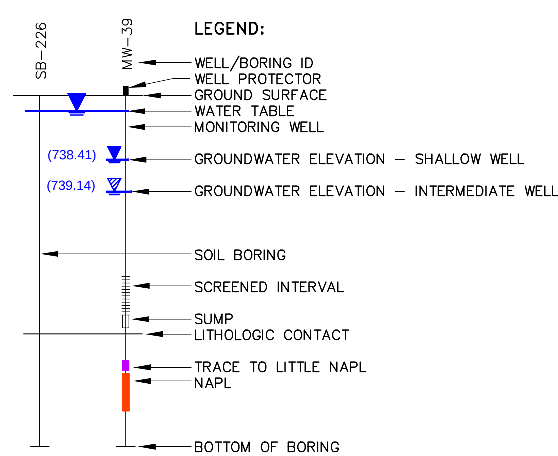
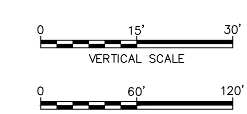


- FILL
- PEAT
- SAND AND GRAVEL
- SILT AND CLAY
- BEDROCK

NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. COORDINATES ARE BASED ON THE NORTH AMERICAN DATUM OF 1983, NEW YORK EAST ZONE.
3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
4. STRATIGRAPHIC CONTACTS BETWEEN SUBSURFACE INVESTIGATION LOCATIONS ARE INFERRED. SOIL DESCRIPTIONS, STRATIGRAPHIC CONTACTS, AND PRESENCE/ABSENCE OF NAPL ARE BASED ON REVIEW/INTERPRETATION OF THE AVAILABLE SUBSURFACE LOGS.
5. GROUNDWATER ELEVATION FOR MW-29 MEASURED ON JANUARY 14, 2008.
6. GROUNDWATER ELEVATION FOR MW-440S/I MEASURED ON NOVEMBER 26, 2008.



NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

GEOLOGIC CROSS SECTIONS F - F' AND G - G'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
9

CITY: SYRACUSE, NY GROUP: ENVCAD DB: P. LISTER, E. KRAHMER PM/TM: J. BRIEN TR: S. POWLIN LYR: ON=*;OFF=REF, (FRZ)
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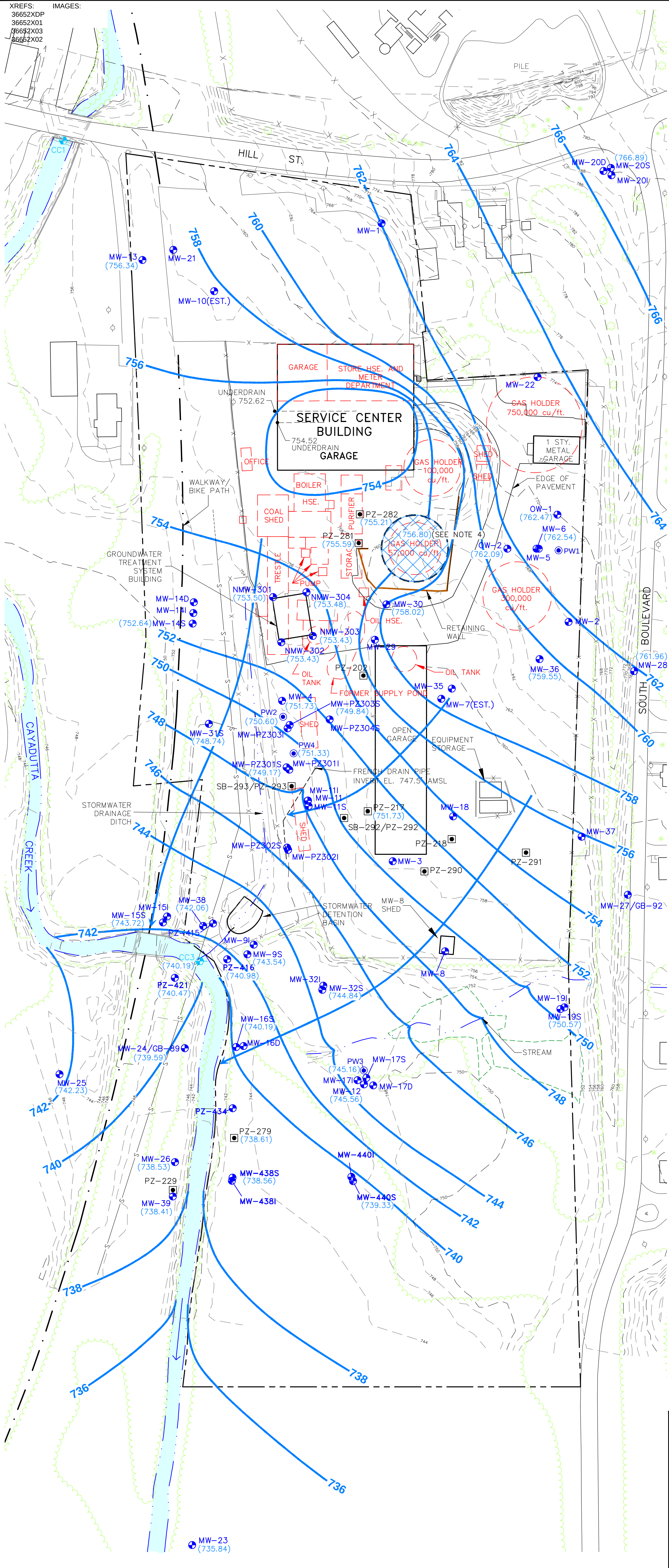

LEGEND:

MW-19I	MONITORING WELL
PZ-291	PIEZOMETER
PW-1	PUMPING WELL
CC1	STREAM GAUGE
	HISTORICAL MGP STRUCTURE
746	TOPOGRAPHIC ELEVATION CONTOUR
	PROPERTY LINE
	WATER
	TREE LINE
	FENCE
S	SANITARY SEWER
	UTILITY POLE
(762.09)	GROUNDWATER ELEVATION
754	INFERRED GROUNDWATER ELEVATION CONTOUR
	INFERRED GROUNDWATER FLOW DIRECTION

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. GROUNDWATER ELEVATION INSIDE FORMER RELIEF HOLDER BASED ON APPROXIMATE ELEVATION OF LOWEST POINT OF CIRCULAR SHEET PILING
5. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETRIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
6. EXISTING SITE FEATURES BASED ON "ASBUILT SURVEY" PROVIDED BY STANTEC ON 7/18/08.
7. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2-4 & 2-5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.
8. INVESTIGATION LOCATIONS COMPLETED AS PART OF THE FOLLOWING INVESTIGATIONS:
   - INITIAL SITE SURVEY (EBASCO, 1983)
   - SUPPLEMENTAL SITE SURVEY (EBASCO, 1985A)
   - PSA/IRM STUDY (ATLANTIC, 1993)
   - REMEDIAL INVESTIGATION (PARSONS, 1997)
   - SOIL AND SEDIMENT INVESTIGATION (STEARNS & WHELER, 2000)
   - ADDITIONAL INVESTIGATION (STEARNS & WHELER, 2002)
   - RI/FS PHASE I DNI (ARCADIS, 2008B)
   - RI/FS PHASE II DNI
   - FS DATA NEEDS INVESTIGATION (2015)

0 60' 120'
GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

WATER TABLE CONTOURS
MARCH 30, 2016

ARCADIS Design & Consultancy for natural and built assets

FIGURE
10

CITY: SYRACUSE, NY GROUP: ENVCAD DB: P. LISTER, E. KRAHMER PM/TM: J. BRIEN TR: S. POWLIN LYR: ON=*;OFF=REF, (FRZ)
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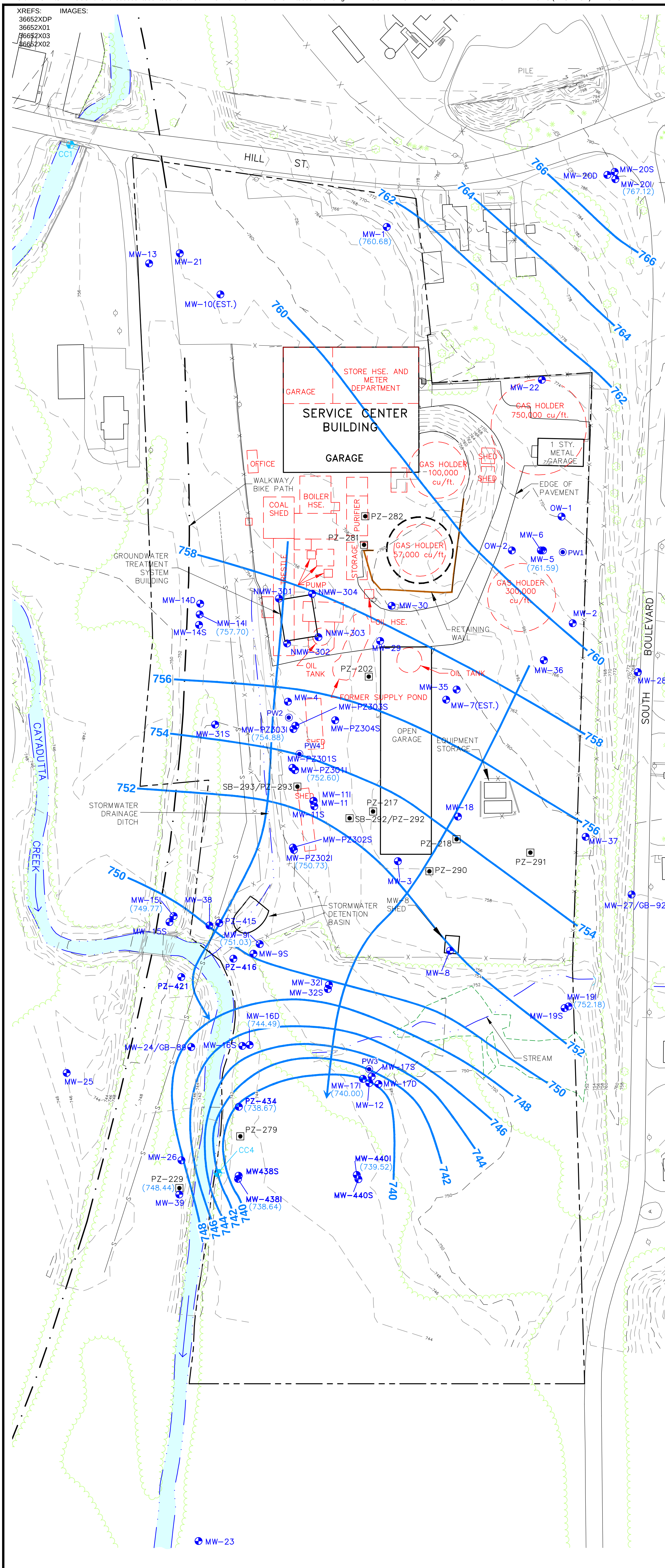

LEGEND:

MW-19I	MONITORING WELL
PZ-291	PIEZOMETER
	HISTORICAL MGP STRUCTURE
PW1	PUMPING WELL
746	TOPOGRAPHIC ELEVATION CONTOUR
	PROPERTY LINE
	WATER
	TREE LINE
	FENCE
S	SANITARY SEWER
	UTILITY POLE
(757.70)	GROUNDWATER ELEVATION
754	INFERRED ELEVATION CONTOUR
	INFERRED GROUNDWATER FLOW DIRECTION

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETRIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
5. EXISTING SITE FEATURES BASED ON "ASBUILT SURVEY" PROVIDED BY STANTEC ON 7/18/08.
6. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2-4 & 2-5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.
7. INVESTIGATION LOCATIONS COMPLETED AS PART OF THE FOLLOWING INVESTIGATIONS:
   - INITIAL SITE SURVEY (EBASCO, 1983)
   - SUPPLEMENTAL SITE SURVEY (EBASCO, 1985A)
   - PSA/IRM STUDY (ATLANTIC, 1993)
   - REMEDIAL INVESTIGATION (PARSONS, 1997)
   - SOIL AND SEDIMENT INVESTIGATION (STEARNS & WHELER, 2000)
   - ADDITIONAL INVESTIGATION (STEARNS & WHELER, 2002)
   - RI/FS PHASE I DNI (ARCADIS, 2008B)
   - RI/FS PHASE II DNI
   - FS DATA NEEDS INVESTIGATION (2015)

0 60' 120'
GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

POTENTIOMETRIC SURFACE CONTOURS IN LOWER SAND AND GRAVEL MARCH 30, 2016

ARCADIS Design & Consultancy for natural and built assets

FIGURE
11

CITY: SYRACUSE, NY GROUP: ENV/IM-DV DB: P. LISTER, K.SARTORI, R. ALLEN PM/TM: J. BRIEN TR: D.RODRIGUEZ LYR: ON=*;OFF=REF, (FRZ)
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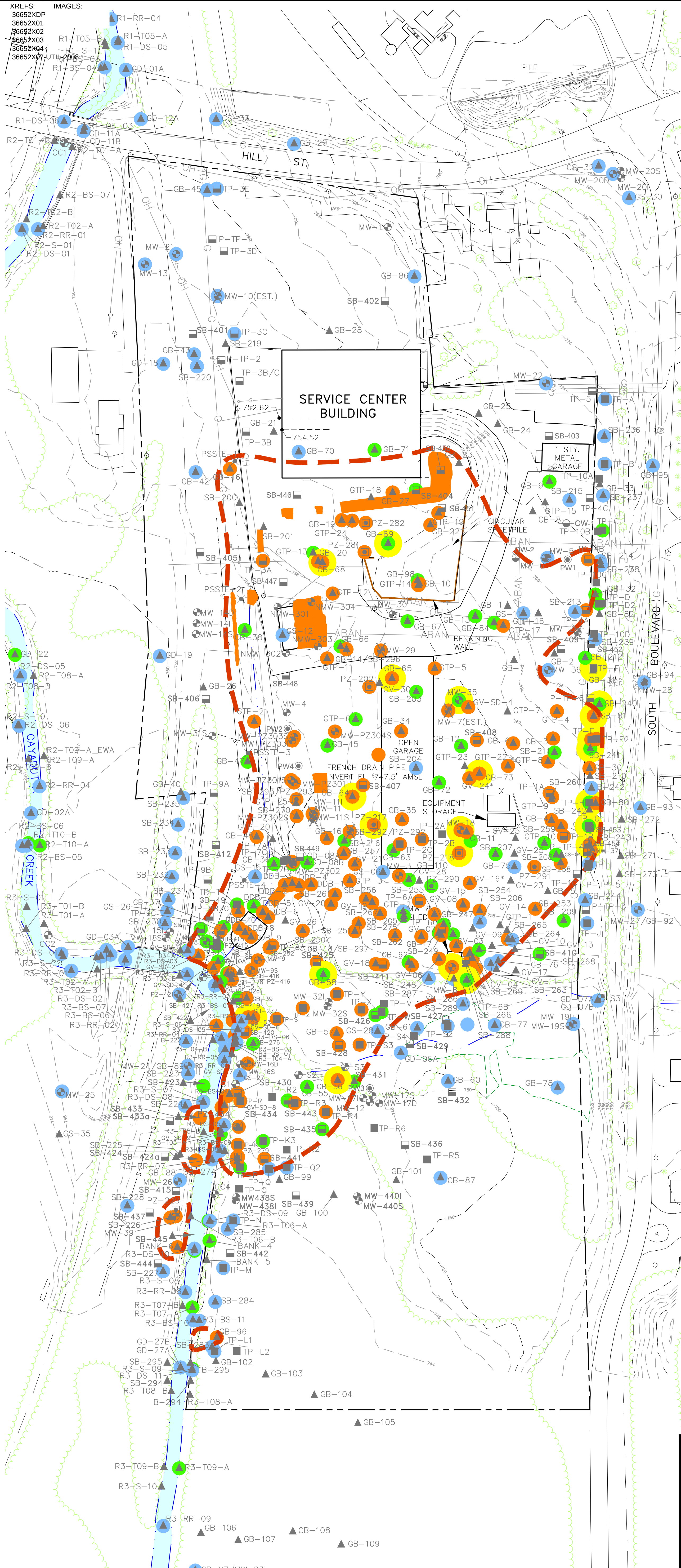


LEGEND:

APPROXIMATE PROPERTY LINE
TOPOGRAPHIC ELEVATION CONTOUR
WATER STREAM
TREE LINE
FENCE
SANITARY LINE
NATURAL GAS DISTRIBUTION LINE
ELECTRICAL
OVERHEAD
ABANDONED
UTILITY POLE
IDENTIFIED WETLAND
OW-2 OBSERVATION WELL
PW1 PUMPING WELL
NMW-301 MONITORING WELL
PZ-290 PIEXOMETER
SB-445 ANGLED SOIL BORING, ARROW INDICATES DIRECTION OF ANGLE
GB-61 SOIL BORING
DDB-1 DRAINAGE DITCH SOIL BORING
TARGOST PROBING LOCATION
* CONFIRMATION BORING COMPLETED AT THIS LOCATION
PSSTE-4 TP-G TP-1B GTP-10 TEST EXCAVATION LOCATION
TEST PIT
CC1 STREAM GAUGE
MW-2 MONITORING WELL OR PIEZOMETER DESTROYED OR OTHERWISE INACCESSIBLE
PROBABLE NAPL CONTAINING AREA
NAPL (TRACE TO SATURATED AMOUNTS)
SHEEN
PAHs > 500 ppm AND BTEX > 10 ppm
PAHs < 500 ppm, BTEX < 10 ppm, AND NO VISUAL IMPACTS

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETRIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
5. EXISTING SITE FEATURES BASED ON "ASBUILT SURVEY" PROVIDED BY STANTEC ON 7/18/08.
6. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2-4 & 2-5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.
7. NAPL AND SHEEN OBSERVATIONS AT ANGLE BORINGS SHOW APPROXIMATE HORIZONTAL LOCATION OF VISUAL IMPACTS.

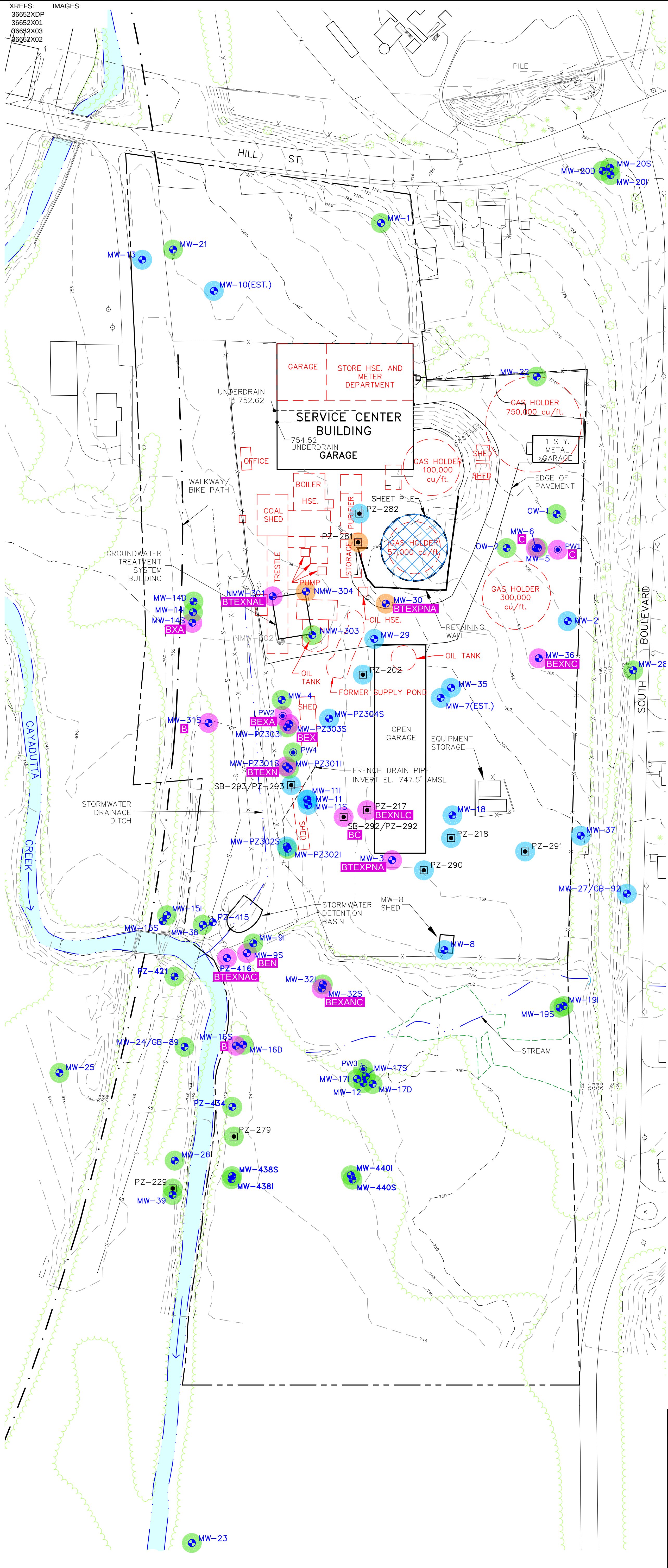
0 60' 120'
GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

PROBABLE NAPL CONTAINING AREA

ARCADIS Design & Consultancy for natural and built assets

FIGURE
12



LEGEND:

MW-19I	MONITORING WELL
PZ-291	PIEZOMETER
PW-1	PUMPING WELL
	HISTORICAL MGP STRUCTURE
746	TOPOGRAPHIC ELEVATION CONTOUR
	PROPERTY LINE
	WATER
	TREE LINE
	FENCE
S	SANITARY SEWER
	UTILITY POLE
	GROUNDWATER SAMPLE ANALYZED BUT NO EXCEEDANCE
BTEXPNALC	MOST RECENT GROUNDWATER SAMPLE CONTAINED ONE OR MORE CONSTITUENTS AT A CONCENTRATION GREATER THAN THE NYSDEC CLASS GA GROUNDWATER STANDARD OR GUIDANCE VALUE (TOGS 1.1.1. JUNE 1996), THE LETTER GIVEN REPRESENTS THE COMPOUND(s) THAT EXCEED THEIR RESPECTIVE STANDARD, AS FOLLOWS: B = BENZENE; T = TOLUENE; E = ETHYLBENZENE; X = XYLENES; P = BENZO(a)PYRENE; N = NAPHTHALENE; A = ACENAPHTHENE; L = PHENOL; C = CYANIDE. * EXCEEDANCES OF GUIDANCE VALUES ARE NOT PROVIDED
	NAPL OBSERVED IN WELL IN APRIL 2016
	DID NOT SAMPLE GROUNDWATER BECAUSE WELL WAS DESTROYED, COULD NOT BE LOCATED, OR CONTAINED NAPL

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. GROUNDWATER SAMPLES COLLECTED FROM APRIL 4 TO APRIL 18, 2016.

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

GROUNDWATER SAMPLING RESULTS - APRIL 2016

ARCADIS Design & Consultancy for natural and built assets

FIGURE
13

XREFS: 36652XDP 36652X01 36652X02 36652X03 36652X04 36652X05
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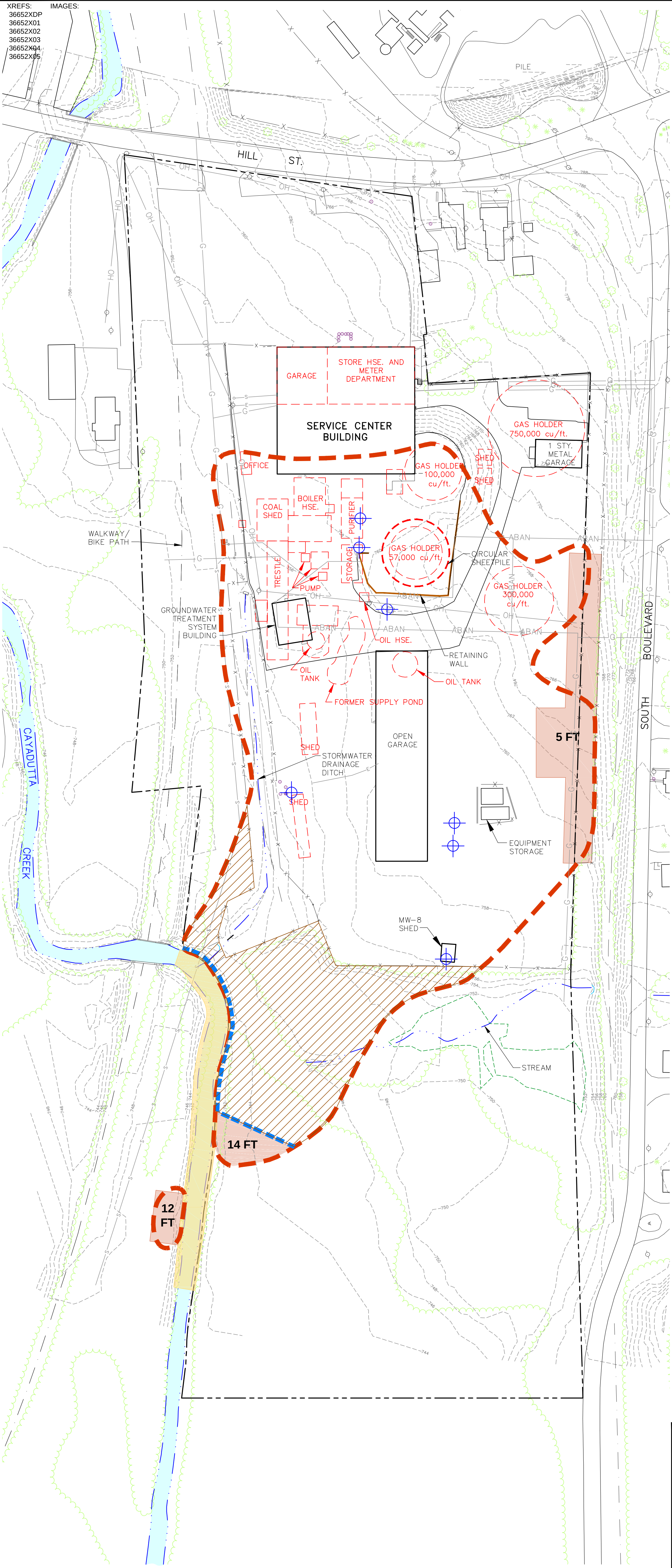

LEGEND:

- APPROXIMATE PROPERTY LINE
- HISTORICAL MGP STRUCTURE
- TOPOGRAPHIC ELEVATION CONTOUR
- WATER STREAM
- TREE LINE
- FENCE
- SANITARY LINE
- NATURAL GAS DISTRIBUTION LINE
- ELECTRICAL
- OVERHEAD
- ABANDONED
- UTILITY POLE
- IDENTIFIED WETLAND
- PROBABLE NAPL CONTAINING AREA
- 12 FT — LIMITS AND DEPTH OF EXCAVATION AREA
- LIMITS OF SURFACE SOIL EXCAVATION AND SOIL COVER
- LIMITS OF SEDIMENT CAPPING AREA
- NAPL BARRIER WALL
- NAPL RECOVERY WELL

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
5. EXISTING SITE FEATURES BASED ON "ASBUILT SURVEY" PROVIDED BY STANTEC ON 7/18/08.
6. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2–4 & 2–5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

REMEDIAL ALTERNATIVE 3

ARCADIS Design & Consultancy for natural and built assets

FIGURE
14

CITY: SYRACUSE, NY GROUP: ENV/IM-DV DB: P. LISTER, K.SARTORI, R. ALLEN PM/TM: J. BRIEN TR: D.RODRIGUEZ LYR: ON=*;OFF=REF, (FRZ)
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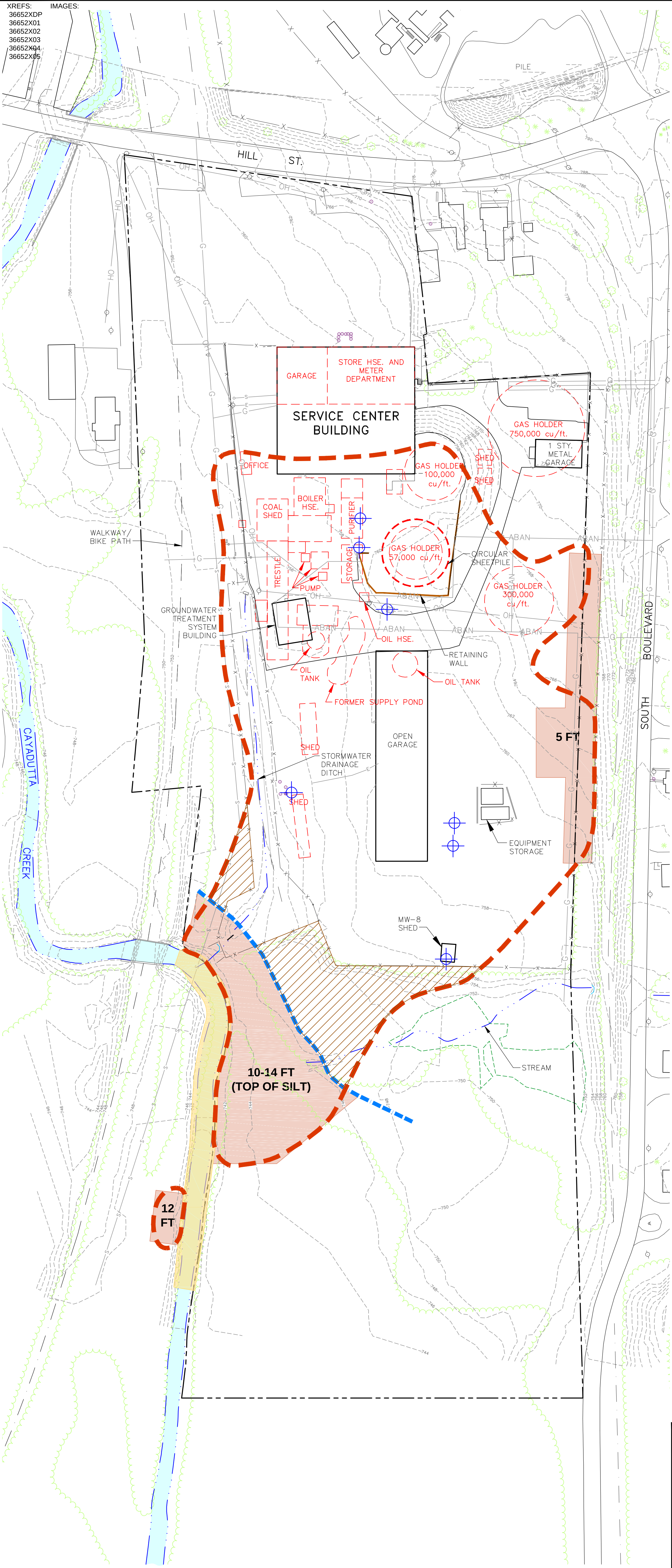

LEGEND:

- APPROXIMATE PROPERTY LINE
- HISTORICAL MGP STRUCTURE
- TOPOGRAPHIC ELEVATION CONTOUR
- WATER STREAM
- TREE LINE
- FENCE
- SANITARY LINE
- NATURAL GAS DISTRIBUTION LINE
- ELECTRICAL
- OVERHEAD
- ABANDONED
- UTILITY POLE
- IDENTIFIED WETLAND
- PROBABLE NAPL CONTAINING AREA
- 12 FT — LIMITS AND DEPTH OF EXCAVATION AREA
- LIMITS OF SURFACE SOIL EXCAVATION AND SOIL COVER
- LIMITS OF SEDIMENT REMOVAL AREA
- NAPL BARRIER WALL
- NAPL RECOVERY WELL

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETRIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
5. EXISTING SITE FEATURES BASED ON "ASBUILT SURVEY" PROVIDED BY STANTEC ON 7/18/08.
6. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2-4 & 2-5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.

0 60' 120'
GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

REMEDIAL ALTERNATIVE 4

ARCADIS Design & Consultancy for natural and built assets

FIGURE
15

CITY: SYRACUSE, NY GROUP: ENV/IM-DV DB: P. LISTER, K.SARTORI, R. ALLEN PM/TM: J. BRIEN TR: D.RODRIGUEZ LYR: ON=*;OFF=REF, (FRZ)
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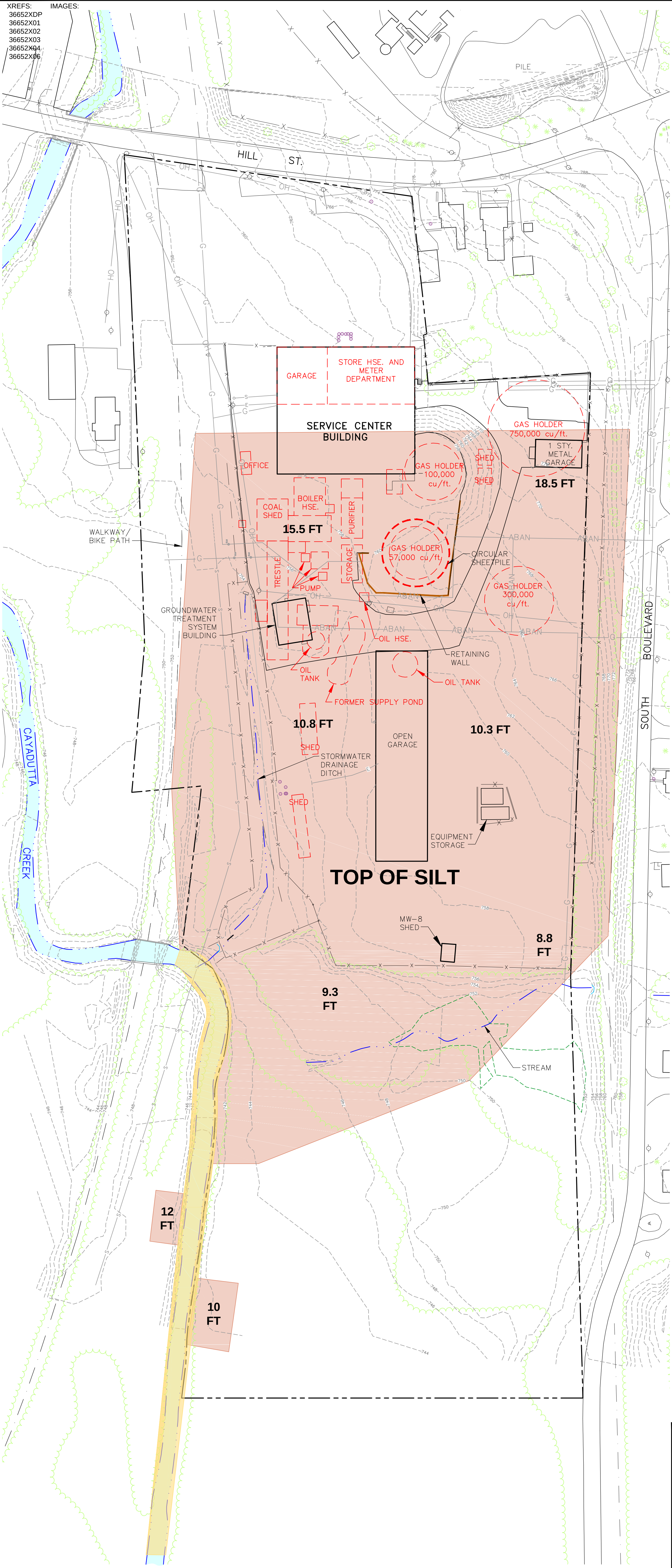

LEGEND:

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- IDENTIFIED WETLAND
- 12 FT LIMITS AND DEPTH OF EXCAVATION AREA
- LIMITS OF SEDIMENT REMOVAL AREA

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0 60' 120'
GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
FEASIBILITY STUDY REPORT

REMEDIAL ALTERNATIVE 5

ARCADIS Design & Consultancy for natural and built assets

FIGURE
16

APPENDIX A

Groundwater Modeling Technical Memorandum

MEMO

To:

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From:

Tracy O'Fallon

Date:

June 6, 2016

Arcadis Project No.:

B0036652.0007.00500

Subject:

Gloversville, New York Former MGP Site

Feasibility Study

Groundwater Modeling Technical Memorandum

INTRODUCTION AND OBJECTIVES

This technical memorandum summarizes the development of a three-dimensional, numerical groundwater flow model for the National Grid Former Manufactured Gas Plant site located in Gloversville, New York (the Site). A site location map showing the numerical model domain is included on Figure 1. A numerical groundwater flow model was first constructed by Arcadis in 2002 and was used at that time to predict groundwater flow conditions under potential remedial scenarios. The model was updated in 2008, 2009, and 2015 to incorporate information and data obtained from additional site investigations and to better represent flow conditions as understood in the evolving conceptual site model. The model was used to evaluate the effectiveness of specific remedial scenarios to support development of the feasibility study (FS). This memo consists of the following:

- A summary of the conceptual site model;
- Numerical model grid development (development of model layers, horizontal and vertical grid discretization, hydraulic property assignments, and boundary conditions);
- Model calibration and sensitivity analysis; and

- Predictive simulations developed to support the FS.

CONCEPTUAL SITE MODEL (CSM)

A CSM for the Site was developed in 2009 and includes information based on a literature review and all Arcadis investigations conducted up through 2008. Additionally, a Feasibility Study Data Needs Investigation (Arcadis 2015) conducted in 2014 included well installation, hydraulic pumping tests, and a wetland assessment; data and information obtained during that investigation is incorporated in this discussion of the CSM. The aquifer system components identified in the site-specific CSM have served as the framework for the continuous development and refinement of the Site numerical groundwater flow model presented herein. The following sections summarize the site setting, site geology and hydrogeology used to develop the numerical model.

SITE SETTING

The Site is located in a mixed commercial and residential area south of downtown Gloversville, New York as shown in Figure 1. The Site is comprised of two pieces of land that can be differentiated by their current usage. These areas are hereinafter referred to as the “northern area” and “southern area”. The northern area is a fenced-in 8-acre parcel that contains several buildings and a gas regulator station that support National Grid’s Service Center for the region. The southern area of the Site abuts the northern area at the southern fence line. The southern area is an approximate 5-acre parcel that is heavily wooded and low-lying relative to the northern area – some of this area can be considered as a swampland or wetland throughout much of the year. A small stream traverses the southern area from east to west, joining Cayadutta Creek to the west. Cayadutta Creek forms the western boundary of the southern area. A site plan is included on Figure 2.

The northern area of the Site was the location of an active carbureted water gas (CWG) MGP from 1898 until 1952. During peak production, the plant consisted of four gas holders, oil storage tanks, a purifier house, a water supply pond, and a variety of support buildings and structures. The majority of the above-grade buildings and structures associated with the MGP were demolished in the late 1950s; however, building foundations and other buried structures remain below grade. Environmental investigations conducted at the Site since 1983 have identified MGP waste materials, including MGP-related tars and localized deposits of purifier wastes, in the subsurface in this area. MGP-related tar is also present beneath the land surface in the northwestern quadrant of the southern area and near Cayadutta Creek. MGP-related tars are also present beneath the eastern bank and in the sediments of Cayadutta Creek in this area.

SITE GEOLOGY/HYDROGEOLOGY

The overburden strata beneath the Site are extremely heterogeneous as a result of the anthropogenic and geologic processes that deposited the soils. These strata, in descending order, consist of fill; peat; an upper sand, gravel, and cobble unit; a silt unit; and a lower sand and gravel unit which is underlain by bedrock or till (in some areas). For more detail regarding the character and depositional history of these strata, see the CSM document referenced above.

The fill materials in the northern area of the Site generally consist of construction and demolition debris and general MGP waste/process materials such as tar, ash, cinder, coal, clinker, slag, and purifier wastes. The lower approximately 3 to 5 feet of the fill is saturated in most of the northern area. The exception is in the area of man-made structures, where the thickness of fill is much greater.

Prior to being developed, the northern area appeared much like the southern area, that is, low-lying and poorly drained, with a thin, discontinuous deposit of peat at the ground surface. A foundation drain system (underdrain system) was installed below the Service Center building in the northern area to help control the groundwater level in this area. Anecdotal information also suggests that other drains were installed throughout the northern area to alleviate groundwater mounding and groundwater seepage at ground surface.

Cayadutta Creek formed as a spillway from a glacial kame during the end of the last glaciation in the northeastern US. At that time, flow from Cayadutta Creek was much greater than what is observed today, and the creek eroded a channel through the kame complex; the Site is located at the mouth of this channel. The high energy environment that existed during this period produced a heterogeneous deposit of alluvial fine grained silt and rounded sands, gravels, cobbles, and boulders which are observed below the peat. These deposits, hereafter referred to as the upper sand and gravel, are observed to be as little as a few feet to as many as 15 feet thick.

The glacial lake that formed during the last deglaciation deposited a package of inter-layered silts and clays which have been observed immediately beneath the upper sand and gravel. This layer, hereafter referred to as the silt unit, is continuous across the northern area; however, it appears to have been eroded away in a portion of the southern area. The region where the silt is absent is referred to as the “silt window”. The silt unit is approximately 5 to 20 feet thick in most areas of the Site, but is generally thinner in the southern area. The presence/absence of the silt unit is important because the hydrogeologic characteristics of this unit combine to form a barrier to downward DNAPL and groundwater migration.

A relatively thick (30 to 70 feet) deposit of permeable glacial outwash, hereafter referred to as the lower sand and gravel, is observed below the silt unit. The silt unit “protects” the lower sand and gravel from the impacts observed in the upper sand and gravel and fill, and with the exception of a few isolated areas, this unit is largely unaffected by the MGP. The lower sand and gravel lies directly on shale bedrock (Canajoharie Formation) under most of the site; however, a localized deposit of till is present below the outwash in the northern end of the Site (near Hill Street). The till and bedrock are insignificant in terms of groundwater flow and transport of MGP-related constituents due to their relatively impermeable nature and because they are hydraulically disconnected from the shallow sand and gravel and fill that appear to contain the majority of MGP-related impacts. Cross-section locations are shown on Figure 2 and geologic cross-sections are included on Figures 3 through 7.

<u>Site Hydrogeology</u>

The water table across the northern area is typically found within the fill materials at approximately 1 to 10 feet below grade. In the southern area, the water table lies approximately 1 to 5 feet below grade. At times, the water table expresses itself in the form of seeps at the ground surface along hill slopes, particularly following storm events. Several drain systems have been installed in the northern area to control these seeps. The drains are located near/beneath the open garage and under the Service Center building. These drains were once connected to a roughly north-south trending pipe that discharged collected groundwater to an unlined ditch in the southwestern corner of the northern area. The drain system also inadvertently collected MGP-related tars and impacted groundwater, and as such, National Grid completed a Storm Sewer Interim Remedial Measure (IRM) in 2007 to divert groundwater from the drains to a treatment system and to alleviate groundwater mounding west of the open garage.

Groundwater flow beneath the Site can be divided into two principal systems that are separated by the silt: flow in the upper sand and gravel/fill and flow in the lower sand and gravel. The geometric mean value of vertical permeability of the silt unit based on laboratory tests is approximately 0.002 ft/d; however, the results of hydraulic testing conducted in 2014 (Arcadis 2015) suggest the average vertical hydraulic conductivity is 0.6 ft/d. Both of these values are low compared to the hydraulic conductivity of the upper and lower sand and gravel, and as such, groundwater flow within the silt unit is negligible compared to flow in the highly permeable sands and gravels located above and below this unit.

Groundwater in the upper sand and gravel/fill is derived chiefly from upgradient sources north and east of the Site as water flows toward and discharges into Cayadutta Creek. These sources generally include runoff and infiltration from surrounding highlands in the north, northeast, west, and northwest of the Site. Some areas upgradient of the Site include topographic lows identified as vegetated or forested marsh/swamps; these areas serve as precipitation and runoff collection points that feed perennial streams within the Cayadutta Creek drainage area (see Figure 1).

The amount of recharge from precipitation that falls on the site is trivial compared to the groundwater flow from these upgradient sources. Groundwater also leaks upward through the silt unit, but this contribution is much less than that from the upgradient sources described above. Shallow groundwater in the northern area flows toward the southwest, in the direction of the two right-angle bends in Cayadutta Creek. Shallow groundwater in the northern site area that is intercepted by the drains beneath the Service Center building and to the west of the open garage is conveyed to an on-site treatment system installed during the 2007 Storm Sewer IRM. The treatment system treats and discharges this groundwater to the Gloversville-Johnstown Joint Wastewater Treatment Facility (GGJWTF) via an on-site sanitary sewer connection.

The saturated thickness of the upper sand and gravel/fill is generally 10 to 15 feet in the northern portion of the Site, but thins near Cayadutta Creek. The silt unit is observed in several areas of the creek bottom in the southern site area indicating that the upper sand and gravel/fill is only a few feet thick in the area of the creek. Based on hydraulic slug tests, specific capacity tests, and hydraulic pump testing, hydraulic conductivity values for the upper sand and gravel/fill have been estimated to range from 0.004 to 630 ft/day with an average of approximately 2 ft/day. The 2014 hydraulic test values for the upper sand and gravel unit ranged from 1.7 to 76 ft/d with a geometric mean of 14.2 ft/d. Groundwater flow within this unit is dominated by highly permeable flow areas (i.e., preferential pathways) that are represented by the hydraulic conductivity values in the higher end of the range. These preferential pathways consist of the coarse-grained Cayadutta Creek-laid deposits and the drains that are located in several locations of the northern area; however, the exact location of the drains in the area of the open garage is not well known. Combining the high-end hydraulic conductivity value with a horizontal hydraulic gradient of approximately 0.03 for this unit yields groundwater flow velocities of approximately 60 ft/day for the higher permeability (i.e. preferential) pathways. Given the coarse nature of the sand and gravel/fill materials and the presence of drains in the northern site area, it is likely that groundwater flow velocities for the preferential pathways are appreciably higher than 60 ft/day in this unit. A water table contour map for the upper sand and gravel unit using the average values obtained from a compilation of historical measurements used in model calibration (discussed below) is included on Figure 8.

The lower sand and gravel is saturated beneath the entire Site. The majority of the groundwater in this unit is derived from upgradient sources to the northeast and east. A small amount of groundwater discharges upward from the underlying bedrock and/or till and into the lower sand and gravel, but this amount is expected to be relatively insignificant. The average estimated hydraulic conductivity of the lower sand and gravel is approximately 13 ft/day, with a range of 0.1 to 120 ft/day. The 2014 hydraulic test values for the lower sand and gravel unit ranged from 6.2 to 20.8 ft/d with a geometric mean of 10.3 ft/d.

Groundwater flow patterns in the lower sand and gravel are largely controlled by the presence/absence of the silt. The silt separates the upper and lower sand and gravel units beneath most of the Site, but the units merge in a portion of the southern area of the site where the silt is missing (i.e., at the “silt window”). Where the silt unit is present, the hydraulic head in the lower sand and gravel is generally 5 to 10 feet higher than the head measured in the upper sand and gravel. In contrast, the head in the lower sand and gravel is only a few tenths of a foot higher in the area where the silt is missing. Groundwater flow in the lower sand and gravel is generally to the southwest or south until it reaches the area near and south of the MW-17 well cluster, which is located near the edge of the silt window. Groundwater in the lower sand and gravel appears to converge toward the silt window. Groundwater that reaches the area of the silt window either moves slowly upward into the upper sand and gravel, and ultimately into Cayadutta Creek, or continues on to the south. The path the groundwater takes depends on the proximity to the silt window. A smaller amount of groundwater also leaks upward through the silt and into the lower sand and gravel. A potentiometric surface map for the lower sand and gravel unit using average values obtained from a compilation of historical measurements used in model calibration (discussed below) is included on Figure 9.

<u>Nature and Extent of MGP-Related Impacts</u>

MGP-related impacts to the subsurface have been observed at the Site in the form of coal tar DNAPL. DNAPL has been generally observed in the upper approximately 20 feet of overburden (i.e., upper sand and gravel, peat, and fill materials), primarily at the top of the silt unit. The configuration of the silt unit influences the distribution of DNAPL observed across the Site. DNAPL has moved downward from potential source areas (e.g., gas holders, possible tar disposal trench), due to gravitational forces, through the unsaturated zone (primarily fill) and reached the water table at several locations. Beneath the water table, DNAPL migration is driven by gravitational and hydraulic forces. These forces have caused DNAPL to move from the assumed source areas in the northern site area toward the south and southeast, in the direction of Cayadutta Creek.

Gravitational forces have caused DNAPL to move downward, reaching the top of the silt. Upon reaching the silt unit, the DNAPL has spread laterally on top of this unit and followed its surface, pooling in low areas in the top of the silt. DNAPL has generally not been able to penetrate the silt due its fine-grained nature and the strong upward hydraulic gradients that have been observed across this unit (between the upper and lower sand and gravel). There are, however, a few areas where the silt is relatively thin or not present - the silt was apparently excavated during construction of the relief holder (north of open garage) and is only a few feet thick in this area, and the silt is not present in a region of the southern area. It appears the lower sand and gravel appears to contain trace amounts of DNAPL near/at these areas, but these areas are isolated and the DNAPL is limited to the upper few feet of lower sand and gravel at the base of the silt. The upward gradients in the lower sand and gravel appear to be strong enough to keep DNAPL from moving deeper in these areas.

Hydraulic forces in the upper sand and gravel and fill have caused DNAPL to move in a general southwesterly direction on top of the silt, toward the right-angle bend in Cayadutta Creek. The upper sand and gravel and fill are not homogeneous; therefore, DNAPL migration is also influenced by changes in hydraulic conductivity, where it would tend to follow more conductive pathways, such as the drain system at the site. The drain system formerly discharged collected groundwater and possibly DNAPL into an unlined ditch near the southwestern corner of the northern site area. The soils surrounding the former ditch are still a likely source of DNAPL. DNAPL has been observed beneath the eastern banks of the creek near and south of this area. DNAPL observed in this area is likely due to a combination of: 1) migration directly from the unlined ditch area due to gravitational and hydraulic forces; 2) migration from upgradient sources in the direction of the predominant hydraulic gradient (southwest) toward Cayadutta Creek; and 3) gravitational forces causing migration on top of the silt unit.

Additional details regarding the extent of DNAPL, as well as groundwater, sediment, and surface water quality impacts, can be found in the CSM document.

NUMERICAL GROUNDWATER FLOW MODEL

Arcadis used MODFLOW (McDonald and Harbaugh 1988) to simulate groundwater flow within the site boundary and surrounding region. MODFLOW is three-dimensional numerical groundwater flow code that is highly versatile, well documented, widely used, and accepted by regulatory agencies.

MODFLOW is a code that iteratively solves the differential equations of groundwater flow. The continuous, three-dimensional groundwater flow system is represented by a three-dimensional grid of discrete, rectilinear "cells", each of which has uniform geometry and hydraulic characteristics. The geometry and hydraulic characteristics of cells, however, vary throughout the model grid, or domain. In combination, the group of numerical cells represents the flow system as a whole. The model input files were created using Groundwater Vistas (ESI 2001), a pre-and post-processor designed for use with MODFLOW. The following sections describe the model development, calibration, and use in predictive simulations to evaluate the remedial scenarios as part of the FS.

MODEL DOMAIN AND GRID DISCRETIZATION

The model grid encompasses an area of approximately 2 square miles surrounding the Site (Figure 1). The active model domain encompasses an area of approximately 1 square mile, and includes highlands and other features upgradient toward the north and east, and extends westward and southward to the location of a regional surface-water feature, Cayadutta Creek (Figure 2). The grid is a rectilinear, three-dimensional, block-centered finite difference model grid with a refined grid cell size in the vicinity of the Site (discretized to 4 feet by 4 feet) to accommodate remedial alternative evaluations for the FS. At the model extents, the horizontal grid cell discretization coarsens to a maximum of 100 feet by 100 feet.

The vertical discretization of the model includes seven model layers representing four distinct hydrogeologic units with non-uniform interface elevations and non-uniform thickness. The variable thickness of each hydrogeologic unit were defined by more than 560 drilling and sampling locations. Figures 10 and 11 present model layer cross sections taken along an east to west orientation (Model Cross Section AA-AA') and a north to south orientation (Model Cross Section BB-BB'); these sections are generally parallel and perpendicular to flow, respectively. The model cross sections depict the geometry of hydrogeologic layers as represented within the model. The seven model layers, from the top to the bottom, are:

- Model Layer 1: Fill/Upper Sand and Gravel;
- Model Layers 2 and 3: Upper Sand and Gravel;
- Model Layer 4 Silt, and the Lower Sand and Gravel where Silt is absent (i.e. silt "window");
- Model Layers 5 and 6: Lower Sand and Gravel; and
- Model Layer 7: Till/Bedrock.

BOUNDARY CONDITIONS

Several regional and local hydraulic boundaries are represented in the model and serve as sources or sinks (or both) of groundwater. These include Cayadutta Creek, several smaller creek tributaries, swamp/marsh areas where runoff and precipitation collect, aerial recharge to groundwater from precipitation infiltration. Model boundary conditions and aerial recharge zones are presented on Figures 12 and 13, respectively. The following sections describe how these features were incorporated into the model as boundary condition assignments.

Cayadutta Creek

The site is bounded by Cayadutta Creek to the west (Figure 12). The Creek is represented using a river boundary condition. River boundary conditions can be either sources or sinks of groundwater; the water removed from or added to groundwater is a function of the difference between groundwater elevation and river stage and the hydraulic conductance term. The hydraulic conductance term is calculated from the river dimensions (length, width, bed thickness) and the river bed vertical hydraulic conductivity. As such, the conductance represents the ease with which water can be exchanged between the river and the groundwater system.

The creek stage in the area west of the site was obtained from a river sediment investigation performed by BBL (now Arcadis) in 2001. Creek levels at the northern end and southern end of the model domain were estimated from the USGS topographic quadrangle maps. The sediment thickness of the creek was assigned one foot and the hydraulic conductivity of the sediment was estimated to range from 5 to 100 feet per day (ft/d). The conductance term was modified during calibration (discussed below).

Intermittent Stream and Marsh

A small stream oriented east to west that discharges to Cayadutta Creek is located just south of the Site; this stream is sourced by water that ponds within a marshy topographic low as shown in Figures 2 and 12. A river boundary condition was used to represent this stream. The water level along the stream was estimated from the site basemap (BBL 2001) and from creek gauging conducted in 2008. The final river conductance was based on model calibration to field flow measurements.

Service Center Building Underdrains and French Drain

An underdrain system is located beneath the Service Center building (Figures 2 and 12). The French drain is located in the southwest portion of the northern area. The underdrain system was installed to prevent groundwater mounding beneath the building that results in flooding of the building floor. The French drain was installed in 2007 during the Storm Sewer IRM to prevent groundwater mounding in this area that resulted in groundwater seepage at ground surface. Water (and DNAPL) collected by both drain systems is conveyed to the on-site groundwater treatment system as discussed above. These drain systems were assigned a drain boundary in the model, which as described above, removes water from the model as a function of the head difference between assigned drain elevation and groundwater, as well as the conductance term. The elevations of the underdrains were estimated based on a construction map from National Grid (1969, M.O. #: 2294) and other as-built design drawings. The elevation of the French drain was estimated based on as-built design drawings for the Storm Sewer IRM. The final drain conductance was adjusted during calibration.

General Head Boundary

A general head boundary was assigned along the western edge of the model domain, extending south of the east-west bend in Cayadutta Creek (Figure 12). This boundary represents regional groundwater inflow from upgradient of the west side of the creek. Activation of the model domain at this location was done to provide the option to evaluate creek re-location scenarios for the FS. A general head boundary simulates flow as a function of aquifer hydraulic properties and an upgradient reference head, which was estimated using regional topographic elevations and extrapolated groundwater elevations in monitoring wells located in this vicinity (see the observed average groundwater contours in Figures 8 and 9).

Recharge

In MODFLOW, recharge to groundwater due to infiltration of precipitation is applied directly to the water table. As such, recharge is an estimate of the amount of water that reaches the water table and does not include evaporative losses, runoff, or water storage within the soil.

Groundwater flow modeling studies reported in the literature for sites in the Northeastern United States typically use groundwater recharge values ranging from approximately 10 to 50 percent of precipitation (Anderson and Woessner, 1992). Annual average precipitation at Gloversville is approximately 45 inches (www.usclimatedata.com). Recharge rates in the calibrated model range from 3 to 15 inches per year (in/yr), which represents approximately 6 to 33 percent of precipitation. Recharge zones assigned in the model are shown on Figure 13. No recharge was applied to the Service Center building footprint. The lowest non-zero recharge rate of 3 in/yr was assigned to the footprint of the Open Pole Barn to account for the roof drains that discharge water to the ground. A recharge rate of 8 in/yr was assigned to the area along the southwest of the Site and the Cayadutta Creek due to the shallow water table and expected high evapotranspiration rate for this area. The highest recharge rate of 15 in/yr was assigned to the surrounding highlands.

HYDRAULIC CONDUCTIVITY

The initial horizontal hydraulic conductivity values assigned to the 2002 model are presented in Table 1; these values were compiled and calculated from published slug test data (Parson 1997) and unpublished specific capacity test data (Stearns & Wheler, 2001). In 2009, an additional 50 values obtained from specific capacity tests were incorporated into the data set and the values were interpolated over the model grid layers corresponding to the upper and lower sand and gravel units. The calibrated horizontal hydraulic conductivity of the confining silt unit was 0.5 ft/d, which is close to the average value of 0.6 ft/d from the 2015 hydraulic testing. The horizontal hydraulic conductivity of the silt window was assigned a value of 50 ft/d; this value represents an average of the values assigned to the upper and lower sand and gravel units within this area.

Comparison of the horizontal hydraulic conductivity values obtained from the 2015 hydraulic pumping tests to the model-assigned values at those specific locations revealed that the model values were consistent with the new observed data; as such, the interpolated hydraulic conductivity values and interpolated distribution were not modified.

Model layer 7, which represents till and bedrock, was assigned a lower hydraulic conductivity value than the field test data as shown in Table 1 because the tested well (MW-20D) is screened at the top weathered portion of the bedrock, which is expected to yield a relatively higher hydraulic conductivity. The soil boring log for this well supports this higher hydraulic conductivity, as fine to very coarse sand and traces of gravel were observed just above the shale bedrock. The till/bedrock layer was assigned a horizontal hydraulic conductivity of 0.3 ft/d, which is representative of till and highly weathered bedrock materials.

Vertical hydraulic conductivity values were assumed to be one tenth of the horizontal hydraulic conductivity values.

Figures 14 through 18 show the log-based contours for the interpolated hydraulic conductivity distributions for the hydrogeologic units represented by model layers 1 through 6, respectively.

MODEL CALIBRATION AND SENSITIVITY ANALYSIS

The earlier versions of the model constructed in 2002 and 2008 were calibrated in steady state to observed groundwater elevations, surface water flows, and the service center subsurface drain flow data available at those times. In 2008, the interpolated hydraulic conductivity distributions described above were adjusted during an automated model calibration procedure. The 2008 model included significant updates and revisions to the 2002 model, including changes to the domain, how certain sources and sinks were represented by various boundary conditions, and the hydraulic conductivity modification from a few discrete zones to the interpolated distributions described above. As such, calibration and results of the 2002 model are not relevant to the current model description and use in the FS, and this model is not discussed in detail herein. However, it is important to note that the 2002 model did include a sensitivity analysis, performed consistent with ASTM guidance (1994) that included evaluation of the influence changes in boundary conductance values have on simulated heads and flows in the calibrated model. The analysis revealed that the model was not highly sensitive to these parameters, and was most sensitive to hydraulic conductivity values and, to a lesser degree, changes in the groundwater recharge rates.

Results of the 2008 calibration are presented in Table 2 and Figure 19. Table 2 shows the residuals (difference between simulated and observed water levels) and residual statistics, and Figure 19 presents a scatter plot of simulated versus observed heads. The table indicates the residual mean, absolute mean, and standard deviation are well within range of expected model error, and the standard deviation relative to the range in observed values is approximately 6%. The scatter plot in Figure 19 reveals the simulated heads match reasonably well with the observed and do not indicate significant spatial bias nor is there bias in the magnitude of residuals above or below the 1:1 ratio perfect fit line.

As indicated above in the model construction section, the hydraulic conductivity distribution was not modified since the 2008 model, and the only significant change to the model since then was the activation of the area south of the bend in Cayadutta Creek. The current model was calibrated to a greater number of observations (70 monitoring wells and piezometers) as shown in Table 3 and the scatter plot in Figure 20. The table indicates the residual mean, absolute mean, and standard deviation are well within range of expected model error, and the standard deviation relative to the range in observed values is still approximately 6%. The scatter plot in Figure 20 reveals the current model simulated heads also match reasonably well with the observed and do not indicate significant spatial bias nor is there bias in the magnitude of residuals above or below the 1:1 ratio perfect fit line.

Figure 21 presents the simulated water table elevation contours for the current calibrated model. The simulated groundwater elevations and flow directions are consistent with the observed average contour map shown in Figure 8.

The calibrated model simulates a groundwater discharge of approximately 22 gpm to the Service Center Building drain system. This matches reasonably well with the observed groundwater treatment system influent data.

Overall, the 2008 and current calibration results demonstrate the model is representative of site conditions and adequately simulates groundwater elevations, flows, and surface water interaction. As such, the model is acceptable for use in predictive analysis.

PREDICTIVE SIMULATIONS

The calibrated steady state model was used to evaluate the potential hydraulic effects associated with the following remedial scenarios:

- Scenario 1 - permeable NAPL barrier wall with downgradient sheet pile on the eastern bank of the creek; and
- Scenario 2 - permeable NAPL barrier wall/conductive drain extending from the Service Center building to the southern area into a groundwater drainage feature (possible constructed wetland), with excavation between the wall and the creek. Sheet pile wall located on the downgradient side of the NAPL barrier wall was also simulated within the lower 4 feet of permeable wall.
- Scenario 3 - permeable NAPL barrier wall/conductive drain extending from the Service Center building to the southern area, with excavation between the wall and the creek.
- Scenario 4 - permeable NAPL barrier wall/conductive drain extending from the Service Center building to the southern area into a groundwater drainage feature (possible constructed wetland), with ISS between the wall and the creek. Sheet pile wall located on the downgradient side of the NAPL barrier wall was also simulated within the lower 4 feet of permeable wall.
- Scenario 5 - sheet pile wall around the impacted are of the site keyed into silt, upgradient drains and pumping manholes/sumps around the outside of the wall, overflow weir on the downgradient side of the sheet pile wall near Cayadutta Creek; and an impermeable cap on the site area.

Scenario 1 is the only scenario that simulated the existing groundwater pump and treat system as operational. The main purpose of Scenarios 2 through 5 was to evaluate potential alternatives that would allow National Grid to shut down the existing groundwater collection and treatment system (i.e., keep the Service Center from flooding without running the existing system). To do this, Arcadis evaluated the water table elevation below the building and areas of mounding on and around the Site that resulted from each scenario. If a particular scenario suggested the building floor would flood, then the scenario was revised by changing certain elements (e.g., drain configurations) and re-run to determine if the building floor could be kept dry. Similarly, if a scenario suggested the water table would rise to grade and create a seep at the ground surface or rise to a level the could reverse the upward gradient across the silt, certain elements of the scenario were revised and the model was re-run. As a result, Arcadis developed and ran models that simulated several iterations of Scenarios 2 through 5 using permeable drain systems, permeable NAPL barrier walls, pumping sumps, and/or low-permeability barriers (i.e., sheet pile).

The summary and conclusions for each modeling scenario are provided below:

Scenario 1

- This scenario represents a passive NAPL barrier wall that incorporates a low permeability (sheet pile) wall within the lower 4 feet of permeable wall on the downgradient side of the wall.
- Pathline analysis (Figure 22) indicates that all groundwater in the NAPL impacted area flows through the wall and into Cayadutta Creek. The particles that appear to not be collected by the wall are within a non-impacted area of the silt unit.

- Scenario 1 was retained for consideration in the FS as Alternative 3.

Scenario 2

- This scenario removes water from the underdrain system below the Service Center building and transmits the underdrain water through a permeable trench that runs from the Service Center building to the southern area and discharges into a potential constructed wetland (modeled using a drain boundary condition with a head elevation of 745 feet AMSL). The permeable trench also collects groundwater in the western portion of the site enroute to the wetland. The scenario assumes the area between the trench and Cayadutta Creek would be excavated and backfilled in kind. This scenario essentially eliminates the need for the active manhole pumping and treating system (installed during the Storm Sewer IRM) at the site and allows water to naturally drain to a wetland.
- Analysis of the resulting head distribution (Figure 23) suggests this scenario would not be successful at keeping the floor of the Service Center building from flooding. The head distribution also suggests groundwater seeps could be present in several areas of the site and the upward vertical hydraulic gradient across the silt could be reversed.
- Scenario 2 was eliminated from consideration in the FS due to the excessive rise in water levels across the site and flooding of the Service Center building.

Scenario 3

- This scenario is the same as Scenario 2, but does not discharge water to a constructed wetland; rather, the water along the length of the trench in the southern area is allowed to discharge below grade in the southern area via gravity drainage.
- Analysis of the resulting head distribution (Figure 24) suggests this scenario would not be successful at keeping the floor of the Service Center building from flooding. The head distribution also suggests groundwater seeps could be present in several areas of the site and the upward vertical hydraulic gradient across the silt could be reversed.
- Scenario 3 was eliminated from consideration in the FS due to the excessive rise in water levels across the site and flooding of the Service Center building.

Scenario 4

- This scenario is the same as Scenario 2, except ISS is assumed in the area between the trench and Cayadutta Creek instead of excavating the area and backfilling in kind.
- Analysis of the resulting head distribution (Figure 25) suggests this scenario would not be successful at keeping the floor of the Service Center building from flooding. The head distribution also suggests groundwater seeps could be present in several areas of the site and the upward vertical hydraulic gradient across the silt could be reversed.
- Scenario 4 was eliminated from consideration in the FS due to the excessive rise in water levels across the site and flooding of the Service Center building.

Scenario 5

- This scenario consists of encircling the impacted area of the site with an impermeable barrier (i.e., sheet pile) and allow the water inside the barrier to escape via an overflow weir near the river. A groundwater collection drain (with pumping sumps/manholes) was simulated on the upgradient side of the wall to hopefully prevent mounding. Figures 26 and 27 show the head distribution and areas of expected mounding/groundwater seeps for two iterations of Scenario 5. The only difference between the two iterations is size of the opening (i.e., weir) that allows water to escape from the interior of the wall.

- Analysis of Figures 26 and 27 suggests this scenario would not be successful at keeping the floor of the Service Center building from flooding. The head distribution also suggests groundwater seeps could be present in several areas of the site and the upward vertical hydraulic gradient across the silt could be reversed.
- Scenario 5 was eliminated from consideration in the FS due to the excessive rise in water levels across the site and flooding of the Service Center building.

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TABLES

Table 1
Summary of Hydraulic Conductivity Values from Field Tests
National Grid
Gloversville (Hill Street) Former MGP Site
Gloversville, New York

Well/ Piezometer	Geologic Unit	Corresponding Model Layer	Stearns & Wheler		Parsons		Average	Minimum	Maximum	Geomean
			Test Type	K	Test Type	K				
MW-3	Fill/Peat/Upper Sand and Gravel	1, 2, and 3	s	0.15			0.15	0.15	2.32	0.81
MW-9S			s	2.32			2.32			
MW-21					s	1.52	1.52			
MW-4					s	0.14	0.14	0.14	510.24	3.6
MW-6					s	90.71	90.71			
MW-12					s	2.06	2.06			
MW-14S					s	2.38	2.38			
MW-15S			s	0.58	s	0.58	0.58			
MW-16S			s	0.25			0.25			
MW-19S			c	0.35	s	1.43	0.89			
MW-20I					s	10.46	10.46			
MW-20S					s	510.24	510.24			
MW-23					s	21.03	21.03			
MW-26S					s	7.06	7.06			
MW-27S					s	0.4	0.4			
MW-28S					s	1.31	1.31			
PZ-217			c	17.97			17.97			
MW-1	Silt	4			s	1.45	1.45	0.85	1.87	1.32
MW-5					s	0.85	0.85			
MW-17S			s	1.68	s	2.05	1.87			
MW-19I			c	0.78	s	1.89	1.33			
MW-9I	Lower Sand and Gravel	5 and 6	c	35.52			35.52	5.52	83.05	17.52
MW-14I			c	5.52			5.52			
MW-17I			c	26.07	s	140.03	83.05			
MW-22					s	5.78	5.78			
MW-11I					s	4.48	4.48	1.2	53.51	9.26
MW-14D			c	53.51			53.51			
MW-15I			c	34.92	s	13.58	24.25			
MW-16D			c	0.91	s	1.49	1.2			
MW-17D			c	9.46	s	10.09	9.78			
MW-20D	Till and Bedrock	7			s	9.44	9.44	9.44	9.44	9.44

Notes:
ft/d = feet per day
s = slug test
c = specific capacity test

Table 2
Calibration Targets - 2008 Model
National Grid
Gloversville (Hill Street) Former MGP Site
Gloversville, New York

Well Name	X	Y	Layers	Observed Head (feet, amsl)	Simulated Head (feet, amsl)	Residual (feet)
MW-01	532095.44	1531631.37	4	762.36	761.96	0.40
MW-04	531976.3	1531058.66	3	752.13	753.77	-1.64
MW-05	532283.94	1531241.07	4	761.91	760.70	1.21
MW-06	532281.5	1531242	3	763.4	760.46	2.94
MW-09S	531934.67	1530754.68	1	744.13	745.25	-1.12
MW-09I	531942.18	1530766.4	5	752.43	749.85	2.58
MW-12	532074.4	1530598.76	3	745.89	743.51	2.38
MW-13	531808.96	1531587.39	3	757.32	757.82	-0.50
MW-14S	531869.1	1531151.36	3	752.52	754.52	-2.00
MW-14I	531869.9	1531164	5	758.68	756.83	1.85
MW-14D	531870.5	1531177	6	760.11	757.09	3.02
MW-15S	531833.9	1530792.7	3	745.06	746.32	-1.26
MW-15I	531838.55	1530800.2	6	750.34	750.45	-0.11
MW-16S	531921.34	1530643.54	3	739.89	741.35	-1.46
MW-16D	531930.13	1530644.67	6	743.98	743.50	0.48
MW-17S	532077.35	1530606.5	4	741.51	743.39	-1.88
MW-17I	532066.7	1530603.8	5	740.82	742.81	-1.99
MW-17D	532085.5	1530597.55	6	741.13	743.00	-1.87
MW-18	532181.37	1530920.08	3	752.97	754.30	-1.33
MW-20S	532370.22	1531697.71	3	769.51	766.44	3.07
MW-20I	532371.08	1531688.93	3	769.79	766.43	3.36
MW-20D	532361.4	1531694.06	7	767.84	767.95	-0.11
MW-22	532282.39	1531446.93	5	761.67	762.76	-1.09
MW-27	532390.67	1530826.04	3	756.37	756.93	-0.56
MW-28	532398.36	1531094.23	3	764.14	759.65	4.49
MW-35	532179.64	1531073.42	3	752.71	757.01	-4.30
MW-38	531882.02	1530788.78	1	742.7	744.73	-2.03
PZ-279	531918.93	1530534.5	3	739.25	740.80	-1.55
PZ-281	532068.17	1531248.01	3	756.31	756.60	-0.29
PZ-282	532069.63	1531282.42	1	755.74	757.34	-1.60
PZ-290A	532146.99	1530854.2	1	752.93	750.96	1.97
PZ-290B	532146.99	1530854.2	3	751.8	752.13	-0.33
PZ-290C	532146.99	1530854.2	3	751.75	752.13	-0.38
MW-23	531868.47	1530046.42	3	736.34	736.58	-0.24
					Residual Mean	0.003
					Residual Standard Deviation	1.99
					Sum of Residuals Squared	134.4
					Absolute Residual Mean	1.63
					Minimum Residual	-4.30
					Maximum Residual	4.49
					Range in Observed (Target) Values	33.45
					Standard Deviation/Range	5.9%

Table 3
Calibration Targets - Current Model
National Grid
Gloversville (Hill Street) Former MGP Site
Gloversville, New York

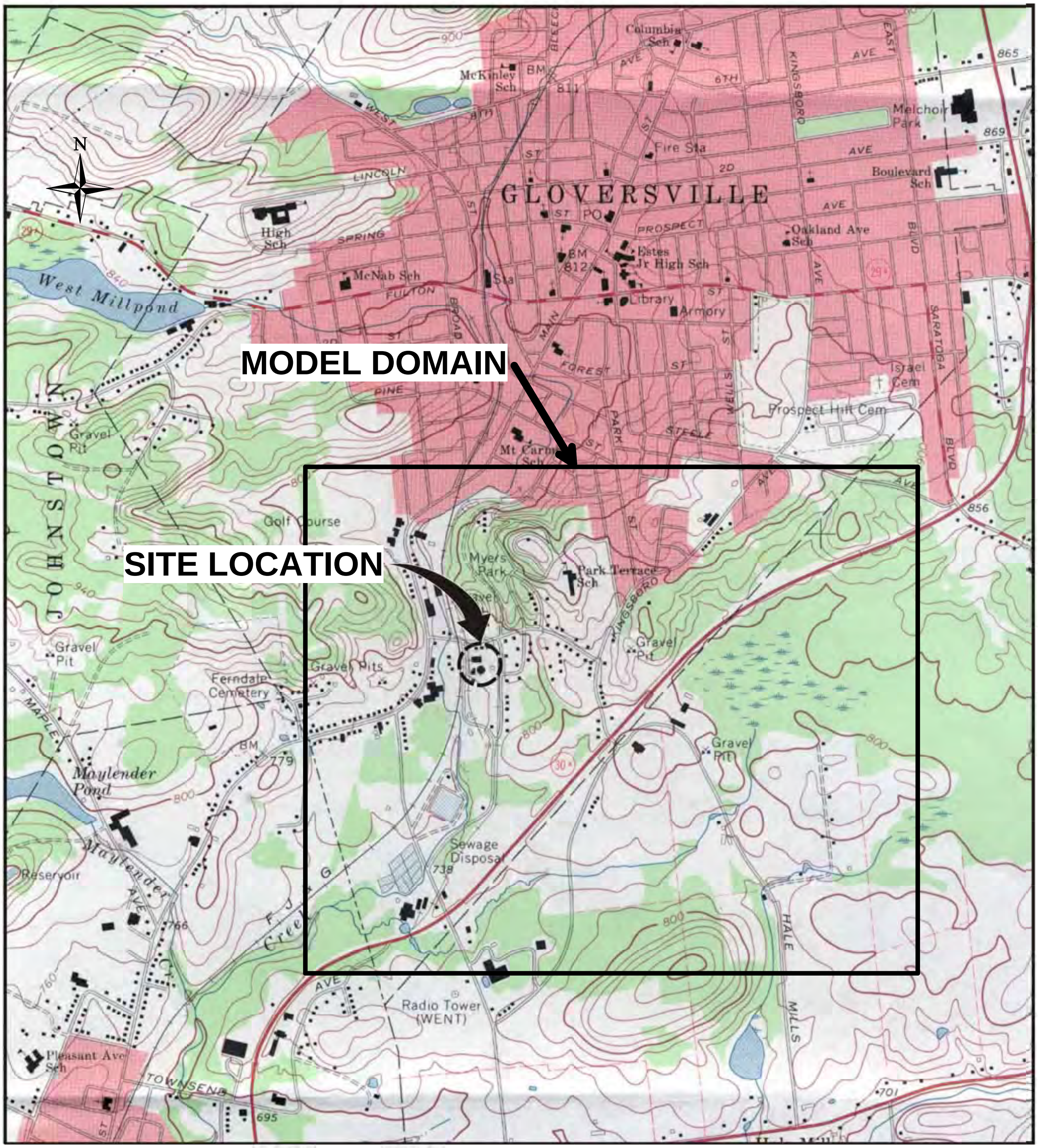
Well Name	X	Y	Layers	Observed Average Head (feet, amsl)	Simulated Head (feet, amsl)	Residual (feet)
MW-20S	532370.22	1531697.71	1	767.88	766.59	1.29
MW-24	531859.61	1530642.15	1	739.54	740.49	-0.95
MW-25	531711.27	1530611.74	1	742.18	740.89	1.29
MW-31S	531888.45	1531030.95	1	748.2	750.33	-2.13
MW-13	531808.93	1531587.31	1	756.24	753.95	2.29
PW-2	531977.39	1531039.62	1	750.65	750.91	-0.26
PW-3	532055.82	1530596.41	1	744.53	742.40	2.13
NMW-301	531965.38	1531183.08	1	753.7	752.45	1.25
NMW-302	531975.31	1531128.92	1	753.64	752.09	1.55
NMW-303	532013.11	1531136.47	1	753.64	752.13	1.51
NMW-304	532005.38	1531188.94	1	753.65	752.40	1.25
MW-440S	532061.28	1530482.78	1	739.36	741.63	-2.27
MW-438S	531916.8	1530486.91	1	738.5	740.40	-1.90
PZ-301S	531981.59	1530978.99	1	749.19	747.71	1.48
PZ-303S	531985.29	1531029.8	1	750.19	750.73	-0.54
PZ-304S	532033.31	1531036.25	1	752	751.32	0.68
PZ-416	531910.56	1530748.63	1	740.78	742.01	-1.23
MW-04	531976.3	1531058.66	2	752.01	751.33	0.68
MW-06	532281.5	1531242	2	762.09	761.55	0.54
MW-11S	532008.05	1530932.62	2	751.7	748.22	3.48
MW-12	532074.4	1530598.76	2	744.75	742.59	2.16
MW-14S	531869.1	1531151.36	2	752.51	753.06	-0.55
MW-16S	531921.34	1530643.54	2	740.07	740.39	-0.32
MW-17S	532077.35	1530606.5	2	743.01	742.98	0.03
MW-18	532181.37	1530920.08	2	752.93	751.31	1.62
MW-19S	532309.83	1530689.22	2	750.39	749.54	0.85
MW-28	532398.36	1531094.23	2	761.61	763.07	-1.46
MW-30	532103.96	1531174.07	2	754.44	753.87	0.57
MW-32S	532024.02	1530712.6	2	744.56	744.75	-0.19
MW-35	532179.64	1531073.42	2	753.49	753.98	-0.49
MW-36	532284.79	1531108.63	2	760.07	759.22	0.85
MW-38	531882.02	1530788.78	2	741.93	743.11	-1.18
PZ-217	532079.01	1530926.38	2	752.89	749.75	3.14
PZ-218	532179.73	1530892.87	2	753.17	750.49	2.68
PZ-279	531918.93	1530534.5	2	738.53	740.35	-1.82
PZ-281	532068.17	1531248.01	2	755.58	753.47	2.11
PZ-282	532069.63	1531282.42	2	755.45	753.88	1.57
PZ-290A	532146.99	1530854.2	2	753.2	748.95	4.25
PZ-290B	532146.99	1530854.2	2	752.1	748.95	3.15
OW-1	532306.21	1531282.02	2	763.4	761.83	1.57
OW-2	532246.31	1531241.1	2	762.88	760.97	1.91
PW-1	532307.47	1531239.38	2	762.93	761.76	1.17

Table 3
Calibration Targets - Current Model
National Grid
Gloversville (Hill Street) Former MGP Site
Gloversville, New York

Well Name	X	Y	Layers	Observed Average Head (feet, amsl)	Simulated Head (feet, amsl)	Residual (feet)
MW-03	532108.91	1530866.25	3	744.69	748.38	-3.69
MW-09S	531934.67	1530754.68	3	743.15	743.64	-0.49
MW-19I	532314.69	1530691.15	3	750.64	749.73	0.91
MW-20I	532371.08	1531688.93	3	768.12	766.62	1.50
MW-26	531850.08	1530507.02	3	738.53	739.70	-1.17
PZ-290C	532146.99	1530854.2	3	752.09	748.91	3.18
MW-01	532095.44	1531631.37	4	761.19	760.34	0.85
MW-05	532283.94	1531241.07	4	760.79	761.40	-0.61
PZ-434	531917	1530570.08	4	738.62	741.10	-2.48
MW-09I	531942.18	1530766.4	5	751.64	747.45	4.19
MW-14I	531869.9	1531164	5	758.13	755.77	2.36
MW-15I	531838.55	1530800.2	5	750.02	747.16	2.86
MW-17I	532066.7	1530603.8	5	740.04	741.86	-1.82
MW-22	532282.39	1531446.93	5	765.61	762.01	3.60
MW-23	531868.47	1530046.42	5	735.72	736.88	-1.16
MW-32I	532025.85	1530717.42	5	746.57	745.66	0.91
MW-39	531845.21	1530464.4	5	738.35	741.26	-2.91
PZ-229	531845.47	1530472.09	5	748.37	741.26	7.11
PW-4	531990.16	1530995.66	5	751.65	750.74	0.91
PZ-301I	531984.81	1530976.18	5	750.12	749.77	0.35
PZ-302I	531983.52	1530879.9	5	751.03	748.08	2.95
MW-14D	531870.5	1531177	6	759.61	756.18	3.43
MW-16D	531930.13	1530644.67	6	743.62	742.71	0.91
MW-17D	532085.5	1530597.55	6	739.89	741.95	-2.06
MW-440I	532059.33	1530487.94	6	739.61	741.64	-2.03
MW-438I	531916.12	1530483.21	6	738.59	741.43	-2.84
PZ-303I	531983.01	1531025.77	6	755.35	752.61	2.74
MW-20D	532361.4	1531694.06	7	766.48	765.77	0.71
					Residual Mean	0.71
					Residual Standard Deviation	2.01
					Sum of Residuals Squared	319.6
					Absolute Residual Mean	1.76
					Minimum Residual	-3.69
					Maximum Residual	7.11
					Range in Observed (Target) Values	32.40
					Standard Deviation/Range	6.2%

Notes:
amsl = above mean sea level

FIGURES



REFERENCE: BASE MAP USGS QUAD., GLOVERSVILLE, NEW YORK, 1970.

2000' 0 2000'

Approximate Scale: 1" = 2000'

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SITE LOCATION AND
MODEL DOMAIN

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

CITY: SYRACUSE, NY GROUP: ENV/IM-DV DB: P. LISTER, W. JONES, R. ALLEN PM/TM: J. BRIEN TR: J. GOLUBSKI LYR: ON=*;OFF=REF, (FRZ)
G:\ENVCAD\SYRACUSE\ACT\B0036652\0004\00422\DWG\REM-INV\36652B07.DWG LAYOUT: 8 SAVED: 9/18/2013 1:59 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/18/2013 1:59 PM BY: ALLEN, ROYCE

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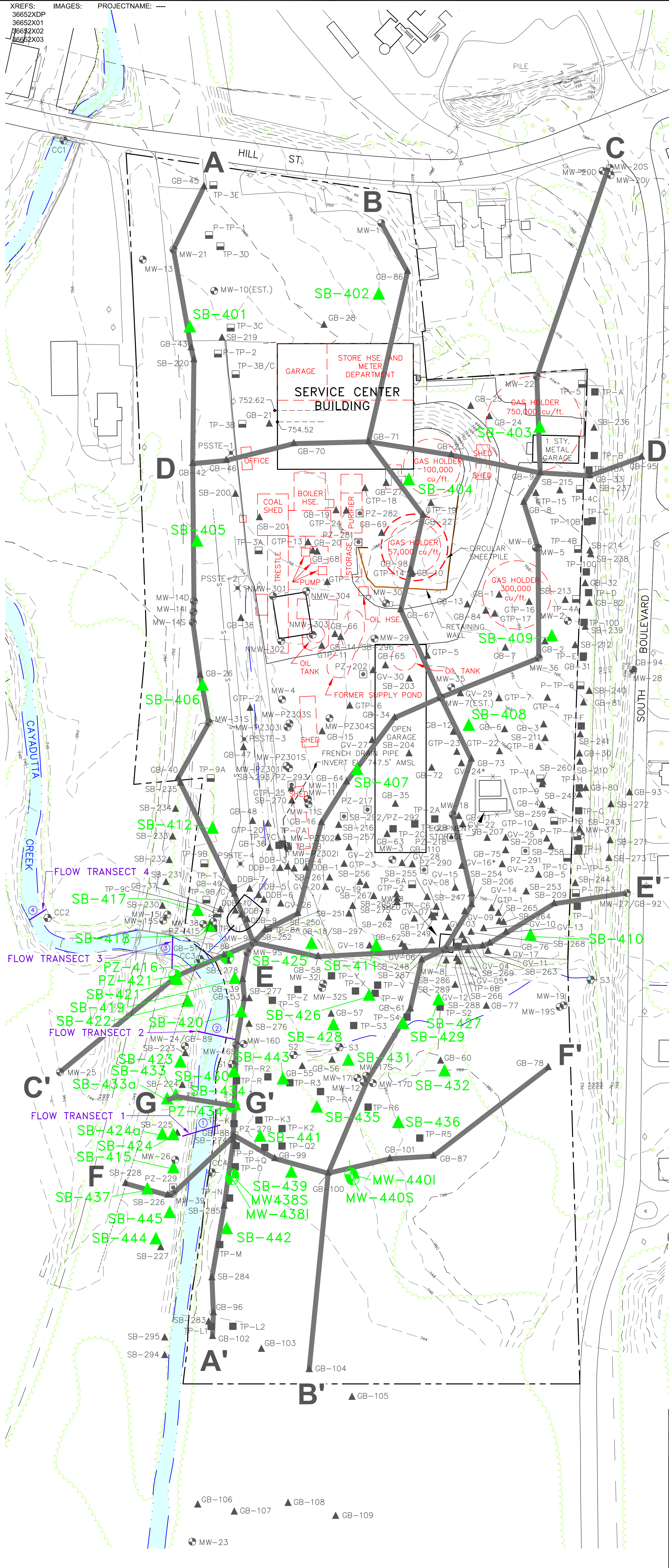


LEGEND:

MW-440S	MONITORING WELL (DECEMBER, 2008 C. T. MALE SURVEY)
MW-19I	MONITORING WELL
PZ-291	PIEZOMETER
SB-423	SOIL BORING (DECEMBER, 2008 C. T. MALE SURVEY)
GB-61	SOIL BORING
DDB-1	DRAINAGE DITCH SOIL BORING
GV-25	TARGOST PROBING LOCATION
*	CONFIRMATION BORING COMPLETED AT THIS LOCATION
PSSTE-4	TEST EXCAVATION LOCATION
TP-G, TP-1B, GTP-10	TEST PIT
CC1	STREAM GAUGE
	CREEK FLOW TRANSECT
	HISTORICAL MGP STRUCTURE
746	TOPOGRAPHIC ELEVATION CONTOUR
A—A'	LINE OF CROSS SECTION
	WATER
	TREE LINE
	FENCE

NOTES:

1. ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. THE NATIONAL GRID PROPERTY LINE SHOWN IS APPROXIMATE.
3. ALL LOCATIONS ARE APPROXIMATE.
4. BASEMAP PREPARED FROM ELECTRONIC SURVEY FILE PROVIDED BY NIAGARA MOHAWK ON 7/23/01. PRIMARY SURVEY CONTROL FOR PHOTOGRAMMETRIC MAPPING WAS ESTABLISHED FROM AN ON THE GROUND SURVEY, PERFORMED ON JULY 28, 1994 USING THE GLOBAL POSITIONING SYSTEM (GPS) AND CONFORMS TO ORDER 2 CLASS 2 FGCS ACCURACY SPECIFICATIONS. THE HORIZONTAL REFERENCE DATUM NORTH AMERICAN DATUM OF 1983 (NAD 83) ON REFERENCE ELLIPSOID ASSOCIATED WITH THE GEODETIC REFERENCE SYSTEM OF 1980 (GRS 80). THE COORDINATES ARE BASED ON THE NEW YORK STATE PLANE GEODETIC SYSTEM OF 1983 (EASTERN ZONE 3101).
5. EXISTING SITE FEATURES BASED ON "ASBUILT SURVEY" PROVIDED BY STANTEC ON 7/18/08.
6. FORMER LOCATIONS OF SITE FEATURES WERE DIGITIZED FROM PHOTOCOPIES OF FIGURES 2-4 & 2-5 FROM THE JUNE 1993 "GLOVERSVILLE MGP SITE IRM REPORT" BY ATLANTIC ENVIRONMENTAL SERVICES, INC., WHICH WERE BASED ON SANBORN INSURANCE MAPS, AND ARE APPROXIMATE ONLY.
7. INVESTIGATION LOCATIONS COMPLETED AS PART OF THE FOLLOWING INVESTIGATIONS:
   - INITIAL SITE SURVEY (EBASCO, 1983)
   - SUPPLEMENTAL SITE SURVEY (EBASCO, 1985A)
   - PSA/IRM STUDY (ATLANTIC, 1993)
   - STORM SEWER IRM STUDY (BBL, 1995A)
   - REMEDIAL INVESTIGATION (PARSONS, 1997)
   - SOIL AND SEDIMENT INVESTIGATION (STEARNS & WHELER, 2000)
   - ADDITIONAL INVESTIGATION (STEARNS & WHELER, 2002)
   - MONITORING WELL MW-8 INVESTIGATION (ARCADIS, 2007B)
   - RI/FS PHASE I DNI (ARCADIS, 2008B)
   - RI/FS PHASE II DNI

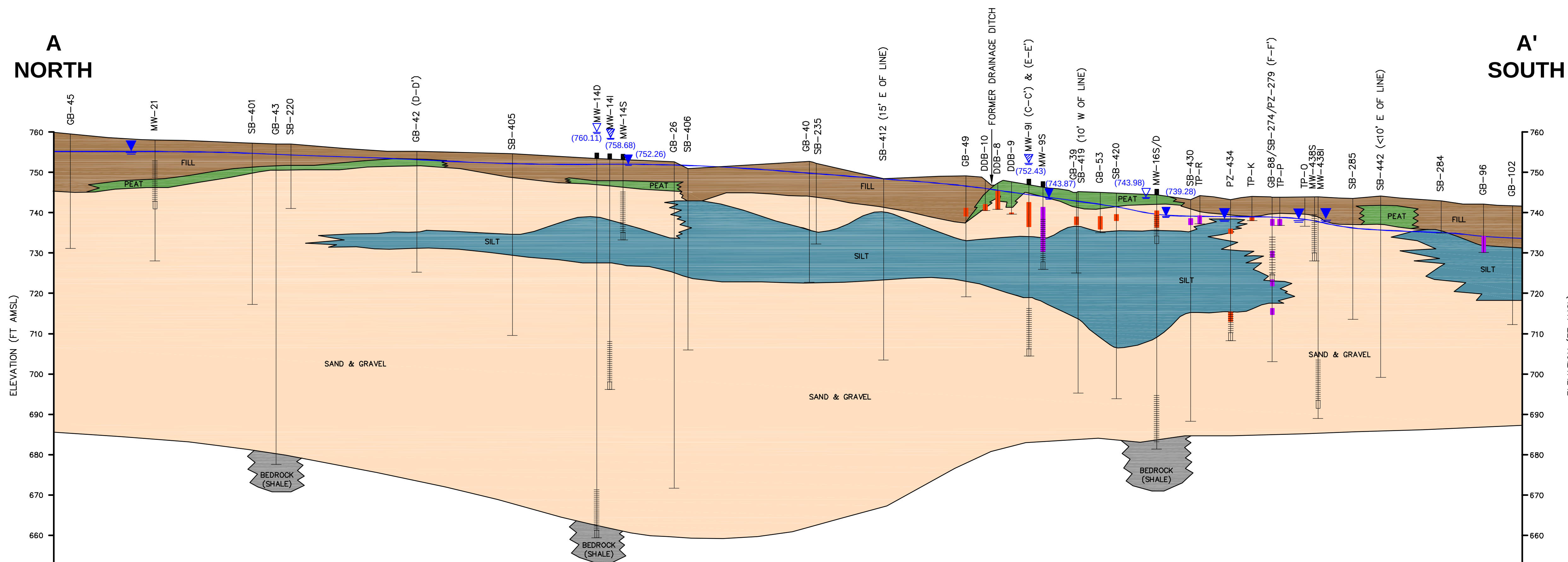
0 60' 120'
GRAPHIC SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SITE PLAN WITH CROSS SECTION LOCATIONS

ARCADIS

FIGURE
2



SB-220
MW-14

LEGEND:

- WELL/BORING ID
- WELL PROTECTOR
- GROUND SURFACE
- WATER TABLE
- MONITORING WELL
- (752.26) GROUNDWATER ELEVATION – SHALLOW WELL
- (758.68) GROUNDWATER ELEVATION – INTERMEDIATE WELL
- (760.11) GROUNDWATER ELEVATION – DEEP WELL
- SOIL BORING
- SCREENED INTERVAL
- SUMP
- LITHOLOGIC CONTACT
- TRACE TO LITTLE NAPL
- NAPL
- BOTTOM OF BORING

- FILL
- PEAT
- SAND AND GRAVEL
- SILT AND CLAY
- BEDROCK

NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. COORDINATES ARE BASED ON THE NORTH AMERICAN DATUM OF 1983, NEW YORK EAST ZONE.
3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
4. STRATIGRAPHIC CONTACTS BETWEEN SUBSURFACE INVESTIGATION LOCATIONS ARE INFERRED. SOIL DESCRIPTIONS, STRATIGRAPHIC CONTACTS, AND PRESENCE/ABSENCE OF NAPL ARE BASED ON REVIEW/INTERPRETATION OF THE AVAILABLE SUBSURFACE LOGS.
5. GROUNDWATER ELEVATIONS MEASURED ON JANUARY 14, 2008.

0 15' 30'
VERTICAL SCALE

0 60' 120'
HORIZONTAL SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

GEOLOGIC CROSS SECTION A - A'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

CITY: SYRACUSE, N.Y. GROUP: ENVCAD-141 DB: A. SCHILLING, P. LISTER, R. ALLEN PM: J. BRIEN TM: J. BRIEN TR: J. OLIVER LYR: ON=*;OFF=REF, (FRZ) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 6/11/2009 4:30 PM BY: JONES, WENDY
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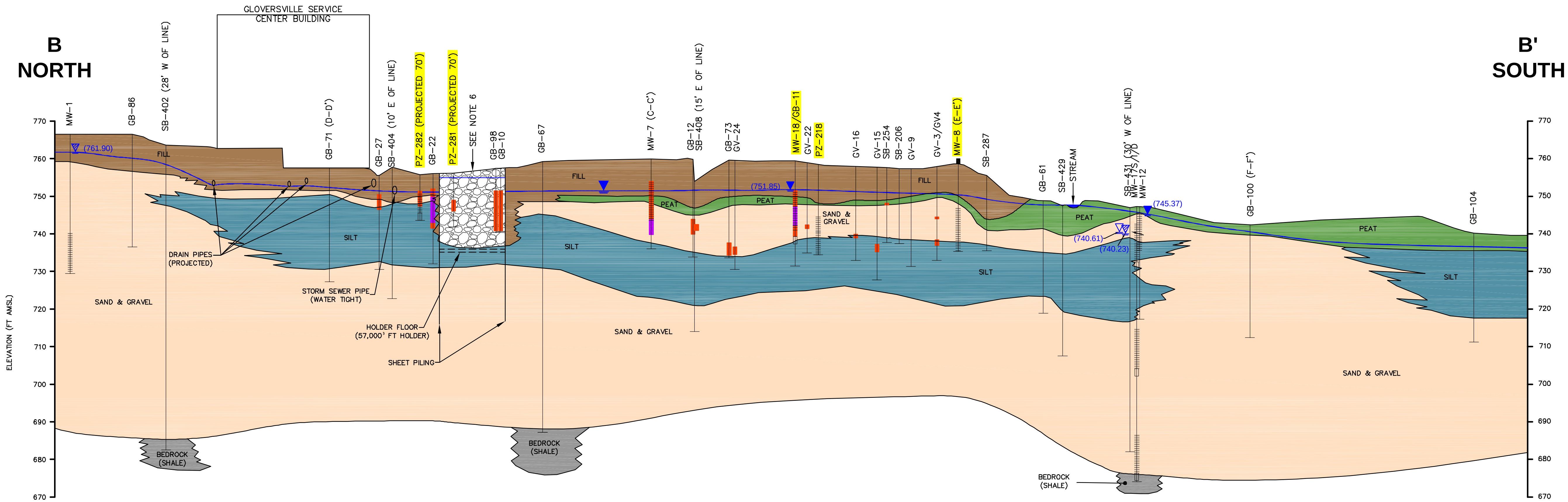
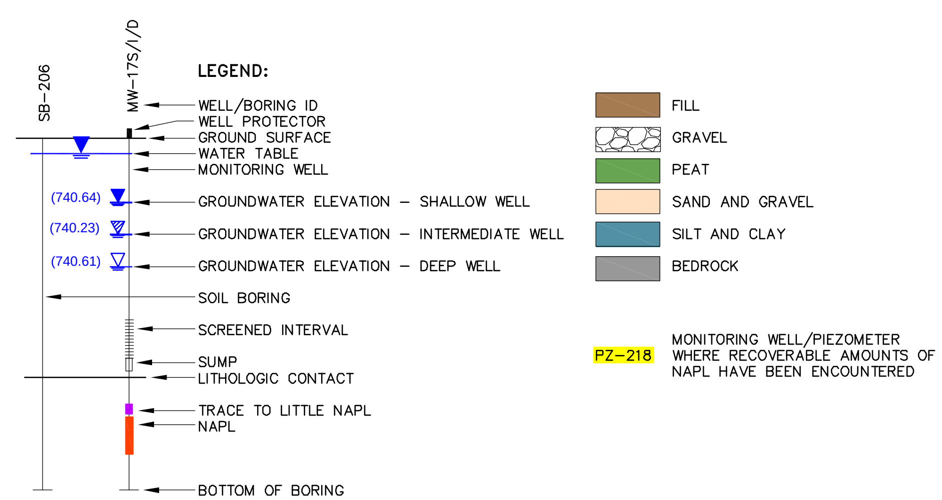
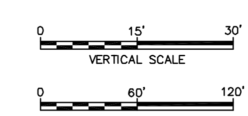




NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. COORDINATES ARE BASED ON THE NORTH AMERICAN DATUM OF 1983, NEW YORK EAST ZONE.
3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
4. STRATIGRAPHIC CONTACTS BETWEEN SUBSURFACE INVESTIGATION LOCATIONS ARE INFERRED. SOIL DESCRIPTIONS, STRATIGRAPHIC CONTACTS, AND PRESENCE/ABSENCE OF NAPL ARE BASED ON REVIEW/INTERPRETATION OF THE AVAILABLE SUBSURFACE LOGS.
5. GROUNDWATER ELEVATIONS MEASURED ON JANUARY 14, 2008.
6. FORMER HOLDER NO. 3 IRM DETAILS OBTAINED FROM DOCUMENT ENTITLED, "FORMER HOLDER NO. 3 INTERIM REMEDIAL MEASURE (IRM) SUMMARY REPORT" (FOSTER WHEELER, OCTOBER 2001).
7. NO VISIBLE INDICATIONS OF NAPL WERE NOTED ON THE BORING LOG FOR MONITORING WELL MW-8 (INSTALLED 1984). HOWEVER, A NAPL RECOVERY IRM WAS CONSTRUCTED AT THIS WELL IN 2000 AND HAS RECOVERED NAPL SINCE ITS INSTALLATION.
8. RECOVERABLE QUANTITIES OF NAPL HAVE BEEN NOTED IN MONITORING WELLS MW-8, MW-18 ND MW-30 (LOG NOT AVAILABLE) AND PIEZOMETERS PZ-218, PZ-281 AND PZ-282.



NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

GEOLOGIC CROSS SECTION B - B'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4

CITY: SYRACUSE, N.Y. GROUP: ENVCAD-141 DB: A. SCHILLING, P. LISTER, R. ALLEN PM: J. BRIEN TM: J. BRIEN TR: J. OLIVER LYR: ON=*;OFF=REF (FRZ) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 6/11/2009 4:31 PM BY: JONES, WENDY
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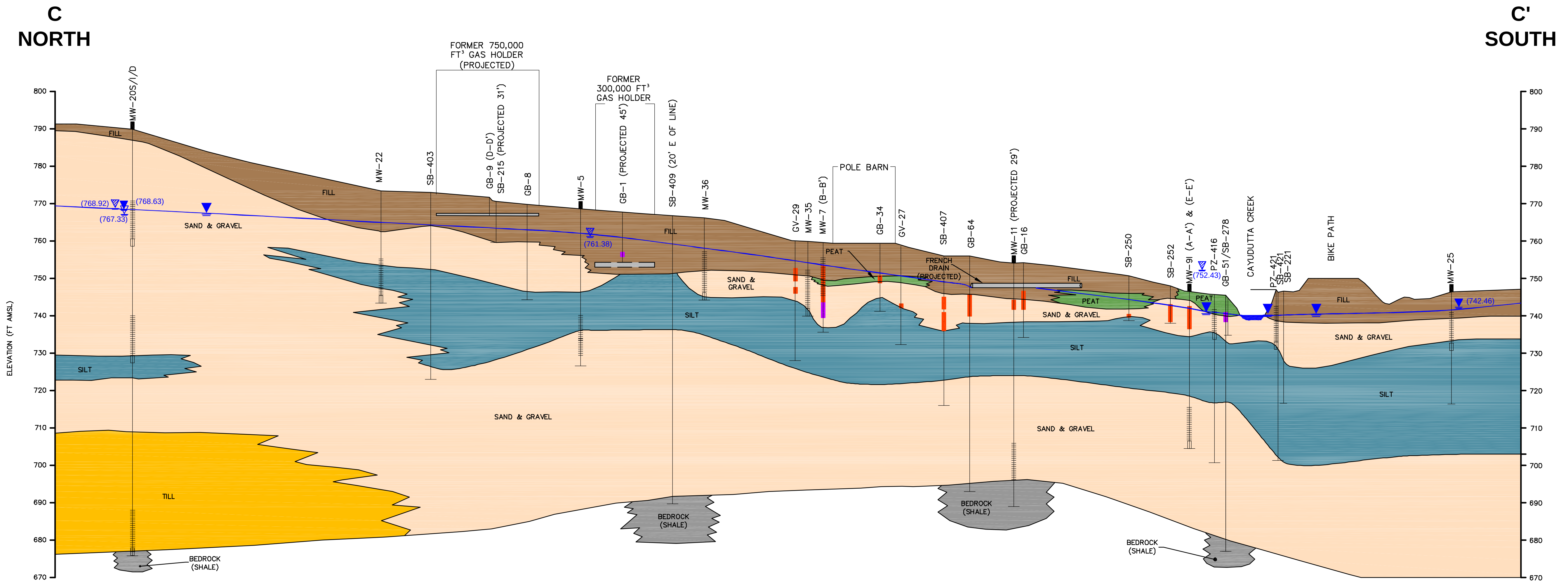

LEGEND:

- SB-250
- MW-20S/I/D
- WELL/BORING ID
- WELL PROTECTOR
- GROUND SURFACE
- WATER TABLE
- MONITORING WELL
- (768.63) GROUNDWATER ELEVATION – SHALLOW WELL
- (768.92) GROUNDWATER ELEVATION – INTERMEDIATE WELL
- (767.33) GROUNDWATER ELEVATION – DEEP WELL
- SOIL BORING
- SCREENED INTERVAL
- SUMP
- LITHOLOGIC CONTACT
- TRACE TO LITTLE NAPL
- NAPL
- BOTTOM OF BORING

- FILL
- PEAT
- SAND AND GRAVEL
- SILT AND CLAY
- TILL
- BEDROCK

NOTE:

1. ALL LOCATIONS ARE APPROXIMATE.
2. COORDINATES ARE BASED ON THE NORTH AMERICAN DATUM OF 1983, NEW YORK EAST ZONE.
3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
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5. GROUNDWATER ELEVATIONS MEASURED ON JANUARY 14, 2008.
6. GROUNDWATER NEAR FRENCH DRAIN WAS BEING CONTROLLED VIA PUMPING AT MANHOLE NMH-6 ON JANUARY 14, 2008.

0 15' 30'
VERTICAL SCALE

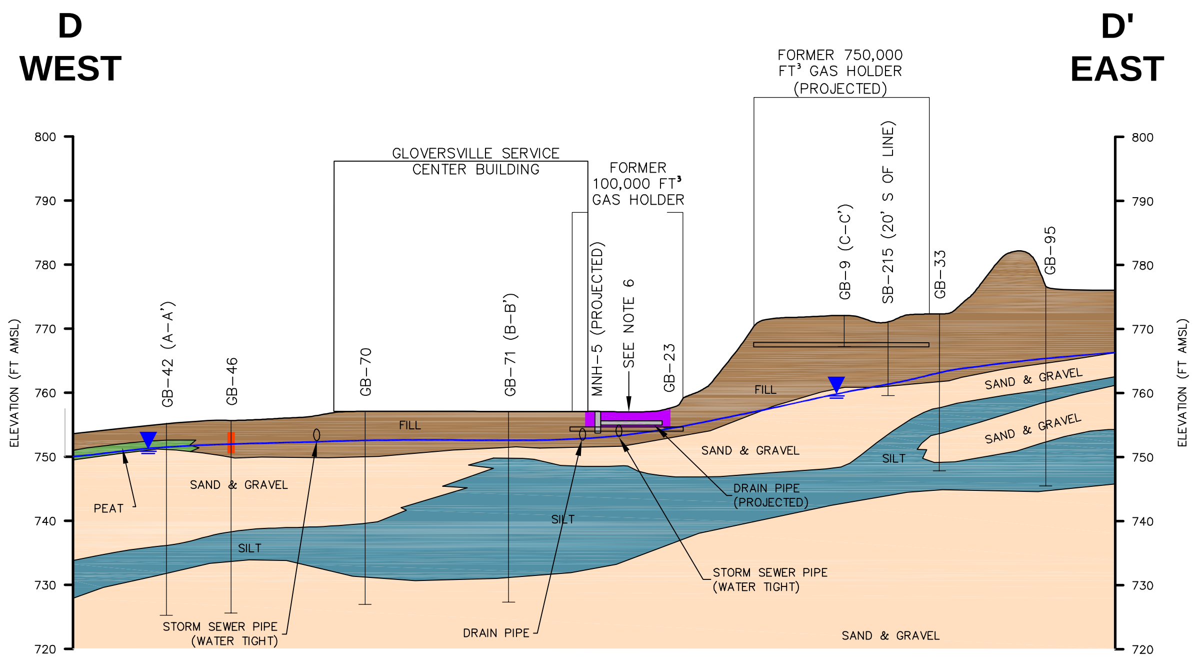
0 60' 120'
HORIZONTAL SCALE

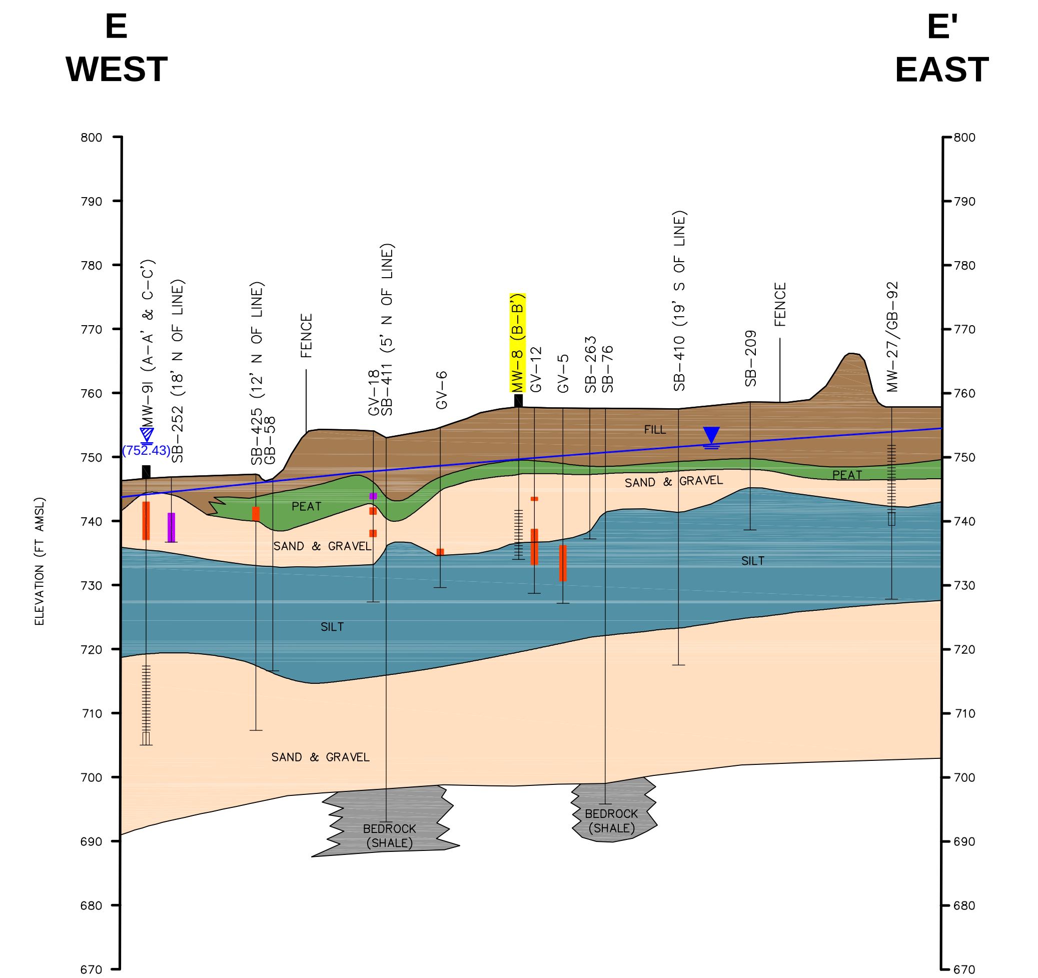
NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

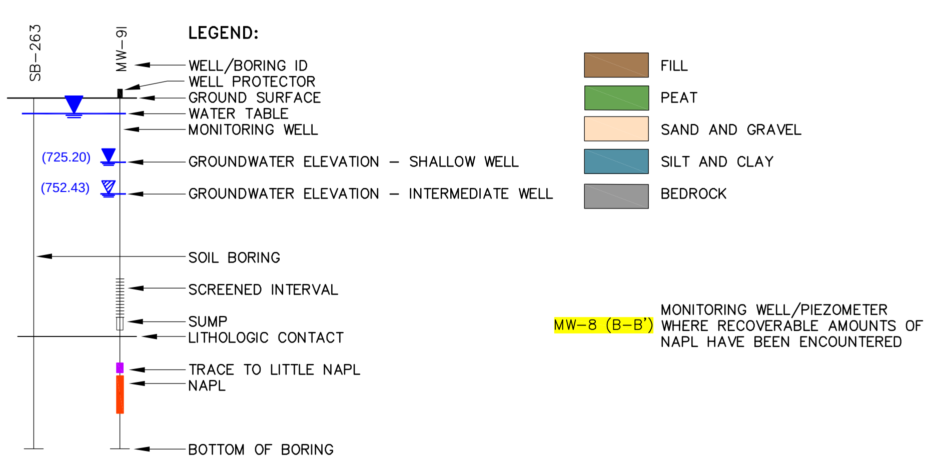
GEOLOGIC CROSS SECTION C - C'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
5







NOTE:

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3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
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5. GROUNDWATER ELEVATIONS MEASURED ON JANUARY 14, 2008.
6. APPROXIMATELY 3-INCH DIAMETER ANGULAR STONE FILL ENCOUNTERED ABOVE FORMER 100,000 FT³ HOLDER FOUNDATION WITH MODERATE TO HEAVY NAPL PRESENT.

0 15' 30'
VERTICAL SCALE

0 60' 120'
HORIZONTAL SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

GEOLOGIC CROSS SECTIONS
D - D' AND E - E'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
6

CITY: SYRACUSE, NY GROUP: ENVCAD DB: A. SCHILLING, R. ALLEN, P. LISTER PM/TM: J. BRIEN TR: J. GOLUBSKI LYR: ON=*;OFF=REF (FRZ) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 6/29/2009 11:38 AM BY: LISTER, PAUL
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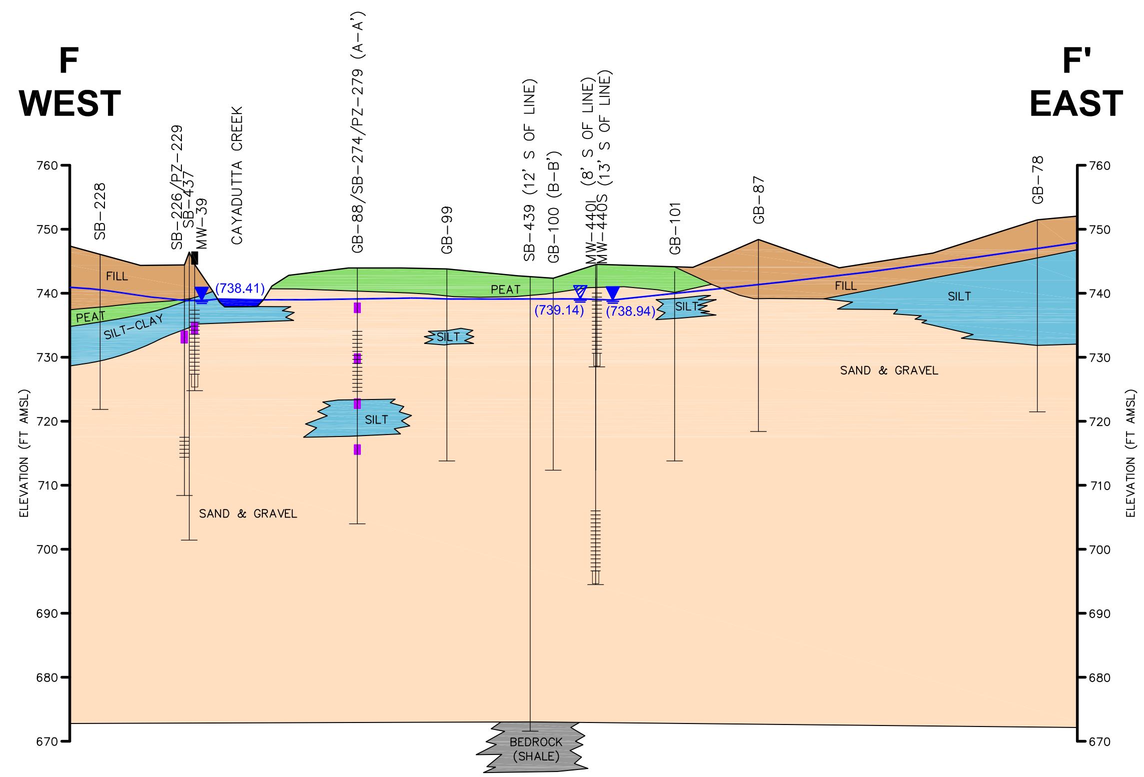

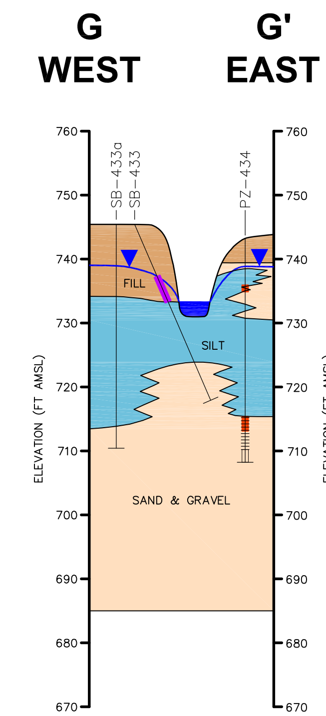

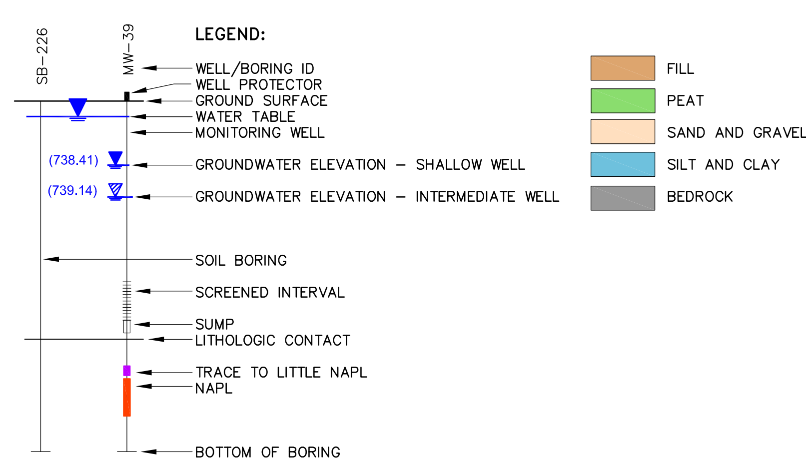

NOTE:

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3. ELEVATIONS ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929.
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5. GROUNDWATER ELEVATION FOR MW-29 MEASURED ON JANUARY 14, 2008.
6. GROUNDWATER ELEVATION FOR MW-440S/I MEASURED ON NOVEMBER 26, 2008.

0 15' 30'
VERTICAL SCALE

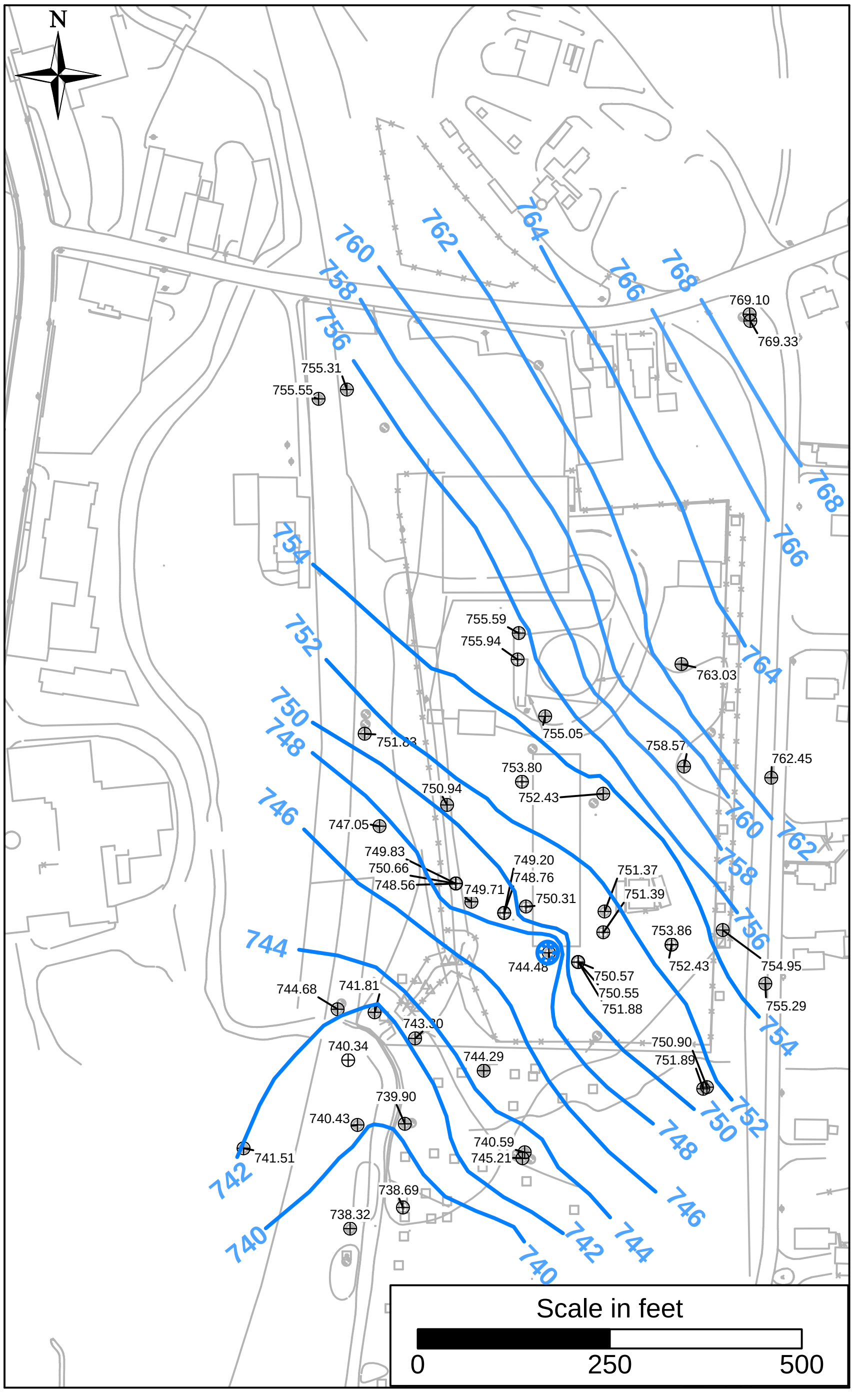
0 60' 120'
HORIZONTAL SCALE

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

GEOLOGIC CROSS SECTIONS F - F' AND G - G'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
7



Legend

746 Observed Groundwater Elevation (ft, amsl)

Notes:

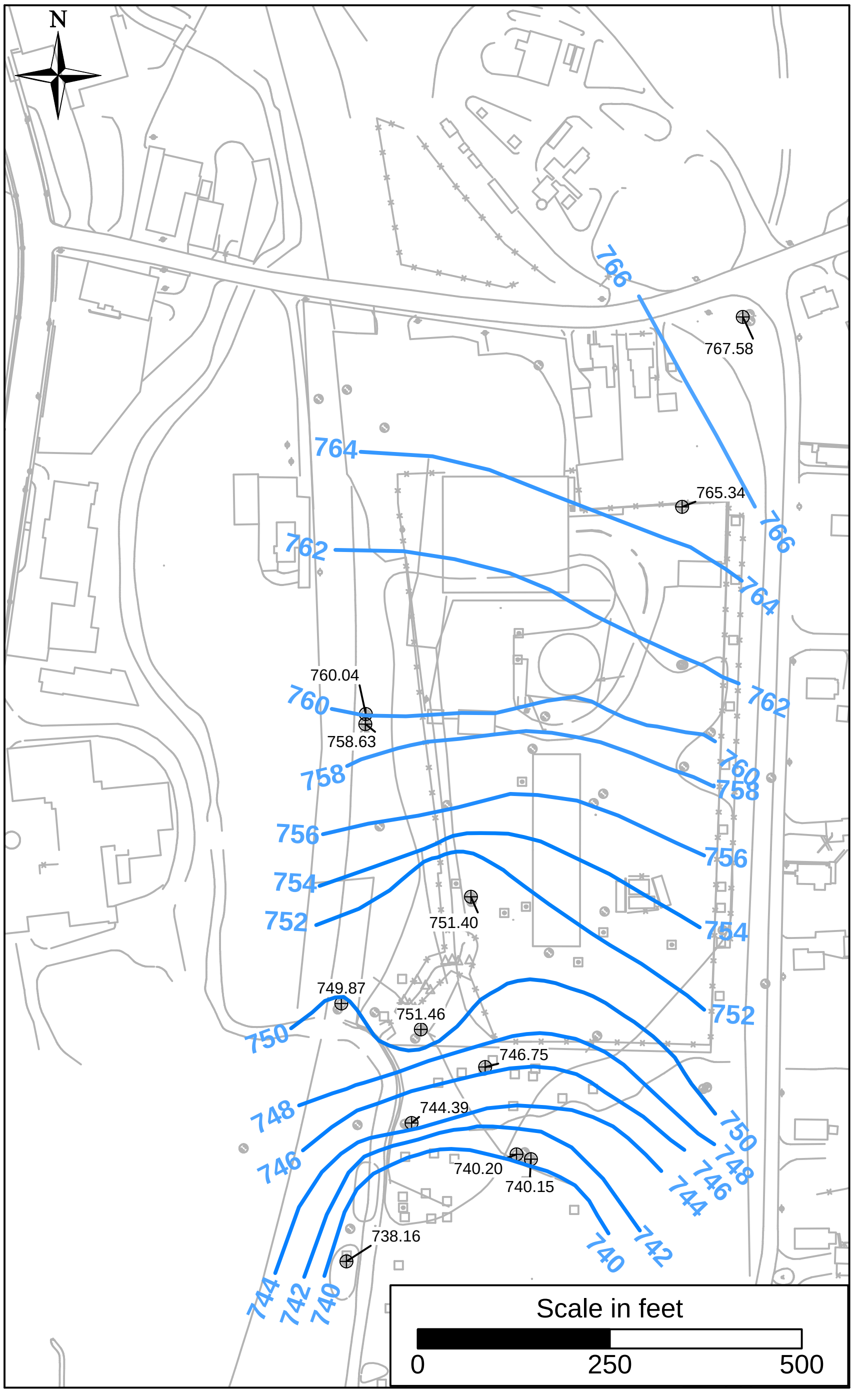
1. Contours generated using average groundwater elevations; data collected in 2001 and 2008.
2. Contour Interval = 2 feet

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

OBSERVED AVERAGE GROUNDWATER ELEVATION MAP, UPPER SAND AND GRAVEL

ARCADIS Design & Consultancy for natural and built assets

FIGURE
8



Legend

746 Observed Groundwater Elevation (ft, amsl)

Notes:
1. Contours generated using average groundwater elevations; data collected in 2001 and 2008.

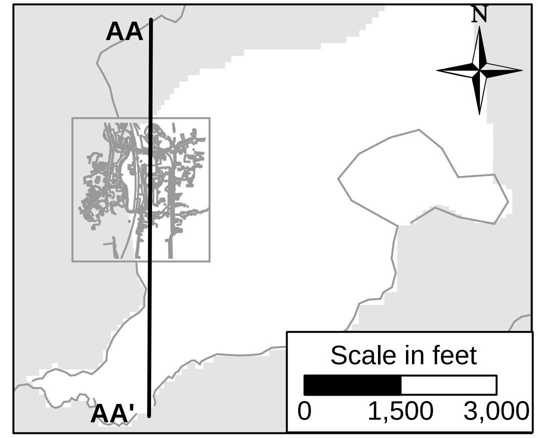
2. Contour Interval = 2 feet

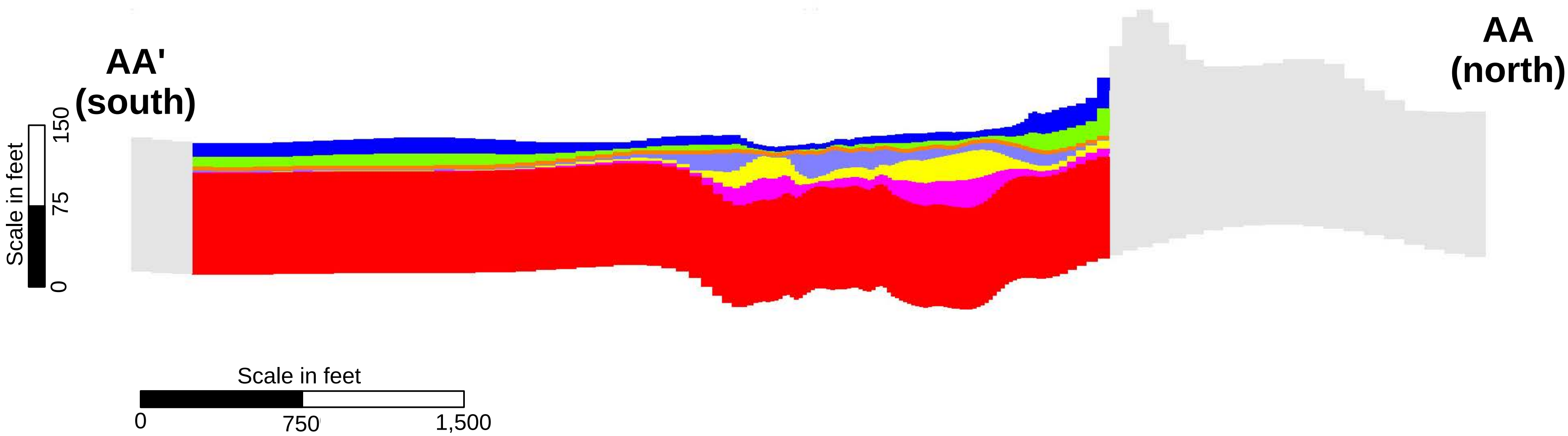
NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

OBSERVED AVERAGE GROUNDWATER ELEVATION MAP, LOWER SAND AND GRAVEL

ARCADIS Design & Consultancy for natural and built assets

FIGURE
9





Legend

- Model Layer 1 = Fill and Upper Sand and Gravel
- Model Layer 2 = Upper Sand and Gravel
- Model Layer 3 = Upper Sand and Gravel
- Model Layer 4 = Silt
- Model Layer 5 = Lower Sand and Gravel
- Model Layer 6 = Lower Sand and Gravel
- Model Layer 7 = Till and Bedrock
- No Flow (Inactive)

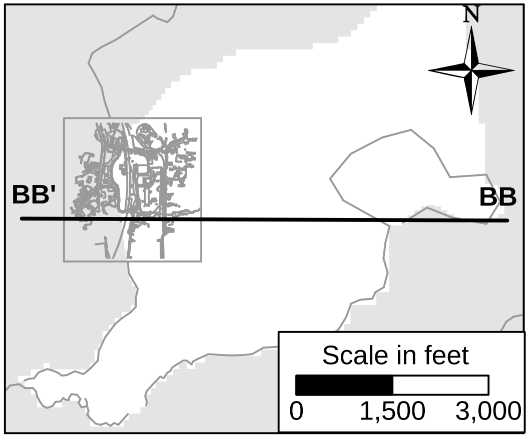
*Vertical Scale is exaggerated 5x.

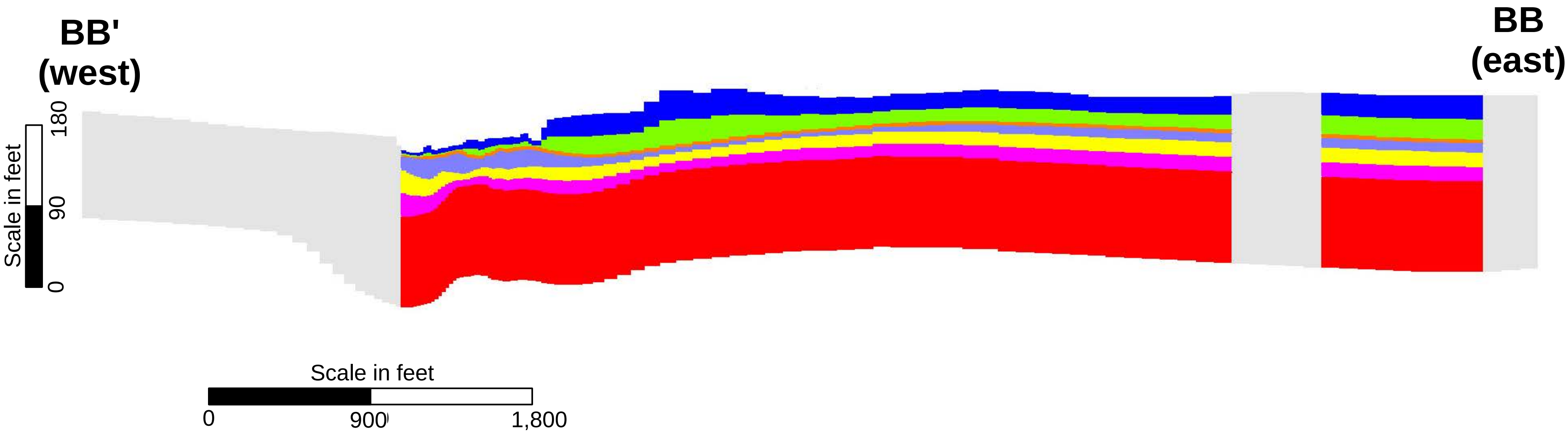
NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

MODEL CROSS SECTION AA-AA'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
10





Legend

- Model Layer 1 = Fill and Upper Sand and Gravel
- Model Layer 2 = Upper Sand and Gravel
- Model Layer 3 = Upper Sand and Gravel
- Model Layer 4 = Silt
- Model Layer 5 = Lower Sand and Gravel
- Model Layer 6 = Lower Sand and Gravel
- Model Layer 7 = Till and Bedrock
- No Flow (Inactive)

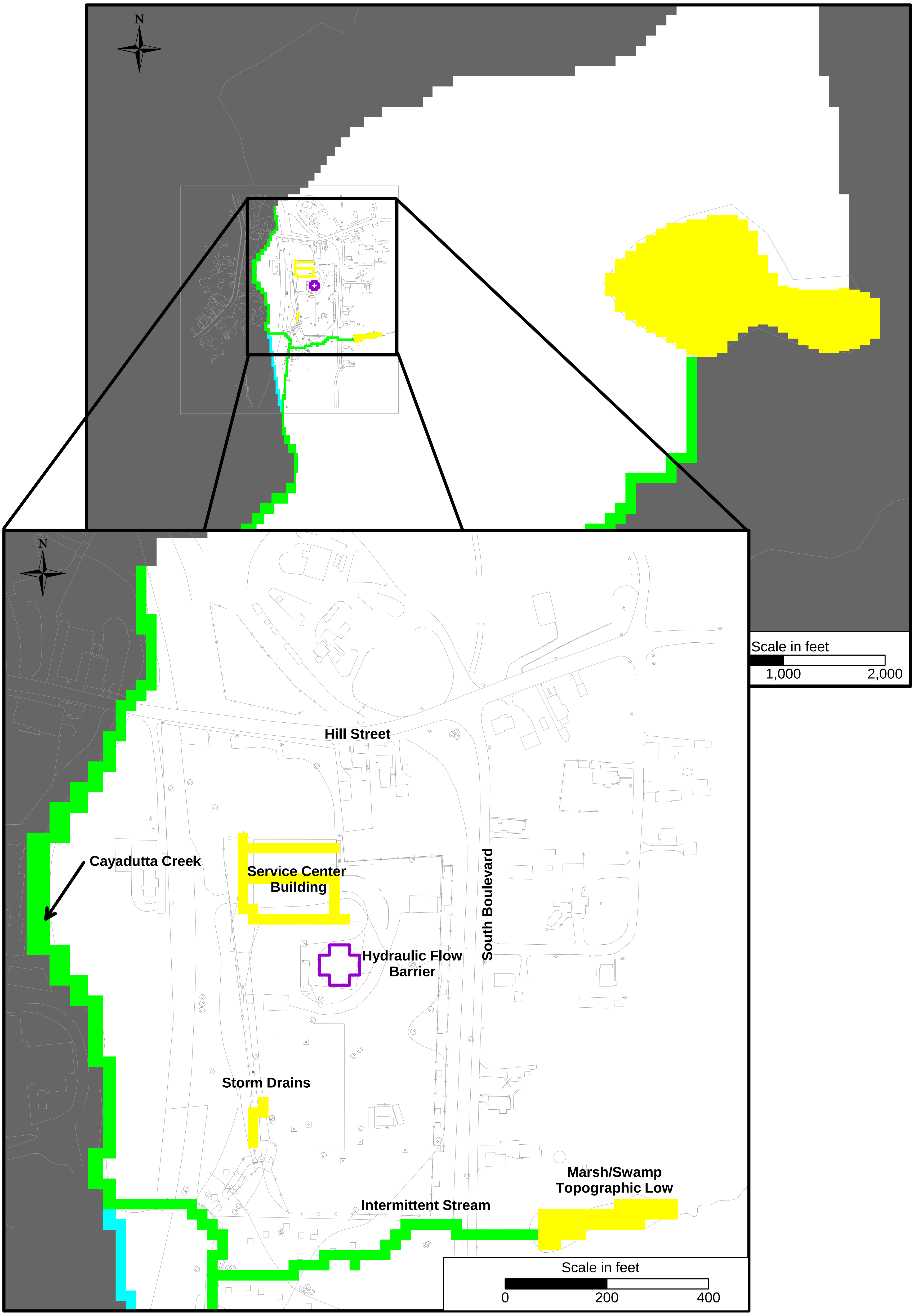
*Vertical Scale is exaggerated 5x.

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

MODEL CROSS SECTION BB-BB'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
11



Legend

- River Boundary
- Drain Boundary
- General Head Boundary
- Hydraulic Flow Barrier
- No Flow (Inactive)

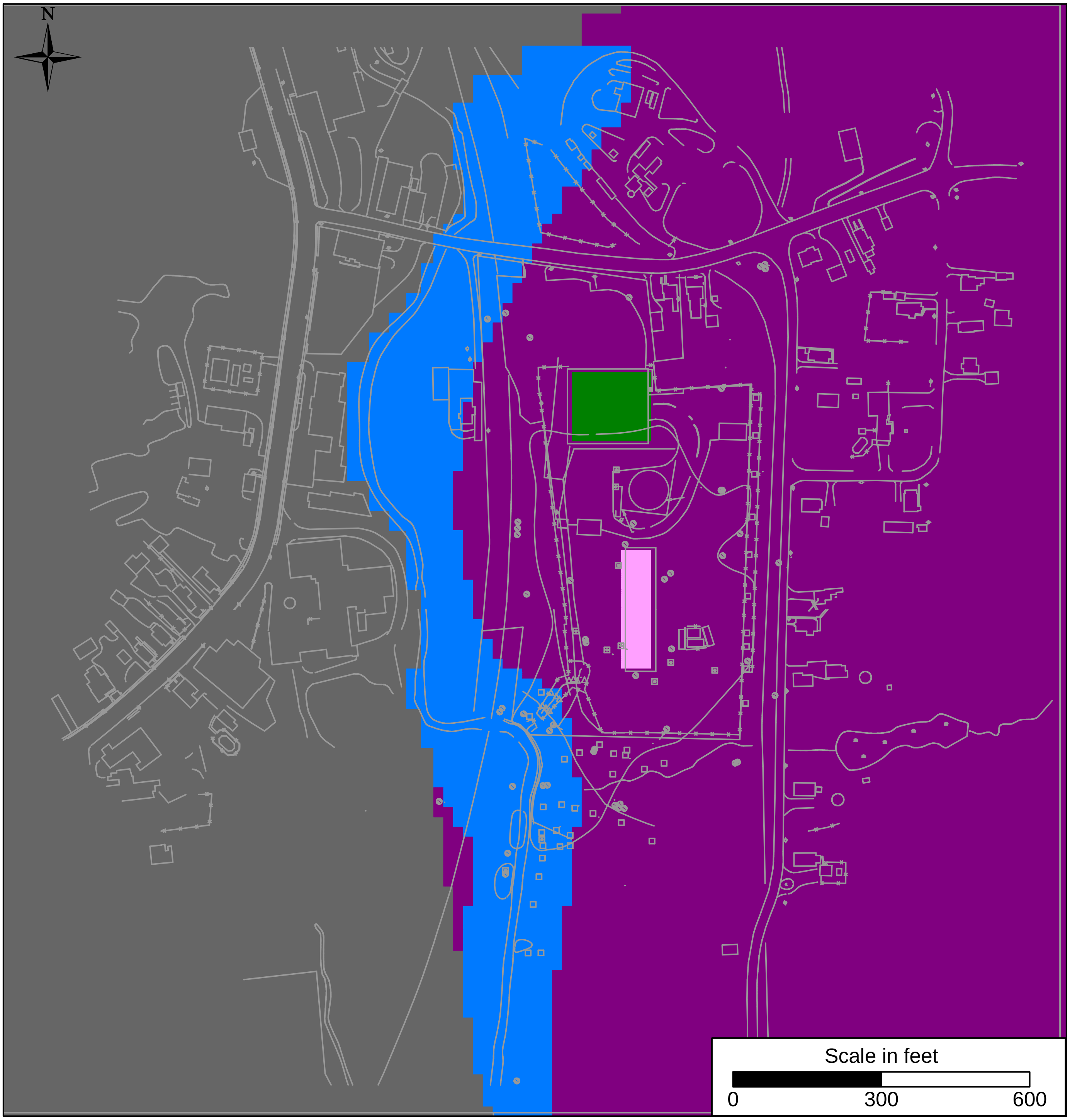
Note: Grid spacing is variable, ranging from 4 feet by 4 feet to 100 feet by 100 ft at the model extents.

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

MODEL DOMAIN AND BOUNDARY CONDITIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
12



Legend

- Recharge Zone 1 = 15 in/yr
- Recharge Zone 2 = 8 in/yr
- Recharge Zone 3 = 0 in/yr
- Recharge Zone 4 = 3 in/yr
- No Flow (Inactive)

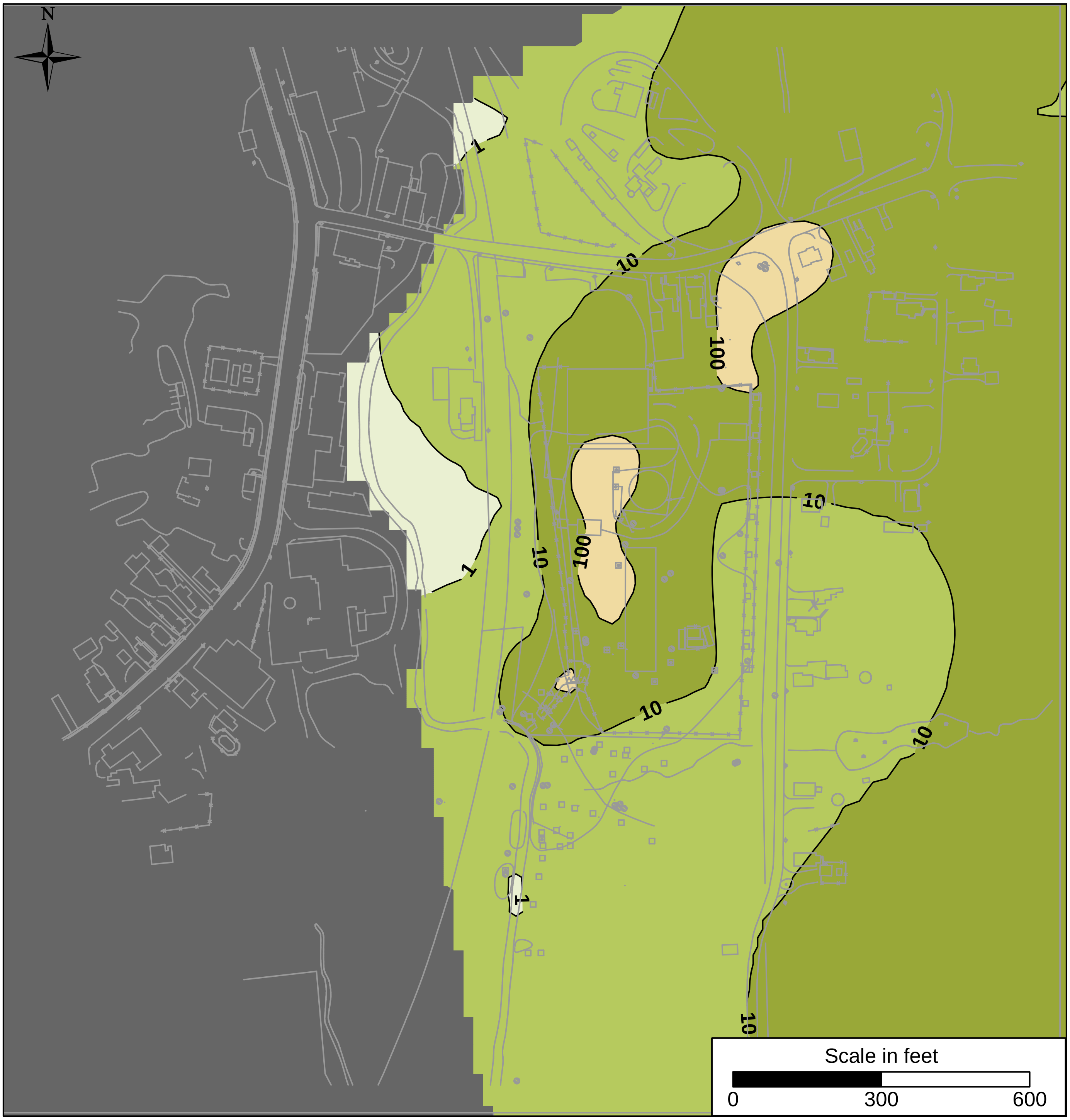
* in/yr = inches per year

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SIMULATED RECHARGE

ARCADIS Design & Consultancy for natural and built assets

FIGURE
13



Legend

No Flow (Inactive)

*Horizontal to vertical hydraulic conductivity ratio is 10:1.

*ft/day = feet per day

Horizontal Hydraulic Conductivity (ft/day)

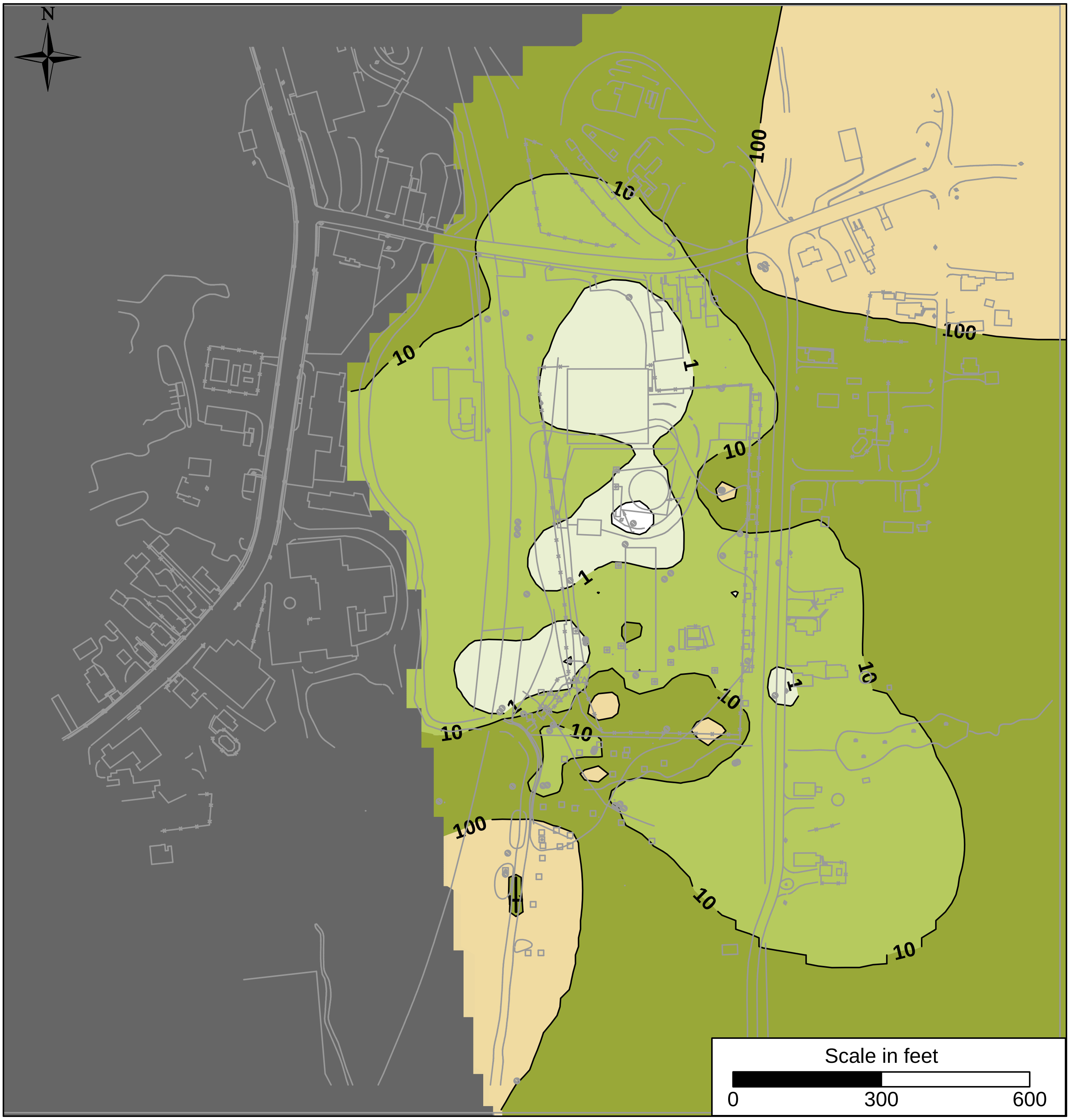
0.1 | 1 | 10 | 100

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

HYDRAULIC CONDUCTIVITY
MODEL LAYER 1
(FILL/SAND)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
14



Legend

No Flow (Inactive)

*Horizontal to vertical hydraulic conductivity ratio is 10:1.

*ft/day = feet per day

Horizontal Hydraulic Conductivity (ft/day)

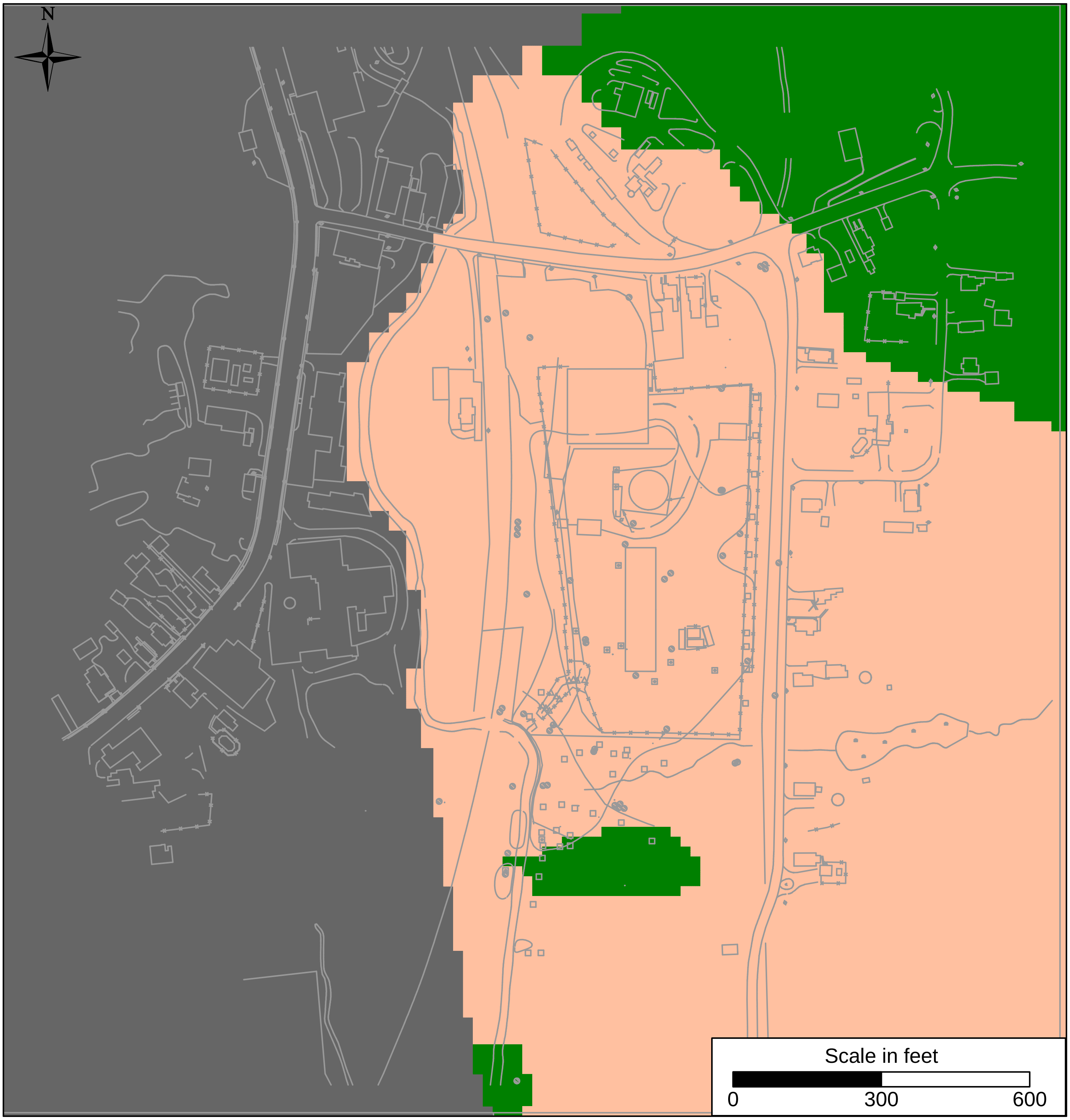
0.1 | 1 | 10 | 100

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

HYDRAULIC CONDUCTIVITY
MODEL LAYERS 2 AND 3
(UPPER SAND AND GRAVEL)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
15



Legend

Horizontal Hydraulic Conductivity = 0.5 ft/day

Horizontal Hydraulic Conductivity = 50 ft/day

No Flow (Inactive)

*Horizontal to vertical hydraulic conductivity ratio is 10:1.

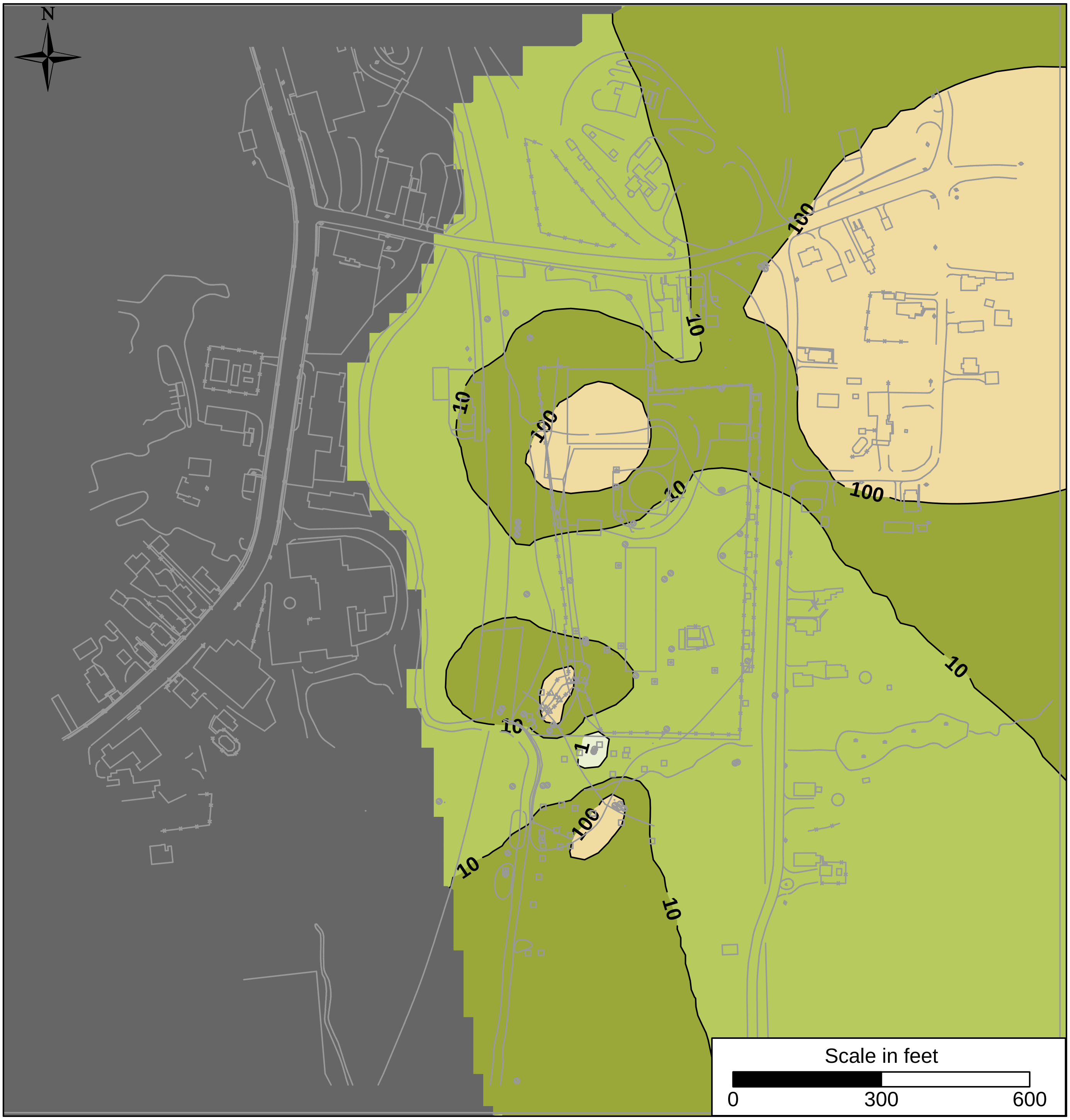
*ft/day = feet per day

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

HYDRAULIC CONDUCTIVITY
MODEL LAYER 4
(SILT)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
16



Legend

No Flow (Inactive)

*Horizontal to vertical hydraulic conductivity ratio is 10:1.

*ft/day = feet per day

Horizontal Hydraulic Conductivity (ft/day)

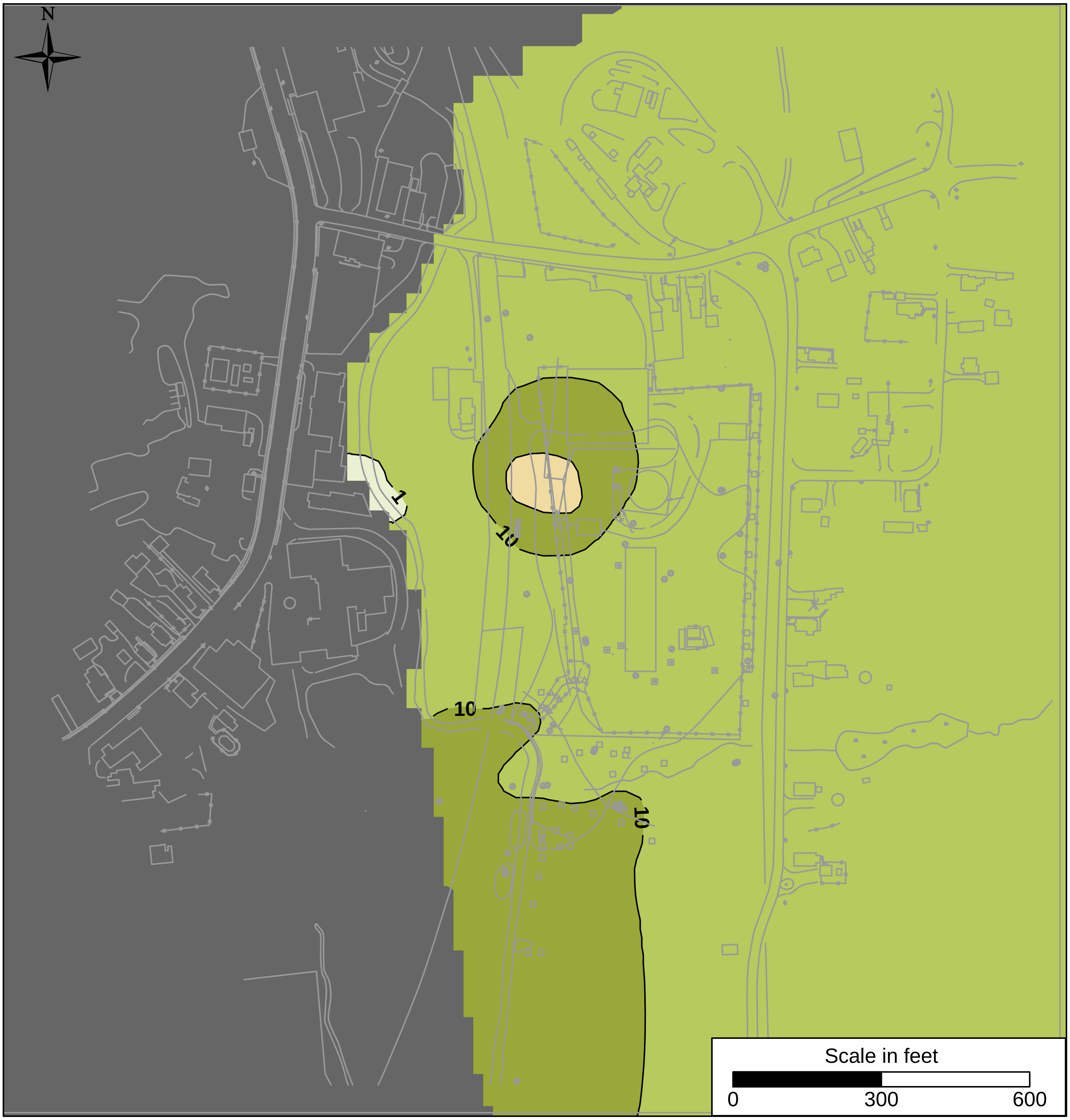
0.1 1 10 100

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

HYDRAULIC CONDUCTIVITY
MODEL LAYER 5
(LOWER SAND AND GRAVEL)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
17



Legend

No Flow (Inactive)

*Horizontal to vertical hydraulic conductivity ratio is 10:1.

*ft/day = feet per day

Horizontal Hydraulic Conductivity (ft/day)

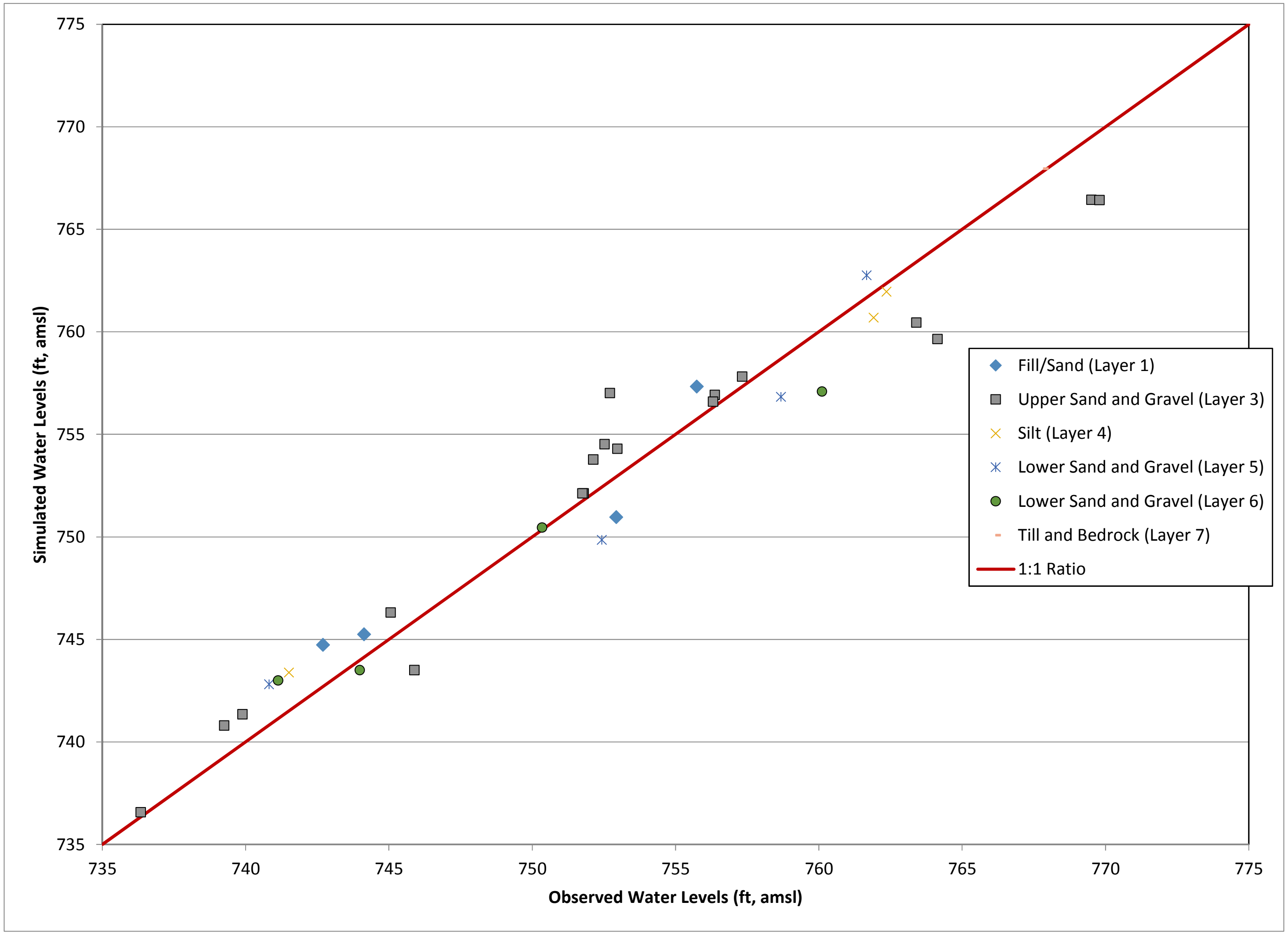
0.1 1 10 100

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

HYDRAULIC CONDUCTIVITY
MODEL LAYER 6
(LOWER SAND AND GRAVEL)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
18

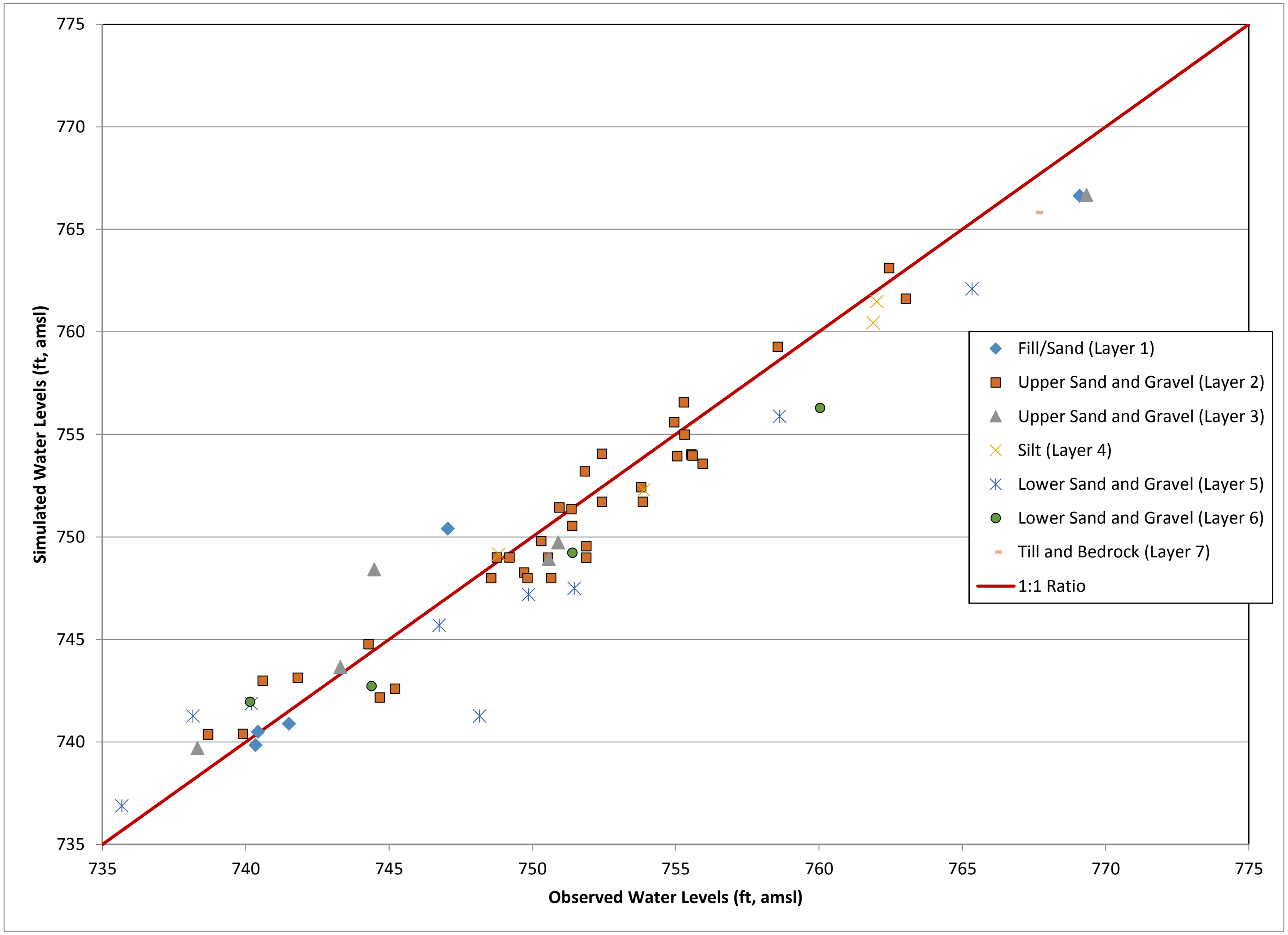


NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

CALIBRATION SCATTER PLOT
2008 CALIBRATION

ARCADIS Design & Consultancy for natural and built assets

FIGURE
19



NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

CALIBRATION SCATTER PLOT
2015 CALIBRATION

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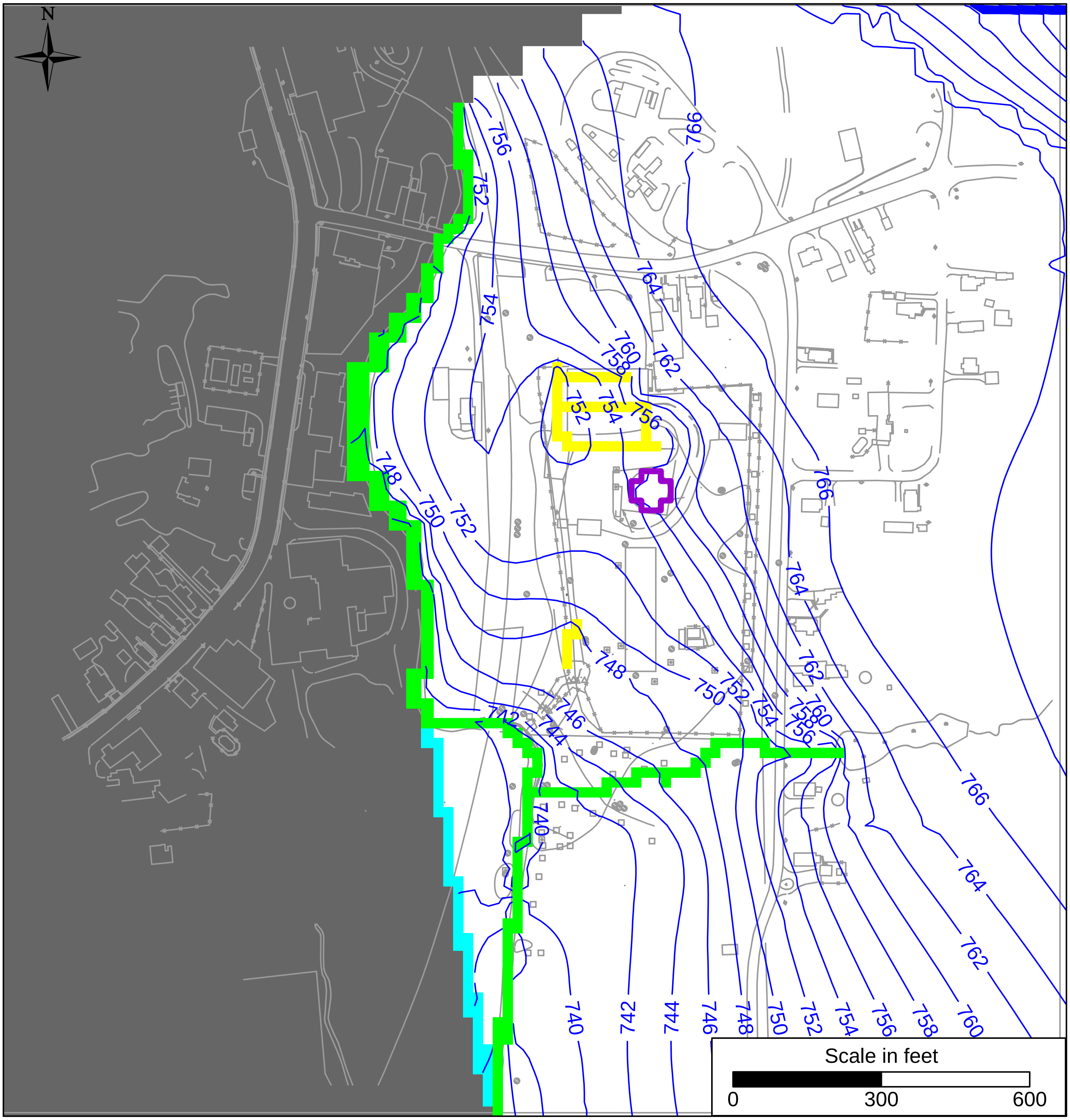
FIGURE
20



Legend

- River Boundary
- Drain Boundary
- General Head Boundary
- Hydraulic Flow Barrier
- No Flow (Inactive)
- 746 Simulated Water Table Elevation (ft, amsl) (Contour Interval = 2 feet)

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SIMULATED WATER TABLE ELEVATION

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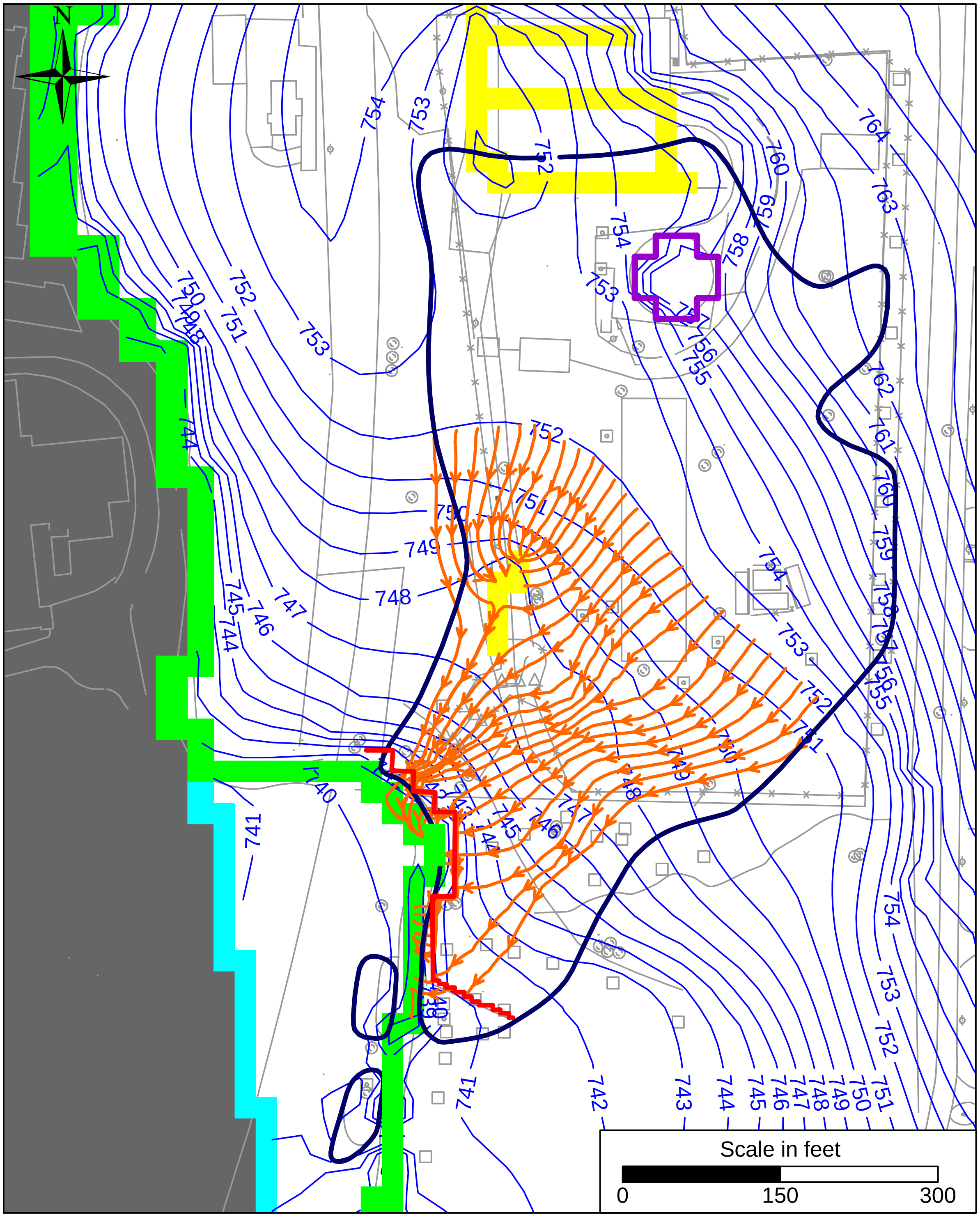
FIGURE 21



Legend

- River Boundary
- Drain Boundary
- General Head Boundary
- Hydraulic Flow Barrier
- No Flow (Inactive)
- 746 Simulated Water Table Elevation (feet, above mean sea level)
- Permeable Trench
- Simulated Groundwater Pathline (Arrows represent 50 feet of travel)

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SIMULATED GROUNDWATER ELEVATIONS AND SELECT FLOW PATHS, SCENARIO 1

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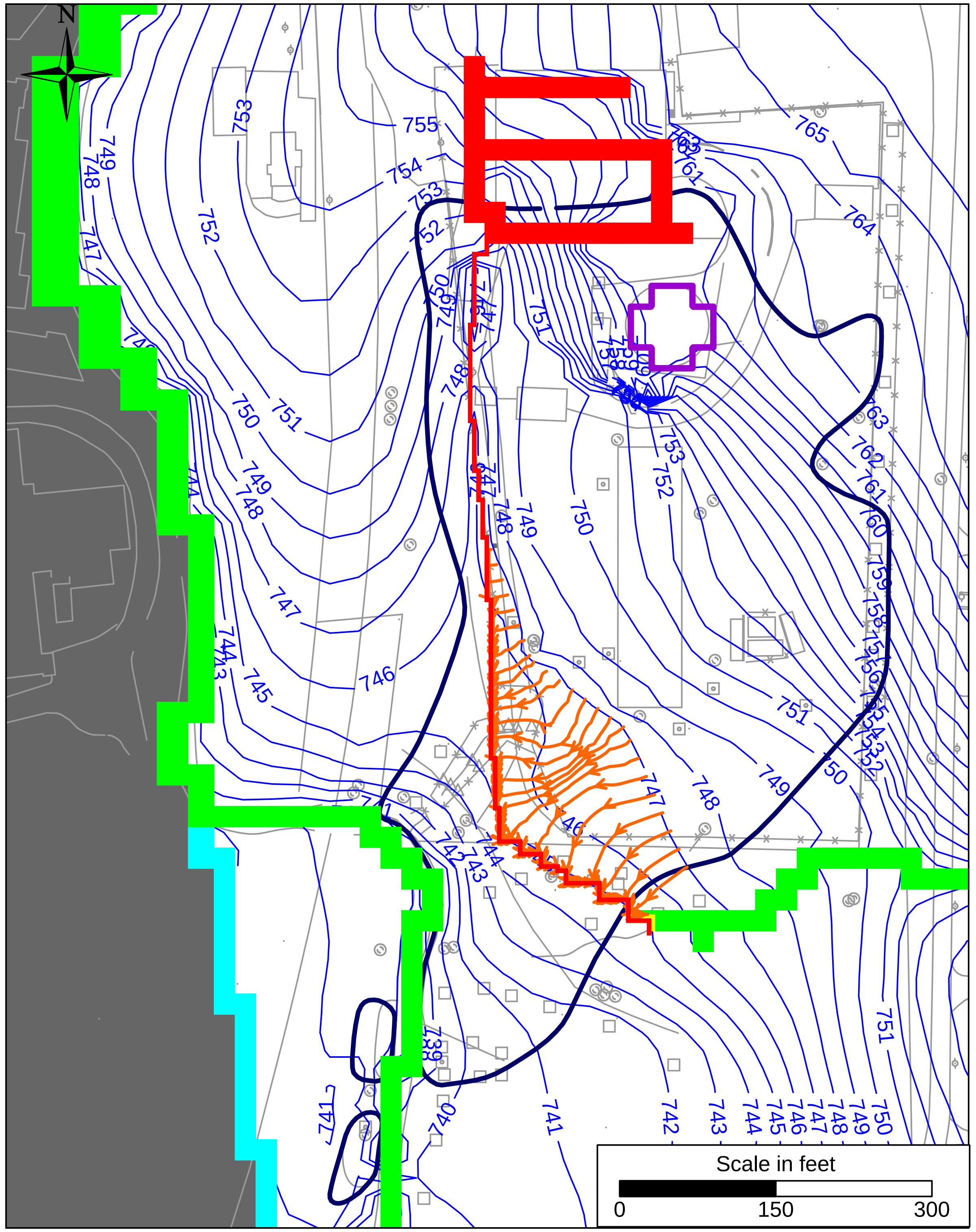
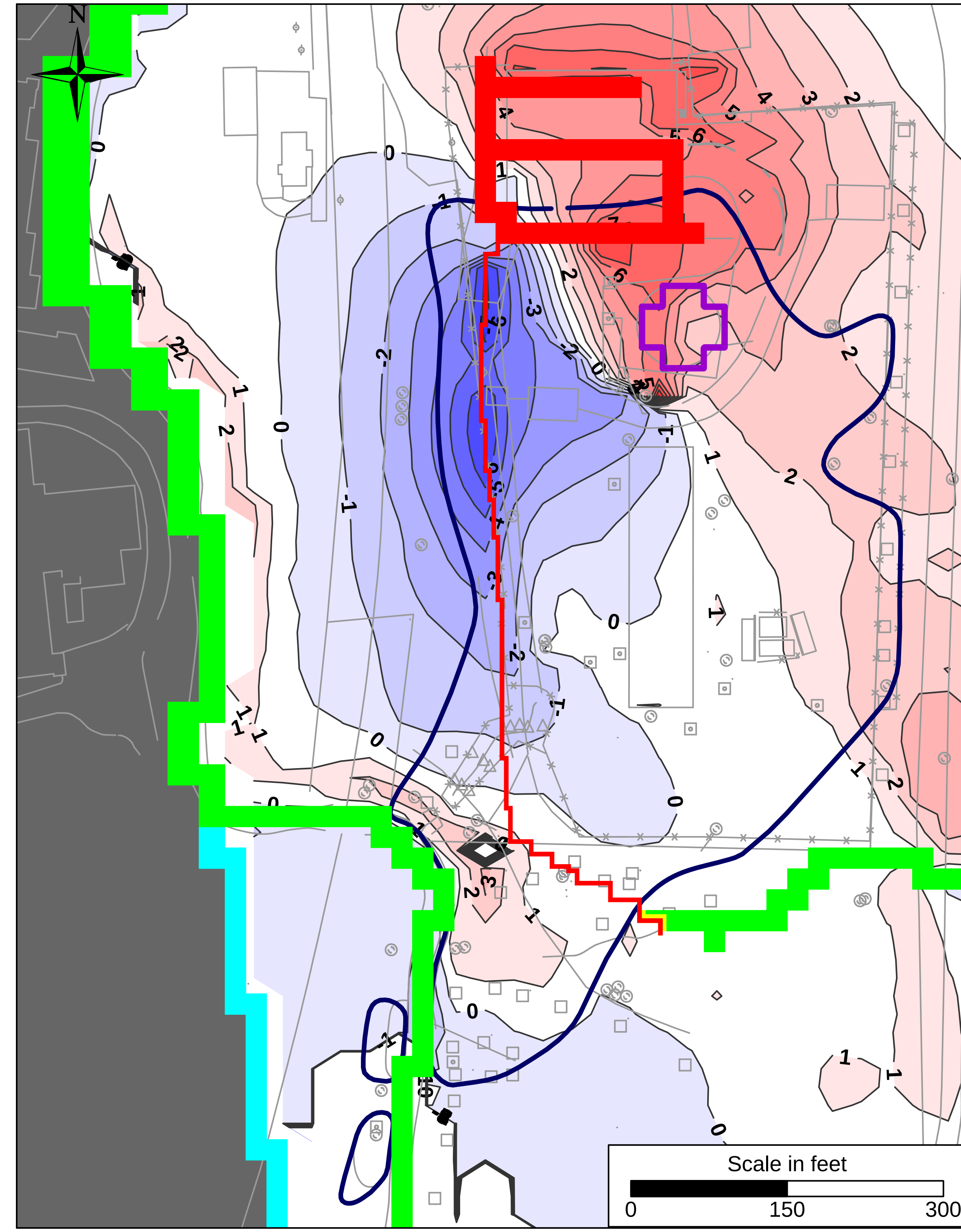
FIGURE
22

SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER MOUNDING



Legend

- River Boundary
- Drain Boundary
- General Head Boundary
- Hydraulic Flow Barrier
- No Flow (Inactive)
- 746 Simulated Water Table Elevation (feet, above mean sea level)
- Permeable Trench
- Simulated Groundwater Pathline (Arrows represent 50 feet of travel)

Change in Simulated Water Level (feet)

(Simulation Conditions - Calibration Conditons)

Drawdown | Mounding

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SIMULATED GROUNDWATER ELEVATIONS, MOUNDING, AND CAPTURE ZONES, SCENARIO 2

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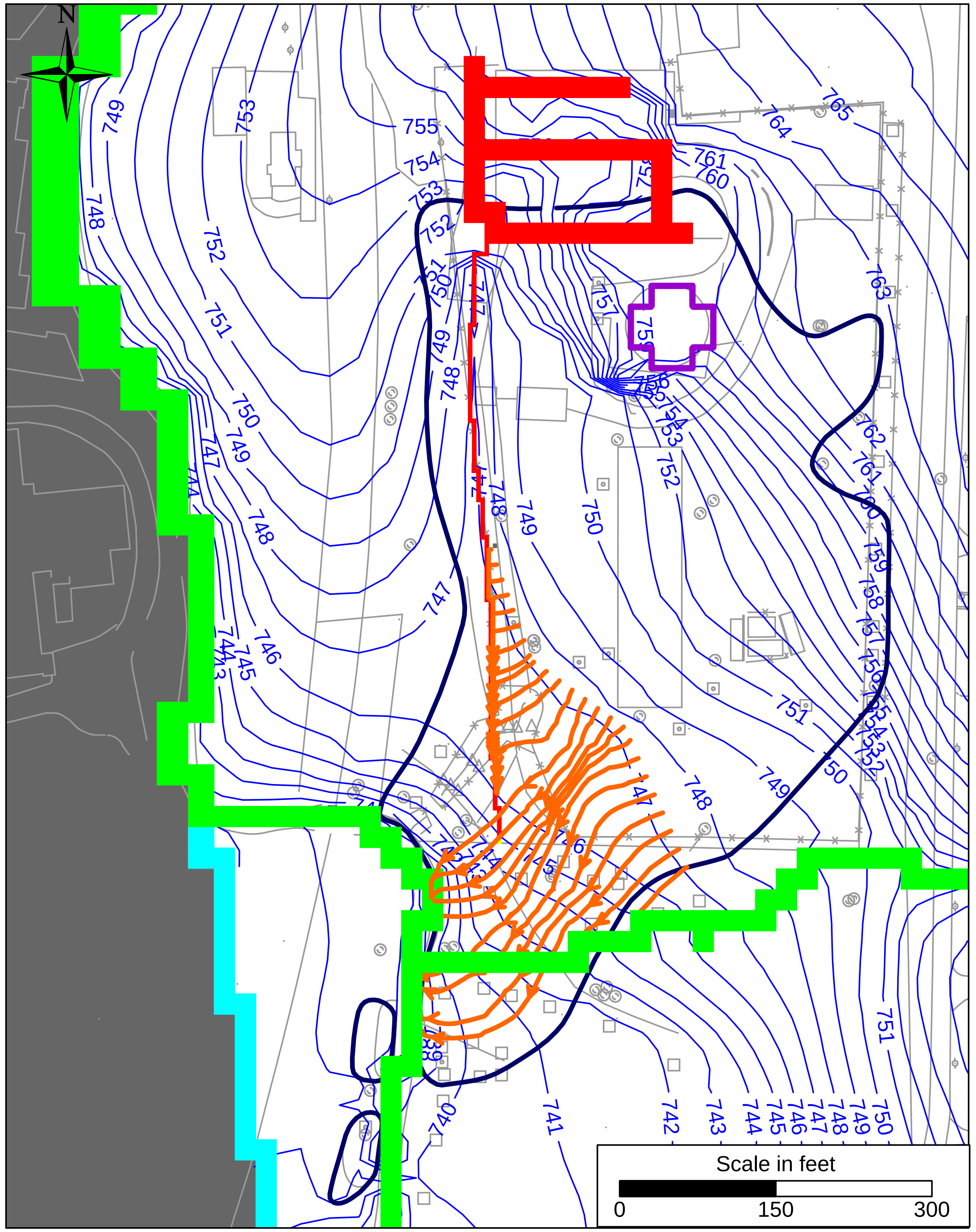
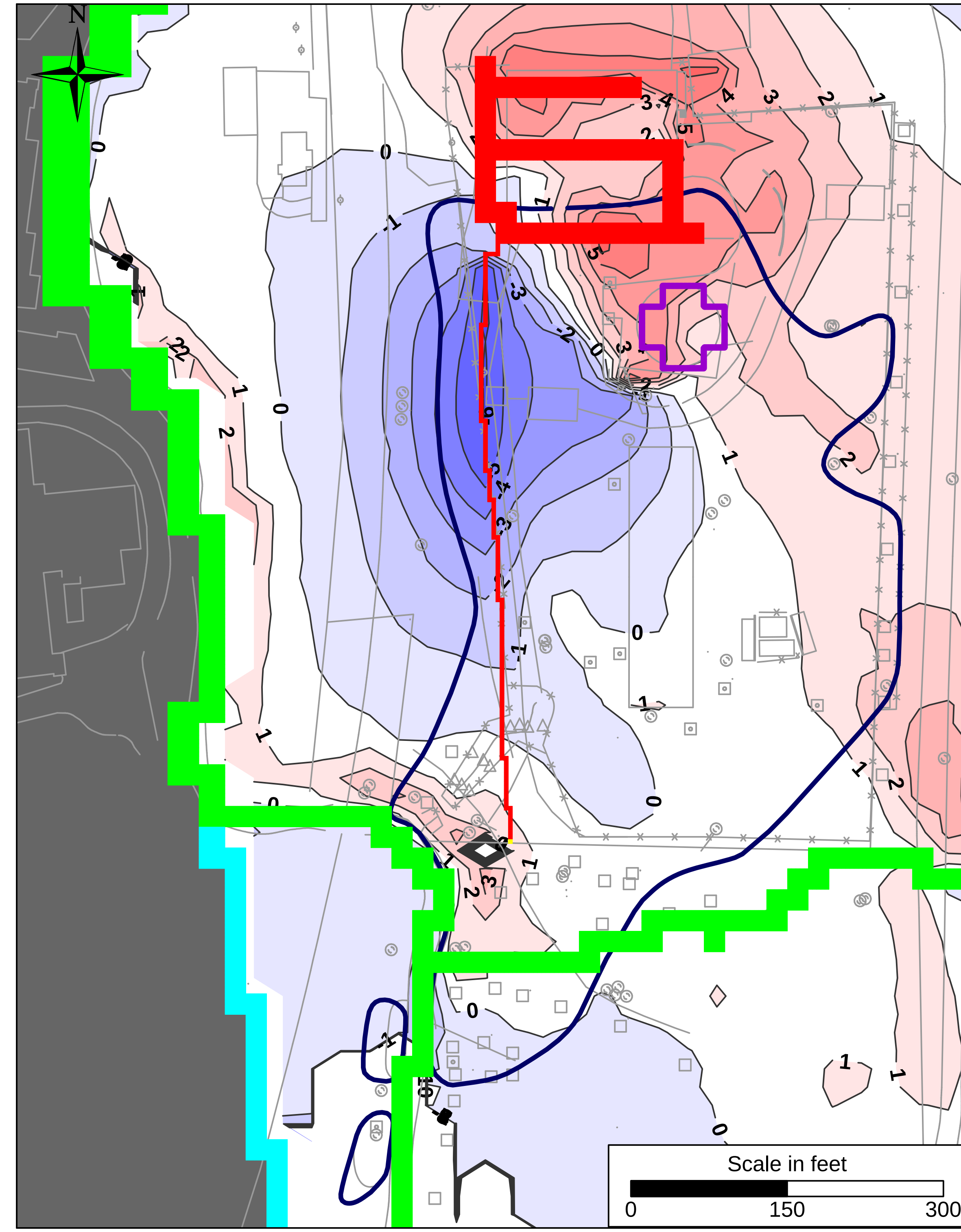
FIGURE
23

SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER MOUNDING



Legend

- River Boundary
- Drain Boundary
- General Head Boundary
- Hydraulic Flow Barrier
- No Flow (Inactive)
- 746 Simulated Water Table Elevation (feet, above mean sea level)
- Permeable Trench
- Simulated Groundwater Pathline (Arrows represent 50 feet of travel)

Change in Simulated Water Level (feet)

(Simulation Conditions - Calibration Conditons)

Drawdown | Mounding

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SIMULATED GROUNDWATER ELEVATIONS, MOUNDING, AND CAPTURE ZONES, SCENARIO 3

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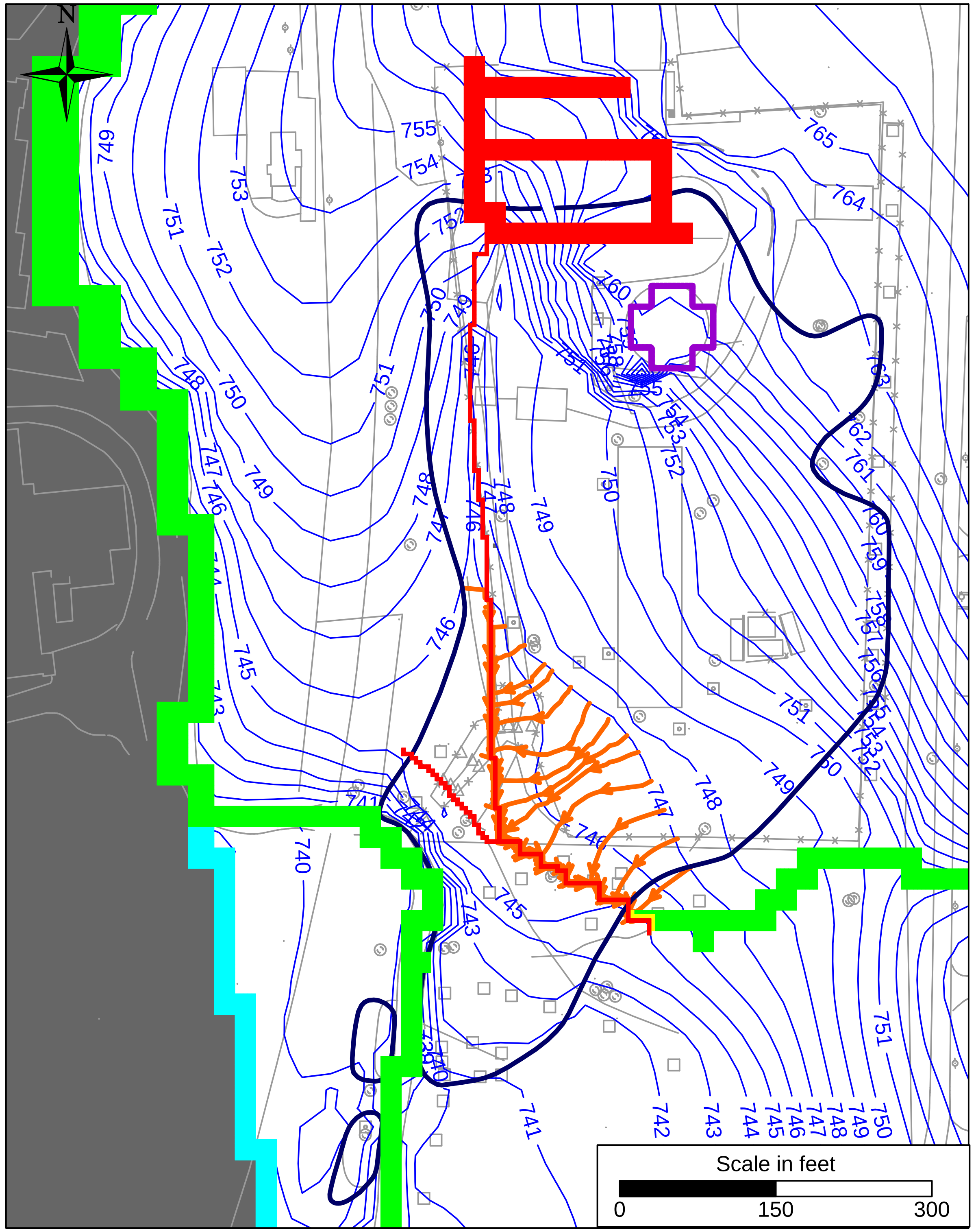
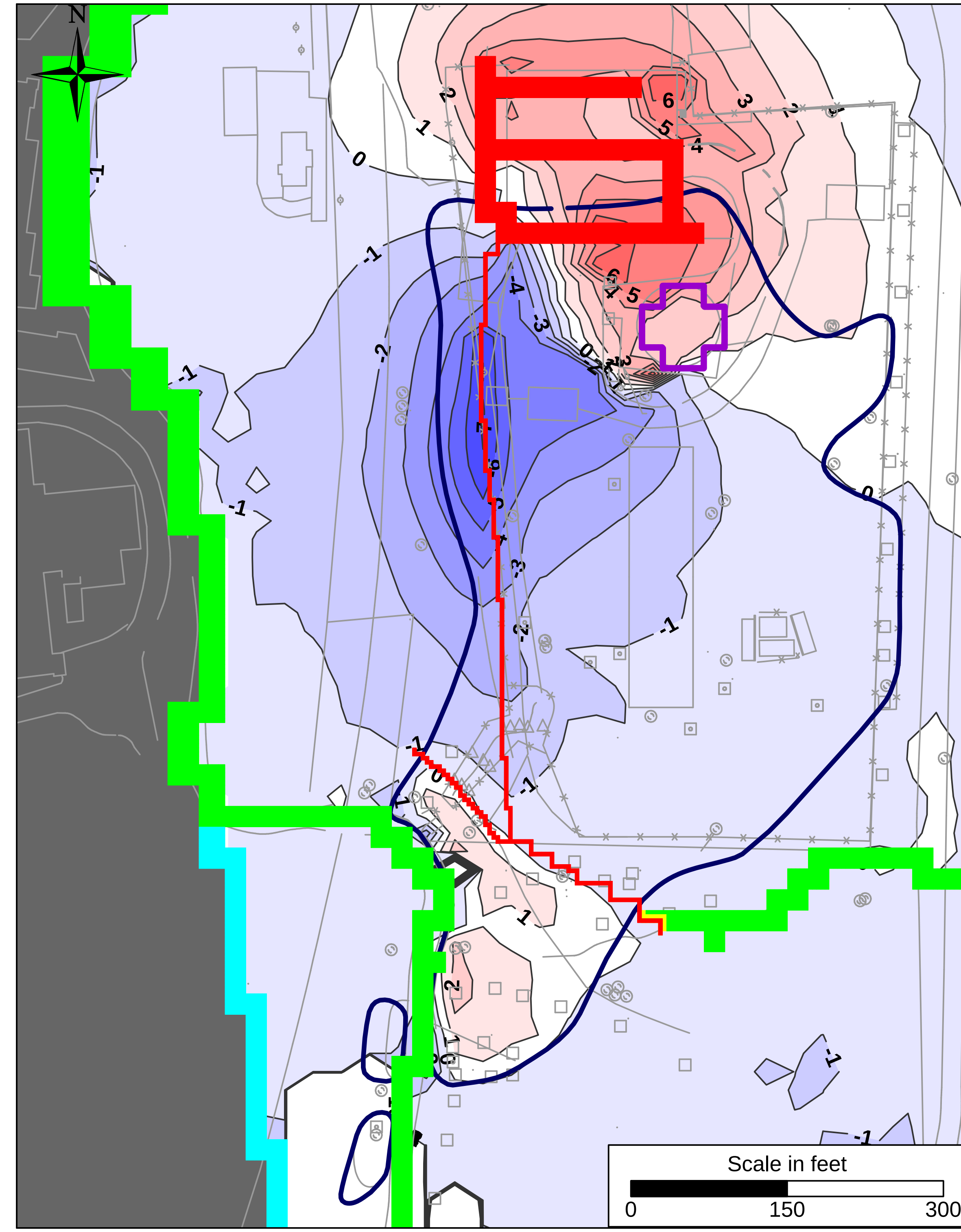
FIGURE
24

SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER MOUNDING



Legend

- River Boundary
- Drain Boundary
- General Head Boundary
- Hydraulic Flow Barrier
- No Flow (Inactive)
- 746 Simulated Water Table Elevation (feet, above mean sea level)
- Permeable Trench
- Simulated Groundwater Pathline (Arrows represent 50 feet of travel)

Change in Simulated Water Level (feet)

(Simulation Conditions - Calibration Conditons)

Drawdown | Mounding

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SIMULATED GROUNDWATER ELEVATIONS, MOUNDING, AND CAPTURE ZONES, SCENARIO 4

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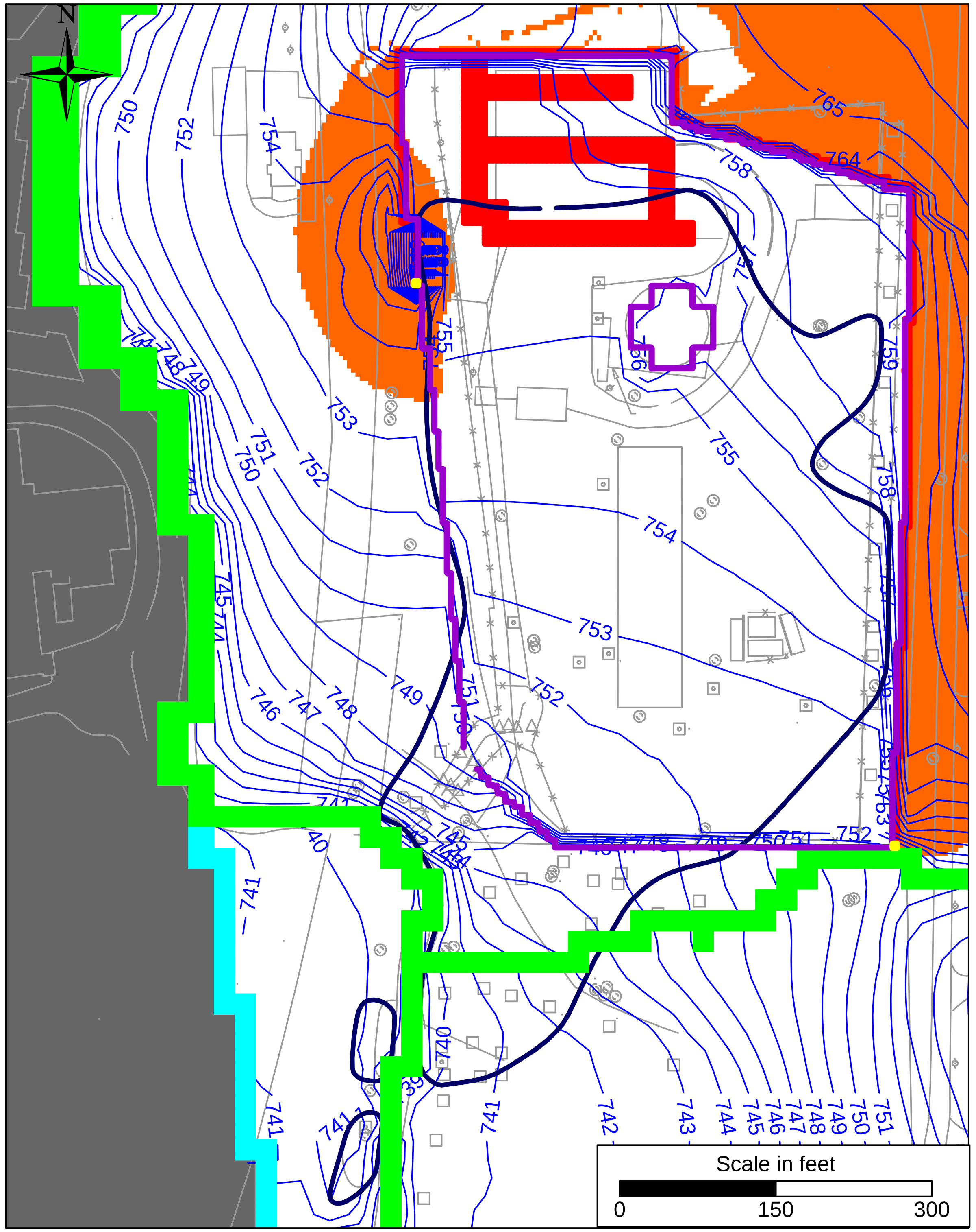
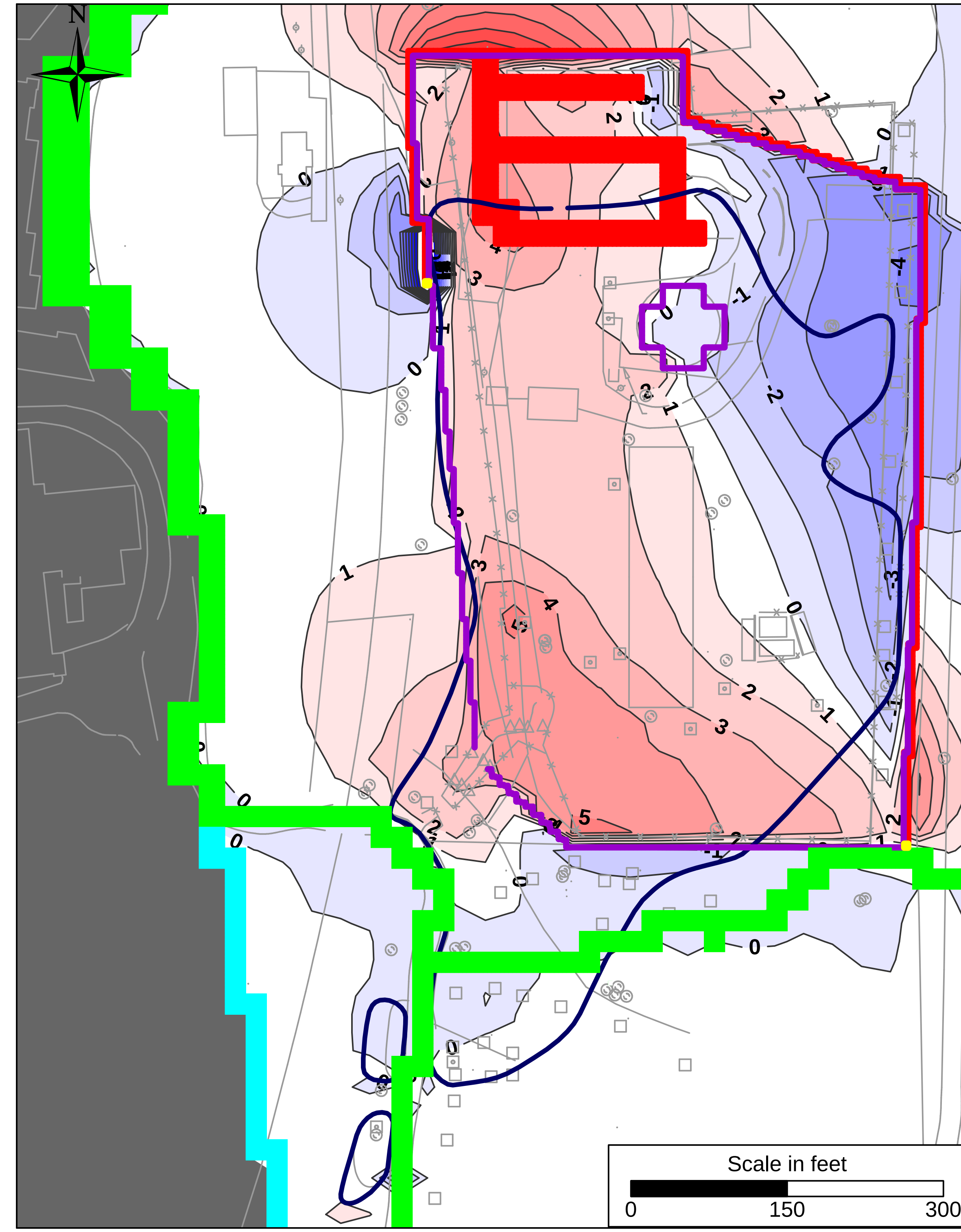
FIGURE 25

SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER MOUNDING



Legend

- River Boundary
- Drain Boundary
- General Head Boundary
- Hydraulic Flow Barrier
- No Flow (Inactive)
- 746 Simulated Water Table Elevation (feet, above mean sea level)
- Permeable Trench
- Simulated Groundwater Capture (Filled areas represent the 50 year capture extent)

Change in Simulated Water Level (feet)

(Simulation Conditions - Calibration Conditons)

Drawdown | Mounding

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SIMULATED GROUNDWATER ELEVATIONS, MOUNDING, AND CAPTURE ZONES, SCENARIO 5A

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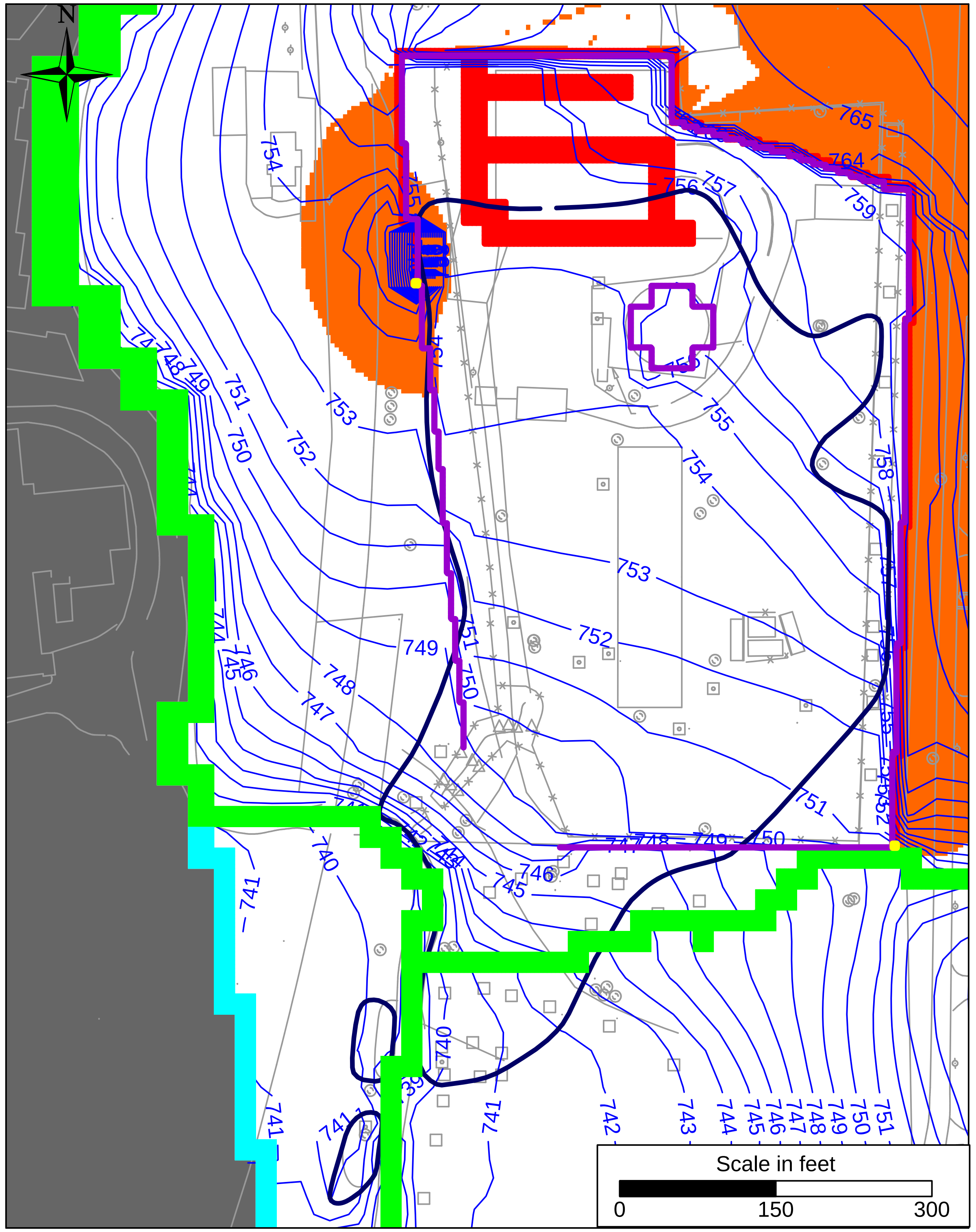
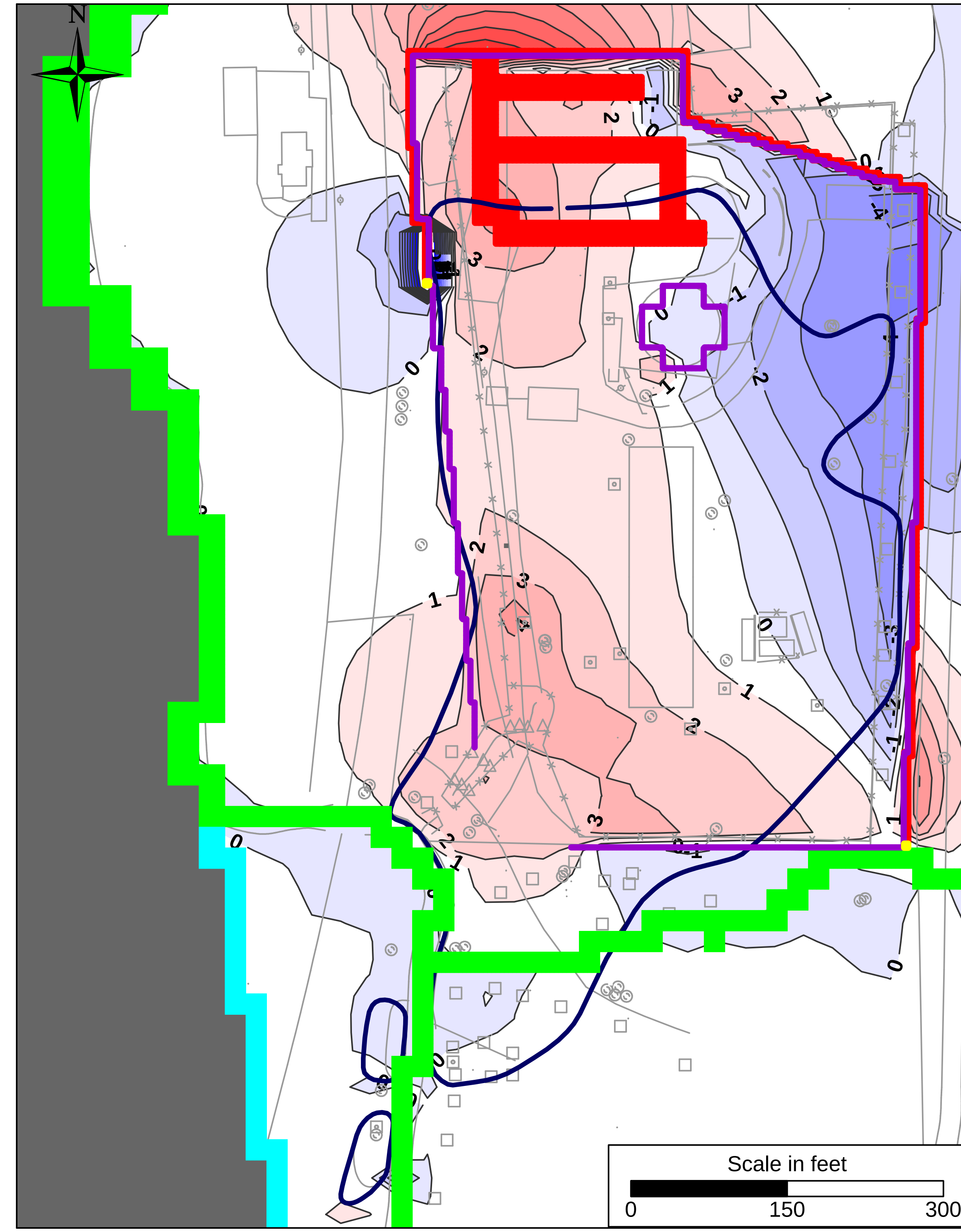
FIGURE 26

SIMULATED GROUNDWATER ELEVATION



SIMULATED GROUNDWATER MOUNDING



Legend

- River Boundary
- Drain Boundary
- General Head Boundary
- Hydraulic Flow Barrier
- No Flow (Inactive)
- 746 Simulated Water Table Elevation (feet, above mean sea level)
- Permeable Trench
- Simulated Groundwater Capture (Filled areas represent the 50 year capture extent)

Change in Simulated Water Level (feet)

(Simulation Conditions - Calibration Conditons)

Drawdown | Mounding

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

NATIONAL GRID
GLOVERSVILLE (HILL STREET) FORMER MGP SITE
GLOVERSVILLE, NEW YORK
GROUNDWATER MODELING TECHNICAL MEMO

SIMULATED GROUNDWATER ELEVATIONS, MOUNDING, AND CAPTURE ZONES, SCENARIO 5B

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FIGURE 27

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