DEC Approval Email for Norwich Final FS

From: Anthony Karwiel [mailto:alkarwie@gw.dec.state.ny.us]
Sent: Wednesday, December 05, 2007 9:00 AM
To: Blazicek, Tracy
Subject: Norwich Final FS

Tracy,
The Final FS, submitted by NYSEG, has included the revisions as requested by the Department and is acceptable. Departmental staff are currently working on the Draft PRAP. A draft copy of the PRAP will be sent to you, for review and comment, as soon as the in-house DEC review is complete and the NYSDOH has had a chance to review and comment on it.
The Final FS can be sent to the document repositories.

Thanks,
Tony

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FINAL FEASIBILITY STUDY REPORT
AND
FINAL FEASIBILITY STUDY REPORT ADDENDUM

NYSEG FORMER MGP SITE
NORWICH, NEW YORK

November 2007

Prepared for:

New York State Electric & Gas Corporation
Kirkwood Industrial Park
Binghamton, New York 13902

Prepared by:

Ish Inc.
804 Salem Woods Drive, Suite 201B
Raleigh, NC 27615

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FINAL FEASIBILITY STUDY REPORT

NYSEG FORMER MGP SITE
NORWICH, NEW YORK

This report presents the Feasibility Study conducted for the NYSEG Former MGP Site in Norwich, New York, and includes the development and evaluation of remedial alternatives performed consistent with NYSDEC guidance. Remedial Investigations completed prior to the preparation of this report provide the basis for the evaluation.

PROFESSIONAL ENGINEER CERTIFICATION

I, William J. Zeli, a Professional Engineer registered in the State of New York, certify that the evaluation referenced above has been conducted consistent with proper engineering practices and that, to the best of my knowledge and belief, this report accurately presents the findings of the evaluation.

William J. Zeli, P.E.
New York License No. 080787
MTR Engineering, Inc.

11/19/07
Date

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EXECUTIVE SUMMARY

This Feasibility Study Report was prepared on behalf of NYSEG (New York State Electric & Gas Corporation) to evaluate remedial alternatives for the Norwich former manufactured gas plant (MGP) site located in the City of Norwich, Chenango County, New York. The remedial alternatives were developed to achieve the remedial action objectives (RAOs) established through discussions with NYSDEC, NYSEG and Ish Inc. staff. Remedial Investigations completed prior to preparation of this report provide the basis for this evaluation.

Site Description and Background

The former MGP site is located at 24 Birdsall Street in the City of Norwich. MGP operations appear to have started sometime between 1863 and 1887. Major expansions to the facility occurred by 1917. Sometime following the cessation of gas production in 1953, former MGP structures were razed and subsequently NYSEG used the site for equipment storage. Today, much of the site is paved with asphalt or covered with compacted gravel. The site is bounded to the north by a plaza with retail shops, to the east by a NYSEG electric substation and residences, to the west by railroad tracks, and to the south by the former Aero Products property and residences. NYSEG purchased the former Aero Products property in 1993. During the summer of 2006, the Aero Products building was demolished.

In 1997, an interim remedial measure (IRM) consisting of excavation and disposal of about 11,500 tons of soil was completed to remove MGP residues from the Site. Soil vapor extraction (SVE) and air sparging systems were also installed and began operating in December 1999 and January 2000, respectively. The air sparging and SVE systems were shut down in June 2003.

Geology and Hydrogeology

Unconsolidated materials at the site consist of glacial lacustrine deposits overlain by a thin layer of alluvial sediments and fill. The fill depth has varied from less than 1 foot to greater than 11 feet within the former excavation area. The alluvium consists of sand and silt at thicknesses ranging from 1 to 8 feet. The alluvium is underlain by a layer of glacial outwash sand and gravel varying from 7 to 15 feet in thickness. The glacial outwash is underlain by deposits of silt and clay. The top of the silt and clay surface acts as a continuous confining layer beneath the shallow aquifer. The silt and clay layer was encountered between 8 and 25 feet below ground surface (bgs). There is a low in the silt and clay layer contour just north of the Site, and another low in the contour south of the site near Front Street.

Shallow groundwater occurs within the sand and gravel interval above the silt and clay confining layer. Depths to groundwater On-Site are generally 9 to 10 feet bgs, and depths to the south of the site (downgradient) are somewhat shallower (e.g., 6 to 7 feet bgs). The thickness of the aquifer is generally 10 to 15 feet, although thinner in some areas where the confining layer is relatively shallow. Shallow groundwater flows generally to the south at an estimated linear velocity of approximately 32 feet per year.

Soil Impacts

On-Site surface soil samples were analyzed during the Task II investigation in 1992. SVOC constituents were above background concentrations in areas associated with the former relief and distribution holders. The IRM soil removal performed in 1997 included approximately 3,300 tons of On-Site surface soils. Off-Site surface soil samples were analyzed during the Task II and Task III investigations. The results were below background concentrations for urban soil. Given the concentrations and completed IRM activities, surface soil is not a concern for the Norwich Site.

Evidence of coal tar NAPL, in the form of sheens and small NAPL globules, was observed in the subsurface soils across the majority of the Norwich former MGP site. NAPL has also migrated along the confining unit to the south, in the direction of groundwater flow. The confining silt and clay layer has prevented downward migration of the NAPL. The majority of the observed NAPL occurred in the 12 to 22 feet bgs interval On-Site, and in the 19 to 24 feet bgs interval in the Off-Site area to the south. Analytical results for subsurface and saturated zone soil samples confirm the general understanding of the nature and extent of impacts derived from the visual NAPL observations. The results confirm that VOCs, specifically BTEX, and SVOCs, specifically PAHs, are the constituents of concern.

Groundwater Impacts

Following the IRM in 1997 and the SVE and air sparging operations through 2003, MGP constituent concentrations in groundwater did not decrease over time. As a result, the Supplemental Remedial Investigation (SRI) was implemented in 2006 and the findings indicate that shallow groundwater has been impacted by VOCs and SVOCs in the saturated sand and gravel interval, present above the silt and clay confining layer. NYSDEC Class GA groundwater standards or guidance values were exceeded in shallow groundwater at sampling locations covering most of the former MGP site and in a plume extending approximately 700 feet to the south. VOCs and SVOCs were not detected in groundwater samples from perimeter locations providing a delineation of the extent of constituent migration within the shallow groundwater zone.

Soil Vapor Evaluation

During the SRI, the vapor intrusion pathway was examined to determine if impacted groundwater in the shallow zone presents a source for vapor phase migration into residences and buildings. Soil vapor intrusion (SVI) potential was evaluated at 14 properties, including 12 residences, one vacant commercial property and one active commercial establishment. Soil vapor or indoor air samples were collected over a period of 24 hours from the sub-slab, basement (where present) and first floor of each of the 14 properties investigated. Because the basement and first floor indoor air sample results were generally within their expected ranges based on the NYSDOH background database for residential properties, it was determined that soil vapors from the Norwich former MGP site are not affecting indoor air quality.

Remedial Goals and Remedial Action Objectives

Discussions with NYSDEC and NYSEG representatives in February 2007 led to establishment of the following RAOs for the NYSEG former MGP site in Norwich, New York:

Source Material:

On-Site

- Remediate, to the extent practicable, areas containing source material.
- Eliminate, to the extent practicable, potential human exposure to source material.

Off-Site

- Control future migration of source material from On-Site to Off-Site areas.
- Eliminate, to the extent practicable, potential human exposure to source material.

Groundwater:

On-Site

- Minimize potential risks to human health from exposure to groundwater containing MGP constituents.
- Improve groundwater quality where impacted by MGP constituents to achieve NYS SCGs, to the extent practicable.

Off-Site

- Minimize potential risks to human health from exposure to groundwater containing MGP constituents.

Subsurface Soil:

On-Site

- Eliminate, to the extent practicable, potential human exposure to subsurface soil containing MGP constituents.

Off-Site

- Eliminate, to the extent practicable, potential human exposure to subsurface soil containing MGP constituents.

Source material is defined as subsurface soils containing visible tar or visible oil, or a total PAH concentration of greater than 1,000 mg/Kg. Material with a visible sheen or stain, discoloration or odor or a total PAH concentration of less than 1,000 mg/Kg is not source material.

Development of Remedial Alternatives

Potentially applicable remedial technologies were identified based on experience at former MGP sites. Based on a preliminary screening, alternatives were developed for the detailed evaluation phase. Communications with NYSDEC representatives occurred as these alternatives were developed so that regulatory inputs could be obtained prior to conducting the detailed analysis.

The On-Site remedial alternatives include the following:

Alternative 1 – No Remedial Action (With Institutional Controls and Groundwater Monitoring)

The no remedial action alternative provides a baseline for comparison with the other alternatives, and is included in the evaluation for consistency with NYSDEC guidance. No future active remediation would be implemented under this alternative. Institutional controls that limit land and groundwater uses, a soil management plan for intrusive activities, and groundwater monitoring for a projected period of 30 years are included as components of this alternative.

Alternative 2 – Excavation of On-Site Source Material, Institutional Controls and Groundwater Monitoring

Alternative 2 involves excavation of On-Site source material within the vadose and saturated zones to the confining layer. An excavation depth of 22 feet within a surface area of approximately 52,200 square feet is estimated. The estimated 70,000 total tons to be excavated includes a contingency volume of approximately 10 percent and an anticipated significant volume of unimpacted material within the vadose zone. Excavated soil that is source material would be transported Off-Site to an acceptable treatment facility. Debris would be transported to a local landfill for disposal. Clean soil from a DOT-approved source would be used as backfill material, along with unimpacted material that would be reused within the lower portions of the excavated areas. Because the excavation would extend into the saturated zone, this alternative includes the installation of sheet piling around the excavation area perimeter. The sheet piling would also provide shoring for the excavation sidewalls. Excavation dewatering and water management systems would be provided at the site during implementation.

This alternative also includes institutional controls and groundwater monitoring as precautionary measures. Remaining soil impacts beyond the extent of the excavation area would be addressed by land use restrictions and a soil management plan for intrusive activities. Alternative 2 includes post-remediation groundwater monitoring for a projected period of three years. The monitoring duration is based on the significant removal of source material within the saturated zone.

Alternative 3 – Installation and Operation of a Free-Phase NAPL Passive Removal System at the Perimeter of the On-Site Source Area, Institutional Controls and Groundwater Monitoring

Alternative 3 addresses mobile, free-phase NAPL On-Site through installation of a collection trench along the downgradient perimeter of the On-Site source area to an estimated depth of 25 feet bgs. Monitoring/recovery points within the gravel trench would be used to determine if mobile NAPL is accumulating within the trench, and to periodically remove the NAPL when enough accumulation occurs. Extraction of groundwater would not be involved with this NAPL removal operation. As noted by the Department, this alternative is effective in containing contaminants from continued downgradient migration but would not remediate non-mobile NAPL.

Institutional controls and groundwater monitoring are included with this alternative. Potential soil exposures would be controlled by a land use restriction and soil management plan for intrusive activities. A groundwater use restriction would assure continued protection of human health. Groundwater monitoring would be implemented over a projected period of 30 years.

Alternative 4 – Installation of Full Barrier Containment System (e.g., Slurry Wall) Around Perimeter of On-Site Source Area with Cap/Cover on Surface, Institutional Controls and Groundwater Monitoring

Alternative 4 involves containment using a physical barrier around the On-Site source material perimeter and maintenance of a surface cap/cover within the containment area. The physical barrier would be approximately 1,100 feet in total length. The cement-bentonite slurry wall method of installation for the physical barrier to a depth of 25 feet has been assumed. Maintenance of a surface cap/cover would limit potential exposure to soil and minimize water infiltration within the physical barrier. Periodic groundwater extraction within the containment barrier is not anticipated.

Institutional controls and groundwater monitoring are included with Alternative 4. A land use restriction and soil management plan for intrusive activities would be used to control potential soil exposures. A groundwater use restriction would assure continued protection of human health. Groundwater monitoring would be implemented over a projected period of 30 years.

Alternative 5 – *In-Situ* Solidification/Stabilization of On-Site Source Material, Institutional Controls and Groundwater Monitoring

This alternative involves the *in-situ* solidification/stabilization (ISS) of On-Site source material. A total treatment depth of 24 feet within a surface area of approximately 52,200 square feet has been estimated. Because the bulk density of the treated material is increased, excess material is generated. Removal of 6 feet of surface material in advance of the ISS process was assumed (approximately 18,000 tons). This surface or overburden material removal would also address potential obstructions in advance of using the ISS process. For evaluation purposes, it was assumed that a sufficient volume of unimpacted material from the overburden removal would be available for use as backfill, and that excess material (estimated at 7,500 tons) would require Off-Site disposal.

Institutional controls and groundwater monitoring are included with Alternative 5. Remaining soil impacts beyond the extent of the ISS area would be addressed by a land use restriction and soil management plan for intrusive activities. A restriction on future groundwater use would assure continued protection of human health. Post-remediation groundwater monitoring would be implemented for a projected period of three years, based on the significant remediation of source material within the saturated zone.

Alternative 6 – *In-Situ* Chemical Oxidation (ISCO) For Treatment of Source Material in On-Site Areas, Institutional Controls and Groundwater Monitoring

This alternative involves the treatment of On-Site source material using *in-situ* chemical oxidation (ISCO) technology. ISCO involves the installation of injectors and the injection of reagents that chemically oxidize the constituents of interest. Although a significant reduction in constituent mass is possible, destruction of all of the free-phase NAPL mass may not be practical to attempt. Oxygen is generated in the ISCO treatment process that may promote biological degradation of residual dissolved phase constituents. Implementation may involve a period of about 15 months using two injection crews.

Institutional controls and routine groundwater monitoring are included with Alternative 6. Soil impacts that may remain within the unsaturated zone would be addressed by a land use restriction and soil management plan for intrusive activities. This alternative would involve imposing a groundwater use restriction and post-remediation groundwater monitoring for a projected period of 20 years.

The Off-Site remedial alternatives include the following:

Alternative 7 – No Remedial Action (With Institutional Controls and Groundwater Monitoring)

The no remedial action alternative provides a baseline for comparison with the other alternatives, and is included for consistency with NYSDEC guidance. Similar to Alternative 1 for the On-Site area, no active remediation would be implemented in the Off-Site area. The institutional controls included with Alternative 7 may vary for each residential/commercial property within the impacted area depending on the location, and are expected to include a groundwater use restriction at a minimum. A soil management plan would likely be appropriate at some locations, particularly those adjacent to the former MGP property, to address deeper excavations into the saturated zone. Land use restrictions may also be appropriate at some locations. Groundwater monitoring is included for a projected period of 30 years.

Alternative 8 – *In-Situ* Chemical Oxidation (ISCO) for Treatment of Off-Site Source Material, Monitored Natural Attenuation for Groundwater, and Institutional Controls

This alternative involves the treatment of Off-Site source material using *in-situ* chemical oxidation (ISCO) technology. Application of ISCO technology is discussed with On-Site Alternative 6. A significant reduction in constituent mass is possible, although complete destruction may not be practical to attempt where free-phase NAPL is present. Access constraints for properties, including a day care facility, are present within portions of the Off-Site source material area, which could exclude treatment of source material by ISCO on those properties. Implementation may involve a period of approximately three months using two injection crews.

Institutional controls included with Alternative 8 are expected to include a groundwater use restriction at a minimum, and soil management plan and land use restrictions where appropriate. Natural attenuation of dissolved phase constituents may be enhanced following the ISCO treatment, thereby further reducing groundwater concentrations. Groundwater monitoring is included for a projected period of 20 years.

Alternative 9 – *In-Situ* Enhanced Bioremediation (Injection of Oxygen-Supplying Product) for Treatment of Off-Site Groundwater beyond Source Material Areas, Institutional Controls and Groundwater Monitoring

Alternative 9 involves enhanced bioremediation of impacted groundwater using *in-situ* treatment. The treatment would involve injection of an oxygen-supplying product using temporary borings. Because enhanced bioremediation would have limited effectiveness within areas containing source material, this alternative involves *in-situ* treatment within areas of groundwater impacts beyond the extent of Off-Site source material. Two initial injection events at 100 spatial locations are assumed. Because re-impacts from the source material are expected, Alternative 9 also includes additional injections on a biannual basis (every two years) for a 20-year period.

Institutional controls would be utilized with Alternative 9, including groundwater use restrictions, land use restrictions and soil management plans as appropriate for the various properties. The anticipated reduction in dissolved phase constituent concentrations via enhanced bioremediation would be monitored for a projected period of 20 years.

Alternative 10 – Installation of Extraction Points in Off-Site Source Areas with Periodic Total Fluids Extraction and Transport to an Off-Site Facility, With Monitored Natural Attenuation for Groundwater, and Institutional Controls

Alternative 10 involves the installation of extraction points in the Off-Site source area, with periodic total fluids extraction and disposal at an Off-Site facility. Access constraints are present within portions of the Off-Site source material area. Installation of 18 extraction wells to a depth of 25 feet bgs is estimated, with periodic total fluids extraction using mobile high vacuum equipment (e.g., vacuum truck). Monitoring of potential NAPL accumulations, and total fluids extraction and disposal of approximately 3,600 gallons from six locations on a monthly basis has been assumed for a three-year period, followed by quarterly monitoring and extraction for seven additional years (10 years total).

Alternative 10 would include the use of institutional controls and groundwater monitoring. Institutional controls such as groundwater and land use restrictions and a soil management plan would be utilized, as appropriate, within the Off-Site area. Reductions in dissolved phase constituent concentrations would be monitored for a projected period of 20 years.

Detailed Evaluation of Remedial Alternatives

In accordance with regulatory guidance, the remedial alternatives were evaluated in detail using the following seven criteria:

- Overall protection of public health and the environment;
- Compliance with standards, criteria and guidance (SCGs);
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility or volume with treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

Comparative Analysis and Recommended Remedy

A comparative analysis of the remedial alternatives using the same criteria was also completed. Tables ES-1 and ES-2 present a summary of the overall acceptability of each alternative regarding the evaluation criteria for the On-Site and Off-Site alternatives, respectively.

On-Site Remedy

Alternative 1 (no remedial action) does not adequately address the RAOs and is not protective of human health and the environment. The containment alternatives, using a NAPL collection trench at the down gradient boundary (Alternative 3) or a physical barrier around the perimeter of the On-Site source material (Alternative 4), are both cost-effective approaches that should be adequately protective of human health. However, the lower overall level of protection of the environment and long-term maintenance requirements make Alternatives 3 and 4 less acceptable in comparison to Alternative 5.

Alternative 6 (ISCO treatment) has similar costs as Alternative 2 but has less certainty in performance than excavation, due primarily to the free-phase NAPL present within the On-Site source material area. Therefore, Alternative 6 is not a preferred remedial alternative. Although Alternative 2 (excavation of source material) would be highly effective in permanently removing the MGP-related impacts, there are significant implementation challenges and the substantially higher cost does not yield a proportionally higher degree of protection for human health and the environment in comparison to Alternative 5.

When considering all of the evaluation criteria, ISS (Alternative 5) appears to be the most effective alternative to address the On-Site source material. This remedial alternative addresses the On-Site RAOs by incorporating the following components:

- Source material is remediated through the use of *in-situ* solidification/stabilization technology to the extent practicable;
- Potential human exposure to residual source material is eliminated to the extent practicable through remediation and the use of institutional controls, including a land use restriction and soil management plan;
- Potential risks to human health from exposure to groundwater containing MGP constituents are minimized through the use of institutional controls and groundwater monitoring;

- Groundwater quality is improved to the extent practicable through the solidification of the source material area and the associated reduction or elimination of dissolved phase constituent mobility; and
- Potential human exposure to subsurface soil containing MGP constituents is eliminated to the extent practicable through remediation and the use of institutional controls, including a land use restriction and soil management plan.

In addition, the Off-Site RAO that involves controlling future migration of source material from On-Site to Off-Site areas is addressed by solidification/stabilization of the source material, which minimizes or eliminates potential mobility.

Off-Site Remedy

Alternative 7 (no remedial action) may adequately address the RAOs for Off-Site and be protective of human health and the environment. However, the other alternatives that involve active remediation provide a higher degree of protection. Given the variable nature of land use and MGP-related impacts within the Off-Site area, a phased approach for remediation is recommended that combines the remaining alternatives for remediation of the Off-Site impacts.

The first phase will entail removal of free-phase NAPL at *selected* Off-Site areas (Alternative 10) to improve effectiveness of the ISCO treatment. The second phase will implement Alternative 8 (ISCO treatment of Off-Site source material, along with institutional controls and groundwater monitoring) for source material treatment except for the two Off-Site properties adjacent to the site located north of Front Street (i.e., 37 and 41 Front Street). These properties are excluded from the first two phases of treatment because of their sensitive land uses/potential receptors (i.e., residential housing at one location and a day care facility at the other location).

It is further recommended that following a sufficient period (2 to 3 years) of monitoring subsequent to ISS treatment (if implemented), NAPL removal and ISCO treatment, NYSEG will consult with NYSDEC to determine the need for applying enhanced bioremediation (Alternative 9) for treatment of any remaining Off-Site residual groundwater impacts.

As noted in the preceding paragraphs, the two Off-Site properties north of Front Street (i.e., 37 and 41 Front Street) are not suitable locations for NAPL extraction and/or ISCO treatment because of their sensitive land uses/potential receptors. NYSEG will negotiate with both property owners to acquire both properties at fair market value. If NYSEG is successful in acquiring the two properties, the existing structures on the properties would be razed and On-Site Alternative 5 (*in-situ* stabilization) would be implemented on those properties. If NYSEG is not successful in acquiring the two properties, then NYSEG will confer with NYSDEC regarding options on how best to proceed with the remediation of the two properties.

In response to the comments from the Department, NYSEG has developed a separate Alternative 11 and has presented it in the Addendum to the final FS. This phased remedial approach as discussed in Alternative 11 further in the Addendum, addresses the Off-Site RAOs by incorporating the following components:

- If implemented, On-Site Alternative 5 (i.e., ISS technology for source material treatment) would control future migration of source material from On-Site to Off-Site areas, and more specifically in this case, it would control future migration of source material within the Off-Site area;
- Potential human exposure to source material is eliminated to the extent practicable through remediation (by ISCO, free-phase NAPL removal, and ISS if implemented) and the use of institutional controls, including land use restrictions and a soil management plan as appropriate for Off-Site properties;
- Potential risks to human health from exposure to groundwater containing MGP constituents are minimized through the use of institutional controls, groundwater monitoring and using enhanced bioremediation (Alternative 9) where appropriate; and
- Potential human exposure to subsurface soil containing MGP constituents is eliminated to the extent practicable through remediation (by ISCO, free-phase NAPL removal and ISS if implemented) and the use of institutional controls, including land use restrictions and a soil management plan as appropriate for each Off-Site property.

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1.0 INTRODUCTION

1.1 Purpose

This Feasibility Study Report (FS Report) was prepared on behalf of NYSEG (New York State Electric & Gas Corporation) to evaluate remedial alternatives for the Norwich former manufactured gas plant (MGP) site located in the City of Norwich, Chenango County, New York. This work was performed in compliance with an Order on Consent between NYSEG and the New York State Department of Environmental Conservation (NYSDEC).

This FS Report presents an evaluation of potential remedial alternatives. The alternatives evaluation was conducted in accordance with appropriate regulatory guidance, including Technical Guidance for Site Investigation and Remediation (NYSDEC, December 2002). Requirements of pertinent NYSDEC regulations, including Part 375 – Environmental Remediation Programs (NYSDEC, December 2006), were considered in the development and evaluation of the alternatives. Remedial Investigations for the site were completed prior to preparation of this report, and provide the basis for this evaluation.

1.2 Site Description

The MGP site previously occupied approximately one acre of land located at 24 Birdsall Street in the City of Norwich, Chenango County, New York (see Figure 1-1). In the years following cessation of gas production, former MGP structures were razed and subsequently NYSEG used the site for equipment storage. Today, much of the property is paved with asphalt or covered with compacted gravel. The site is bounded to the west by railroad tracks. A NYSEG electric substation exists on the eastern portion of the Site, and private residences are located east of the former MGP.

The northern part of the former MGP location has been encroached by a plaza with retail shops. NYSEG purchased the former Aero Products facility located to the south and used the building for storage for several years. During the summer of 2006, NYSEG demolished the former Aero Products building. The Off-Site area that extends to the south of the former Aero Products building is comprised of mostly residential housing.

1.3 Site Background

MGP operations appear to have started sometime between 1863 and 1887. The gas manufacturing process and the feed fuels were changed several times during the operational history of the MGP. Oil, coal and coke were used at various times as feed fuels for the coal gasification, water gas and/or carbureted water gas processes used at the plant.

Historical Sanborn maps from 1887 show that the gas works facility operated by Norwich Gas Light Company consisted of a large coal storage area, a 35,000 cubic foot gas holder or gasometer, and a main production building situated over a tar well. Coke storage facilities and several other buildings were also present On-Site. In 1892, the operator name was changed to Norwich Illuminating Company, which was changed again in 1917 to Norwich Gas and Electric Company. Major expansions to the facility at that time, including a water gas plant and an electric power plant, are indicated on the Sanborn map. Modifications included the construction of two steel gas holders, three oil tanks, a purifier building, and additional coal storage. NYSEG acquired the property by 1939 and Sanborn maps from that time indicate a tar pit on the west side of the purifier building and an oxide storage area in the purifier building, indicating that the gas cleansing process was used. Gas plant structures were razed sometime after gas works operations ceased in 1953.

In 1997, an interim remedial measure (IRM) was completed by NYSEG to remove MGP residues from source areas at the Site. During the IRM, approximately 11,500 tons of soil were excavated and removed from the Site. In addition, the below-ground portions of the vertical air sparging and horizontal soil vapor extraction (SVE) systems were installed at that time. The SVE system began operating in December 1999 and the vertical air sparging system was activated in January 2000. The air sparging/SVE system was shut down in June 2003. Based on calculations in the final semi-annual status report for the system (Shaw, July 2003), approximately 586 pounds of benzene, toluene, ethylbenzene and xylenes (BTEX) and 761 pounds of total volatile organic compounds were removed from the subsurface by the air sparging/SVE system during its operation.

2.0 SUMMARY OF INFORMATION FROM THE SRI REPORT

2.1 Geology and Hydrogeology

2.1.1 Site Geology

Prior to the 1997 IRM that included removal of impacted soils, the unconsolidated materials under the site were described as consisting of Quaternary glacial lacustrine deposits overlain by a thin layer of alluvial sediments and fill. The observed depth of fill has varied from less than 1 foot to the south, east and west of the site to greater than 11 feet On-Site within the former excavation area that extended from the former relief holder to the tar wells and gas plant building to the southwest.

During the years 2005 and 2006, Ish Inc. completed a Supplemental Remedial Investigation (SRI) for the Norwich site and found the fill at the site generally consists of varying quantities of silt, sand and gravel. The alluvium consists of sand and silt observed at thicknesses ranging from 1 to 8 feet. The alluvium is underlain by a layer of glacial outwash sand and gravel varying from 7 to 15 feet in thickness. The glacial outwash is underlain by glacial lacustrine deposits of silt and clay. No borings fully penetrated the lacustrine layer and therefore its thickness is unknown.

The top of the silt and clay surface acts as a continuous confining layer beneath the thin shallow aquifer. The silt and clay layer was encountered between 8 and 25 feet below ground surface (bgs), and was typically 22 to 24 feet bgs. A contour map of the silt and clay layer surface is provided as Figure 2-1. The surface of the confining layer on the site generally slopes toward the center of the site from the east and west, with a dip to the south on the southern portion of the site and a dip to the north on the northern portion of the Site. There is a low in the contour just north of the site at boring DP28. In addition, there is a low in the contour south of the site near Front Street, in the area of borings DP23, DP26, DP37 and DP40. This contour is consistent with the dense non-aqueous phase liquid (DNAPL) observed in this area and the generally north to south flow of groundwater from the Site. Beyond this low to the south, the silt and clay layer rises slightly to the approximate elevation found On-Site.

Four geologic cross-sections for the site and surrounding area were presented in the SRI Report (Ish Inc., October 2006) based on previously gathered information and the results of soil borings from the SRI work. The geologic cross-sections run from north to south, across the site from southwest to northeast, approximately east to west just south of the Site, and generally east to west to the south of Front Street.

2.1.2 Site Hydrogeology

Shallow groundwater at the site occurs within a sand and gravel interval above the top of the silt and clay confining layer. The depth to groundwater ranges from approximately 4 to 14 feet bgs within this zone. Depths to groundwater On-Site are generally 9 to 10 feet bgs, and depths to the south of the site (downgradient) are somewhat shallower (e.g., 6 to 7 feet bgs). The thickness of the aquifer is generally 10 to 15 feet, although thinner in some areas where the confining layer is relatively shallow. The confining layer that underlies the shallow groundwater zone is present at depths ranging from approximately 8 to 25 feet, and was typically encountered at 22 to 24 feet bgs. Comparison of water levels in wells screened within the upper and lower portions of the shallow groundwater zone indicates that the vertical hydraulic gradient is negligible.

Shallow groundwater flows generally to the south, with some convergence from the east and west immediately around the former MGP location. The horizontal hydraulic gradient at the site is relatively flat, with the average for two monitoring events conducted in 2005 estimated at 0.0012 feet/feet. The hydraulic conductivity of the shallow zone has been estimated at 25.8 feet per day, based on the geometric mean of slug test data obtained by Engineering-Science, Inc. in 1992. Assuming an effective porosity for the sand and gravel interval of 0.35, the estimated linear shallow groundwater velocity is approximately 32 feet per year.

2.2 Nature and Extent of Subsurface Impacts

Characterization of the nature and extent of environmental impacts at the Norwich former MGP site was completed during the SRI. The constituents analyzed included volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and total cyanide. Results were compared to recommended soil cleanup objectives (RSCOs) provided in NYSDEC guidance TAGM 4046 (NYSDEC, January 1994) or the Class GA groundwater standards or guidance values provided in NYSDEC guidance (NYSDEC, June 1998).

2.2.1 Impacts to Surface Soil

Five On-Site surface soil samples were analyzed for VOCs, SVOCs and total cyanide during the Task II investigation in 1992. Where detected, VOCs and total cyanide were limited to very low concentrations. SVOC constituents, specifically polycyclic aromatic hydrocarbons (PAHs), were described as above background concentrations in the areas associated with the former relief and distribution holders. The IRM soil removal performed in 1997 included approximately 3,300 tons of On-Site surface soils. Six Off-Site surface soil samples were analyzed for VOCs, SVOCs and total cyanide during the Task II and Task III investigations. The results were characterized as below background concentrations for urban soil.

Given the concentrations and completed IRM activities, the potential for exposure to MGP-related constituents in surface soil (either On-Site or Off-Site) is insignificant. As a result, surface soils are not a concern to be addressed in this FS.

2.2.2 Impacts to Subsurface and Saturated Zone Soils

Evidence of coal tar NAPL, in the form of sheens and small NAPL globules, was observed in the subsurface soil across the majority of the former MGP site. NAPL has also migrated Off-Site along the surface of the silt and clay confining unit to the south of the Site, in the direction of groundwater flow. Locations with visual observations of sheen or NAPL in subsurface or saturated zone soil are identified on Figure 2-2. The NAPL observed was reddish-brown in color and was intermixed with water within the pore spaces of the relatively loose sand and gravel outwash present in the shallow aquifer above the silt and clay confining layer. The confining layer contour map (Figure 2-1) shows a depression in the area of borings DP23, DP37, DP26 and DP40, which is consistent with the NAPL observed in this area. The silt and clay layer appears to have prevented further downward migration of the NAPL, which has spread laterally and with the flow of groundwater to the south.

At the former MGP location and on the former Aero Products building property, scattered NAPL impacts were observed in a 5 to 10 feet thick zone. Further south, NAPL impacted layers, when present, were less than 5 feet thick. When observed, NAPL was found at depths ranging from approximately 7 to 26 feet bgs. The majority of the observed NAPL occurred in the 12 to 22 feet bgs interval On-Site, and 19 to 24 feet bgs interval Off-Site. Substantial NAPL was observed in GW01-15D, GW04-16 and PZ09 during monitoring well and piezometer gauging events. GW01-15D and GW04-16 are located On-Site and PZ09 is located in the low area of the clay contour south of Front Street, where substantial NAPL was observed during soil boring activities. These data indicate that in some On-Site areas and in one Off-Site area downgradient from the Site, there is sufficient NAPL present in the subsurface to collect in monitoring wells or piezometers.

The cross-sections provided in the SRI Report (Ish Inc., October 2006) indicate that NAPL is present in the saturated sand and gravel interval above the confining layer, which is consistent with a southerly migration of NAPL and groundwater flow from the Site.

Analytical results for subsurface and saturated zone soil samples submitted for analyses confirmed the general understanding of the nature and extent of impacts based on the visual NAPL observations. The results confirm that VOCs (specifically BTEX) and SVOCs (specifically PAHs) are the constituents of concern at the Site. BTEX compounds were detected in many subsurface samples from the saturated soils above the silt and clay layer at levels above New York State Technical and Administrative Guidance Memorandum (TAGM) #4046 RSCOs. No VOCs other than BTEX were detected above RSCOs. The vast majority of the SVOCs detected at the site were PAHs. In addition to PAHs, dibenzofuran was the only other SVOC detected above its RSCO. Similar to the BTEX results, a number of samples collected from the saturated soils above the silt and clay layer contained one or more SVOCs at concentrations above their respective RSCOs.

The analytical data, along with the observations of NAPL in the subsurface, indicate that there is NAPL present across the site in the saturated zone that is confined from moving downward by the silt and clay layer but has moved Off-Site to the south and into the depression in the confining layer to the south of Front Street. The VOC and SVOC results confirm that the impacts from MGP residuals (coal tar) that are present in the sand and gravel interval are not migrating deep into the silt and clay confining unit. VOCs and SVOCs were not detected and no sheens or NAPL were observed in soil samples from perimeter borings, which provides a delineation of MGP-related impacts.

2.2.3 Impacts to Groundwater

Because of the remedial activities conducted at the Site, including the IRM excavation in 1997 and the air sparging/SVE system operation from 1999 to 2003, a decreasing trend of chemical concentrations in groundwater might be expected. However, groundwater concentrations did not show a consistent decrease in dissolved MGP constituents over time. As a result, the SRI was implemented to determine the nature and extent of potential source material remaining in the subsurface, as well as the full extent of the Off-Site groundwater plume.

The SRI Report (Ish Inc., October 2006) documents the occurrence of constituents of concern in groundwater. Shallow groundwater at the site has been impacted by VOCs and SVOCs related to MGP residuals in the saturated sand and gravel layer, present above the silt and clay confining layer. NYSDEC Class GA groundwater standards or guidance values were exceeded in groundwater at sampling locations covering most of the former MGP location and in a plume extending approximately 700 feet Off-Site to the south. VOCs measured above the Class GA groundwater standards or guidance values included BTEX and isopropylbenzene. SVOCs measured above the standard or guidance values were primarily PAHs. The depth to groundwater at the site and surrounding areas varies from approximately 4 to 14 feet bgs with an aquifer thickness of generally 10 to 15 feet thick.

VOCs and SVOCs were not detected in groundwater samples from perimeter locations, which provide a delineation of the extent of constituent migration within the shallow groundwater zone. The MGP-related groundwater impacts are consistent with the groundwater flow direction at the Site, which is to the south. The approximate extent of groundwater impacts based on the findings of the SRI is depicted on Figure 2-3.

2.3 Soil Vapor Evaluation

As part of the SRI work, the soil vapor intrusion pathway was examined to determine if impacted groundwater in the shallow zone presents a source for vapor phase migration into residences and buildings. Soil vapor intrusion (SVI) potential was evaluated at 14 properties during SRI activities, including 12 residences and one vacant commercial building to the south and one commercial location to the north. The area of interest for the SVI evaluation is mostly located downgradient (to the south) of the former MGP location. A commercial plaza located just to the north occupies part of the former MGP location. The Off-Site groundwater plume area to the south is a mostly residential neighborhood, comprised of two story homes with one or two families. Most of the residential basements were not finished and if used at all were used for storage and laundry. Most of the basements did not have a complete concrete floor, and four locations had only a dirt floor. At the southern end of the potentially impacted area is a vacant one story commercial building. The western side of the potentially impacted area includes a railroad right-of-way.

Soil vapor or indoor air samples were collected over a period of 24 hours from the sub-slab, from the basement (where present) and from the first floor of each of the 14 buildings investigated. Basement and first floor air samples were collected from the breathing zone height (i.e., 3 to 5 feet above the floor). First floor air samples were collected from a living space. For each day of sampling, three outdoor air samples were collected.

Low levels of VOCs were detected in most of the samples collected. The presence of these compounds in indoor air samples is not unexpected given their widespread use in common household products. Because of the ubiquitous nature of these chemicals, it was not possible to attribute them to any particular source. Because the chemicals detected in the basement and first floor indoor air samples at each location were generally within their expected ranges based on the NYSDOH background database for residential sites, it was determined that soil vapors from the former MGP site are not affecting indoor air quality at the test locations.

3.0 REMEDIAL GOALS AND REMEDIAL ACTION OBJECTIVES

The selected remedy will eliminate or mitigate significant threats to public health and the environment associated with the former MGP operations. Discussions with NYSDEC and NYSEG representatives in February 2007 led to establishment of the following Remedial Action Objectives (RAOs) for the NYSEG former MGP site in Norwich, New York:

Source Material:

On-Site

- Remediate, to the extent practicable, areas containing source material.
- Eliminate, to the extent practicable, potential human exposure to source material.

Off-Site

- Control future migration of source material from On-Site to Off-Site areas.
- Eliminate, to the extent practicable, potential human exposure to source material.

Groundwater:

On-Site

- Minimize potential risks to human health from exposure to groundwater containing MGP constituents.
- Improve groundwater quality where impacted by MGP constituents to achieve NYS SCGs, to the extent practicable.

Off-Site

- Minimize potential risks to human health from exposure to groundwater containing MGP constituents.

Subsurface Soil:

On-Site

- Eliminate, to the extent practicable, potential human exposure to subsurface soil containing MGP constituents.

Off-Site

- Eliminate, to the extent practicable, potential human exposure to subsurface soil containing MGP constituents.

Source material is defined as subsurface soils containing visible tar or visible oil, or a total PAH concentration of greater than 1,000 mg/Kg. Material with a visible sheen or stain, discoloration or odor or a total PAH concentration of less than 1,000 mg/Kg is not source material.

The approximate aerial extent of source material, both On-Site and Off-Site, is depicted on Figure 3-1. The approximate extent of significant MGP-related groundwater impacts is also identified on Figure 3-1. The occurrence of source material is generally limited to the saturated sand and gravel interval above the silt and clay confining layer. The source material primarily occurs at approximate depths of 12 to 22 feet bgs On-Site, and in the 19 to 24 feet bgs interval to the south of the Site. Impacted groundwater occurs within the same interval, with vertical migration prevented by the confining layer. Depth to groundwater generally ranges from approximately 6 to 10 feet bgs within this area.

4.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

4.1 Preliminary Screening

Potentially applicable remedial technologies have been identified based on the experience of NYSEG and the Ish Inc. team at similar former MGP sites.

Remediation Technologies for Unsaturated Soils

Technologies for addressing unsaturated zone soils within the areas of interest are identified in Table 4-1. Nine general technologies are included. As noted in the table, technologies may be combined to develop alternatives for the evaluation to identify a preferred alternative.

As summarized in Table 4-1, five soil technologies have been eliminated from further consideration. *In-situ* chemical oxidation (ISCO) is not appropriate to address impacts within the unsaturated zone at the Site, but is considered further to address NAPL and groundwater impacts within the saturated zone. *In-situ* biological treatment was eliminated because vadose zone impacts are limited, and it would not be effective On-Site in conjunction with saturated zone treatment due to the presence of source material with a significant amount of NAPL. Soil venting was eliminated because of limited vadose zone impacts, unless it is necessary in conjunction with treatment within the saturated zone that results in volatilization of constituents. Excavation with On-Site thermal desorption treatment and backfill is not feasible at the NYSEG Norwich site because of implementation concerns due to residences in the vicinity of the Site.

Institutional controls and maintenance of a surface cover were eliminated as stand-alone remediation technologies, but are retained for consideration as components of other alternatives. The primary soil technologies retained for further evaluation include no action, *in-situ* stabilization (ISS) and excavation with Off-Site treatment and disposal. No action (combined with institutional controls and monitoring) is being retained as a baseline for comparison with other alternatives. Excavation within the unsaturated zone with Off-Site treatment and disposal is being retained in conjunction with excavation to address saturated zone impacts. ISS is being retained for further consideration for On-Site vadose zone impacts in conjunction with its application to remediate source material within the On-Site saturated zone. As requested by the Department, NYSEG has included the following summary of field scale application of the ISS technology at MGP sites in the U.S.

Over the last 15 years the following seven MGP sites have used In-Situ Stabilization/Solidification (ISS) technology to remediate subsurface soils/materials containing coal tar NAPL. There are additional MGP sites that are planning to implement ISS technology in the near future.

Site Name and State	Cubic Yards of Material	Year ISS implemented
Columbus, GA	84,000	1992
Macon, GA	35,000	2002
Augusta, GA	71,000	2003
Appleton, WI	33,850	2004
Westside, WI	35,000	2006
Racine, WI	6,350	2006
Nyack, NY	13,400	2007

The Columbus, GA site was the first full scale and large ISS project for an MGP site carried out by Georgia Power Company. After 10 years of the solidification/stabilization work, an evaluation of the effectiveness of the ISS technology use at the Columbus site was performed and an EPRI report No. 1009095 was published in September 2003, which provides the technical information on effectiveness of the ISS technology at the Columbus former MGP site.

NAPL and Groundwater Remediation Technologies

Technologies for addressing NAPL and groundwater within the areas of interest at the site are identified in Table 4-2. Twelve general technologies are included. As noted in the table, technologies may be combined to develop alternatives for the evaluation.

As summarized in Table 4-2, three technologies have been completely eliminated from further consideration. *In-situ* thermal treatment was eliminated because of the site setting and potential for the technology to cause air emission concerns. Hydraulic containment was eliminated because a physical barrier was selected for evaluation of a containment approach for On-Site source material. Groundwater extraction and treatment technology was eliminated due to potential implementation constraints and its limited effectiveness. Institutional controls and groundwater monitoring were also eliminated as stand-alone technologies, but retained as components of other alternatives.

The primary NAPL and groundwater technologies retained for further evaluation include no action, NAPL collection, source removal via excavation, *in-situ* treatment (using ISS, ISCO or enhanced bioremediation technologies), or physical containment. No action is being retained as a baseline for comparison with other alternatives. NAPL collection will be evaluated using a collection trench at the downgradient perimeter of the On-Site source area, and using wells for periodic extraction of fluids within the Off-Site source area. Removal of source material within the saturated zone On-Site via excavation will be considered further along with the necessary hydraulic controls for implementation. ISS will be considered further for On-Site source material. ISCO will be evaluated for both On-Site and Off-Site source material areas. *In-situ* bioremediation will be retained for evaluation as a component to address Off-Site groundwater impacts beyond the extent of the source material area. Containment using a physical barrier around the perimeter of the On-Site source material will also be retained for the alternatives evaluation.

4.2 Identification of Alternatives

Based on the preliminary screening of potentially applicable remedial technologies, alternatives have been developed for the detailed evaluation phase of the FS for the NYSEG Norwich site. Table 4-3 identifies the six On-Site alternatives and four Off-Site alternatives that have been retained for evaluation.

Communications with NYSDEC representatives have occurred as these alternatives were developed so that potential regulatory inputs could be obtained prior to conducting the detailed analysis. The remedial alternatives are described further in Section 5.0 of this FS, and are evaluated in detail using the criteria specified by NYSDEC.

5.0 EVALUATION OF REMEDIAL ALTERNATIVES

The remedial alternatives identified in Section 4.0 are described in further detail in this section. In accordance with regulatory guidance entitled Technical Guidance for site Investigation and Remediation (NYSDEC, December 2002), the remedial alternatives are also evaluated using the following criteria:

- Overall protection of public health and the environment;
- Compliance with standards, criteria and guidance (SCGs);
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility or volume with treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

Each alternative is first evaluated independently. The ability of each alternative to achieve the RAOs identified in Section 3.0 is considered in evaluating overall protection of public health and the environment. Compliance with SCGs includes consideration of the actions involved as well as groundwater and soil quality. Potentially applicable SCGs are identified in Section 7.0 and Appendix 7A of the DER-10 guidance document (NYSDEC, December 2002).

5.1 On-Site Alternatives

A summary of the On-Site alternatives evaluation is presented in Table 5-1. Cost estimates for each alternative, developed for comparative purposes, are presented in Table 5-2. A comparative analysis using the same criteria follows in Section 6.0.

5.1.1 Alternative 1 – No Remedial Action (With Institutional Controls and Groundwater Monitoring)

The no remedial action alternative provides a baseline for comparison with the other alternatives, and is included in the evaluation for consistency with NYSDEC guidance (NYSDEC, December 2002). On-Site remediation was previously conducted during the IRM activities and subsequent operation of the air sparging/SVE system. No future active remediation would be implemented under this alternative.

Institutional controls that limit land and groundwater uses, a soil management plan for intrusive activities, and routine groundwater monitoring are included as components of this alternative.

The no remedial action alternative would not impact current or expected future land uses at the Site. Soil and groundwater quality would not be effected other than through natural attenuation. The surface cover currently in place limits potential human exposures to soils, and maintenance of the cover would occur. Institutional controls would assure continued protection of human health On-Site. Potential exposure to impacted soil would be controlled by a land use restriction and soil management plan. Groundwater standards would not be met. Exposure to impacted groundwater does not currently occur as On-Site shallow zone groundwater is not used. A groundwater use restriction would assure that On-Site exposure to impacted groundwater does not occur.

Groundwater monitoring is included with the no remedial action alternative. The estimated monitoring costs are based on analyses of groundwater samples collected at eight locations on an annual basis for a period of 30 years. The well network and monitoring program would be finalized prior to implementation. As part of the monitoring events, groundwater level measurements would be obtained to evaluate groundwater flow directions and assure that an appropriate monitoring well network is maintained.

Overall Protection of Public Health and the Environment

The current surface cover provides protection from direct exposure to soil. There is no current or anticipated future use of groundwater within the On-Site impacted area. However, the presence of source material within the saturated zone under this alternative poses a continued threat to the subsurface environment.

RAOs that involve exposure controls are addressed. Active remediation of source material or groundwater would not occur, nor would any active measures be used to control potential future migration of source material to Off-Site areas. Alternative 1 reduces the potential for human exposure to source material and impacted groundwater through the use of institutional controls. The no remedial action alternative is low in acceptability because it is not adequately protective of public health or the environment. Furthermore, the potential for human exposure to MGP constituents can be reduced/minimized by active remedial actions.

Compliance With SCGs

Actions under Alternative 1 would be limited to institutional controls (including land and groundwater use restrictions and a soil management plan) and groundwater monitoring. Compliance with SCGs associated with these actions would primarily involve proper management of purge water from well sampling activities and segregated soil from On-Site excavations, which is achievable.

Remediation of source material or soils exceeding NYSDEC recommended soil cleanup objectives would not occur. The objective of improving groundwater quality to NYS SCGs On-Site would not be achieved with this alternative. The overall acceptability of this alternative is low regarding this criterion.

Long-Term Effectiveness and Permanence

The soil management plan and land use restriction would address potential exposures to impacted soil. There is no current or anticipated future use of groundwater within the impacted area. Therefore, a groundwater use restriction and monitoring should be adequate to provide long-term protection from potential exposures to impacted groundwater.

Risks related to the continued presence of source material in the subsurface would persist, and long-term impacts to groundwater quality would continue unless the source material is addressed. This alternative is low in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

No active treatment of soil or groundwater would occur with Alternative 1. Significant reductions in constituent concentrations through natural attenuation are not expected to occur without removal/destruction of source material. Constituent mobility would not significantly change.

NAPL within the saturated zone would remain as a source of dissolved phase constituents that will continue to migrate with groundwater flow and maintain the current groundwater plume. Acceptability regarding this criterion is low because the toxicity, mobility or volume of constituents would not be reduced.

Short-Term Effectiveness

The no action alternative would not have any adverse short-term effects on the community or remediation workers. Short-term environmental impacts beyond the current extent of constituent occurrence are not expected. Alternative 1 is highly effective in the short-term, although groundwater monitoring would occur for a projected period of 30 years.

Implementability

This alternative would not impact current or expected future land uses, other than the need to maintain the existing monitoring well network. Institutional controls such as use restrictions are commonly adopted. Groundwater monitoring and management of soil from excavations are routine tasks. Therefore, this alternative is readily implementable, although it may not be acceptable to regulatory agencies.

Cost

The initial cost to implement Alternative 1 is estimated at $19,000, to cover preparation of the land and groundwater use restrictions, soil management plan and groundwater monitoring plan. Annual costs for groundwater monitoring and periodic cover maintenance and soil management activities, including project management and reporting, are estimated at $26,000.

Assuming monitoring and management activities occur over a 30-year period, the estimated total present worth cost is approximately $418,700. Table 5-2 provides the detailed cost estimate for Alternative 1. This alternative is considered very good in acceptability regarding the cost criterion.

5.1.2 Alternative 2 – Excavation of On-Site Source Material, Institutional Controls And Groundwater Monitoring

Alternative 2 would involve excavation of On-Site source material within the vadose and saturated zones to the confining layer. The excavation would include removal of former MGP structures that remain in the subsurface following the IRM excavation in 1997. This alternative also includes institutional controls and groundwater monitoring as precautionary measures.

The general area for the excavation activities used for evaluation purposes is identified on Figure 5-1. The confining layer depth varies from 14 to 26 feet bgs across the Site, and was typically encountered at approximately 18 to 20 feet bgs during SRI activities. An excavation depth of 22 feet within a surface area of approximately 52,200 square feet has been estimated for evaluation purposes. The delineation of source material would be refined and the planned extent of soil excavation would be finalized during the remedial design phase should this alternative be chosen for implementation.

The estimated 70,000 total tons of soils to be excavated for Alternative 2 includes a contingency volume of approximately 10 percent and an anticipated significant volume of unimpacted material within the vadose zone, particularly where IRM activities were previously conducted. Excavated soil that is MGP residuals-impacted would be transported off-site to a low temperature thermal desorption (LTTD) or other acceptable treatment facility. Debris would be transported to a local landfill for disposal. Approved waste profiles would be in place meeting acceptance criteria for the Off-Site facilities utilized for disposal. Clean soil from a DOT-approved source would be used as backfill material, along with unimpacted material that would be reused within the lower portions of the excavated areas.

Because the excavation would extend into the saturated zone, where a significant amount of groundwater inflow is anticipated, this alternative includes the installation of hydraulic controls to support the excavation activities. For evaluation purposes, installation of sheet piling around the excavation area at the perimeter depicted on Figure 5-1 has been assumed. The sheet piling would also provide shoring of the excavation sidewalls. The proposed hydraulic control location is tentative at this time, and would be determined based on information obtained during the remedial design investigation. Other methods of hydraulic control (e.g., a slurry wall) may be viable, and the method employed would be evaluated further during the remedial design phase. Waste material generated during installation of the hydraulic controls would be managed similar to material from the excavated area. Excavation dewatering and water management systems would be provided at the site during implementation. The excavation water will require either On-Site pretreatment and discharge to POTW or transport to an Off-Site facility for treatment and disposal. The preferred and available option would be selected during the remedial design phase. For cost estimating purposes, transport to an Off-Site disposal facility has been assumed.

Remaining soil impacts beyond the extent of the excavation area would be addressed by a land use restriction and soil management plan for intrusive activities. Exposure to impacted groundwater On-Site does not currently exist. Groundwater quality would be significantly improved via removal of material from the vadose and saturated zones that acts as a source of groundwater impacts. However, groundwater standards may not be achieved with Alternative 2 due to residual coal tar NAPL that may remain beyond the excavation areas. A groundwater use restriction would assure that On-Site exposure to impacted groundwater does not occur in the future. Should future monitoring indicate that groundwater standards have been met, NYSEG would submit a request to NYSDEC that the groundwater use restriction be removed.

Post-remediation groundwater monitoring would be implemented with Alternative 2. The cost estimate assumes that annual monitoring at eight well locations would be conducted for a period of three years. The need for groundwater monitoring subsequent to the three-year period would be discussed by NYSEG with NYSDEC based on the data obtained and an evaluation of the data. The reduced monitoring duration of this alternative is based on the significant removal of source material within the saturated zone. Groundwater level measurements obtained during the monitoring events would be used to evaluate groundwater flow directions and assure that an appropriate monitoring well network is maintained. The monitoring program would be finalized during remedial design activities.

Overall Protection of Public Health and the Environment

Through the excavation of On-Site source material and the use of institutional controls (a land use restriction and soil management plan), this alternative would eliminate the potential for direct exposure to impacted soil. The excavation of source material within the saturated zone would directly address the source of potentially mobile NAPL and dissolved phase constituents that pose a threat of continued human health and environmental impacts.

Use of groundwater does not currently exist. A groundwater use restriction and groundwater monitoring would further reduce the potential for human exposure. The saturated zone excavation would remediate source material, control potential NAPL migration Off-Site, and improve groundwater quality. Each of the On-Site RAOs is addressed, as well as the Off-Site RAO regarding control of source material migration. Alternative 2 provides adequate protection of public health and the environment.

Compliance With SCGs

Actions under Alternative 2 would include excavation within the vadose and saturated zones with installation of hydraulic controls to support the excavation activities, along with institutional controls and groundwater monitoring. Compliance with SCGs would involve proper management of excavated material and water extracted from the excavation areas during implementation. Compliance should be achieved, although requirements associated with the excavation dewatering may impose some constraints. Management of purge water generated during groundwater monitoring activities consistent with requirements is achievable.

Source material in the vadose and saturated zones would be addressed. The mass of coal tar NAPL acting as a source of groundwater impacts would be eliminated from both the unsaturated and saturated zones within the excavated area. Depending on the degree of residual NAPL that may remain beyond the excavation areas, groundwater quality standards may not be met throughout the entire On-Site area. This alternative is considered good in overall acceptability regarding this criterion.

Long-Term Effectiveness and Permanence

Excavation of source material within both the unsaturated and saturated zones provides an effective and permanent long-term solution to potential impacted soil exposures and the sources of groundwater impacts within the excavation area. Maintenance of institutional controls should be achievable to provide additional protective measures for potential soil exposures beyond the excavation areas.

The saturated zone remediation should result in permanent improvements to groundwater quality. The use restriction and groundwater monitoring would provide additional protection from potential exposure to impacted groundwater. Overall, Alternative 2 is good in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

Direct reduction of toxicity, mobility and volume of MGP constituents On-Site would occur via physical removal of source material from the vadose and the saturated zones. Post-remediation groundwater concentrations would be monitored. The acceptability of Alternative 2 regarding this criterion is good because the mass of constituents in both the unsaturated and saturated zones would be permanently reduced. Furthermore, the thermal treatment of the impacted source material would permanently destroy the toxic organic constituents.

Short-Term Effectiveness

Because of the size of the excavation, need for hydraulic controls, and handling a significant volume of wet material from the saturated zone, the excavation operations would have short-term effects such as an increased potential for exposure to constituents in the excavated material. Procedures are available to mitigate the potential risks and assure adequate protection during the remediation activities. However, excavation operations and associated impacts to the surrounding area would occur for a relatively long period of time (approximately one year).

Implementation of institutional controls and groundwater monitoring would not have any adverse short-term effects on the community or remediation workers. Excavation of source material reduces the potential for environmental impacts beyond the current extent of constituent occurrence. Alternative 2 includes groundwater monitoring as an additional protective measure for a projected duration of three years. Overall, this alternative would have moderate short-term effectiveness.

Implementability

The vadose zone excavation work associated with Alternative 2 is considered technically implementable, although logistical, potential underground structure and existing utility issues must be addressed. Concerns exist regarding the implementability of the saturated zone excavation work due to the depth and anticipated dewatering requirements. Installation of a physical barrier around the excavation area for hydraulic control and sidewall shoring is anticipated. Dewatering of the saturated zone suitably for excavation purposes may involve administrative constraints that would need to be addressed in the design phase.

Institutional controls such as land and groundwater use restrictions and soil management plans are commonly adopted and considered readily implementable. Following the excavation work, this alternative would not impact current or expected future land use other than the need to maintain access to the monitoring well network. Groundwater monitoring is a routine task that is readily implementable.

Overall, Alternative 2 has implementability issues due to the deep excavation work and the dewatering requirements.

Cost

The initial cost to implement Alternative 2 is estimated at $13,388,400, to cover excavation costs with hydraulic controls for the saturated zone, institutional controls, and soil management and groundwater monitoring plans. Annual costs for groundwater monitoring, periodic cover maintenance and limited soil management are estimated at $19,800. Site management costs following groundwater monitoring are estimated at $10,800.

Assuming groundwater monitoring and management activities occur over a 3-year period, and site management costs continue over a 30-year period, the estimated total present worth cost is approximately $13,578,900. Table 5-2 provides the detailed cost estimate for this alternative. The initial costs are relatively high, although long-term costs after implementation would be low due to the limited monitoring period.

5.1.3 Alternative 3 – Installation and Operation of a Free-Phase NAPL Passive Removal System at the Perimeter of the On-Site Source Area, Institutional Controls and Groundwater Monitoring

This alternative would involve installation and operation of a collection trench to capture mobile, free-phase NAPL at the downgradient perimeter of the On-Site source area. Institutional controls to restrict land and groundwater uses, a soil management plan for intrusive activities, and routine groundwater monitoring are included as components of Alternative 3.

Based on the completed IRM activities and data available from the supplemental remedial investigations conducted at the Site, it appears that the bulk of the source material is present within the saturated zone On-Site. Alternative 3 would address removal of the free-phase, mobile NAPL through installation of a trench along the downgradient perimeter of the On-Site source area. The general location for construction of the NAPL passive collection trench is identified on Figure 5-2. Details associated with the trench, including the location, length, method of installation, materials of construction and NAPL removal method would be determined during the design phase if this alternative is chosen for implementation. For FS evaluation purposes, installation of a gravel trench within the saturated zone to a depth of 25 feet bgs at the location depicted on Figure 5-2 has been assumed.

Waste material and excavation water generated during installation of the trench would be managed in a similar manner to material and water from the excavation area described under Alternative 2. Approved waste profiles would be in place with treatment or disposal facilities utilized to assure that the material meets their acceptance criteria. Given the location of the trench beyond the anticipated extent of source material, the majority of the excavated material should be clean overburden or material that is suitable for disposal with debris at a local landfill. A water management system would be provided at the site during installation of the collection trench. The water generated will require either On-Site treatment and discharge to POTW or transport to an off-site facility for treatment and disposal. The preferred option would be selected during the remedial design phase. For cost estimating purposes, transport to an off-site treatment and disposal facility has been assumed.

Monitoring/recovery points located within the trench (22 assumed) would be used to determine if free phase mobile NAPL is accumulating within the trench, and to periodically remove the NAPL when sufficient accumulation occurs. Extraction of groundwater would not be involved with NAPL removal operation. For costing purposes, bimonthly monitoring, monthly NAPL removal, and annual disposal of three drums of NAPL has been assumed for a 25-year duration.

Potential soil exposures would be controlled by a land use restriction and soil management plan for intrusive activities. Groundwater standards would not be achieved On-Site with this alternative due to the continued presence of source material within the saturated zone. Exposure to impacted groundwater does not currently exist, and a groundwater use restriction would assure continued protection of human health On-Site.

Groundwater monitoring would be implemented in a manner similar to Alternative 1. The cost estimate is based on annual monitoring at eight well locations On-Site for a period of 30 years. During the monitoring events, groundwater level measurements would be obtained to evaluate groundwater flow directions and assure that an appropriate well network is maintained. The well network and monitoring program would be finalized during remedial design activities.

Overall Protection of Public Health and the Environment

The land use restriction and soil management plan for intrusive activities would address the potential for direct exposure to impacted soil. The presence of source material within the saturated zone On-Site would remain as an on-going environmental impact. However, the collection trench would address potential Off-Site NAPL migration, and there is no current or anticipated future use of groundwater within the impacted area.

Alternative 3 further reduces the potential for human exposure through a groundwater use restriction and groundwater monitoring. The RAOs that involve exposure controls are addressed. Active remediation of source material or impacted groundwater On-Site would not occur, although the potential for further Off-Site migration of NAPL would be controlled. This alternative should provide adequate protection of public health and the environment, although source material is not addressed other than the free-phase NAPL migration.

Compliance With SCGs

Actions under Alternative 3 would include installation of a collection trench with NAPL monitoring and removal, institutional controls and groundwater monitoring. Compliance with SCGs associated with these actions would primarily involve proper management of material generated during the trench installation, purge water from well sampling activities, segregated soil from On-Site excavations and recovered NAPL from the collection trench, which is achievable.

Remediation of source material or soils exceeding NYSDEC recommended soil cleanup objectives would occur via removal of free-phase NAPL. The objective of restoring groundwater quality to NYS SCGs On-Site would not be achieved with this alternative due to the continued presence of source material within the saturated zone. This alternative is fair in overall acceptability regarding this criterion.

Long-Term Effectiveness and Permanence

The soil management plan and land use restriction would address potential exposures to impacted soil. There is no current or anticipated future use of groundwater within the impacted area. Therefore, a groundwater use restriction and monitoring should be adequate to provide long-term protection from potential exposures to impacted groundwater.

Risks related to the continued presence of source material in the subsurface would persist On-Site. The collection trench would capture mobile, free-phase NAPL at the downgradient perimeter of the On-Site source area. However, long-term impacts to groundwater quality would continue, and long-term monitoring and recovery of NAPL at the collection trench would be necessary. This alternative is fair in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

A reduction in the mobility and volume of MGP constituents On-Site would occur via collection and subsequent removal of free-phase NAPL within the collection trench. Source material that remains within the saturated zone On-Site would act as a source of dissolved phase constituents that may continue to migrate with groundwater flow. Significant reductions in groundwater concentrations On-Site through natural attenuation are not expected to occur. Alternative 2 is considered fair in acceptability regarding this criterion.

Short-Term Effectiveness

The collection trench installation would have some potential short-term effects. However, routine procedures are available to mitigate the potential risks and assure adequate protection, and these procedures could be implemented within a reasonable timeframe. Implementation of institutional controls, periodic NAPL monitoring and removal (when present), and groundwater monitoring would not have any adverse short-term effects on the community or remediation workers.

The NAPL removal component of this alternative addresses the mobility associated with the source material On-Site. Environmental impacts beyond the current extent of MGP constituent occurrence are not expected. The short-term effectiveness for initial implementation of Alternative 2 is good, although NAPL monitoring/removal and groundwater monitoring are projected to continue for an extended period of time.

Implementability

Institutional controls such as use restrictions are commonly adopted and considered readily implementable. Installation of the collection trench should be implementable, although temporary dewatering and material management and disposal issues will need to be addressed in the design and implementation phases. Administrative constraints on implementation are not anticipated.

Following the collection trench installation work, this alternative would not impact current or expected future land use other than the need to maintain access to the NAPL monitoring/recovery points and the groundwater monitoring well network. NAPL monitoring and removal (should accumulation occur), groundwater monitoring, and management of soil from excavations are routine tasks. Alternative 3 is considered implementable without significant issues or constraints.

Cost

The initial cost to implement Alternative 3 is estimated at $1,553,500, to cover installation of the NAPL collection trench and management of associated waste materials, institutional controls, and soil management and groundwater monitoring plans. Annual costs for groundwater monitoring, periodic cover maintenance and soil management, and NAPL monitoring and removal are estimated at $56,350. If NAPL monitoring and removal are no longer needed, the estimated annual costs would be reduced to $26,000.

Assuming the monitoring, management and NAPL removal activities occur over a 25-year period, with additional groundwater monitoring and management for five years (30-year period total), the estimated total present worth cost is approximately $2,380,900. Table 5-2 provides the detailed cost estimate for Alternative 3. The initial costs and estimated total present worth cost of this alternative are considered good. However, due to the routine operation, maintenance and NAPL removal requirements associated with the collection trench, the annual costs after implementation are relatively high.

5.1.4 Alternative 4 – Installation of Full Barrier Containment System (e.g., Slurry Wall) Around Perimeter of On-Site Source Area with Cap/Cover On Surface, Institutional Controls and Groundwater Monitoring

Alternative 4 would involve perimeter containment using a physical barrier around the On-Site source material area and maintenance of a surface cap/cover within the containment area. Institutional controls to restrict land and groundwater uses, a soil management plan for intrusive activities, and routine groundwater monitoring are also included.

The perimeter isolation/containment approach of Alternative 4 involves installation of a physical barrier to greatly reduce or eliminate groundwater movement through the source material area within the saturated zone. Containment of groundwater within the source area would mitigate the potential for continued migration of dissolved phase constituents. Perimeter containment would also address potential mobility of free-phase NAPL within the saturated zone.

The physical barrier location developed for evaluation purposes in this FS is identified on Figure 5-3. The barrier would be approximately 1,100 feet in total length. The proposed location is tentative at this time, and would be determined based on information obtained during the remedial design investigation.

For evaluation purposes, installation of a physical barrier using the cement-bentonite slurry wall method to a depth of 25 feet has been assumed based on the SRI data. Slurry wall installations generally involve excavating a narrow vertical trench. Where possible, the depth is extended to bedrock or a low permeability confining layer. During excavation, the trench is filled with a slurry mixture that prevents caving or sloughing of the trench walls. The excavation equipment used depends on the depth, with backhoe-type equipment generally most efficient for the depth anticipated at the Norwich former MGP site. After excavation, the slurry-filled trench is backfilled with a soil/bentonite/cement/water mixture to create a low permeability barrier. Other barrier types (*in-situ* stabilization barrier, sheet piling, jet grout wall, GundWall system, etc.) may be viable. The type, location and depth of the barrier would be finalized during remedial design should this alternative be selected for implementation.

Waste material and fluids generated during installation of the physical barrier would be managed similar to material and water from the excavation area described under Alternative 2. Approved waste profiles would be in place with treatment or disposal facilities utilized to assure that the material meets their acceptance criteria. Given the location of the physical barrier beyond the anticipated extent of source material, the majority of the excavated material should be clean overburden or material that is suitable for disposal with debris at a local landfill. A water management system would be provided at the site during installation of the barrier. The water generated will require either On-Site treatment and discharge or transport to an off-site facility. The preferred option would be selected during the remedial design phase. For cost estimating purposes, transport to an off-site disposal facility has been assumed.

Maintenance of a surface cap/cover would occur with Alternative 4 to limit potential exposure to soil and minimize water infiltration within the barrier. Periodic groundwater extraction within the physical barrier is not anticipated. If necessary, openings at the top of the physical barrier (extending to the top of the water table) may be appropriate on the downgradient side for hydraulic control purposes. Details of the physical barrier would be developed during the remedial design phase.

In addition to the cap/cover, potential soil exposures would be controlled by a land use restriction and soil management plan for intrusive activities. The budgetary estimate of this alternative includes costs for initial improvement as well as routine maintenance for the cap/cover, and periodic soil management related costs. Groundwater standards would not be achieved On-Site with this alternative due to the continued presence of source material within the saturated zone. Exposure to impacted groundwater does not currently exist, and a groundwater use restriction would assure continued protection of human health On-Site.

Groundwater monitoring would be implemented in a manner similar to Alternative 1. The cost estimate is based on annual monitoring at eight well locations for a period of 30 years. During the monitoring events, groundwater level measurements would be obtained to evaluate groundwater flow directions and assure that an appropriate well network is maintained. The well network and monitoring program would be finalized during remedial design activities.

Overall Protection of Public Health and the Environment

The potential for direct exposure to impacted soil would be eliminated by maintenance of a surface cap/cover, the soil management plan for intrusive activities, and the land use restriction. Although source material would remain within the saturated zone, full containment would control potential Off-Site NAPL migration and the migration of groundwater impacted by MGP constituents.

Groundwater is not currently used within the impacted area, and a restriction on groundwater use and groundwater monitoring would further reduce the potential for human exposure. RAOs that involve exposure controls are addressed. Although active remediation of source material or groundwater would not occur, the full isolation provided by the containment barrier addresses the potential for continued environmental impacts and future migration of source material from On-Site to Off-Site areas. This alternative provides adequate protection of public health and the environment.

Compliance With SCGs

Actions under Alternative 4 would include installation of a physical barrier around the On-Site source material, maintenance of a surface cap/cover, institutional controls and groundwater monitoring. Compliance with SCGs associated with these actions would primarily involve proper management of material and fluids generated during installation of the physical barrier, purge water from sampling activities and segregated soil from On-Site excavations, and surface cap/cover maintenance, which is expected to be achievable.

Remediation of soils exceeding NYSDEC recommended soil cleanup objectives would not occur. Because source material within the saturated zone would remain, groundwater quality standards would not be met On-Site. This alternative is considered moderate in overall acceptability regarding this criterion.

Long-Term Effectiveness and Permanence

Maintenance of the surface cap/cover should be achievable in the long-term to provide a protective measure for potential exposures to impacted soil. The land use restriction and soil management plan would also control potential soil exposures.

Residual risks related to the continued presence of source material in the saturated zone would be addressed through full containment around the perimeter. The full physical barrier would also significantly mitigate groundwater quality impacts to Off-Site areas.

Groundwater is not currently used and future use is not expected. Therefore, a groundwater use restriction and monitoring should provide adequate long-term protection. Overall, Alternative 4 is good in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

The mobility of constituents within the saturated zone would be significantly reduced or eliminated through installation of a full physical barrier around the On-Site source material. The barrier would mitigate the potential migration of NAPL and dissolved phase constituents with groundwater flow. However, NAPL within the saturated zone would remain On-Site and significant reductions in groundwater concentrations through natural attenuation are not expected. Toxicity of the constituents would not be reduced under this option. Overall, the acceptability of Alternative 4 regarding this criterion is good because mobility to Off-Site areas is fully addressed.

Short-Term Effectiveness

The physical barrier installation would have some potential short-term effects. Materials generated during installation would need properly managed, and utilities located at the property boundary would need to be addressed in the design and properly managed during implementation. Procedures are available to mitigate the potential risks and assure adequate protection, and these procedures could be implemented within a reasonable timeframe. Implementation of institutional controls, routine surface cover maintenance and groundwater monitoring would not have any adverse short-term effects on the community or remediation workers.

The physical barrier component of Alternative 4 would assure that environmental impacts due to continued constituent migration do not occur. Environmental impacts beyond the current extent of occurrence are not expected. This alternative includes groundwater monitoring as an additional protective measure for a projected duration of 30 years. Because the initial remedial actions, including installation of the physical barrier around the On-Site source material, could be implemented within a reasonable timeframe, this alternative would have good short-term effectiveness.

Implementability

Institutional controls such as land and groundwater use restrictions are commonly adopted and considered readily implementable. Installation of the physical barrier should be implementable, although waste material management and utility issues would need to be addressed in the design and implementation phases. Administrative constraints on implementation are not anticipated.

Following the barrier installation work, this alternative should not impact current or expected future land uses. Maintenance of the surface cap/cover and monitoring wells would be necessary, however. Groundwater monitoring and management of soil from excavations are routine tasks. Alternative 4 is considered implementable without significant issues or constraints.

Cost

The initial cost to implement Alternative 4 is estimated at $1,742,300, to cover installation of the physical barrier and management of associated waste material, initial cap/cover improvements, institutional controls, and soil management and groundwater monitoring plans. Annual costs for groundwater monitoring, cap/cover maintenance and periodic soil management are estimated at $37,000.

Assuming monitoring, maintenance and management activities occur over a 30-year period, the estimated total present worth cost is approximately $2,311,100. Table 5-2 provides the detailed cost estimate for this alternative. This alternative is considered good in acceptability regarding this criterion, based on both the initial costs and estimated total present worth cost.

5.1.5 Alternative 5 – *In-Situ* Solidification/Stabilization of On-Site Source Material, Institutional Controls and Groundwater Monitoring

This alternative would involve the *in-situ* solidification/stabilization (ISS) of On-Site source material, along with institutional controls to restrict land and groundwater uses, a soil management plan for future intrusive activities, and groundwater monitoring.

The general area where ISS is proposed under this alternative is identified on Figure 5-1. The confining layer was typically encountered approximately 18 to 20 feet bgs across the site during SRI activities. A total treatment depth of 24 feet within a surface area of approximately 52,200 square feet has been estimated for evaluation purposes. The delineation of source material would be refined and the planned extent of ISS would be finalized during the remedial design phase should this alternative be chosen for implementation.

ISS technology generally involves the mixing of impacted soil or DNAPL-saturated material with treatment reagents to solidify the subsurface material and immobilize constituents of concern, minimizing or eliminating leaching and the migration of constituents in groundwater. The process alters the chemical and physical characteristics of the impacted material, and reduces the potential for infiltration of rain water or groundwater contact with the immobilized constituents. A large-diameter auger is typically moved through the targeted treatment interval, while reagents prepared at an On-Site batch plant are mixed with the material resulting in solidification. The ISS process results in an increase in both the bulk density and volume of the treated material. Treatment proceeds in columns, with the auger retracted after completion and repositioned to overlap the previously treated column, and the process is repeated.

Because the bulk density of the treated material is increased, excess material generated within the treated area would need to be addressed. For evaluation purposes, the surficial 6 feet of material would be removed in advance of the ISS process (approximately 18,000 tons). This removal and stockpiling of overburden soil would also address potential underground structures and obstructions in advance of the ISS process. Based on a treatment depth of 24 feet bgs, an 18-foot interval would be treated via the ISS process (approximately 34,800 cubic yards).

Debris or unimpacted excess material that is encountered during the surficial soil removal would be transported to a local landfill for disposal. If source material is encountered in the surficial excavation zone, it would be transported to a LTTD or other acceptable treatment facility. Approved waste profiles would be in place meeting acceptance criteria for the off-site facilities utilized for disposal. Clean soil from the temporary excavations would be reused as backfill. For cost estimating purposes, it was assumed that a sufficient volume of clean material from the overburden material stockpile would be available for use as backfill, and the remaining excess stockpile material (estimated at 7,500 tons) would require off-site disposal.

Remaining soil impacts beyond the extent of the ISS area would be addressed by a land use restriction and soil management plan for intrusive activities. Although the ISS process is expected to minimize constituent concentrations in groundwater by stabilizing the source material, groundwater standards may not be achieved On-Site outside the stabilized area where residual contamination will remain in place. Exposure to groundwater does not currently exist. This alternative involves a restriction on future groundwater use to assure continued protection of human health. Implementation of ISS On-Site would mitigate the potential for Off-Site migration of dissolved constituents.

Post-remediation groundwater monitoring would be implemented with Alternative 5. The cost estimate assumes that annual monitoring at eight well locations would be conducted for a period of three years. The need for further groundwater monitoring subsequent to the three-year period would be determined through discussions by NYSEG with NYSDEC based on the data obtained and the evaluation of the data. The reduced monitoring duration of this alternative is based on the significant remediation of source material within the saturated zone. Measurements of groundwater levels during the monitoring events would be used to evaluate flow directions and assure that an appropriate well network is maintained. The monitoring program would be finalized during remedial design activities.

Overall Protection of Public Health and the Environment

If encountered, excavation and Off-Site disposal of source material within unsaturated zone soils would occur during implementation of this alternative. Through the excavation and use of institutional controls (land use restriction and soil management plan), Alternative 5 would eliminate the potential for direct exposure to impacted soil.

ISS of source material would address potentially mobile NAPL and sources of impact to groundwater that pose a continued threat of environmental impacts. There is no current or anticipated future use of groundwater On-Site. Alternative 5 further reduces the potential for human exposure through restricting groundwater use and by groundwater monitoring.

Solidification/stabilization would provide effective remediation of On-Site source material, and would improve groundwater quality beyond the extent of the ISS area. Each of the On-Site RAOs would be addressed, as well as the Off-Site RAO regarding control of source material migration. Alternative 5 protects public health and the environment by addressing impacted vadose zone soil, if encountered, and saturated zone source material.

Compliance with SCGs

Actions under Alternative 5 would include excavation of soil and *in-situ* solidification/stabilization of source material. Institutional controls, a soil management plan and groundwater monitoring would also be involved. Compliance with SCGs associated with these actions would include proper management of material excavated during application of ISS or segregated from future On-Site excavations, as well as purge water from sampling activities, which is expected to be achievable.

The ISS process may also generate waste material requiring proper management and possibly disposal. Compliance with additional requirements associated with ISS should be achievable with proper design. The excavation and ISS components of this alternative would immobilize or eliminate the mass of material that is a source of groundwater impacts. ISS technology results in the solidification of impacted material. Based on the experiences from other MGP sites that have used ISS technology, it is observed that the ISS treated area does not yield much groundwater because of low permeability of the material, which essentially eliminates groundwater impacts in the stabilized area. Improvements to groundwater would result beyond the ISS area. Alternative 5 is good in overall acceptability regarding this criterion.

Long-Term Effectiveness and Permanence

Off-Site disposal of source material in excavated soil, if encountered, provides a permanent long-term solution to potential exposures. Material acting as a source of groundwater impacts in subsurface soils and the saturated zone would be addressed via *in-situ* solidification/stabilization. With proper design and implementation, ISS treatment is expected to be effective in addressing On-Site source material in the long-term.

There is no current or anticipated future use of groundwater On-Site. Residual risks would be primarily related to the continued presence of immobilized/stabilized coal tar NAPL within the saturated zone, and residual NAPL that may remain beyond the ISS treatment area. Land and groundwater use restrictions, a soil management plan, and groundwater monitoring would provide additional long-term protection to address the residual risks. Alternative 5 is considered good in overall acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

Treatment would occur via physical removal of impacted surficial soils, if encountered, and *in-situ* stabilization/solidification of source material in subsurface soils and the saturated zone. The ISS technology reduces/eliminates the mobility of the NAPL and dissolved phase constituents in the groundwater. Toxicity of constituents in the stabilized mass is not reduced but potential exposure is less. Post-remediation groundwater concentrations would be monitored. The acceptability of Alternative 5 regarding this criterion is good because the mass of constituents in both the unsaturated and saturated zones would be permanently removed, treated or reduced in mobility.

Short-Term Effectiveness

Implementation of institutional controls and groundwater monitoring would not have any adverse short-term effects on the community or remediation workers. *In-situ* stabilization and the associated excavation component would have some potential short-term effects, such as an increased potential for exposure to constituents, that would need proper management. Routine procedures are available to mitigate the potential exposure risks and assure adequate protection during implementation.

The stabilization and excavation components of this alternative address source material, and assure that potential exposure to impacted soil or groundwater On-Site would not occur. Impacts on the environment during implementation of this alternative are considered acceptable. ISS of source material reduces the potential for environmental impacts beyond the current extent of constituent occurrence.

Post-remediation groundwater monitoring is projected for a period of 3 years. Overall, Alternative 5 would have good short-term effectiveness.

Implementability

The soil excavation work under Alternative 5 is considered technically implementable, with limited logistical concerns. Underground structures and existing utility issues must be addressed. ISS would involve technical considerations and administrative requirements that would need to be addressed during design for safe and proper implementation.

Institutional controls such as land and groundwater use restrictions and soil management plans are commonly adopted and considered readily implementable. Following the excavation and *in-situ* stabilization work, current or expected future land uses should not be adversely impacted. However, the solidified area would need to be considered with any potential future construction work involving construction of subsurface structures or foundations, and the monitoring well network would need to be maintained. Groundwater monitoring is a routine task that is readily implementable.

Alternative 5 is considered implementable, although some technical issues and administrative requirements would need to be addressed in the design phase.

Cost

The initial cost to implement Alternative 5 is estimated at $6,177,500, to cover excavation of soil and the ISS of source material On-Site, along with institutional controls, and soil management and groundwater monitoring plans. Annual costs for groundwater monitoring, periodic cover maintenance and limited soil management are estimated at $19,800. Site management costs following groundwater monitoring are estimated at $10,800.

Assuming monitoring and management activities occur over a 3-year period, and site management costs continue over a 30-year period, the estimated total present worth cost is approximately $6,368,000. Table 5-2 provides the detailed cost estimate for this alternative. The initial costs are moderate to high, although long-term costs after implementation would be low due to the reduced monitoring period.

5.1.6 Alternative 6 – *In-Situ* Chemical Oxidation (ISCO) For Treatment of Source Material in On-Site Areas, Institutional Controls and Groundwater Monitoring

This alternative would involve the treatment of On-Site source material using *in-situ* chemical oxidation (ISCO) technology. Institutional controls to restrict land and groundwater uses, a soil management plan for future intrusive activities, and routine groundwater monitoring are also included.

ISCO technology involves introducing an oxidant to chemically destroy organic constituents, which is achieved through the installation of injectors screened within the target treatment zone and the injection of reagents that chemically oxidize the constituents of interest. The injectors are spaced at a distance that ensures overlap. The injector screens are set to ensure vertical coverage of the saturated zone and efficient delivery of the oxidant. Chemical oxidants tend to be non-selective and can readily react with naturally occurring and anthropogenic organic materials, and are readily scavenged by carbonate minerals. The radius of influence of the treatment is a function of subsurface conditions, with larger radii requiring fewer injectors. ISCO requires contact with the constituents to ensure treatment. Preferential flow may reduce effectiveness with subsequent diffusion of dissolved phase constituents following treatment. ISCO treatment involving the use of hydrogen peroxide that reacts with a catalyst (typically ferrous iron) to form a solution characteristic of Fenton's reagent has been assumed for evaluation of this alternative. Fenton's reagent is a strong oxidizer via the generation of hydroxyl radicals and results in rapid chemical destruction of organic compounds. Fenton's reagent is non-selective and readily reacts with available organic materials within the treatment zone. Beneficial oxygen is generated in the ISCO treatment process that may promote biological degradation of residual dissolved phase constituents. .

The application of ISCO technology within an area of NAPL occurrence must be carefully managed and must account for the mass of free-phase and adsorbed NAPL constituents. The destruction of all free-phase NAPL mass may not be practical to attempt. ISCO treatment On-Site could significantly reduce the mass of source material and, if effective, would result in a permanent solution. However, the extent and mass of free-phase and residual NAPL must be sufficiently quantified and accessible for treatment. Although a significant improvement in groundwater quality is possible, the groundwater standards may not be achieved because of residual amounts of constituents in the subsurface.

For evaluation purposes, Alternative 6 assumes 118 single injectors and 65 dual injectors would be installed within the source material area identified on Figure 5-1. The delineation of source material would be refined and the planned extent of the treatment area would be finalized during remedial design should this alternative be chosen for implementation. Waste material generated during installation of the injectors would be managed appropriately. Approved waste profiles would be in place with any treatment or disposal facility utilized to assure that the material meets their acceptance criteria. A water management system (e.g., frac tank) or drums would be utilized at the site during the injector installations to manage waste fluids and development water. The preferred option for water disposal (On-Site treatment and discharge or transport to an off-site facility) would be selected during the remedial design.

The reagent volume estimate is based on a 20:1 ratio of reagent to constituent mass and 80 percent destruction of constituent mass being achievable. For cost estimating purposes, adsorbed constituent mass On-Site is assumed to occur within a 5 to 10 foot interval above the confining layer with concentrations in the 1,000 to 3,000 parts per million (ppm) range. Free-phase NAPL is assumed to occur in approximately 25 percent of the treatment area identified on Figure 5-1, with saturations of 5 to 20 percent within a 5-foot interval. For implementation, two injection crews are assumed to rotate injections throughout the treatment area for a period of 15 months. The injector locations, injection intervals, reagent types and volumes, duration of treatment and other details would need to be evaluated further during remedial design. Additional characterization during installation of the injectors may also be appropriate to better estimate the necessary reagent volume.

Soil impacts that may remain within the unsaturated zone would be addressed by a land use restriction and soil management plan for intrusive activities. Exposure to impacted groundwater does not currently exist. *In-situ* treatment within the saturated zone On-Site would mitigate potential impacts to Off-Site groundwater by treating the source. Because achieving groundwater standards On-Site may be technically impracticable, this alternative would involve imposing a groundwater use restriction and groundwater monitoring. The use of institutional controls would assure continued protection of human health On-Site.

Post-remediation groundwater monitoring would be implemented with Alternative 6. The cost estimate assumes that annual monitoring for 20 years at eight well locations would be conducted. Groundwater level measurements would be obtained to evaluate flow directions and assure that an appropriate well network is maintained. The monitoring program would be finalized during remedial design activities.

Overall Protection of Public Health and the Environment

The potential for direct exposure to impacted soil would be addressed by the soil management plan for intrusive activities and land use restriction. The unsaturated zone would not be addressed by active remediation. Alternative 6 would provide adequate protection from unsaturated zone impacts through the exposure controls.

In-situ treatment of source material within the saturated zone would address sources of impact to groundwater that pose a continued threat of environmental impacts. There is no current or anticipated future use of groundwater On-Site. This alternative further reduces the potential for human exposure through groundwater use restrictions and a monitoring plan.

RAOs that involve exposure controls would be achieved. Treatment of source material within the saturated zone would occur, and On-Site groundwater quality would be improved assuming that the targeted level of treatment is accomplished. In addition, potential NAPL migration to Off-Site areas and the migration of impacted groundwater would be mitigated. Alternative 6 protects public health and the environment through the use of exposure controls and aggressive remediation of source material.

Compliance With SCGs

Actions under Alternative 6 would include *in-situ* treatment of source material within the saturated zone, institutional controls and groundwater monitoring. Compliance with SCGs associated with these actions would include proper management of material generated during injector installations, fluids generated during the injection process, soil segregated from future On-Site excavations, and purge water from sampling activities, which is expected to be achievable. Compliance with requirements for the safe and proper injection of chemicals during *in-situ* treatment would also be necessary, and should be achievable with proper design and implementation.

Remediation of unsaturated zone soils that may exceed NYSDEC recommended soil cleanup objectives would not occur. The *in-situ* treatment component of this alternative would significantly reduce the mass of material that is a source of groundwater impacts. However, groundwater standards may not be achieved site-wide due to the potential for residual DNAPL to remain beyond the treatment area, subsurface constraints on reagent distribution, and practical limitations of ISCO technology where DNAPL is present. This alternative is considered good in overall acceptability regarding this criterion.

Long-Term Effectiveness and Permanence

Material within the saturated zone acting as a source of groundwater impacts would be addressed via *in-situ* treatment. ISCO treatment results in a permanent destruction of constituents where implemented effectively. The land use restriction and soil management plan would provide long-term protective measures for potential impacted soil exposures.

Groundwater is not currently used and future use is not expected. Therefore, a groundwater use restriction and monitoring should provide adequate long-term protection. Future risks would be primarily related to residual DNAPL that may remain within and beyond the treatment area. The exposure controls would provide additional long-term protection to address the residual risks. Overall, Alternative 6 is good in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

Direct treatment of source material within the saturated zone would occur via *in-situ* chemical oxidation, resulting in an overall reduction in constituent mass. The potential for migration of On-Site source material to Off-Site areas should also be reduced because the mass would be significantly reduced.

Oxygen may be provided within the saturated zone as a by-product of the ISCO process, which may promote biological degradation of dissolved phase organic compounds. Post-treatment groundwater concentrations would be monitored. Overall, the acceptability of Alternative 6 regarding this criterion is good because the mass of constituents would be permanently reduced.

Short-Term Effectiveness

Implementation of institutional controls and groundwater monitoring would not have any adverse short-term effects on the community or remediation workers. Application of ISCO would involve the potential for some short-term effects. Waste materials and fluids would need to be properly managed. Routine procedures are available to mitigate the potential risks and assure adequate protection.

The ISCO treatment component of this alternative addresses source material. Impacts on the environment during implementation are considered acceptable. Environmental impacts beyond the current extent of constituent occurrence are not expected.

Injections would occur for a projected duration of 15 months, and post-remediation groundwater monitoring is projected for a period of 20 years. Overall, Alternative 6 would be fair in short-term effectiveness.

Implementability

Institutional controls such as land and groundwater use restrictions are commonly adopted and considered readily implementable. Groundwater monitoring and management of soil from excavations are routine tasks. *In-situ* treatment of source material On-Site should be implementable, assuming technical issues (e.g., safe injection rates, waste material and fluids handling) and administrative requirements are addressed during remedial design.

Because of treatment requirements primarily associated with the free-phase NAPL present within the area, injection operations On-Site would need to occur for a relatively long period of time (estimated at two years for evaluation purposes). Following the *in-situ* treatment work, this alternative would not impact current or expected future land uses other than the need to maintain a monitoring well network. Alternative 6 is considered implementable, although some technical issues and administrative requirements for the injections would need to be addressed.

Cost

The initial cost to implement Alternative 6 is estimated at $13,367,000, to cover ISCO treatment of the On-Site source material, along with institutional controls, and soil management and groundwater monitoring plans. Annual costs for groundwater monitoring and periodic cover maintenance and soil management are estimated at $26,000. Site management costs following groundwater monitoring are estimated at $17,000.

Assuming monitoring and management activities occur over a 20-year period, and site management costs continue over a 30-year period, the estimated total present worth cost is approximately $13,740,500. Table 5-2 provides the detailed cost estimate for this alternative. The initial costs and estimated total present worth cost are high, primarily due to the presence of free-phase NAPL mass On-Site and ISCO treatment being a relatively high cost approach to treatment of free-phase NAPL.

5.2 Off-Site Alternatives

A summary of the Off-Site alternatives evaluation is presented in Table 5-3. Cost estimates for each alternative, developed for comparative purposes, are presented in Table 5-4. A comparative analysis using the same criteria follows in Section 6.0.

5.2.1 Alternative 7 – No Remedial Action (With Institutional Controls and Groundwater Monitoring)

The no remedial action alternative provides a baseline for comparison with the other alternatives, and is included in the evaluation for consistency with NYSDEC guidance (NYSDEC, December 2002). Similar to Alternative 1 that addresses the On-Site area, no active remediation would be implemented under this alternative on the Off-Site area. Institutional controls and routine groundwater monitoring are included as components of this alternative. The institutional controls may vary for each property within the impacted area depending on the location, and are expected to include a groundwater use restriction at a minimum. A soil management plan would likely be appropriate at some locations, particularly those adjacent to the former MGP property. The soil management plan would address deeper excavations into the saturated zone, where MGP constituents may be present above the confining layer. Land use restrictions may also be appropriate at some locations.

The no action alternative would not impact current or expected future land uses in the area. Soil quality would not be effected other than through natural attenuation. On-Site remedial activities are expected to provide beneficial effects to Off-Site groundwater. Institutional controls would assure continued protection of human health. Exposure to impacted groundwater does not currently exist. Groundwater use restrictions would assure that exposure does not occur. Potential exposure to impacted soil would be controlled by a soil management plan and land use restrictions, where appropriate.

Groundwater monitoring is included with the no remedial action alternative. The estimated monitoring costs are based on analyses of groundwater samples collected at 14 Off-Site locations on an annual basis for a period of 30 years. The well network and monitoring program would be finalized prior to implementation. As part of the monitoring events, groundwater level measurements would be obtained to evaluate groundwater flow directions and assure that an appropriate monitoring well network is maintained.

<u>Overall Protection of Public Health and the Environment</u>

Because MGP constituent occurrence Off-Site is associated with migration within the saturated zone above the confining layer, the potential for surface soil-related exposures is limited. There is no current or anticipated future use of groundwater within the impacted area. However, the presence of source material within the saturated zone under this alternative poses a continued threat to the subsurface environment.

RAOs that involve exposure controls are addressed. Active remediation of Off-Site source material or groundwater would not occur. Active measures to control potential future migration of On-Site source material to Off-Site areas are addressed with the On-Site alternatives. Alternative 7 reduces the potential for human exposure through groundwater monitoring and groundwater use restrictions, and through the use of institutional controls to address source material and soil, where appropriate. The no remedial action alternative may be adequately protective of public health and the environment because potential exposures are addressed.

Compliance With SCGs

Actions under Alternative 7 would include institutional controls (groundwater use restrictions, and a soil management plan and land use restrictions where appropriate) and groundwater monitoring. Compliance with SCGs associated with these actions would primarily involve proper management of purge water from well sampling activities and segregated soil from some excavations into the saturated zone, which is achievable.

Remediation of source material or soils exceeding NYSDEC recommended soil cleanup objectives would not occur, and groundwater that exceeds NYS SCGs Off-Site would not be directly addressed with Alternative 7. The overall acceptability of this alternative is moderate regarding this criterion.

Long-Term Effectiveness and Permanence

The Off-Site MGP-related impacts are essentially within the saturated zone above the confining layer. Therefore, a soil management plan for Off-Site properties that addresses deeper excavation work and land use restrictions, where appropriate, should provide adequate long-term effectiveness and protection from potential exposures to impacted soil. There is no current or anticipated future use of groundwater within the impacted area. Therefore, a groundwater use restriction and monitoring may be adequate to provide long-term protection from potential exposures to impacted groundwater.

Risks related to the continued presence of source material in the subsurface would persist, and long-term impacts to groundwater quality would continue unless the source material is addressed. This alternative is moderate in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

No active treatment of soil or groundwater Off-Site would occur with Alternative 7. Significant reductions in constituent concentrations through natural attenuation are not expected to occur without removal of source material. Constituent mobility would not significantly change.

NAPL within the saturated zone would remain as a source of dissolved phase constituents that will continue to migrate with groundwater flow. Therefore, the current groundwater plume would likely be maintained under this alternative, although remedial actions On-Site are expected to have some beneficial effects on Off-Site groundwater quality. Acceptability regarding this criterion is low because the toxicity, mobility or volume of constituents would not be reduced other than through potential natural attenuation.

Short-Term Effectiveness

The no remedial action alternative would not have any adverse short-term effects on the community or remediation workers. Short-term environmental impacts beyond the current extent of constituent occurrence are not expected. Alternative 7 is highly effective in the short-term, although groundwater monitoring would occur for a projected period of 30 years.

Implementability

This alternative would not impact current or expected future land uses, other than the need to maintain the existing monitoring well network. Institutional controls such as use restrictions are commonly adopted where property owner objections are not an issue. This alternative should be readily implementable, although it may not be acceptable to regulatory agencies.

Cost

The initial cost to implement Alternative 7 is estimated at $65,000, to cover the groundwater monitoring plan, soil management plan, and preparation of the land and groundwater use restrictions. Annual costs for groundwater monitoring and periodic soil management activities, including project management and reporting, are estimated at $36,000.

Assuming monitoring and management activities occur over a 30-year period, the estimated total present worth cost is approximately $618,400. Table 5-4 provides the detailed cost estimate for Alternative 1. This alternative is considered very good in acceptability regarding the cost criterion.

5.2.2 Alternative 8 – *In-Situ* Chemical Oxidation (ISCO) for Treatment of Off-Site Source Material, Monitored Natural Attenuation for Groundwater, and Institutional Controls

This alternative would involve the treatment of Off-Site source material using *in-situ* chemical oxidation (ISCO) technology. Monitoring of natural attenuation in groundwater and institutional controls are also included as components of this remedial alternative.

ISCO technology involves the installation of injectors screened within the target treatment zone and the injection of reagents to chemically oxidize the constituents of interest. The general approach to application of ISCO technology for evaluation purposes in this FS is described with On-Site Alternative 6. Constraints associated with application of ISCO technology in the presence of significant free-phase NAPL are also discussed with On-Site Alternative 6. As noted in that discussion, although a significant improvement in groundwater quality is possible, groundwater standards may be technically impracticable to achieve where free-phase NAPL is present.

Access constraints are present within portions of the Off-Site source material area, including a public roadway (Front Street), private structures/properties, a day-care facility, and railroad right-of-way. For evaluation purposes, Alternative 8 assumes 113 single injectors would be installed within the source material area identified on Figure 5-4. Should this alternative be chosen for implementation, the delineation of source material would be refined, availability of access for injection would be determined, and the planned extent of the treatment area would be finalized during the remedial design. Waste material generated during installation of the injectors would be managed appropriately. Approved waste profiles would be in place with treatment or disposal facilities utilized to assure that the material meets their acceptance criteria. A water management system (e.g., frac tank) or drums would be utilized at the site during the injector installations to manage waste fluids and development water. The preferred option for water disposal (On-Site treatment and discharge or transport to an off-site facility) would be selected during the remedial design phase.

The reagent volume estimate is based on a 20:1 ratio of reagent to constituent mass and 80 percent destruction of constituent mass is targeted by the ISCO treatment process. For cost estimating purposes, adsorbed constituent mass Off-Site is assumed to occur within a 2 to 5 foot interval above the confining layer with concentrations in the 1,000 to 2,000 ppm range. Free-phase NAPL is assumed to occur in approximately 30 percent of the treatment area identified on Figure 5-4, with saturations of 5 to 20 percent within a 1 to 2 foot interval. For implementation, two injection crews are assumed to rotate injections throughout the treatment area for a period of approximately three months. The injector locations, injection intervals, reagent types and volumes, laboratory treatability testing, duration of treatment and other details would need to be evaluated further during the remedial design phase. Additional characterization of the source material during installation of the injectors may also be appropriate to better estimate the necessary reagent volume. The injection events associated with Alternative 8 have some potential short-term effects that would need to be properly managed. Following completion of the ISCO injections, this alternative should not have adverse effects on land uses.

The institutional controls may vary for each property within the impacted area depending on the location, and are expected to include a groundwater use restriction at a minimum. Institutional controls would assure continued protection of human health. Exposure to impacted groundwater does not currently exist. Groundwater use restrictions would assure that future exposure does not occur. A soil management plan and land use restrictions may also be appropriate at some locations to control potential exposure to residual impacted soil. The soil management plan would address deeper excavations into the saturated zone, where MGP constituents may be present above the confining layer.

Biodegradation of dissolved phase constituents may be enhanced following the injections of chemical oxidants, and changes in dissolved phase constituent concentrations in groundwater would be monitored. The estimated groundwater monitoring costs are based on collection and analyses of groundwater samples at approximately 14 Off-Site locations on an annual basis for a period of 20 years. The well network and monitoring program would be finalized prior to implementation. Groundwater levels would be measured during the monitoring events to evaluate groundwater flow directions and assure that an appropriate monitoring well network is maintained.

Overall Protection of Public Health and the Environment

MGP constituent occurrence in the Off-Site area is associated with migration within the saturated zone above the confining layer. Therefore, the potential for surface soil-related exposures is limited. There is no current or anticipated future use of groundwater within the impacted area. *In-situ* treatment would be used to address Off-Site source material within the saturated zone.

RAOs that involve exposure controls would be achieved, and active remediation of Off-Site source material would occur. Active measures to control potential future migration of On-Site source material to Off-Site areas are addressed with the On-Site alternatives. Sufficient characterization of the treatment area, particularly where free-phase NAPL potentially exists, would be necessary to assure that ISCO is implemented in a manner that does not increase the mobility of Off-Site source material. Alternative 8 reduces the potential for human exposure through groundwater monitoring and groundwater use restrictions, and through the use of institutional controls to address source material and soil, where appropriate. This alternative would be adequately protective of public health and the environment.

Compliance with SCGs

Actions under Alternative 8 would include *in-situ* treatment of source material within the saturated zone, institutional controls (groundwater use restrictions, and a soil management plan and land use restrictions where appropriate) and groundwater monitoring. Compliance with SCGs associated with these actions would include proper management of material generated during injector installations, fluids generated during the injection process, purge water from sampling activities, and soil segregated from some excavations into the saturated zone, which is expected to be achievable. Compliance with NYSDEC and access-related requirements for the safe and proper injection of chemicals during *in-situ* treatment would be necessary, particularly at Off-Site residential properties including the day care facility.

Remediation of source material within the saturated zone would occur. The *in-situ* treatment component of this alternative would significantly reduce the mass of material that is a source of groundwater impacts. However, groundwater standards may not be achieved due to the potential for residual DNAPL to remain beyond the treatment area, subsurface constraints on reagent distribution, and practical limitations of ISCO technology where DNAPL is present. This alternative is considered good in overall acceptability regarding this criterion.

Long-Term Effectiveness and Permanence

The Off-Site source material and MGP-related impacts occur within the saturated zone above the confining layer. Therefore, a soil management plan for Off-Site properties that addresses deeper excavation work and land use restrictions, where appropriate, should provide adequate long-term effectiveness and protection from potential exposures to impacted subsurface soil. Use of groundwater within the impacted area does not currently exist and is not anticipated. Therefore, groundwater use restrictions and monitoring should provide adequate long-term protection from potential exposures to impacted groundwater.

Material within the saturated zone acting as a source of groundwater impacts would be addressed via *in-situ* treatment. ISCO treatment results in a permanent destruction of constituents. Risks would be primarily related to residual DNAPL that may remain beyond the treatment area. The exposure controls would provide additional long-term protection to address the residual risks. Overall, Alternative 8 is good in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

Direct treatment of source material within the saturated zone would occur via *in-situ* chemical oxidation, resulting in an overall reduction in constituent mass. Potential constituent mobility should also be reduced because the mass would be significantly reduced.

Because oxygen may be provided within the saturated zone as a by-product of the ISCO process, biological degradation may be promoted. Post-treatment groundwater concentrations would be monitored. Overall, the acceptability of Alternative 8 regarding this criterion is good because significant mass of constituents would be permanently destroyed.

Short-Term Effectiveness

Implementation of institutional controls and groundwater monitoring would not have adverse short-term effects on the community or remediation workers. Application of ISCO would involve the potential for some short-term effects. Waste materials and fluids would need to be properly managed, and procedures to mitigate the potential risks and assure adequate protection would be required, particularly in Off-Site residential areas including the day care facility.

Source material is addressed by the ISCO treatment component of this alternative. Impacts on the environment during implementation are considered acceptable, although a short-term increase in free-phase DNAPL mobility may occur. Environmental impacts beyond the current extent of constituent occurrence are not expected.

Injections would occur for a projected period of three months, with the duration determined primarily by treatment requirements in the NAPL saturated areas. Post-remediation groundwater quality would be monitored for a projected period of 20 years. Overall, Alternative 8 would be moderate in short-term effectiveness.

Implementability

Institutional controls such as land and groundwater use restrictions are commonly adopted where property owner objections are not an issue. Groundwater monitoring and management of soil from excavations are routine tasks. *In-situ* treatment of source material is technically implementable, assuming site-specific procedures for safe implementation are developed during remedial design. Administrative requirements would need to be addressed, particularly access-related issues. Given the land use within the Off-Site source material area, access constraints are possible that may significantly impact the successful implementation of ISCO treatment Off-Site.

Following the *in-situ* treatment work, this alternative would not impact current or expected future land uses other than the need to maintain a monitoring well network. Alternative 8 should be implementable, although some technical and administrative issues for the injections, especially access-related requirements, would need to be addressed.

Cost

The initial cost to implement Alternative 8 is estimated at $3,387,700, to cover ISCO treatment of the Off-Site source material, soil management and groundwater monitoring plans, and preparation of groundwater and land use restrictions. Annual costs for groundwater monitoring and periodic soil management, including project management and reporting, are estimated at $36,000.

Assuming monitoring and management activities occur over a 20-year period, the estimated total present worth cost is approximately $3,836,400. Table 5-4 provides the detailed cost estimate for this alternative. The initial costs and estimated total present worth cost of this alternative are high, primarily due to the presence of free-phase NAPL in the Off-Site source material and ISCO treatment being a relatively high cost approach to treat free-phase NAPL.

5.2.3 Alternative 9 – *In-Situ* Enhanced Bioremediation (Injection of Oxygen-Supplying Product) For Treatment of Off-Site Groundwater beyond Source Material Areas, Institutional Controls and Groundwater Monitoring

Alternative 9 would involve enhanced bioremediation of impacted groundwater using *in-situ* treatment, along with institutional controls and groundwater monitoring. The treatment would involve injection of an oxygen-supplying product using temporary borings. Assuming microbial populations and available nutrients are adequate, this process increases dissolved oxygen concentrations in groundwater and stimulates microbial activity to enhance constituent biodegradation in the saturated zone.

Because biodegradation is expected to have limited effectiveness within areas containing source material, this alternative involves *in-situ* treatment within areas of groundwater impacts beyond the extent of source material Off-Site. Figure 5-5 depicts the general areas where *in-situ* enhanced bioremediation is potentially applicable. Unless the Off-Site source material is addressed, long-term impacts to groundwater quality would continue to occur. As groundwater flows through upgradient source material, dissolved phase migration into treated areas would occur. Therefore, this alternative to treat the groundwater plume may be more appropriate for implementation in conjunction with other measures to address the Off-Site source material.

Access constraints are present within the areas of remaining groundwater impacts, including a public roadway (Front Street), private structures and a railroad. For evaluation purposes, the cost estimate assumes two initial injection events, with 100 injection locations per event and 30 pounds of oxidant injected per location. Details regarding accessible locations, spacing of injection borings, mass of oxidant injected per boring and the number of applications would be developed further during the remedial design phase.

The injection events associated with Alternative 9 should not have significant adverse effects on land uses. Natural biodegradation of dissolved phase constituents would be supplemented by treatment via the oxygen addition, and the anticipated reduction in dissolved phase constituent concentrations would be monitored.

The institutional controls may vary for the properties within the impacted area, and are expected to include a groundwater use restriction at a minimum. Institutional controls would assure continued protection of human health. Exposure to groundwater does not currently exist. Groundwater use restrictions would assure that future exposure does not occur. A soil management plan and land use restrictions may also be appropriate at some locations to control potential exposure to impacted soil. The soil management plan would address deeper excavations into the saturated zone, where MGP constituents may be present above the confining layer.

The estimated groundwater monitoring costs are based on collection and analyses of groundwater samples at 14 Off-Site locations on an annual basis for a period of 20 years. The well network and monitoring program would be finalized prior to implementation. Groundwater level measurements would be obtained during the monitoring events to evaluate groundwater flow directions and assure that an appropriate monitoring well network is maintained.

Overall Protection of Public Health and the Environment

Exposure to groundwater does not exist and is not anticipated. Assuming microbial populations and available nutrients are adequate, injection of an oxygen-supplying product is expected to enhance the rate of constituent biodegradation and reduce the timeframe to meet groundwater standards to the extent practicable.

The acceptability of Alternative 9 regarding this criterion is very good within the areas being addressed (beyond the Off-Site source material areas) because potential human exposures and the Off-Site RAOs are addressed, groundwater monitoring would provide additional protection of human health, and reductions in constituent concentrations in groundwater would continue at a similar or increased rate.

Compliance With SCGs

Actions under Alternative 9 would include institutional controls, the injection of an oxygen-supplying product, and groundwater monitoring. Compliance with SCGs associated with these actions would primarily involve requirements associated with the injections, and proper management of purge water from monitoring activities and segregated soil from some excavations into the saturated zone. Compliance with NYSDEC and access-related requirements for the injections and the proper management of purged groundwater and segregated soil from excavations is expected to be achievable.

Remediation of source material or soils exceeding NYSDEC recommended soil cleanup objectives would not occur. Injection of an oxygen-supplying product into the saturated zone would improve the rate that biodegradation of constituent concentrations would occur. The overall acceptability of this alternative is good regarding this criterion for the areas being addressed based on the applicability of the technology.

Long-Term Effectiveness and Permanence

The Off-Site source material and associated groundwater impacts occur within the saturated zone above the confining layer. Therefore, a soil management plan for Off-Site properties that addresses deeper excavation work and land use restrictions, where appropriate, should provide adequate long-term effectiveness and protection from potential exposures to impacted soil.

Because there is no current or anticipated future use of groundwater within the impacted area, a groundwater use restriction and monitoring should be adequate to provide long-term protection from potential exposures to impacted groundwater.

The addition of oxygen should enhance conditions within the saturated zone so that biodegradation of dissolved phase constituents will continue to occur, although access constraints may limit the spatial improvements. Risks related to the continued presence of source material Off-Site would persist. Unless the source is addressed, dissolved phase migration of constituents may occur as groundwater flows through upgradient source material and treated areas may be re-impacted. Alternative 9 is low in long-term effectiveness because of the effects of the upgradient Off-Site source material and need for re-injection over an extended period of time.

Reduction of Toxicity, Mobility or Volume with Treatment

Treatment of groundwater would occur with Alternative 9. Microbial activity would be stimulated through the addition of oxygen, which would result in increased biodegradation of constituents. The *in-situ* treatment process would reduce toxicity, mobility and volume of constituents within the areas that are treated. Groundwater concentrations would be monitored to determine the rate and extent of reductions over time.

Remedial actions On-Site are expected to have some beneficial effects on Off-Site groundwater quality, and the Off-Site groundwater plume appears to be in a near steady-state condition. However, unless the Off-Site source material is addressed, NAPL within the saturated zone Off-Site would act as a source of dissolved phase constituents that would migrate with groundwater flow into treated areas. Therefore, the injections would need to continue periodically for an extended period of time. Acceptability regarding this criterion is fair because the reductions achieved by *in-situ* treatment would be adversely effected by constituent migration from upgradient Off-Site source material into treated areas.

Short-Term Effectiveness

Depending on the locations selected for injection, this alternative may have limited short-term impacts on land uses. However, some discretion is available in determining boring locations. Injection of oxygen products is a common remediation method that can be safely and reliably implemented. However, careful implementation plans would be required because of the sensitive residential land use in the treatment area. The management of purged groundwater from monitoring activities and soil from deep excavations within impacted areas would pose limited risks to workers, and to the community during transport. However, routine procedures to mitigate potential risks and assure adequate protection are available.

The short-term effectiveness of this alternative in addressing impacted groundwater within the shallow zone would depend upon the rate that biodegradation processes would be enhanced by the addition of oxygen. The *in-situ* treatment component should improve groundwater conditions and reduce the timeframe to achieve groundwater standards to the extent practicable. Access constraints within areas of groundwater impacts may limit the improvements, however. Also, treated areas would likely be re-impacted by upgradient source areas and require additional injections.

Although each injection event would be relatively limited in duration (e.g., three weeks), the applications are projected to occur biannually for 20 years due to the effects of the upgradient source material. Groundwater monitoring would occur for a projected period of 20 years. Short-term environmental impacts beyond the current extent of groundwater impacts would not be expected. The overall short-term effectiveness of Alternative 3 is considered moderate.

Implementability

This alternative would not impact current or expected future land uses, other than the need to maintain the monitoring well network and for access for periodic injection of the oxygen-supplying product. The primary constraints to successful implementation of Alternative 9 are the limitations on access within the impacted area, due to the presence of the public roadway, private structures and railroad, and the administrative requirements associated with obtaining approval for injection on Off-Site properties. Some discretion is available in determining each boring location, and each injection event would be completed within a relatively limited timeframe. Therefore, the injection component of this alternative is considered implementable.

Institutional controls such as use restrictions are commonly adopted where property owner objections are not an issue. The groundwater monitoring component of this alternative is readily implementable. Overall, Alternative 9 is considered implementable, although access for injections may be a constraint at some specific locations.

Cost

The initial cost to implement Alternative 9 is estimated at $352,700. The estimated cost covers institutional controls and development of detailed plans for the injection events, soil management and groundwater monitoring. Two initial injection events for the oxygen-supplying product, with documentation reports for each event, are included in the estimate. Annual costs for groundwater monitoring, biannual injections and periodic soil management activities, including project management and reporting, are estimated at $90,550. The annual cost estimate is based on one-half of the cost for the biannual injections.

Assuming monitoring and management activities occur over a 20-year period, the estimated total present worth cost is approximately $1,481,200. Table 5-4 provides the detailed cost estimate for Alternative 9. This alternative is considered good in acceptability regarding the cost criterion, although no direct benefits associated with the Off-Site source material would be involved.

5.2.4 Alternative 10 – Installation of Extraction Points in Off-Site Source Areas with Periodic Total Fluids Extraction and Transport to an Off-Site Facility, with Monitored Natural Attenuation For Groundwater, and Institutional Controls

Alternative 10 would involve installation of extraction points in the Off-Site source area, with periodic total fluids extraction and Off-Site disposal. Monitoring of natural attenuation in groundwater and institutional controls are also included as components of this remedial alternative.

Access constraints are present within portions of the Off-Site source material area, including a public roadway (Front Street), private structures and railroad right-of-way. However, some discretion is available in determining each well location. The general layout of the extraction well network within the Off-Site source material area is depicted on Figure 5-6. The number of proposed extraction wells and their locations are tentative at this time, and would be determined during the remedial design phase. For evaluation purposes, Alternative 10 assumes 18 extraction wells would be installed to a depth of 25 feet bgs within the Off-Site source material area at the locations identified on Figure 5-6. Waste material and fluids generated during installation and development of the wells would be managed appropriately. Approved waste profiles would be in place with treatment or disposal facilities utilized to assure that the material meets their acceptance criteria.

Periodic total fluids extraction using mobile high vacuum equipment (e.g., vacuum truck) with off-site disposal of the recovered fluids has been assumed for evaluation purposes. The method for extraction and disposal would be evaluated further during the remedial design phase. For costing purposes, monitoring of potential NAPL accumulations, and total fluids extraction and disposal of approximately 3,600 gallons from six locations on a monthly basis have been assumed for a three-year period, followed by quarterly monitoring and extraction for seven additional years (10 years total). Criteria for the frequency and duration of extraction would be developed during remedial design. It is anticipated that the benefits of extraction (primarily mass removal) would decrease significantly as the recovery of free-phase NAPL diminishes. The primary objective of the extraction program would be removal of NAPL and high concentration groundwater via total fluids removal, resulting in a reduction of constituent mass within the Off-Site source material area. In-well measurements to check for potential NAPL accumulations would be used to direct the extraction efforts, because the benefits of NAPL removal are significantly greater than removal of lower concentration groundwater at the outer portions of the source area.

Institutional controls at each property within the impacted area may vary depending on the location, and are expected to include a groundwater use restriction at a minimum. Exposure to groundwater does not currently exist, and groundwater use restrictions would assure that future exposure does not occur. A soil management plan and land use restrictions may also be appropriate at some locations to control potential exposure to impacted soil. The soil management plan would address deeper excavations into the saturated zone, where MGP constituents may be present above the confining layer. The institutional controls would assure continued protection of human health.

Extraction of NAPL and the groundwater containing higher concentrations within the Off-Site source material area may enhance the natural attenuation process for impacted groundwater. Reductions in dissolved phase constituent concentrations would be monitored with this alternative. The estimated groundwater monitoring costs are based on collection and analyses of groundwater samples at 14 Off-Site monitoring well locations on an annual basis for a period of 20 years. The well network and monitoring program would be finalized prior to implementation. Groundwater level measurements would be utilized to evaluate flow directions and assure that an appropriate monitoring well network is maintained.

Overall Protection of Public Health and the Environment

MGP constituent occurrence Off-Site is associated with migration within the saturated zone above the confining layer. Therefore, the potential for surface soil-related exposures is limited. There is no current or anticipated future use of groundwater within the impacted area. Total fluids extraction would reduce the mass of Off-Site source material and dissolved constituents within the saturated zone.

RAOs that involve exposure controls would be achieved, and active remediation of the Off-Site source material area would occur. Active measures to control potential future migration of On-Site source material to Off-Site areas are addressed with the On-Site alternatives. Alternative 10 reduces the potential for human exposure through groundwater monitoring and groundwater use restrictions, and through the use of institutional controls to address source material and soil, where appropriate. This alternative would be adequately protective of public health and the environment.

Compliance With SCGs

Actions under Alternative 10 would include installation of extraction wells, periodic total fluids extraction in Off-Site areas, institutional controls (groundwater use restrictions, and a soil management plan and land use restrictions where appropriate) and groundwater monitoring. Compliance with SCGs associated with these actions would include proper management of cuttings and fluids generated during the well installations, fluids generated during the extraction process, purge water from sampling activities, and soil segregated from some excavations into the saturated zone, which is expected to be achievable. Compliance with requirements for the safe and proper extraction of fluids would be necessary, particularly at Off-Site residential properties.

Remediation of source material within the saturated zone would occur. Total fluids extraction would reduce the constituent mass within the Off-Site source material area, particularly through the removal of free-phase NAPL where accumulations occur. However, groundwater standards would not be achieved due to the presence of residual DNAPL within the saturated zone. This alternative is considered good in overall acceptability regarding this criterion.

Long-Term Effectiveness and Permanence

The Off-Site source material and MGP-related groundwater impacts occur within the saturated zone above the confining layer. Therefore, a soil management plan for Off-Site properties that addresses deeper excavation work and land use restrictions, where appropriate, should provide adequate long-term effectiveness and protection from potential exposures to impacted soil. Use of groundwater within the impacted area does not currently exist and is not anticipated. Therefore, groundwater use restrictions and monitoring should provide adequate long-term protection from potential exposures to impacted groundwater.

Material within the saturated zone acting as a source of groundwater impacts would be addressed via total fluids extraction, which results in a permanent removal of constituents from the subsurface. The degree of effectiveness would relate primarily to the volume of free-phase DNAPL that is mobile and recoverable via extraction. The extraction process may need to occur for a relatively long period of time. Residual risks would be primarily related to residual DNAPL that would remain within the saturated zone and continue to be a source of groundwater impacts. The exposure controls would provide additional long-term protection to address the residual risks. Overall, Alternative 10 is moderate to good in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

Direct treatment of source material within the saturated zone would occur via extraction, resulting in an overall reduction in volume. Potential constituent mobility would also be reduced because the mass would be reduced, particularly the mobile portion. Groundwater concentrations would be monitored to determine the extent of constituent reductions over time. Overall, the acceptability of Alternative 10 regarding this criterion is expected to be moderate to good, depending primarily on the volume of free-phase NAPL that is recoverable.

Short-Term Effectiveness

Implementation of institutional controls and groundwater monitoring would not have any adverse short-term effects on the community or remediation workers. Installation of the extraction wells would have some potential short-term effects, along with periodic extraction from the wells during the extraction process. Waste materials and fluids would need to be properly managed, and incidental spills would need to be controlled. Procedures to mitigate the potential risks and assure adequate protection would be required, particularly in Off-Site residential areas including the day care facility.

Mobile source material is addressed by the extraction component of this alternative. Impacts on the environment during implementation are considered acceptable. Environmental impacts beyond the current extent of constituent occurrence are not expected.

Monitoring of groundwater quality would be conducted for a projected period of 20 years. The need to potentially continue periodic extraction for an extended period of time adversely impacts the short-term effectiveness of Alternative 10.

Implementability

Installation of the extraction wells would be similar to the monitoring well and piezometer installations that were previously installed successfully in the Off-Site source area. Institutional controls such as land and groundwater use restrictions are commonly adopted and considered readily implementable where property owner objections are not an issue. Groundwater monitoring and management of soil from excavations are routine tasks.

Following the well installations, this alternative should not adversely impact current or expected future land uses. However, access to the extraction and monitoring wells would need to be maintained. Alternative 10 should be implementable, assuming access-related issues can be satisfactorily resolved.

Cost

The initial cost to implement Alternative 10 is estimated at $321,500, to cover installation of the extraction wells, soil management and groundwater monitoring plans, and preparation of groundwater and land use restrictions. Annual costs for groundwater monitoring, periodic soil management and monthly extraction and disposal of fluids from the wells are estimated at $112,000. Annual costs for groundwater monitoring, periodic soil management and quarterly extraction and disposal of fluids from the wells are estimated at $62,200. If extraction and disposal of fluids from the wells are no longer needed, the estimated annual costs would be reduced to $36,000.

Assuming the monitoring, management and extraction activities occur over a 10-year period (with monthly monitoring and extraction for three years and quarterly monitoring and extraction for seven additional years), with groundwater monitoring and management (without extraction) for an additional ten years (20-year period total), the estimated total present worth cost is approximately $1,113,000. Table 5-4 provides the detailed cost estimate for this alternative. The initial costs of this alternative are relatively low. However, due to the extraction and disposal requirements associated with total fluids removal from the wells, the annual costs are relatively high.

6.0 COMPARATIVE ANALYSIS

Each remedial alternative for the site was evaluated using the seven evaluation criteria identified in Section 5.0. This section presents separate comparative analyses of the On-Site and Off-Site alternatives. The comparative analyses are summarized in Tables 6-1 and 6-2.

6.1 On-Site Alternatives

Six On-Site alternatives for the NYSEG Norwich site were described in detail and evaluated independently in Section 5.0 using seven evaluation criteria. The On-Site alternatives are compared in this section using the same criteria. A summary of the comparative analysis is provided in Table 6-1.

6.1.1 Overall Protection of Public Health and the Environment

Each alternative includes the use of institutional controls and monitoring to control potential exposures. Because remediation of source material or groundwater is not addressed, Alternative 1 (no remedial action) is the least protective of public health and the environment.

Alternative 3 includes a collection trench for passive removal of free-phase NAPL, which achieves the RAO of controlling future migration of source material from On-Site to Off-Site areas. Alternative 4 would be more protective than Alternative 3 because full containment around the perimeter of the source area is provided, and impacted groundwater is addressed as well as potential for free-phase NAPL migration from the source material area.

Alternatives 5 and 6 may be slightly more protective than Alternative 4 because the source material is addressed more directly. With Alternative 5, source material is solidified in place to significantly reduce or eliminate constituent mobility and possibly toxicity. The chemical oxidation process (Alternative 6) permanently destroys constituents rather than immobilizing them in-place. However, there is less certainty of complete treatment with ISCO than with the ISS process.

Alternative 2 (excavation of On-Site source material) is the most protective of public health and the environment because source material from the vadose and saturated zones would be removed. Following the excavation activities, the potential for exposure would be eliminated, sources of impact to groundwater would be eliminated, and the RAO of controlling NAPL migration to Off-Site areas would be achieved.

6.1.2 Compliance with SCGs

The limited activities associated with Alternative 1 could be conducted in compliance with SCGs. However, remediation of source material or impacted groundwater would not occur. Therefore, the “no remedial action” alternative is low in overall acceptability regarding this criterion. Each of the other On-Site alternatives includes the institutional controls and groundwater monitoring components of Alternative 1, as well as additional measures to address the source material.

Actions associated with Alternative 3 would include installation and operation of a free-phase NAPL passive collection system at the downgradient perimeter of the On-Site source material area. Actions associated with Alternative 4 would include installation of a full barrier containment system around the On-Site source material area. SCGs associated with implementation of these alternatives should be achievable. However, the containment approaches of Alternatives 3 and 4 would not directly address soil or groundwater quality SCGs.

Actions associated with implementation of Alternative 5 (excavation of soil and ISS of the source material area) and Alternative 6 (ISCO treatment within the saturated zone of the source material area) should comply with SCGs, although more issues would be involved than with Alternatives 3 or 4. However, Alternatives 5 and 6 are better at addressing soil and groundwater quality SCGs. Alternatives 5 and 6 are similar overall regarding compliance with SCGs, with Alternative 5 slightly better because Alternative 6 would not address source material that may remain within the unsaturated zone.

Measures to assure proper implementation of Alternative 2 would be critical to compliance with action-based SCGs due to the significant extent of the planned excavation and the associated dewatering requirements. Source material would be significantly reduced or eliminated, along with the potential for NAPL migration, and groundwater quality would be significantly improved. Assuming safe and reliable procedures can be developed to conduct the excavation, Alternative 2 would be the best alternative regarding compliance with SCGs because of the resultant improvements to soil and groundwater quality.

6.1.3 Long-Term Effectiveness and Permanence

Exposure to surface soil is not a concern, and there is no current or anticipated future use of groundwater On-Site. However, without being addressed, residual risks related to the continued presence of source material in the subsurface would persist, along with the associated impacts to groundwater quality. Each alternative includes land and groundwater use restrictions, a soil management plan for future intrusive activities and groundwater monitoring as exposure controls to assure adequate protection is maintained.

Because no active remediation would occur under Alternative 1, it is unreliable and the lowest ranked alternative at assuring long-term effectiveness and protection from potential exposures. The collection trench component of Alternative 3 would capture mobile, free-phase NAPL at the downgradient perimeter of the On-Site source area. However, long-term impacts to groundwater quality would continue, and long-term monitoring and recovery of NAPL at the collection trench would be necessary. Therefore, this alternative is less acceptable regarding this criterion than the other alternatives with active remediation.

Alternative 4 relies on a physical barrier around the source material to minimize or eliminate constituent mobility, which is more reliable regarding long-term protection than Alternative 3. Alternatives 5 and 6 are similar regarding long-term protection. Alternative 5 immobilizes the source material using the ISS process. This approach is comparable to excavation (Alternative 2), although ISS technology involves less certainty regarding permanence. Alternative 6 achieves significant mass reduction through the chemical oxidation process. However, ISCO technology involves less certainty than excavation. Excavation (Alternative 2) provides the most effective and permanent long-term solution to address source material and the associated groundwater impacts.

6.1.4 Reduction of Toxicity, Mobility or Volume with Treatment

No direct treatment would occur with Alternative 1. Natural attenuation is not expected to be significant without removal of source material, and constituent mobility would not be significantly affected. The “no remedial action” alternative is the least acceptable alternative regarding this criterion.

Alternative 3 involves installation of a collection trench to capture mobile, free-phase NAPL. This approach addresses free-phase constituent mobility, and achieves mass reduction through removal and disposal of NAPL. However, because significant NAPL migration is not expected, the mass reduction would be limited and dissolved phase migration associated with the source material is not addressed.

Alternatives 4, 5 and 6 are similar in overall mobility or volume reduction. Alternative 4 relies on a physical barrier around the source material to minimize or eliminate constituent mobility. The full containment approach of Alternative 4 would be more effective than Alternative 3 at reductions in mobility or volume for both free-phase and dissolved phase constituents. Alternative 5 immobilizes the source material using the ISS process. Through the chemical oxidation process, Alternative 6 achieves volume reduction rather than a reduction in mobility. Excavation (Alternative 2) provides the most effective overall reduction in mobility or volume of constituents within the On-Site source material area.

6.1.5 Short-Term Effectiveness

None of the alternatives are expected to result in short-term environmental impacts beyond the current extent of constituent occurrence. Implementation of institutional controls and groundwater monitoring, components of each alternative, would not have adverse short-term effects on the community or remediation workers.

Application of ISCO (Alternative 6) would involve the potential for some short-term effects. Safe and reliable procedures would be necessary to mitigate the potential risks and assure adequate protection. Based primarily on the estimated extent of free-phase NAPL On-Site, the injections would occur for a projected duration of about 15 months. Therefore, Alternative 6 is considered the least effective regarding the short-term criterion.

Installation of the hydraulic control measures and handling of the significant volume of wet excavated material would affect the overall timeframe for implementation of Alternative 2, although the subsequent groundwater monitoring period would be relatively limited. Installation of the collection trench with Alternative 3 could be completed in a relatively short period of time in comparison with the other On-Site alternatives. However, NAPL monitoring/removal and groundwater monitoring are projected to continue for an extended period of time, which adversely impacts the short-term effectiveness of Alternative 3.

Alternative 5 (ISS with an associated excavation component) would require procedures to mitigate potential risks and assure adequate protection from potential short-term effects. However, it does not involve the long-term requirements of Alternative 3 and could be completed in a much shorter timeframe than Alternatives 2 or 6. Alternative 4, which includes installation of a physical barrier around the perimeter of the On-Site source material, would also require procedures to address potential short-term effects. However, without the long-term O&M requirements of Alternative 3 and because of the relatively short timeframe for implementation, Alternative 4 may have the best short-term effectiveness of the alternatives with active remediation.

“No remedial action” (Alternative 1) would not affect the community or remediation workers, and the limited activities involved would not cause any adverse environmental effects. Therefore, it is the most effective alternative in the short-term, although source material would not be remediated and groundwater monitoring and other exposure controls would occur for an extended period.

6.1.6 Implementability

Each On-Site alternative includes institutional controls and groundwater monitoring. Institutional controls such as land and groundwater use restrictions and soil management plans, and measures such as groundwater sampling and maintenance of a monitoring well network, are common actions that are considered readily implementable. Differences regarding implementability relate primarily to the manner in which remediation of the source material is addressed.

Due to the significant extent of the planned excavation work within the saturated zone, Alternative 2 would be the most difficult alternative to implement. Alternatives 5 and 6 are comparable overall in implementability. Alternative 5 (ISS of the source material area) would be more disruptive to the site however, Alternative 6 (ISCO treatment) would occur for a much longer period of time.

The containment approaches (Alternatives 3 and 4) should be easier to implement than Alternatives 2, 5 or 6, and are comparable overall regarding this criterion. Installation of the downgradient NAPL collection trench (Alternative 3) is more involved than installation of a physical barrier (Alternative 4). However, the trench installation is less extensive because it would not be installed around the entire source material area. Periodic monitoring and removal of NAPL from the trench should be achievable using equipment that is generally available. Long-term extraction and disposal of NAPL, if necessary, may pose O&M constraints in the future.

No remedial action (Alternative 1) would not have potential implementability constraints and would be the easiest alternative to implement technically; however, it is unlikely to be acceptable to the regulatory agencies.

6.1.7 Cost

Comparative cost estimates for the On-Site remedial alternatives are presented in Table 5-2, including the estimated initial cost, annual cost, duration and total present worth cost. The estimates are based on the alternative descriptions and assumptions provided in Section 5.1.

Alternatives 2 (excavation) and 6 (ISCO treatment) are comparable in terms of initial remediation costs. Although effective where the treatment can be completed sufficiently, ISCO represents a relatively high cost approach to remediation where significant quantities of free-phase NAPL are present. Because post-remediation monitoring and management requirements would likely be necessary for a much longer duration, the estimated present worth cost of Alternative 6 is slightly more than for Alternative 2. Although effective where implementable, excavation of source material at significant depths into the saturated zone is also a relatively high cost approach to remediation. The long-term costs after implementation should be relatively low, however, due to the potential for a significantly reduced monitoring period compared with other alternatives.

In-situ solidification/stabilization of the On-Site source material (Alternative 5) is a moderate cost alternative in comparison to the other alternatives evaluated. Because of the anticipated effectiveness of the technology, post-remediation costs should be relatively low due to the potential for a significantly reduced monitoring period. The estimated total present worth cost of Alternative 5 is about $7.2 million less than Alternative 2 (excavation), and about $4.0 million higher than the perimeter containment approaches (Alternatives 3 and 4). Alternative 3 (free-phase NAPL passive collection trench at the downgradient boundary) and Alternative 4 (physical containment barrier at the perimeter of the On-Site source material) are comparable in estimated total present worth costs, at approximately $2.3 to 2.4 million each. Alternative 3 is slightly lower in initial costs, and higher in annual costs due to the need for monitoring and removal of NAPL at the collection trench.

Alternative 1 (no active remediation, with institutional controls and groundwater monitoring) involves minimal initial costs. Although the annual costs would be incurred over an extended period of time, the estimated total present worth cost is the lowest overall. The no action alternative was included in the evaluation to provide a baseline for comparison with the other alternatives.

6.2 Off-Site Alternatives

Four Off-Site alternatives for the NYSEG Norwich site were described in detail and evaluated independently in Section 5.0 using seven evaluation criteria. The Off-Site alternatives are compared in this section using the same criteria. A summary of the comparative analysis is provided in Table 6-2.

6.2.1 Overall Protection of Public Health and the Environment

Alternative 7 involves the use of institutional controls and monitoring to control potential exposures. This approach achieves the RAOs and should provide adequate protection of public health and the environment. Because the other Off-Site alternatives involve active remediation in addition to the exposure controls of Alternative 7, they would be more protective.

Alternative 9 includes injection of an oxygen-supplying product to enhance bioremediation in areas with groundwater impacts beyond the source material area. Although this treatment should provide more protection than Alternative 7, the difference may not be significant due to continuing re-contamination potentials from upgradient source material.

Alternatives 8 (ISCO treatment) and 9 (periodic extraction) provide reduction of constituent mass within the Off-Site source material area. Alternative 8 may be the most protective alternative, assuming the presence of free-phase NAPL does not pose practical constraints to successful implementation.

6.2.2 Compliance with SCGs

The limited activities associated with Alternative 7 could be conducted in compliance with SCGs. However, remediation of source material would not occur. Therefore, the other Off-Site alternatives are better at addressing groundwater quality SCGs.

Activities associated with implementation of Alternatives 8, 9 and 10 should comply with SCGs. However, issues involved with injection or extraction would need to be addressed, particularly in Off-Site residential areas including the day-care facility. Even with successful treatment, Alternative 8 (injection of an oxygen-supplying product) may not result in groundwater quality SCGs being achieved because source material would remain upgradient of the treated areas.

Alternative 10 may be the most effective alternative at reducing constituent mass in areas with recoverable free-phase NAPL. However, because of the presence of residual NAPL, it is unlikely that extraction would result in groundwater quality SCGs being achieved. Alternative 10 (ISCO treatment) has the greatest potential to achieve SCGs for groundwater outside of areas where significant free-phase NAPL is present.

6.2.3 Long-Term Effectiveness and Permanence

No remedial action (Alternative 7) is the least effective approach regarding this criterion. However, adequate long-term protection may be provided because of the exposures controls. The long-term effectiveness and permanence of Alternative 9 is adversely impacted by the upgradient source material not being addressed, which may re-impact the areas treated by injection of an oxygen-supplying product.

Periodic extraction of total fluids within the source material area (Alternative 10) would reduce constituent mass and provide permanent removal. The long-term effectiveness of Alternative 10 relates primarily to the volume of free-phase NAPL that is mobile and recoverable. ISCO treatment results in a permanent destruction of constituent mass via chemical oxidation. Assuming sufficient treatment occurs, Alternative 8 would be the most effective and permanent long-term solution.

6.2.4 Reduction of Toxicity, Mobility or Volume with Treatment

No direct treatment would occur with Alternative 7. Natural attenuation is not expected to be significant without removal of source material, and constituent mobility would not be significantly improved. The “no remedial action” alternative is the least acceptable alternative regarding this criterion. Through injection of an oxygen-supplying product, Alternative 8 is expected to enhance the biodegradation rate and improve the rate of dissolved constituent reductions. However, this approach is applicable in areas with groundwater impacts outside the source material area, where the constituent mass is relatively limited and reductions may not be significant.

Alternatives 8 and 10 are better regarding this criterion because they address the source material area where most of the constituent mass is present. Unless a significant volume of free-phase NAPL is available for recovery via extraction (Alternative 10), the ISCO treatment approach of Alternative 8 is the best at reducing constituent mass. The ISCO process may also benefit biodegradation by increasing oxygen to the saturated zone, although the process could adversely affect constituent mobility if the treatment is insufficient to address significant free-phase NAPL.

6.2.5 Short-Term Effectiveness

Exposure to impacted soil or groundwater does not currently exist, and none of the alternatives are expected to result in short-term environmental impacts beyond the current extent of constituent occurrence. Implementation of institutional controls and groundwater monitoring would not have any adverse short-term effects on the community or remediation workers.

Alternative 10 (extraction within Off-Site source material area) is the least effective short-term alternative because of the need for long-term extraction and disposal. The benefits of the extraction would likely diminish over time, particularly if significant volumes of recoverable free-phase NAPL are not present throughout the extraction period.

The oxygen-supplying injection events of Alternative 9 would be relatively limited in duration. However, Alternative 9 is adversely impacted by the need to periodically reinject over a relatively long period of time. Alternative 8 (ISCO treatment) is better in the short-term than Alternative 9, although the extent of free-phase NAPL within the treatment area would have an impact on the timeframe to complete remediation.

“No remedial action” (Alternative 7) would not affect the community or remediation workers, and the limited activities involved would not cause adverse environmental effects. Therefore, it is the most effective alternative in the short-term, although source material would not be remediated and groundwater monitoring would occur for an extended period.

6.2.6 Implementability

Each Off-Site alternative includes institutional controls and groundwater monitoring. Institutional controls such as groundwater and land use restrictions and soil management plans are commonly where property owner objections are not an issue. Measures such as groundwater sampling and well maintenance are common actions that are readily implementable. Differences between the alternatives relate primarily to the manner that remediation of the Off-Site source material or impacted groundwater is addressed.

Given the nature of the Off-Site area, Alternative 8 may be the most difficult alternative to implement due to the need to install injectors and subsequently conduct the *in-situ* chemical oxidation process with the associated equipment.

Alternatives 9 and 10 are comparable overall in terms of implementability. Alternative 9 requires access for periodic injections using temporary borings. However, some discretion is available in determining each boring location, and each injection event would be completed within a relatively limited timeframe. Alternative 10 would involve the installation of extraction wells, which would be similar to the installation of monitoring wells that was previously implemented successfully Off-Site. Subsequent extraction would be required periodically using mobile equipment. Both alternatives should be implementable, although Off-Site access-related issues may pose some constraints.

No remedial action (Alternative 7) should not have implementability constraints and would be the easiest alternative to implement technically; however, it is unlikely to be acceptable to the regulatory agencies.

6.2.7 Cost

Comparative cost estimates for the Off-Site remedial alternatives are presented in Table 5-4, including the estimated initial cost, annual cost, duration and total present worth cost. The estimates are based on the alternative descriptions and assumptions provided in Section 5.2.

Alternative 8 is the highest cost Off-Site alternative in terms of both initial and total costs. As noted with the On-Site alternatives, ISCO represents a relatively high cost approach to remediation where significant quantities of free-phase NAPL are present. Based on estimates for the Norwich former MGP site, the estimated total present worth cost for ISCO treatment of Off-Site source material is about $2.7 million higher than for total fluids extraction within the source area (Alternative 10) or enhanced bioremediation of groundwater beyond the source material areas (Alternative 9). Alternatives 9 and 10 are comparable in initial and estimated present worth costs. Each is relatively low in initial costs and high in annual costs due to the need for periodic extraction and disposal of total fluids (Alternative 10) or periodic re-injections of an oxygen-supplying product (Alternative 9).

Alternative 7 (no active remediation, with institutional controls and groundwater monitoring) involves the lowest initial costs. Although annual costs would be incurred over an extended period of time, the estimated total present worth cost is the lowest overall. The no remedial action alternative was included in the evaluation to provide a baseline for comparison with the other alternatives, and may be a viable approach Off-Site depending on the selected On-Site remedy.

7.0 RECOMMENDED REMEDY

Based on the findings of the Remedial Investigation and the FS presented in this report, sufficient information exists to select a remedy for the On-Site and Off-Site areas at the NYSEG former MGP site in Norwich, New York. The recommendation has been developed based on the RAOs and the seven criteria utilized in the evaluation pursuant to NYSDEC guidance.

<u>On-Site Remedy</u>

Alternative 1 (no remedial action) does not adequately address the RAOs and is not protective of human health and the environment. The containment alternatives, using a NAPL collection trench at the down gradient boundary (Alternative 3) or a physical barrier around the perimeter of the On-Site source material (Alternative 4), are both cost-effective approaches that should be adequately protective of human health. However, the lower overall level of protection of the environment and long-term maintenance requirements make Alternatives 3 and 4 less acceptable in comparison to Alternative 5.

Alternative 6 (ISCO treatment) has similar costs as Alternative 2 but has less certainty in performance than excavation, due primarily to the free-phase NAPL present within the On-Site source material area.

Therefore, Alternative 6 is not a preferred remedial alternative. Although Alternative 2 (excavation of source material) would be highly effective in permanently removing the MGP-related impacts, there are significant implementation challenges and the substantially higher cost does not yield a proportionally higher degree of protection for human health and the environment in comparison to Alternative 5.

When considering all of the evaluation criteria, ISS (Alternative 5) appears to be the most effective alternative to address the On-Site source material. This remedial alternative addresses the On-Site RAOs by incorporating the following components:

- Source material is remediated through the use of *in-situ* solidification/stabilization technology to the extent practicable;
- Potential human exposure to residual source material is eliminated to the extent practicable through remediation and the use of institutional controls, including a land use restriction and soil management plan;
- Potential risks to human health from exposure to groundwater containing MGP constituents are minimized through the use of institutional controls and groundwater monitoring;
- Groundwater quality is improved to the extent practicable through the solidification of the source material area and the associated reduction or elimination of dissolved phase constituent mobility; and
- Potential human exposure to subsurface soil containing MGP constituents is eliminated to the extent practicable through remediation and the use of institutional controls, including a land use restriction and soil management plan.

In addition, the Off-Site RAO that involves controlling future migration of source material from On-Site to Off-Site areas is addressed by solidification/stabilization of the source material, which minimizes or eliminates potential mobility.

<u>Off-Site Remedy</u>

Alternative 7 (no remedial action) may adequately address the RAOs for Off-Site and be protective of human health and the environment. However, the other alternatives that involve active remediation provide a higher degree of protection. Given the variable nature of land use and MGP-related impacts within the Off-Site area, a phased approach for remediation is recommended that combines the remaining alternatives for remediation of the Off-Site impacts.

The first phase will entail removal of free-phase NAPL at *selected* Off-Site areas (Alternative 10) to improve effectiveness of the ISCO treatment. The second phase will implement Alternative 8 (ISCO treatment of Off-Site source material, along with institutional controls and groundwater monitoring) for source material treatment except for the two Off-Site properties adjacent to the site located north of Front Street (i.e., 37 and 41 Front Street). These properties are excluded from the first two phases of treatment because of their sensitive land uses/potential receptors (i.e., residential housing at one location and a day care facility at the other location).

It is further recommended that following a sufficient period (2 to 3 years) of monitoring subsequent to ISS treatment (if implemented), NAPL removal and ISCO treatment, NYSEG will consult with NYSDEC to determine the need for applying enhanced bioremediation (Alternative 9) for treatment of any remaining Off-Site residual groundwater impacts.

As noted in the preceding paragraphs, the two Off-Site properties north of Front Street (i.e., 37 and 41 Front Street) are not suitable locations for NAPL extraction and/or ISCO treatment because of their sensitive land uses/potential receptors. NYSEG will negotiate with both property owners to acquire both properties at fair market value. If NYSEG is successful in acquiring the two properties, the existing structures on the properties would be razed and On-Site Alternative 5 (*in-situ* stabilization) would be implemented on those properties.

The Addendum to this FS describes and presents an additional Alternative 11, which combines the phased approach for the remediation of the Off-Site areas. Please refer to the Addendum for the details.

This phased remedial approach addresses the Off-Site RAOs by incorporating the following components:

- If implemented, On-Site Alternative 5 (i.e., ISS technology for source material treatment) would control future migration of source material from On-Site to Off-Site areas, and more specifically in this case, it would control future migration of source material within the Off-Site area;
- Potential human exposure to source material is eliminated to the extent practicable through remediation (by ISCO, free-phase NAPL removal, and ISS if implemented) and the use of institutional controls, including land use restrictions and a soil management plan as appropriate for Off-Site properties;
- Potential risks to human health from exposure to groundwater containing MGP constituents are minimized through the use of institutional controls, groundwater monitoring and using enhanced bioremediation (Alternative 9) where appropriate; and
- Potential human exposure to subsurface soil containing MGP constituents is eliminated to the extent practicable through remediation (by ISCO, free-phase NAPL removal and ISS if implemented) and the use of institutional controls, including land use restrictions and a soil management plan as appropriate for each Off-Site property.

8.0 REFERENCES

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TABLES

TABLE 4-1

SCREENING OF POTENTIAL SOIL TECHNOLOGIES

NYSEG Former MGP Site
Norwich, New York

Technology	Description	Conclusion
No action	No remedial measures taken	**Retain** as a baseline for comparison with other alternatives
Institutional controls	Addresses potential risks by restricting property uses to non-residential and through a Soil Management Plan	**Eliminate** as a stand-alone technology, but include as a component of other alternatives
Surface cover	Maintain a cover (e.g., vegetation, stone, pavement) over impacted areas	**Eliminate** as a stand-alone technology, but include as a component of other alternatives
Soil venting	Application of vacuum to vadose zone to induce removal of primarily volatile constituents, with release to atmosphere after treatment if needed	**Eliminate** due to limited vadose zone impacts, unless needed in conjunction with *in-situ* treatment of underlying saturated zone due to volatilizing of constituents
In-situ stabilization	Reduce mobility of constituents in-place by mixing with a binding agent and solidification	**Retain** for further evaluation, in conjunction with ISS within the saturated zone
In-situ biological treatment	Reduce constituent concentrations in-place by enhancing natural biodegradation	**Eliminate** due to limited vadose zone impacts, and would not be effective at addressing underlying source material in saturated zone with significant NAPL impacts
In-situ chemical oxidation	Chemical destruction of adsorbed constituents through injection of reagents	**Eliminate** as a technology to address impacts within the unsaturated zone
Excavation, on-site thermal desorption and backfill	Excavate impacted soils, treat on-site via thermal desorption, and reuse treated soil as backfill	**Eliminate** - implementation concerns with on-site thermal desorption due to site setting with residences in area
Excavation, off-site treatment and disposal	Excavate impacted soils, transport off-site for treatment and disposal	**Retain** for further evaluation, in conjunction with saturated zone excavation

Notes:
1. Retained technologies may be combined for the alternatives evaluation.

TABLE 4-2

SCREENING OF POTENTIAL NAPL AND GROUNDWATER TECHNOLOGIES

NYSEG Former MGP Site
Norwich, New York

Technology	Description	Conclusion
No action	No remedial measures taken	**Retain** as a baseline for comparison with other alternatives
Institutional controls	Address risks by restricting groundwater use	**Eliminate** as a stand-alone technology, but include as a component of other alternatives
Natural attenuation monitoring	Groundwater sampling and analyses to evaluate potential migration and natural attenuation of dissolved phase constituents	**Eliminate** as a stand-alone technology, but include as a component of other alternatives
NAPL collection	Use of wells or trenches to collect and remove free phase, mobile NAPL from the subsurface	**Retain** for further evaluation on-site and off-site
Source removal via excavation	Excavate impacted material within the saturated zone, using hydraulic controls if necessary	**Retain** for further evaluation on-site
In-situ stabilization	Solidification in-place by mixing with a binding agent to immobilize subsurface constituents	**Retain** for further evaluation as an *in-situ* treatment approach on-site
In-situ bioremediation	Enhancement of natural attenuation by addition of oxygen, and nutrients if needed, to increase biodegradation of constituents	**Retain** for further evaluation off-site; eliminate on-site due to limited effectiveness in areas with significant NAPL impacts
In-situ chemical oxidation	Chemical destruction of adsorbed and dissolved phase constituents through injection of reagents	**Retain** for further evaluation as an *in-situ* treatment approach on-site and off-site
In-situ thermal treatment	Application of heat to increase volatilization rate and facilitate extraction	**Eliminate** due to site setting and potential to create soil vapor intrusion risks that do not presently exist
Hydraulic containment	Use of limited groundwater extraction or phytoremediation to provide containment of dissolved phase constituents and mobile NAPL	**Eliminate** from further consideration - evaluate containment on-site using physical barrier approach
Physical containment	Installation of a physical barrier (e.g., slurry wall) to provide containment of dissolved phase constituents and mobile NAPL	**Retain** for further evaluation of full containment on-site
Groundwater extraction and treatment	Installation of a groundwater extraction system throughout impacted areas with treatment and discharge	**Eliminate** due to implementability constraints and effectiveness limitations

Notes:
1. Retained technologies may be combined for the alternatives evaluation.

TABLE 4-3

POTENTIAL REMEDIAL ALTERNATIVES

NYSEG Former MGP Site
Norwich, New York

	DESCRIPTION OF ALTERNATIVES FOR ON-SITE REMEDY
1	No remedial action of on-site areas - consists of institutional controls (soil management plan, land and groundwater use restrictions) and groundwater monitoring with no other active remediation conducted.
2	Excavation of on-site source material, combined with institutional controls (soil management plan, land and groundwater use restrictions) and groundwater monitoring.
3	Installation and operation of a free-phase NAPL passive removal system at the perimeter of the on-site source area (upgradient of the off-site area). Also includes institutional controls (soil management plan, land and groundwater use restrictions) and groundwater monitoring.
4	Installation of full barrier containment system (e.g., slurry wall) around perimeter of on-site source area with cap/cover on surface, combined with institutional controls (soil management plan, land and groundwater use restrictions) and groundwater monitoring.
5	*In-situ* solidification/stabilization of on-site source material, combined with institutional controls (soil management plan, land and groundwater use restrictions) and groundwater monitoring.
6	*In-situ* chemical oxidation (ISCO) for treatment of source material in on-site areas, combined with institutional controls (soil management plan, land and groundwater use restrictions) and groundwater monitoring.
	DESCRIPTION OF ALTERNATIVES FOR OFF-SITE REMEDY
7	No remedial action for off-site areas - consists of institutional controls (soil management plan, land and groundwater use restrictions) and groundwater monitoring with no other active remediation conducted.
8	I*n-situ* chemical oxidation (ISCO) for treatment of off-site source material with monitored natural attenuation for groundwater. Also includes institutional controls (soil management plan, land and groundwater use restrictions).
9	In-situ enhanced bioremediation (injection of oxygen-supplying product) for treatment of off-site groundwater beyond source material areas. Also includes institutional controls (soil management plan, land and groundwater use restrictions) and groundwater monitoring.
10	Installation of extraction points in off-site source areas with periodic total fluids extraction and transport to an off-site treatment and disposal facility with monitored natural attenuation for grounwater. Also includes institutional controls (soil management plan, land and groundwater use restrictions).

Notes:
1. Alternatives with excavation involve off-site treatment or landfill disposal of excavated material.

TABLE 5-1

ON-SITE REMEDIAL ALTERNATIVES EVALUATION

NYSEG Former MGP Site
Norwich, New York

Criteria	**Alternative 1** **No Remedial Action (With Institutional Controls and Groundwater Monitoring)**	**Alternative 2** **Excavation of On-Site Source Material, Institutional Controls and Groundwater Monitoring**	**Alternative 3** **Installation and Operation of a Free-Phase NAPL Passive Removal System at the Perimeter of the On-Site Source Area, Institutional Controls and Groundwater Monitoring**
Overall Protection of Public Health and the Environment	• Relies solely on the use of institutional controls and monitoring • Only RAOs that involve exposure controls are addressed	• Provides adequate protection through excavation and use of institutional controls • Each of the RAOs is addressed • Saturated zone excavation remediates source material and groundwater, and addresses potential NAPL migration	• Should provide adequate protection by eliminating potential for exposure to impacted media and addressing potential NAPL migration • RAOs involving exposure controls and NAPL containment are addressed • Active remediation of source material would occur via removal of free-phase NAPL
Compliance with SCGs	• Activities would comply • Remediation to address source material or soil impacts would not occur • Groundwater restoration to achieve SCGs on-site not addressed	• Activities should comply, although requirements associated with saturated zone excavation and dewatering may have constraints • Source material in vadose and saturated zones is addressed • Groundwater restoration to achieve SCGs on-site may occur if residual NAPL beyond excavation area is not significant	• Activities should comply • Remediation of source material would occur via NAPL removal, and potential migration would be addressed • Groundwater restoration to achieve SCGs on-site would not occur
Long-Term Effectiveness and Permanence	• Does not provide adequate long-term protection • Residual risks related to presence of source material in subsurface would continue	• Provides permanent long-term solution • Institutional controls provide additional protective measures • Saturated zone excavation remediates groundwater and provides permanent solution	• Long-term effectiveness of this alternative is uncertain • Residual risks related to presence of source material on-site would continue • Residual risks related to potentially mobile NAPL addressed by collection trench
Reduction of Toxicity, Mobility or Volume with Treatment	• No direct treatment or reduction in constituent mobility • Reductions limited to natural attenuation, which would likely be not significant without source removal • Coal tar in saturated zone would remain a source of groundwater impacts	• Direct treatment via source material removal from vadose and saturated zones • Mass of constituents is permanently reduced, and natural attenuation may provide additional reductions	• Potentially mobile NAPL controlled by collection trench • Source material within saturated zone would remain • Reductions via natural attenuation would likely be not significant
Short-Term Effectiveness	• Effective in protecting community and remediation workers • No effect within impacted area	• Short-term impacts to community and remediation workers would need properly managed • Impacts on environment are considered acceptable, with proper measures utilized for saturated zone excavation • Installation of hydraulic controls and wet material handling could affect overall timeframe	• Short-term impacts to community and remediation workers are considered acceptable • Impacts on environment during implementation are considered acceptable • NAPL monitoring/removal may need to continue for an extended period of time
Implementability	• Readily implementable without site constraints • May not be acceptable to regulatory agencies	• Technical implementability concerns due to depth and dewatering requirements, logistical issues and existing utilities would need addressed in design • Management of excavation water may pose an administrative constraint • Impacts on land use would be minimal following completion of the excavation work	• Considered technically implementable, although logistical issues, existing utilities and water control for the trench installation must be addressed • Administrative constraints on implementation not anticipated • Impacts on land use would be minimal
Cost	• Initial costs $19,000 • Annual costs $26,000 • Estimated total present worth costs (30 years) $418,700	• Initial costs $13,388,400 • Annual costs $19,800 (w/ groundwater monitoring) and $10,800 (w/o groundwater monitoring) • Estimated total present worth costs (30 years) $13,578,900	• Initial costs $1,553,500 • Annual costs $56,350 (w/ NAPL removal) and $26,000 (w/o NAPL removal) • Estimated total present worth costs (30 years) $2,380,900

TABLE 5-1

ON-SITE REMEDIAL ALTERNATIVES EVALUATION

NYSEG Former MGP Site
Norwich, New York

Criteria	Alternative 4 Installation of Full Barrier Containment System (e.g., Slurry Wall) Around Perimeter of On-Site Source Area with Cap/Cover on Surface, Institutional Controls and Groundwater Monitoring	Alternative 5 *In-Situ* Solidification/Stabilization of On-Site Source Material, Institutional Controls and Groundwater Monitoring	Alternative 6 *In-Situ* Chemical Oxidation (ISCO) for Treatment of Source Material in On-Site Areas, Institutional Controls and Groundwater Monitoring
Overall Protection of Public Health and the Environment	• Provides adequate protection by eliminating potential for exposure to impacted media and containing migration from saturated zone source areas • RAOs involving exposure controls and NAPL containment are addressed • Remediation of source material and impacted groundwater would be provided by containment	• Provides adequate protection by addressing soil and saturated zone source areas • Each of the RAOs is addressed • *In situ* stabilization remediates source material and groundwater, and limits potential NAPL migration	• Provides adequate protection by reducing constituent mass via chemical treatment, along with institutional controls and monitoring • Each of the RAOs is addressed • *In situ* treatment remediates source material and groundwater, and should limit potential NAPL migration
Compliance with SCGs	• Activities should comply • Remediation of source material addressed by surface cap/cover and subsurface containment • Groundwater restoration to NYSDEC standards would likely not occur due to continued presence of source material in saturated zone	• Activities should comply, although issues associated with ISS would need addressed • Source material on-site addressed via excavation or ISS • Groundwater restoration to NYSDEC standards may occur beyond ISS area if residual NAPL is not significant	• Activities should comply, although issues associated with ISCO treatment would need addressed • Impacted soils in vadose zone are not addressed • Groundwater restoration to NYSDEC standards may not be achieved due to residual NAPL and technology constraints
Long-Term Effectiveness and Permanence	• Provides adequate long-term protection • Residual risks related to source material in subsurface addressed through full containment • Institutional controls and surface cap/cover provide additional protective measures	• Provides adequate long-term protection • Source material either removed via excavation or stabilized *in situ* which provides long-term solution • Although immobilized, coal tar would remain in the saturated zone	• Provides adequate long-term protection, and permanent where treatment is sufficient • Source material within saturated zone treated via ISCO which provides permanent destruction • Assuming sufficient treatment occurs, post-remediation risks involve residual impacts beyond treatment area
Reduction of Toxicity, Mobility or Volume with Treatment	• Mobility of constituents within saturated zone fully controlled by physical barrier • Source material within saturated zone would remain • Reductions limited to natural attenuation, which would likely be not significant without source removal	• Direct treatment via physical removal of source material in surface soil • ISS of source material would significantly reduce or eliminate constituent mobility	• Direct treatment provided via chemical oxidation of source material in saturated zone • ISCO of source material may adversely effect constituent mobility if treatment is not sufficient • Additional reductions through natural attenuation would be monitored
Short-Term Effectiveness	• Short-term impacts to community and remediation workers would need properly managed, including impacts to existing utilities • Impacts on environment during implementation are considered acceptable • Addresses impacts within a reasonable timeframe	• Short-term impacts to community and remediation workers would need properly managed • Impacts on environment during implementation are considered acceptable	• Impacts on environment during implementation are considered acceptable, although a short-term increase in NAPL mobility may occur • Application of ISCO would involve potential for some short-term impacts that would need properly managed • The timeframe for implementation is adversely impacted by the presence of free-phase NAPL in the treatment area
Implementability	• Considered technically implementable, although logistical issues and existing utilities must be addressed • Administrative constraints on implementation not anticipated • Impacts on land use would be minimal	• Considered technically implementable, although logistical issues and existing utilities must be addressed • Administrative constraints not anticipated, although ISS would involve issues to address in design • Solidified area may need to be considered during any future work involving subsurface structures or foundations	• Considered implementable, although technical issues and administrative requirements must be addressed • Injections would need to occur for a relatively long period of time, due primarily to the presence of free-phase NAPL • Impacts on land use would be minimal following treatment
Cost	• Initial costs $1,742,300 • Annual costs $37,000 • Estimated total present worth costs (30 years) $2,311,100	• Initial costs $6,177,500 • Annual costs $19,800 (w/ groundwater monitoring) and $10,800 (w/o groundwater monitoring) • Estimated total present worth costs (30 years) $6,368,000	• Initial costs $13,367,000 • Annual costs $26,000 (w/ groundwater monitoring) and $17,000 (w/o groundwater monitoring) • Estimated total present worth costs (30 years) $13,740,500

TABLE 5-2

COMPARATIVE COST ESTIMATES FOR ON-SITE REMEDIAL ALTERNATIVES

NYSEG Former MGP Site
Norwich, New York

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Remediation:						
RD investigation	0	35,000	20,000	20,000	40,000	70,000
RD/RA work plan/design	4,000	104,000	74,000	94,000	109,000	94,000
Geotechnical evaluation	0	20,000	0	15,000	15,000	0
Preconstruction/permitting	0	50,000	40,000	50,000	65,000	50,000
Project management	2,000	77,000	32,000	37,000	47,000	82,000
Initial cap/cover improvements	0	0	0	41,000	0	0
Physical barrier/slurry wall	0	0	0	323,500	0	0
Slurry wall waste management	0	0	0	667,000	0	0
NAPL collection trench installation	0	0	539,000	0	0	0
Collection trench or wells waste management	0	0	362,500	0	0	0
Manage obstructions and utilities	0	104,000	12,000	22,000	104,400	0
Barrier wall/sheet piling for excavation	0	1,330,000	0	0	0	0
Temporary excavation, stockpile and reuse	0	1,400,000	0	0	0	0
Wet material conditioning	0	525,000	0	0	0	0
Excavation/off-site LTTD treatment	0	2,695,000	0	0	0	0
Excavation/landfill disposal	0	1,575,000	0	0	0	0
Backfill	0	840,000	0	0	0	0
Oxygen product addition with backfill	0	100,000	0	0	0	0
Water management	0	1,482,000	78,000	0	0	0
Monitoring well replacements	0	8,000	0	0	8,000	0
Site restoration	0	130,000	15,000	27,500	130,500	91,500
Disposal characterization	0	84,000	6,000	10,000	0	0
Confirmatory sampling	0	36,000	0	0	0	0
In-situ stabilization	0	0	0	0	2,834,000	0
In-situ stabilization material management	0	0	0	0	1,500,000	0
ISCO - injector and vent installations	0	0	0	0	0	621,800
Injector waste management	0	0	0	0	0	38,600
ISCO - chemical injections	0	0	0	0	0	9,360,000
ISCO - water management	0	0	0	0	0	99,120
Oversight	0	266,500	42,400	56,300	132,400	397,100
Air monitoring	0	216,900	34,600	41,500	108,200	139,900
Deed restrictions	5,000	5,000	5,000	5,000	5,000	5,000
Soil management plan	5,000	4,000	5,000	5,000	4,000	5,000
Surveying	0	10,000	5,000	7,500	10,000	15,000
RA Documentation Report	0	60,000	24,000	30,000	35,000	70,000
Contingency (approx. 20%)	3,000	2,231,000	259,000	290,000	1,030,000	2,228,000
Estimated Remediation Cost:	**19,000**	**13,388,400**	**1,553,500**	**1,742,300**	**6,177,500**	**13,367,020**
Annual Costs						
Groundwater monitoring	8,000	8,000	8,000	8,000	8,000	8,000
Maintain cap/cover and manage soil	11,600	7,600	11,600	19,400	7,600	11,600
Project management and reporting	2,400	1,200	2,400	3,600	1,200	2,400
NAPL/total fluids removal	0	0	25,350	0	0	0
Contingency (approx. 20%)	4,000	3,000	9,000	6,000	3,000	4,000
Estimated Annual Cost:	**26,000**	**19,800**	**56,350**	**37,000**	**19,800**	**26,000**
Estimated Annual Cost (post-gw monitoring):		**10,800**			**10,800**	**17,000**
Estimated Annual Cost (post-NAPL removal):			**26,000**			
Estimated NAPL Duration (years):	0	0	25	0	0	0
Estimated Soil Management Duration (years):	30	30	30	30	30	30
Estimated Groundwater Duration (years):	30	3	30	30	3	20
Estimated Total Cost:	**799,000**	**13,739,400**	**3,092,250**	**2,852,300**	**6,528,500**	**14,057,020**
Estimated Present Worth Cost:	**418,685**	**13,578,924**	**2,380,932**	**2,311,083**	**6,368,024**	**13,740,512**
Estimated Present Worth Cost (-30%):	**293,080**	**9,505,247**	**1,666,653**	**1,617,758**	**4,457,617**	**9,618,359**
Estimated Present Worth Cost (+50%):	**628,028**	**20,368,387**	**3,571,398**	**3,466,624**	**9,552,037**	**20,610,769**

Alternatives:

1) No remedial action (with institutional controls and groundwater monitoring)
2) Excavation of on-site source material, institutional controls and groundwater monitoring
3) Installation and operation of a free-phase NAPL passive removal system at the perimeter of the on-site source area, institutional controls and groundwater monitoring
4) Installation of full barrier containment system (e.g., slurry wall) around perimeter of on-site source area with cap/cover on surface, institutional controls and groundwater monitoring
5) *In-situ* solidification/stabilization of on-site source material, institutional controls and groundwater monitoring
6) *In-situ* chemical oxidation (ISCO) for treatment of source material in on-site areas, institutional controls and groundwater monitoring

Assumptions/Notes:

1) Present worth costs are based on 5% interest rate.

TABLE 5-3

OFF-SITE REMEDIAL ALTERNATIVES EVALUATION

NYSEG Former MGP Site
Norwich, New York

Criteria	Alternative 7 No Remedial Action (With Institutional Controls and Groundwater Monitoring)	Alternative 8 *In-Situ* Chemical Oxidation (ISCO) for Treatment of Off-Site Source Material, Monitored Natural Attenuation for Groundwater, and Institutional Controls	Alternative 9 *In-Situ* Enhanced Bioremediation (Injection of Oxygen-Supplying Product) for Treatment of Off-Site Groundwater Beyond Source Material Areas, Institutional Controls and Groundwater Monitoring	Alternative 10 Installation of Extraction Points in Off-site Source Areas with Periodic Total Fluids Extraction and Transport to an Off-Site Facility, with Monitored Natural Attenuation for Groundwater, and Institutional Controls
Overall Protection of Public Health and the Environment	• May provide adequate protection because potential exposures are addressed • RAOs involve exposure controls and are achieved • RAO regarding migration of source material to off-site areas addressed by on-site alternatives	• Provides adequate protection by reducing constituent mass via chemical treatment, along with institutional controls and monitoring • RAOs for off-site area involve exposure controls and are achieved; RAO regarding migration of source material to off-site areas addressed by on-site alternatives • *In situ* treatment remediates source material and groundwater, and should limit potential NAPL migration	• Provides adequate protection within the areas being addressed • Natural attenuation of groundwater impacts is enhanced, and institutional controls and monitoring provide additional protective measures • RAOs involve exposure controls and are achieved in the areas being addressed	• Provides adequate protection by reducing constituent mass via extraction, along with institutional controls and monitoring • RAOs involve exposure controls and are achieved; RAO regarding migration of source material to off-site areas addressed by on-site alternatives • Extraction of total fluids remediates source material and groundwater, and reduces potential NAPL migration
Compliance with SCGs	• Activities would comply • Remediation to address source material would not occur • Groundwater impacts would not be addressed	• Activities should comply, although issues associated with ISCO treatment would need addressed, particularly in off-site residential areas • Groundwater restoration to NYSDEC standards may not be achieved due to residual NAPL and technology constraints	• Activities should comply, although requirements associated with off-site injections would need addressed, particularly in off-site residential areas • Restoration of groundwater to NYSDEC standards may not be achieved if upgradient source material is not addressed	• Activities should comply, although procedures for safe extraction, particularly in off-site residential areas, would need developed • Groundwater restoration to NYSDEC standards may not be achieved due to residual NAPL
Long-Term Effectiveness and Permanence	• Long-term protection provided by institutional controls may be adequate • Residual risks related to presence of source material in subsurface would continue	• Long-term protection provided by institutional controls and source material treatment should be adequate • Source material within saturated zone treated via ISCO which provides permanent destruction • Assuming sufficient treatment occurs, post-remediation risks involve residual impacts beyond treatment area	• Long-term protection provided by institutional controls may be adequate in areas being addressed • Residual groundwater impacts are addressed, although access constraints may limit improvements • Off-site source material would not be addressed, adversely impacting long-term effectiveness by re-impacting treated areas and causing need for reinjections	• Long-term protection provided by institutional controls and mass removal via extraction should be adequate • Extraction of source material within saturated zone provides permanent removal Long-term effectiveness relates primarily to volume of free-phase NAPL that is mobile and recoverable via extraction
Reduction of Toxicity, Mobility or Volume with Treatment	• No direct treatment or reduction in constituent mobility • Reductions limited to natural attenuation, which would likely be not significant without source removal • Coal tar in saturated zone would remain a source of groundwater impacts	• Direct treatment provided via chemical oxidation of source material in saturated zone • ISCO of source material may adversely effect constituent mobility if treatment is not sufficient • Additional reductions through natural attenuation would be monitored	• Treatment provided via oxygen addition to enhance bioremediation of groundwater • Post-remediation groundwater concentrations and natural attenuation would be monitored • Source material that would remain in saturated zone could re-impact treated areas	• Direct treatment provided via extraction of NAPL and impacted groundwater from off-site source material area • Extraction would provide overall reduction in constituent mass and potential constituent mobility Additional reductions through natural attenuation would be monitored
Short-Term Effectiveness	• Effective in protecting community and remediation workers • No effect within impacted area	• Impacts on environment during implementation are considered acceptable, although a short-term increase in NAPL mobility may occur • Application of ISCO would involve potential for some short-term impacts that would need properly managed • Timeframe for implementation determined primarily by the extent of free-phase NAPL in the treatment area	• Short-term impacts to community and remediation workers are considered acceptable • Minimal short-term impacts on the environment during implementation are acceptable • Likely need for reinjections and the potential for access issues to limit improvements adversely impacts the short-term effectiveness of this approach	• Short-term impacts to community and remediation workers are considered acceptable • Impacts on environment during implementation are considered acceptable • Potential timeframe for implementation adversely impacts short-term effectiveness of this alternative, and benefits would likely diminish with time
Implementability	• Readily implementable, unless use restrictions are an issue for specific locations • May not be acceptable to regulatory agencies	• Considered implementable, although technical issues and administrative requirements must be addressed • Access-related issues may adversely impact successful implementation of ISCO in off-site source material area • Impacts on land use would be minimal following treatment	• Considered implementable, although off-site access would need to be obtained and may provide some constraints • Technical requirements should not pose constraints to implementation • Impacts on land use should be minimal	• Should be implementable, with extraction well installations similar to previous installations completed off-site • Should not adversely impact land use following the well installations, although access to the wells would need to be maintained • Access-related issues may adversely impact successful implementation
Cost	• Initial costs $65,000 • Annual costs $36,000 • Estimated total present worth costs (30 years) $618,400	• Initial costs $3,387,700 • Annual costs $36,000 • Estimated total present worth costs (20 years) $3,836,400	• Initial costs $352,700 • Annual costs $90,550 • Estimated total present worth costs (20 years) $1,481,200	• Initial costs $321,500 • Annual costs $112,000 (monthly fluids removal), $62,200 (quarterly fluids removal) and $36,000 (w/o fluids removal) • Estimated total present worth costs (20 years) $1,113,000

TABLE 5-4

COMPARATIVE COST ESTIMATES FOR OFF-SITE REMEDIAL ALTERNATIVES

NYSEG Former MGP Site
Norwich, New York

Item	Alternative 7	Alternative 8	Alternative 9	Alternative 10
Remediation:				
RD investigation	0	60,000	15,000	0
RD/RA work plan/design	4,000	84,000	29,000	39,000
Preconstruction/permitting	0	50,000	27,500	20,000
Project management	13,000	43,000	22,000	23,000
Monitor/recovery wells installation	0	0	0	81,000
Collection trench or wells waste management	0	0	0	5,600
Site restoration	0	59,000	10,000	9,000
ISCO - injector and vent installations	0	327,800	0	0
Injector waste management	0	24,600	0	0
ISCO - chemical injections	0	1,920,000	0	0
ISCO - water management	0	20,240	0	0
In-situ treatment borings	0	0	60,000	0
In-situ treatment chemical	0	0	54,000	0
Oversight	0	108,500	29,200	17,100
Air monitoring	0	51,100	0	11,800
Deed restrictions	21,000	21,000	21,000	21,000
Soil management plan	16,000	16,000	16,000	16,000
Surveying	0	12,500	0	9,000
RA Documentation Report	0	25,000	10,000	15,000
Contingency (approx. 20%)	11,000	565,000	59,000	54,000
Estimated Remediation Cost:	**65,000**	**3,387,740**	**352,700**	**321,500**
Annual Costs				
Groundwater monitoring	14,000	14,000	14,000	14,000
Groundwater injections	0	0	45,550	0
Maintain cap/cover and manage soil	4,000	4,000	4,000	4,000
Project management and reporting	12,000	12,000	12,000	12,000
NAPL/total fluids removal	0	0	0	63,000
Contingency (approx. 20%)	6,000	6,000	15,000	19,000
Estimated Annual Cost:	**36,000**	**36,000**	**90,550**	**112,000**
Estimated Annual Cost (reduced NAPL removal):				**62,200**
Estimated Annual Cost (post-NAPL removal):				**36,000**
Estimated NAPL Duration (years):	0	0	0	10
Estimated Soil Management Duration (years):	30	20	20	20
Estimated Groundwater Duration (years):	30	20	20	20
Estimated Total Cost:	**1,145,000**	**4,107,740**	**2,163,700**	**1,452,900**
Estimated Present Worth Cost:	**618,410**	**3,836,379**	**1,481,152**	**1,113,049**
Estimated Present Worth Cost (-30%):	**432,887**	**2,685,465**	**1,036,807**	**779,134**
Estimated Present Worth Cost (+50%):	**927,615**	**5,754,569**	**2,221,728**	**1,669,573**

Alternatives:

7) No remedial action (with institutional controls and groundwater monitoring)
8) *In-situ* chemical oxidation (ISCO) for treatment of off-site source material, monitored natural attenuation for groundwater, and institutional controls
9) *In-situ* enhanced bioremediation (injection of oxygen-supplying product) for treatment of off-site groundwater beyond source material areas, institutional controls and groundwater monitoring
10) Installation of extraction points in off-site source areas with periodic total fluids extraction and transport to an off-site facility, with monitored natural attenuation for groundwater, and institutional controls

Assumptions/Notes:

1) Present worth costs are based on 5% interest rate.
2) Alternative 9 annual costs include 1/2 cost for biannual injections (every 2 years) following initial injection event.
3) Alternative 10 annual and present worth costs based on monthly NAPL monitoring/extraction in years 1 thru 3, quarterly in years 4 thru 10, and none required in years 11 thru 20.

TABLE 6-1

COMPARATIVE ANALYSIS OF ALTERNATIVES - ON-SITE

NYSEG Former MGP Site
Norwich, New York

Criteria	Alternative 1 No Remedial Action (With Institutional Controls and Groundwater Monitoring)	Alternative 2 Excavation of On-Site Source Material, Institutional Controls and Groundwater Monitoring	Alternative 3 Installation and Operation of a Free-Phase NAPL Passive Removal System at the Perimeter of the On-Site Source Area, Institutional Controls and Groundwater Monitoring
Overall Protection of Public Health and the Environment	Least protective (no active remediation)	Most protective because all source material would be removed to the extent practicable	Should provide adequate protection
Compliance with SCGs	Limited activities would comply, but remediation of source material and impacted groundwater would not occur	Activities would involve the most issues due to excavation size, depth and dewatering requirements; best overall at addressing source material and groundwater impacts	Activities should comply, and would address SCGs for source material and impacted groundwater better than Alternative 1
Long-Term Effectiveness and Permanence	Least effective long-term	Most effective long-term	Better than Alternative 1, although long-term effectiveness is uncertain
Reduction of Toxicity, Mobility or Volume with Treatment	Provides least reduction	Best alternative regarding this criterion	Better than Alternative 1 because NAPL migration to off-site areas is addressed
Short-Term Effectiveness	Community and remediation workers not effected, but no benefits to impacted media are achieved	Significant short-term impacts compared with other alternatives due to activities involved and anticipated time to complete excavation	Initial activities may be best in short-term effectiveness; however, subsequent requirement for NAPL monitoring and removal may continue for years
Implementability	Easiest to implement, although likely unacceptable to regulatory agencies	Most difficult to implement technically due to size, depth and dewatering requirements of excavation	Comparable to Alternative 4 overall, with collection trench installation more involved but less extensive
Cost	Minimal initial costs, and lowest total present worth costs	Comparable to Alternative 6 with highest initial and total present worth costs; post-remediation costs are relatively low	Comparable to Alternative 4 in total present worth costs, with lower initial costs but higher annual costs during NAPL removal
Overall Summary	Unacceptable based on overall effectiveness	Most protective and effective long-term at addressing on-site source material, although an expensive and difficult alternative to implement	Cost-effective approach that should be adequately protective, although with relatively higher annual costs

TABLE 6-1

COMPARATIVE ANALYSIS OF ALTERNATIVES - ON-SITE

NYSEG Former MGP Site
Norwich, New York

Criteria	Alternative 4 Installation of Full Barrier Containment System (e.g., Slurry Wall) Around Perimeter of On-Site Source Area with Cap/Cover on Surface, Institutional Controls and Groundwater Monitoring	Alternative 5 *In-Situ* Solidification/Stabilization of On-Site Source Material, Institutional Controls and Groundwater Monitoring	Alternative 6 *In-Situ* Chemical Oxidation (ISCO) for Treatment of Source Material in On-Site Areas, Institutional Controls and Groundwater Monitoring
Overall Protection of Public Health and the Environment	Full containment provides more overall protection than Alternative 3	Slightly less effective than Alternative 2, because source material is solidified in place versus removed	Comparable to Alternative 5 overall, with chemical oxidation more protective than stabilization but with less certainty of complete treatment
Compliance with SCGs	Activities should comply; comparable overall to Alternative 3 regarding SCGs compliance	Activities involve more issues than Alternatives 3 and 4, but are better at addressing soil and groundwater quality SCGs	Similar to Alternative 5 regarding activity compliance issues, but source material in unsaturated zone would not be addressed if present
Long-Term Effectiveness and Permanence	More reliable regarding long-term protection than Alternative 3	Comparable to Alternative 2, although ISS technology involves less certainty regarding permanence than excavation	Less effective than Alternative 2 because unsaturated zone is not addressed, and ISCO technology involves less certainty than excavation
Reduction of Toxicity, Mobility or Volume with Treatment	Addresses constituent mobility in saturated zone more fully than Alternative 3	Similar in overall mobility or volume reduction to Alternative 6	Similar overall to Alternative 5, with more volume reduction possible with complete treatment
Short-Term Effectiveness	Similar to Alternative 3 in short-term effectiveness, without the long-term O&M requirements of the collection trench	Better overall than Alternatives 2 and 6 regarding short-term effectiveness	Active remediation would occur for the longest period of time, and short-term impacts would need managed
Implementability	Comparable to Alternative 3 overall, with perimeter of containment barrier more extensive but installation less involved	Considered implementable, although more issues would need addressed than with Alternatives 3 and 4	Comparable overall to Alternative 5; ISCO technology is less disruptive to the site, but activities would occur for a much longer period
Cost	Comparable to Alternative 3 in total present worth costs, with higher initial costs but lower annual costs than Alternative 3 with NAPL removal	Moderate cost alternative; 4th in initial and total present worth costs, with relatively low post-remediation costs	Comparable to Alternative 2 with highest initial and total present worth costs; longer duration for annual costs than Alternative 2
Overall Summary	Cost-effective approach that provides adequate protection, although long-term annual costs would be involved	Viable approach that provides adequate protection and relatively low post-remediation costs	Similar cost but less certainty than excavation, due primarily to presence of free-phase NAPL within on-site source material area

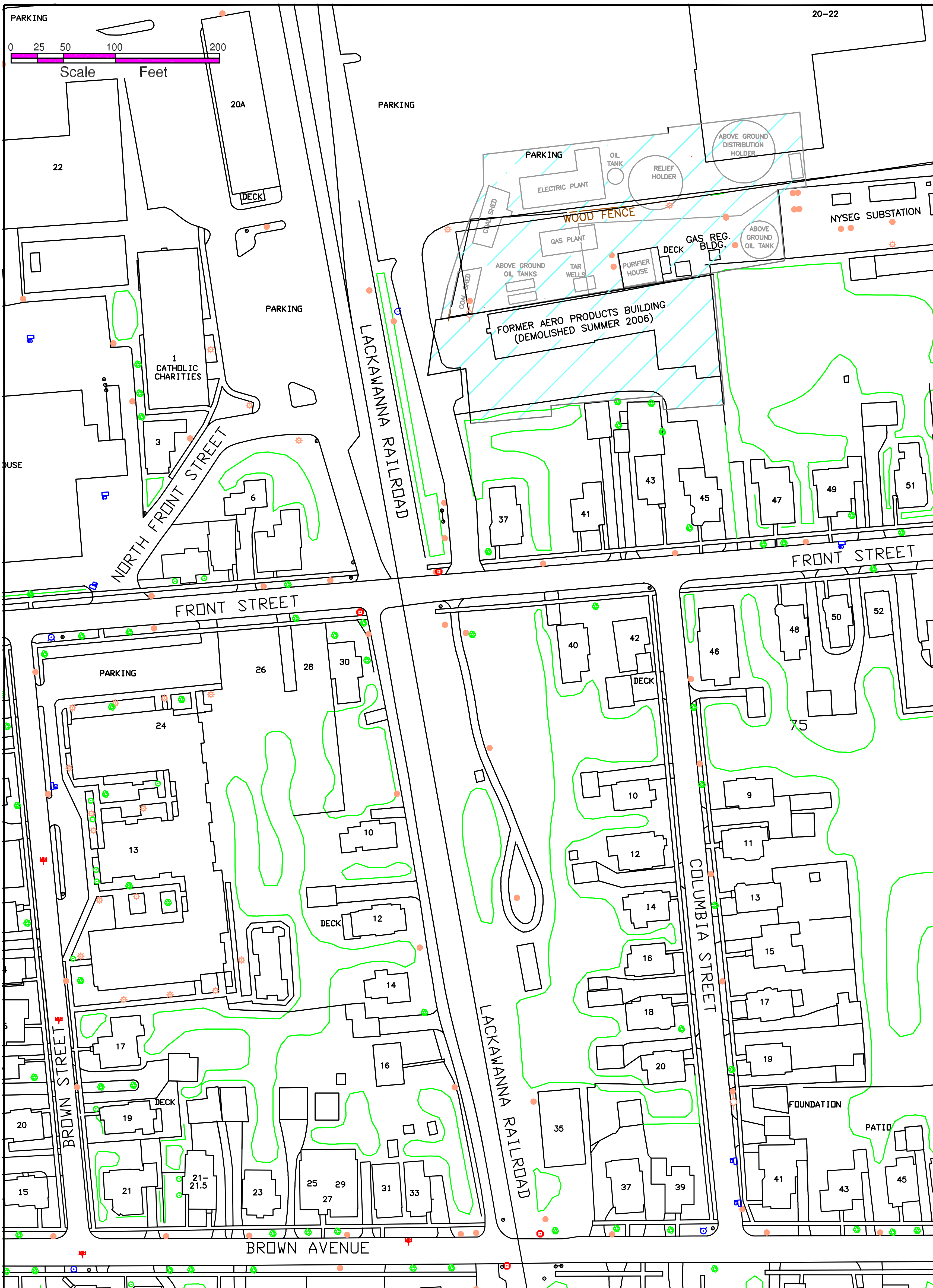
TABLE 6-2

COMPARATIVE ANALYSIS OF ALTERNATIVES - OFF-SITE

NYSEG Former MGP Site
Norwich, New York

Criteria	Alternative 7 No Remedial Action (With Institutional Controls and Groundwater Monitoring)	Alternative 8 *In-Situ* Chemical Oxidation (ISCO) for Treatment of Off-Site Source Material, Monitored Natural Attenuation for Groundwater, and Institutional Controls	Alternative 9 *In-Situ* Enhanced Bioremediation (Injection of Oxygen-Supplying Product) for Treatment of Off-Site Groundwater Beyond Source Material Areas, Institutional Controls and Groundwater Monitoring	Alternative 10 Installation of Extraction Points in Off-site Source Areas with Periodic Total Fluids Extraction and Transport to an Off-Site Facility, with Monitored Natural Attenuation for Groundwater, and Institutional Controls
Overall Protection of Public Health and the Environment	Least protective, although exposure controls may be adequate	May be most protective, if treatment is complete and NAPL mobility is not adversely impacted	More protective than Alternative 7, although difference may not be significant	More protective than Alternative 7 because constituent mass in source material area is reduced
Compliance with SCGs	Limited activities would comply, but remediation of source material and impacted groundwater would not occur	Comparable to Alternatives 9 and 10 regarding compliance of activities with SCGs; potentially better than Alternative 10 regarding groundwater quality SCGs, particularly outside areas with free-phase NAPL accumulations	Activities involve more issues than Alternative 7 but should comply; groundwater quality SCGs in treated area may not be met if upgradient source material is not addressed	Comparable to Alternatives 8 and 9 regarding compliance of activities with SCGs; better than Alternatives 7and 9 regarding groundwater quality SCGs because source material is addressed
Long-Term Effectiveness and Permanence	Least effective long-term, although protection may be adequate	May be most effective long-term, especially outside areas with free-phase NAPL	Long-term effectiveness is adversely impacted by upgradient source material not being addressed, which may re-impact treated areas	May be comparable to Alternative 8, and more viable within areas with free-phase NAPL accumulations
Reduction of Toxicity, Mobility or Volume with Treatment	Provides least reduction	Should provide most reduction of constituent mass; mobility may be adversely effected in free-phase NAPL areas without complete treatment	Improves reductions through natural attenuation only (Alternative 7) in areas being addressed	Reductions in comparison to Alternative 8 could be comparable in areas with free-phase NAPL accumulations
Short-Term Effectiveness	No adverse short-term effects, although remediation of impacted media would not occur	Excluding no remedial action, could be best alternative overall regarding short-term effectiveness, depending on extent of free-phase NAPL in treatment area	May be better than Alternative 10 because injection events would be limited in duration, but adversely impacted by the need to periodically re-inject over time due to upgradient source material	Least effective in short-term due to the need for long-term extraction and disposal, and benefits would likely diminish with time
Implementability	Easiest to implement, although likely unacceptable to regulatory agencies	May be the most difficult to implement due to nature of off-site area	Comparable in implementability to Alternative 10, assuming access to injection locations does not pose constraints	Comparable to Alternative 9, assuming access issues for wells do not pose constraints
Cost	Lowest initial and total present worth costs	Highest in initial and total present worth costs	Moderate cost alternative; comparable to Alternative 10 in initial and total present worth costs	Moderate cost alternative; comparable to Alternative 9 in initial and total present worth costs; highest annual costs while extraction occurs
Overall Summary	May be an acceptable approach, depending on selected remedy on-site	High cost approach that may be viable to address source material in areas outside of free-phase NAPL occurrence	May be viable to supplement other alternatives that address source material, but not viable as stand-alone alternative because treated areas would be re-impacted and reinjections would be necessary	May be viable approach to address portion of source material area with recoverable amounts of free-phase NAPL

FIGURES



LEGEND

- Location of Former Facility Structures
- Site Boundary
- Power Pole
- Tree or Shrub
- Man Hole
- Utility Pole
- Catch Basin
- Fire Hydrant

Note:
Field surveying completed by NYSEG on September 14 and 15, November 1, 2004, May 5, June 17 and December 19 and 20, 2005.

Base map drawn by NYSEG 12/30/2005

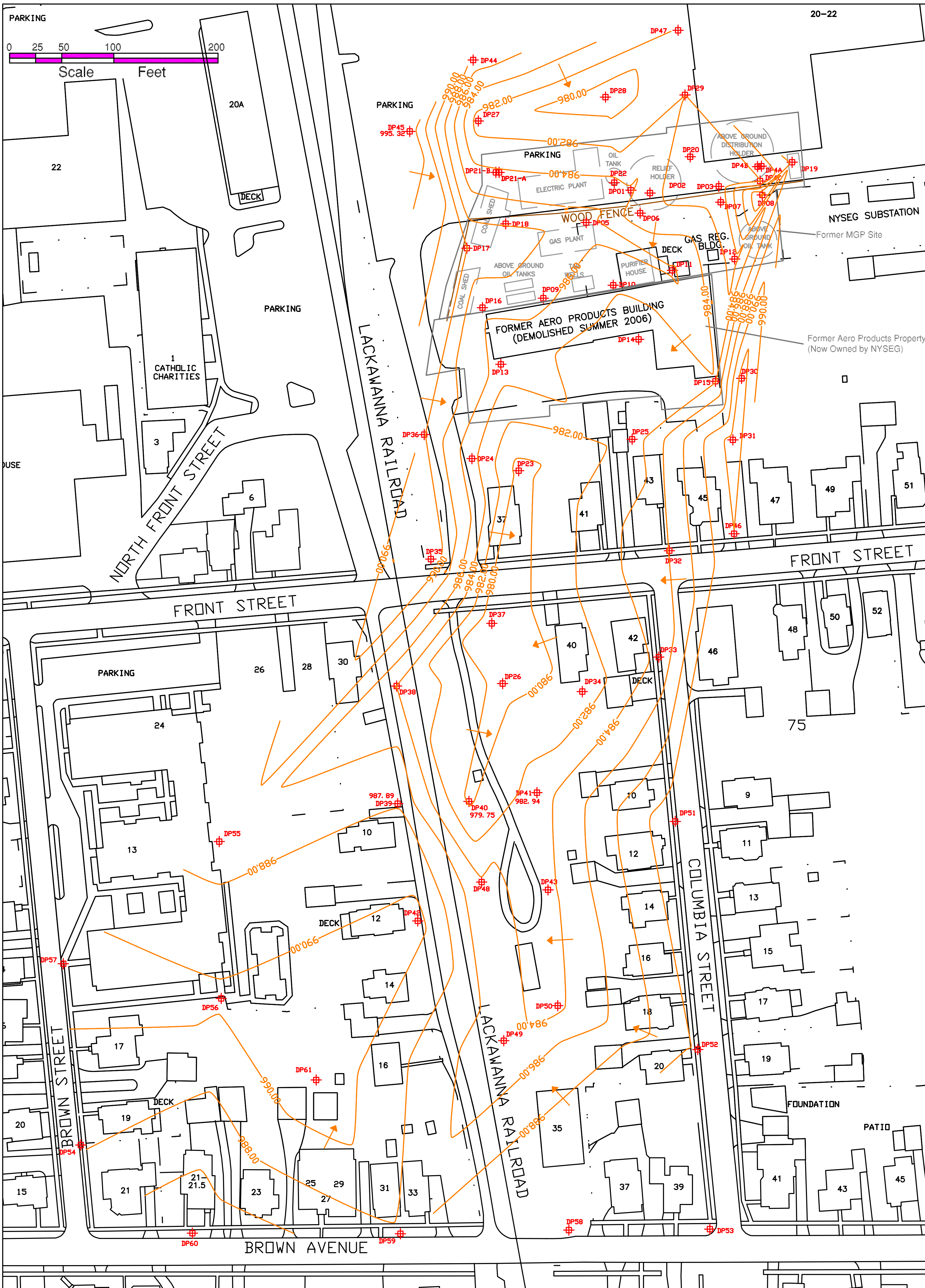
N

FIGURE 1-1

General Site Map

Norwich Former MGP Site
24 Birdsall Street, Norwich, New York

Date: 4/23/2007	Ish Inc. / MTR	Figure 1-1



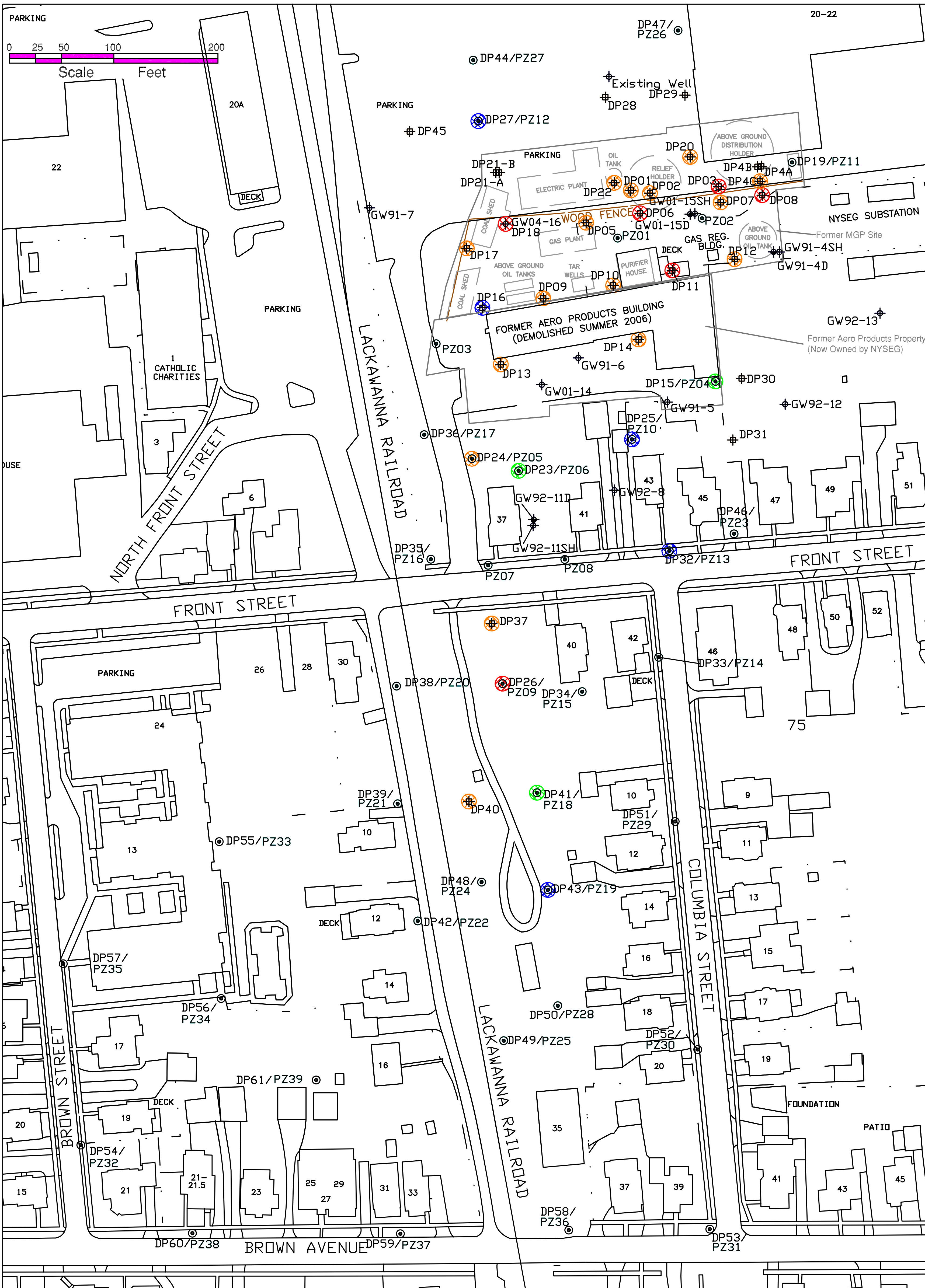
LEGEND

- Location of Former Facility Structures
- Site Boundary
- Direct Push Sampling Location with Silty Clay Interval Elevation (900.00 feet above MSL)
- Silty Clay Contour Line and Slope Direction

Note:
Field surveying completed by NYSEG on September 14 and 15, November 1, 2004, May 5, June 17 and December 19 and 20, 2005.

Base map drawn by NYSEG 12/30/2005

FIGURE 2-1		
Silty Clay Layer Elevation Contour		
Norwich Former MGP Site 24 Birdsall Street, Norwich, New York		
Date: 4/30/07	Ish Inc. / MTR	Figure 2-1



LEGEND

- Location of Former Facility Structures
- Site Boundary
- Piezometer
- Monitoring Well Shallow
- Monitoring Well Deep
- Direct Push Sampling Location

NOTES:

- All visual observations were made during the logging of soil borings, except for sheens at DP43/PZ19, which were noted during piezometer development.

Summary of Visual Observations in Soil

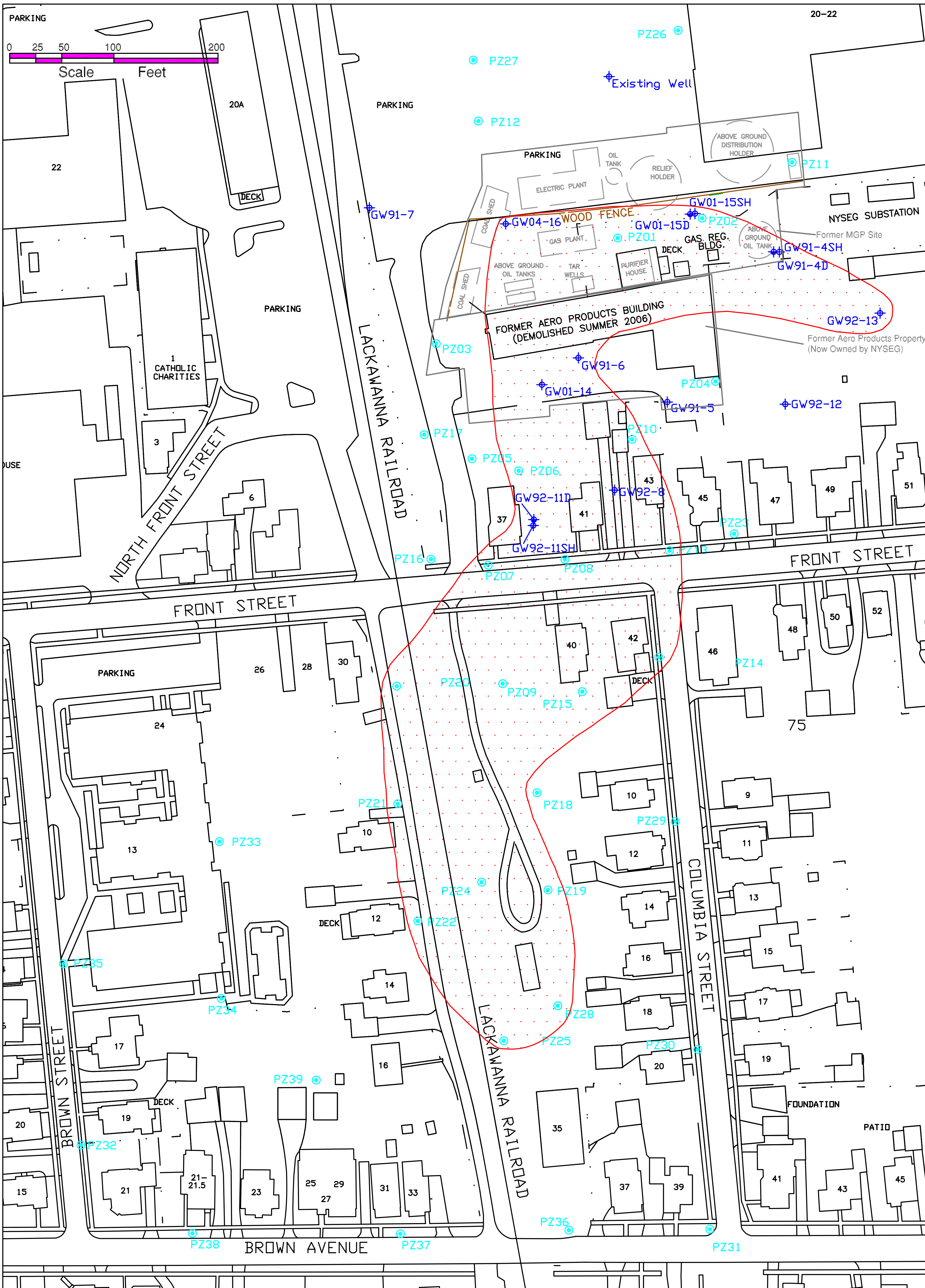
- Substantial NAPL
- Moderate NAPL
- Slight NAPL
- Sheens

Note:
Field surveying completed by NYSEG on September 14 and 15, November 1, 2004, May 5, June 17 and December 19 and 20, 2005.

Base map drawn by NYSEG 12/30/2005

N

FIGURE 2-2		
Visual Observations of Sheen or NAPL in Subsurface or Saturated Zone Soil		
Norwich Former MGP Site 24 Birdsall Street, Norwich, New York		
Date: 4/30/07	Ish Inc. / MTR	Figure 2-2



- Location of Former Facility Structures
- Site Boundary
- Piezometer
- Monitoring Well Shallow
- Monitoring Well Deep
- Estimated Extent of MGP-related Groundwater Impacts

Notes:

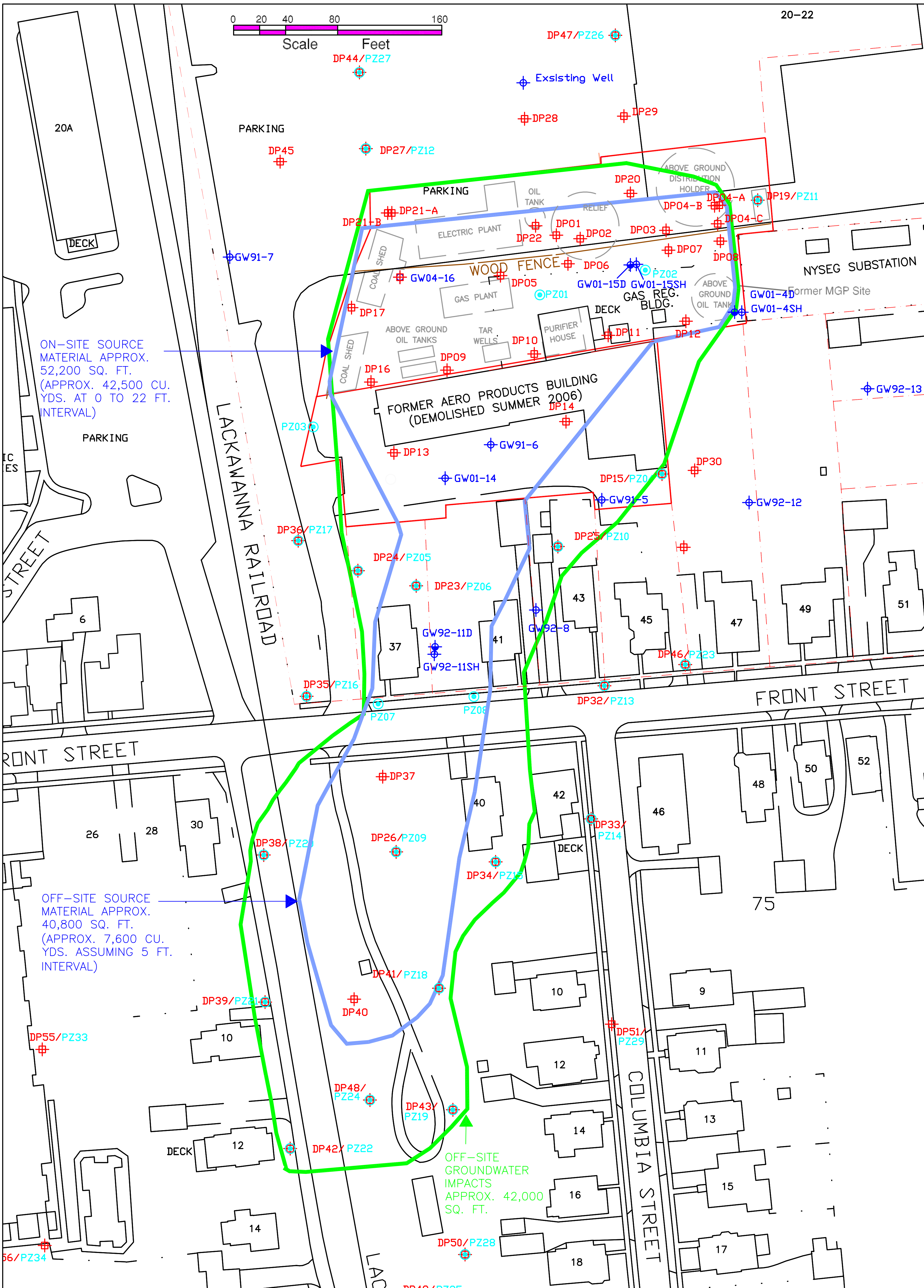
- Sampling locations inside the "plume" had one or more MGP-related compounds measured above NYSDEC Class GA standards or guidance values
- Groundwater plume based on groundwater sampling in July and December 2005
- Field surveying completed by NYSEG on September 14 and 15, November 1, 2004, May 5, June 17 and December 19 and 20, 2005.
- Base map drawn by NYSEG 12/30/2005

FIGURE 2-3

Estimated Extent of MGP-Related Groundwater Impacts

Norwich Former MGP Site
24 Birdsall Street, Norwich, New York

Date: 4/30/07	Ish Inc. / MTR	Figure 2-3



LEGEND

- Location of Former Facility Structures
- Site Boundary
- Piezometer
- Direct Push Sampling Location
- Monitoring Well Shallow
- Monitoring Well Deep
- Estimated Extent of MGP-related Groundwater Impacts
- Estimated Extent of Source Material
- Property Line (approximate)

FIGURE 3-1

Approximate Extent of MGP-Related Source Material and Groundwater Impacts

Norwich Former MGP Site
24 Birdsall Street, Norwich, New York

Date: 4/23/2007	Ish Inc. / MTR	Figure 3-1

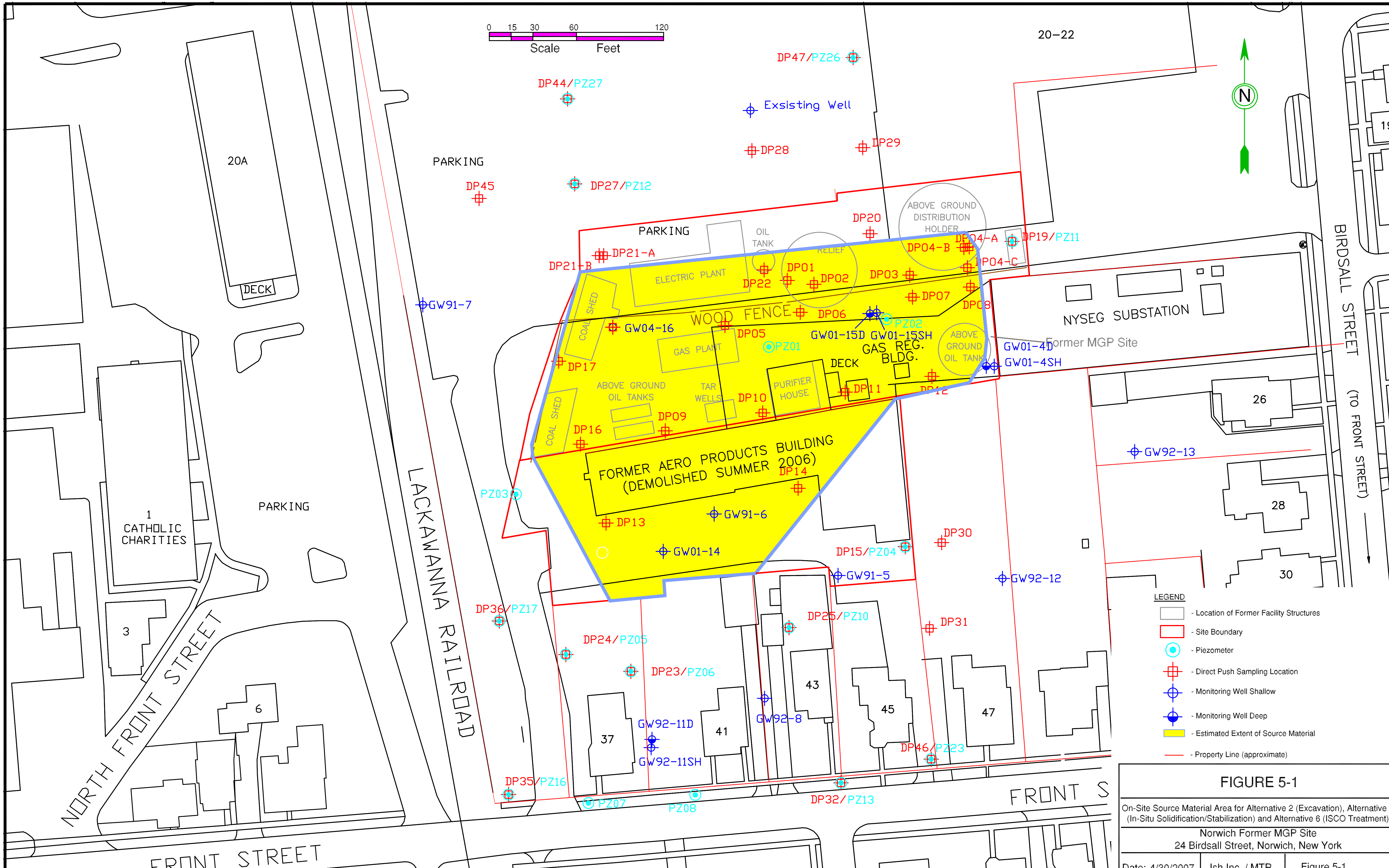


FIGURE 5-1

On-Site Source Material Area for Alternative 2 (Excavation), Alternative 5 (In-Situ Solidification/Stabilization) and Alternative 6 (ISCO Treatment)

Norwich Former MGP Site
24 Birdsall Street, Norwich, New York

Date: 4/30/2007 | Ish Inc. / MTR | Figure 5-1

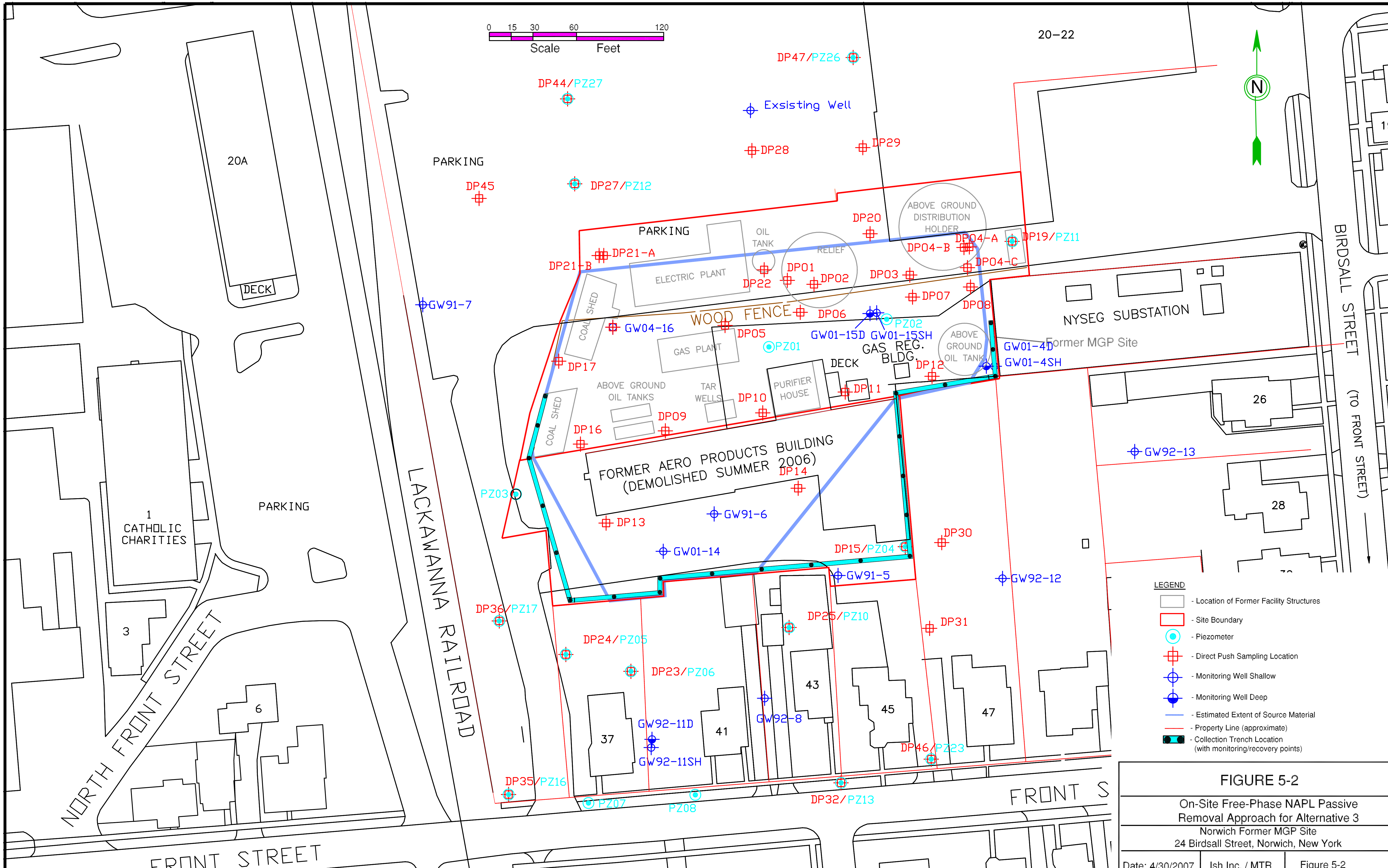


FIGURE 5-2

On-Site Free-Phase NAPL Passive Removal Approach for Alternative 3

Norwich Former MGP Site

24 Birdsall Street, Norwich, New York

Date: 4/30/2007 | Ish Inc. / MTR | Figure 5-2

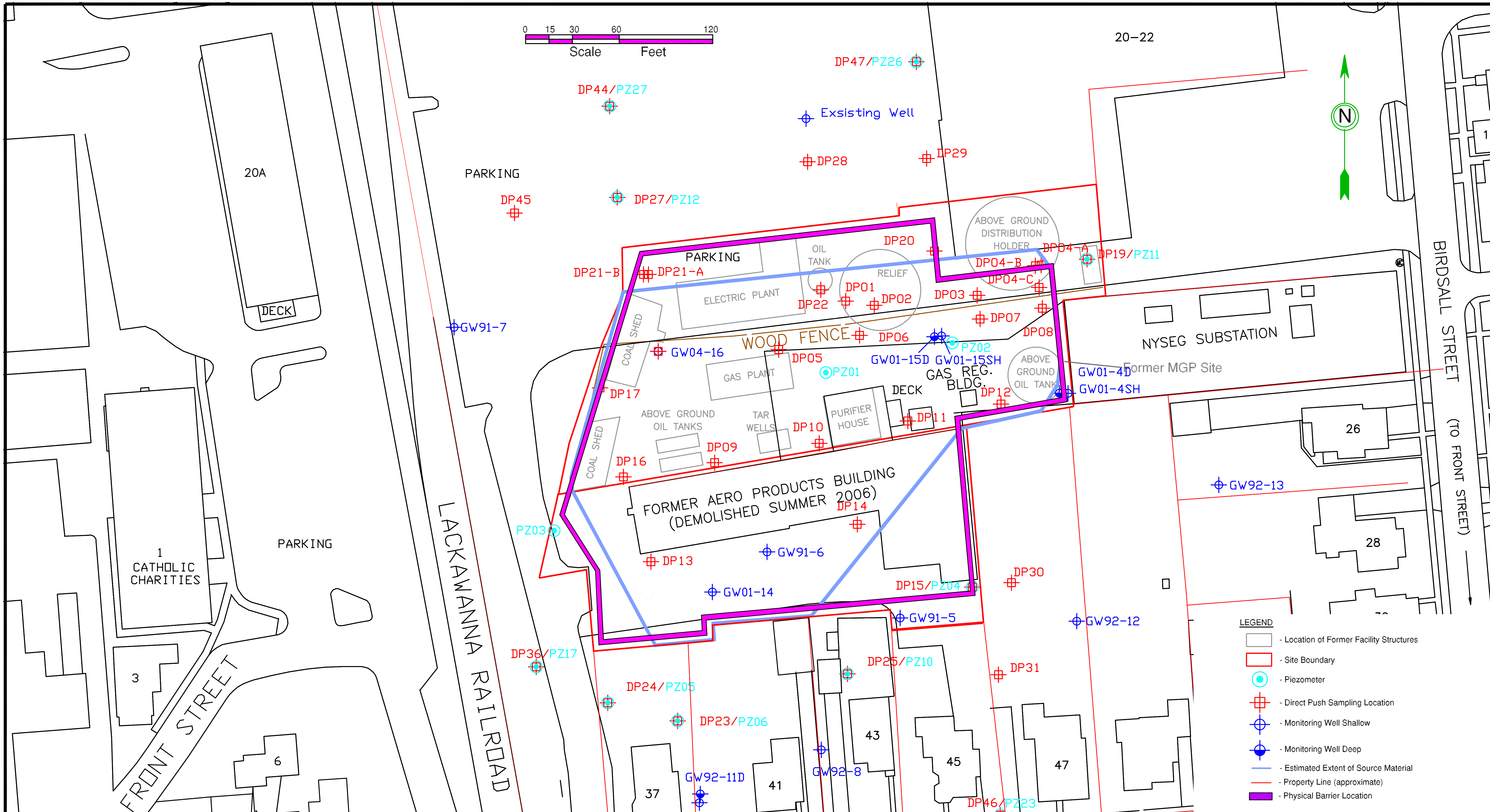


FIGURE 5-3

On-Site Perimeter Containment Approach for Alternative 4

Norwich Former MGP Site

24 Birdsall Street, Norwich, New York

Date: 4/30/2007	Ish Inc. / MTR	Figure 5-3

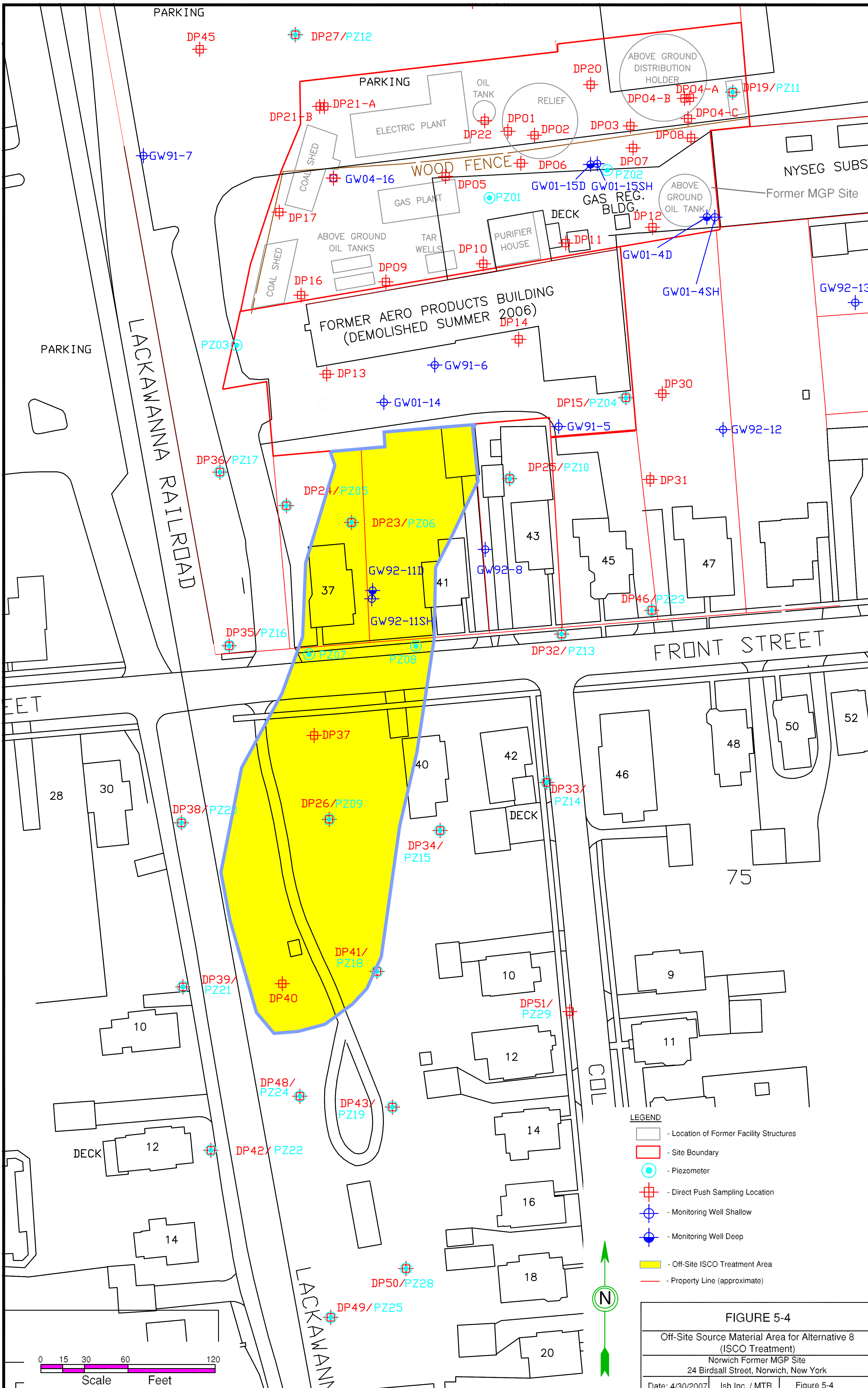


FIGURE 5-4

Off-Site Source Material Area for Alternative 8 (ISCO Treatment)

Norwich Former MGP Site
24 Birdsall Street, Norwich, New York

Date: 4/30/2007 | Ish Inc. / MTR | Figure 5-4

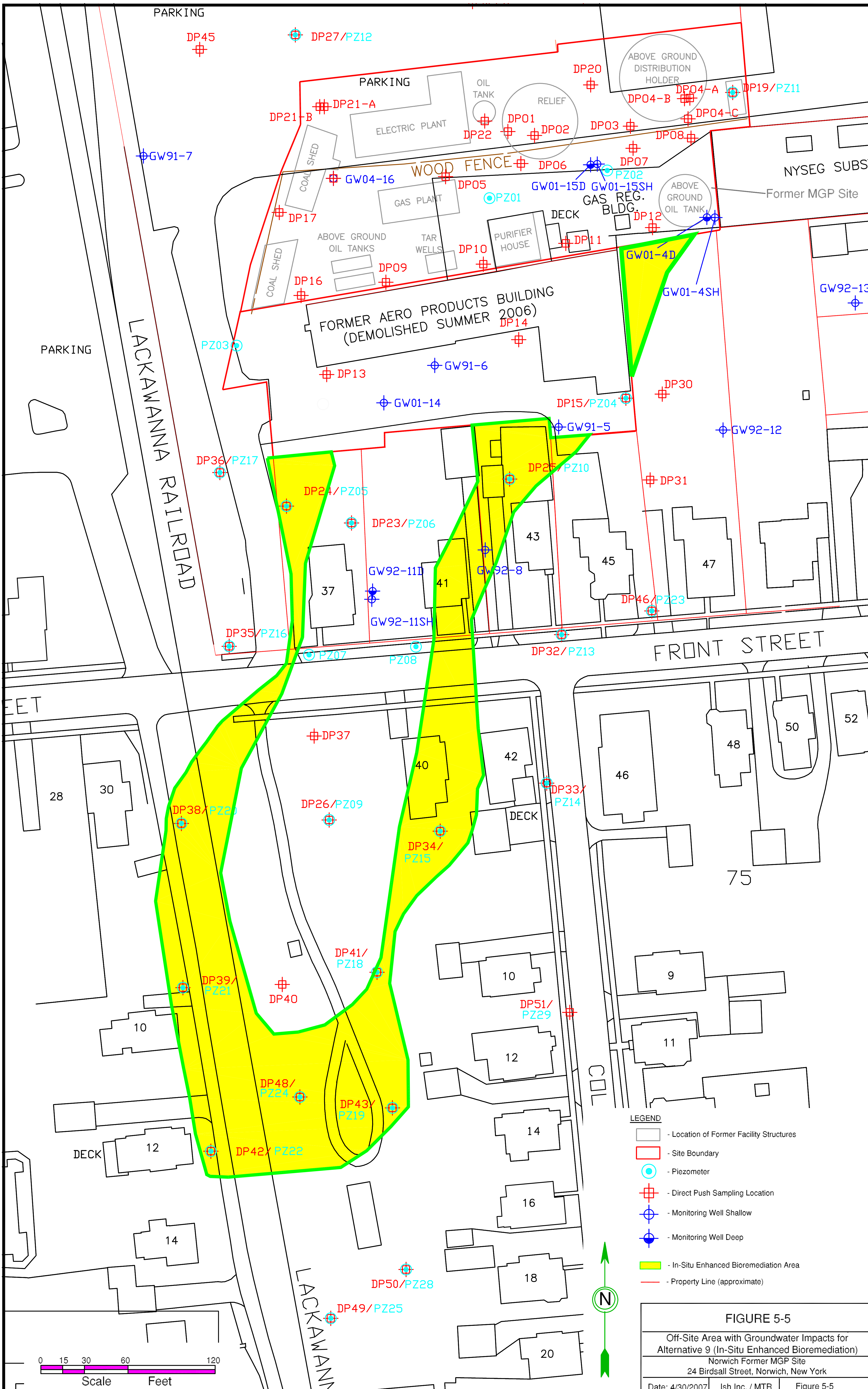


FIGURE 5-5

Off-Site Area with Groundwater Impacts for Alternative 9 (In-Situ Enhanced Bioremediation)

Norwich Former MGP Site
24 Birdsall Street, Norwich, New York

Date: 4/30/2007 | Ish Inc. / MTR | Figure 5-5

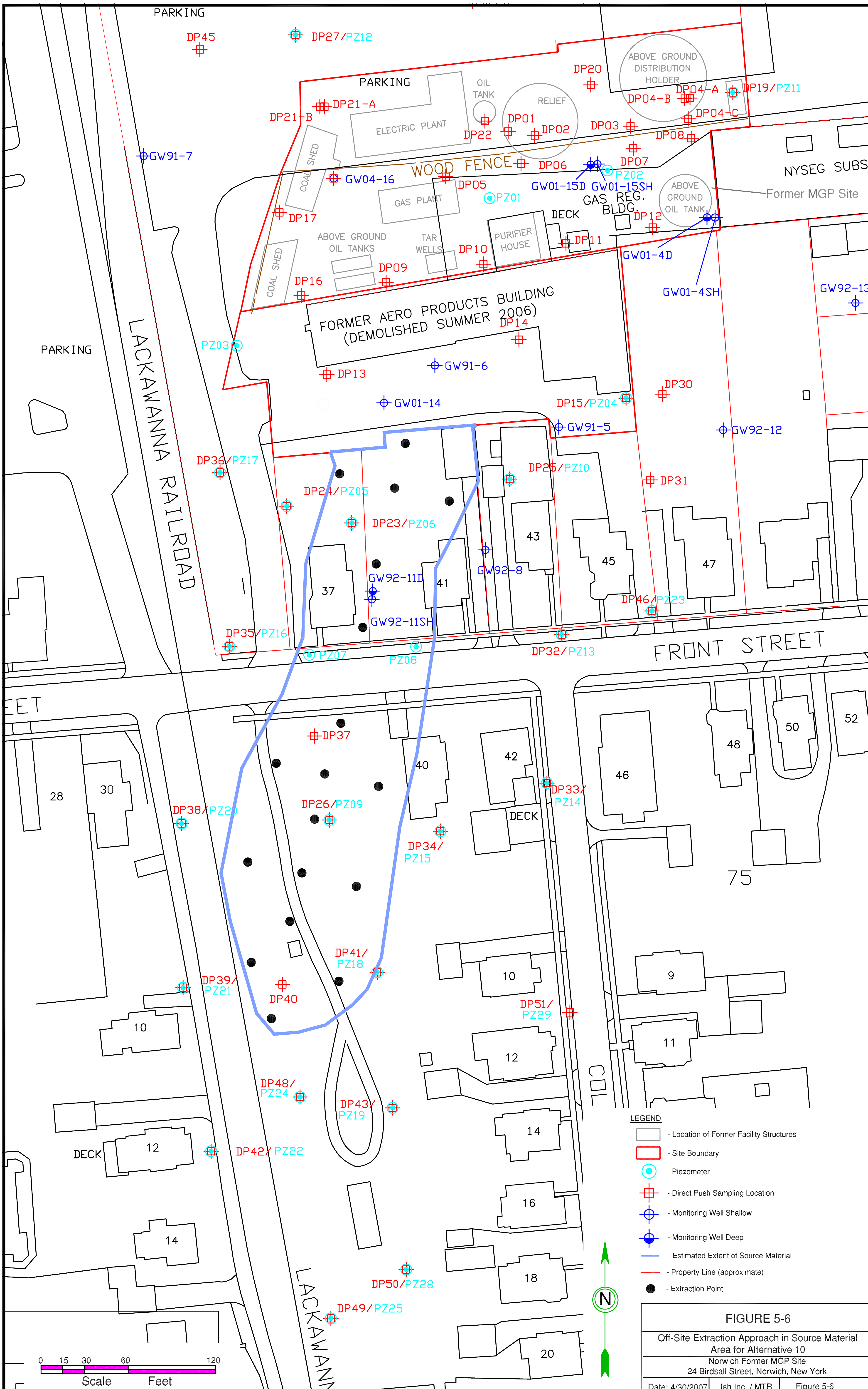


FIGURE 5-6

Off-Site Extraction Approach in Source Material Area for Alternative 10

Norwich Former MGP Site
24 Birdsall Street, Norwich, New York

Date: 4/30/2007 | Ish Inc. / MTR | Figure 5-6

FINAL FEASIBILITY STUDY REPORT ADDENDUM

NYSEG FORMER MGP SITE
NORWICH, NEW YORK

November 2007

Prepared for:

New York State Electric & Gas Corporation
Kirkwood Industrial Park
Binghamton, New York 13902

Prepared by:

Ish Inc.
804 Salem Woods Drive, Suite 201B
Raleigh, NC 27615

FINAL FEASIBILITY STUDY REPORT ADDENDUM

NYSEG FORMER MGP SITE
NORWICH, NEW YORK

This Addendum to the Feasibility Study for the NYSEG Former MGP Site in Norwich, New York presents an evaluation of an additional Off-Site alternative and a recommended Off-Site remedy as follow-up to NYSDEC review of the Draft Feasibility Study Report (Ish Inc., May 2007).

PROFESSIONAL ENGINEER CERTIFICATION

I, William J. Zeli, a Professional Engineer registered in the State of New York, certify that the evaluation referenced above has been conducted consistent with proper engineering practices and that, to the best of my knowledge and belief, this report accurately presents the findings of the evaluation.

William J. Zeli, P.E.
New York License No. 080787
MTR Engineering, Inc.

11/19/07
Date

STATE OF NEW YORK
WILLIAM J. ZELI
080787
LICENSED PROFESSIONAL ENGINEER

UNAUTHORIZED
ALTERATION
OF THIS ITEM
IS UNLAWFUL

FINAL FEASIBILITY STUDY REPORT ADDENDUM

NYSEG FORMER MGP SITE
NORWICH, NEW YORK

INTRODUCTION

This Addendum to the Feasibility Study Report (FS Report) for the former manufactured gas plant (MGP) site at 24 Birdsall Street in Norwich, New York has been prepared by the Ish Inc. team on behalf of NYSEG (New York State Electric & Gas Corporation).

The New York State Department of Environmental Conservation (NYSDEC) provided comments on the Draft FS Report (Ish Inc., May 2007) in a letter dated August 2, 2007. Following subsequent discussions between NYSDEC, NYSEG and Ish Inc. representatives, responses to the NYSDEC comments were provided in a submittal dated August 25, 2007.

As follow-up to submittal of the responses, a description and evaluation of the new Off-Site alternative (Alternative 11) and additional information on the use of ISS technology for remediation of MGP sites were submitted on September 20, 2007. In a letter dated September 24, 2007, NYSDEC indicated agreement with the recommended alternative and that NYSEG should submit the revised Final FS Report to the Department.

The purpose of this FS Report Addendum is to supplement the Final FS Report by incorporating Off-Site Alternative 11 into the FS, including an evaluation of Alternative 11 using the FS criteria. As required by the Department, an updated recommendation for the Off-Site remedy is also provided in this Addendum.

ADDITIONAL OFF-SITE ALTERNATIVE

The following remedial alternative has been developed to address the Off-Site source material area at the NYSEG former MGP site in Norwich, New York.

Alternative 11 – Property Purchases and *In-Situ* Solidification/Stabilization of Off-Site Source Material, Installation of Extraction Points in Remaining Off-Site Source Areas with Periodic NAPL Extraction and Transport to an Off-Site Facility, *In-Situ* Chemical Oxidation (ISCO) of Off-Site Source Material Following Sufficient NAPL Removal, *In-Situ* Enhanced Bioremediation of Off-Site Groundwater (if Appropriate Following a Period of Monitoring), Institutional Controls and Groundwater Monitoring)

Alternative 11 involves a phased approach to remediation that incorporates components of the other Off-Site remedial alternatives. This alternative has been developed for consideration based on the diverse nature of land use and MGP-related impacts within the Off-Site area. Alternative 11 involves the purchase of two properties north of Front Street and *in-situ* stabilization (ISS) of source material at those properties, and the installation of NAPL extraction points in remaining Off-Site source areas south of Front Street with periodic extraction and transport to an Off-Site disposal facility. *In-situ* chemical oxidation (ISCO) of remaining Off-Site residual material would be conducted following a sufficient period of NAPL removal. If appropriate following a period of groundwater monitoring subsequent to the ISCO treatment, *in-situ* enhanced bioremediation of Off-Site groundwater would occur. Institutional controls and groundwater monitoring are also components of this alternative.

The two Off-Site properties north of Front Street (i.e., 37 and 41 Front Street) are not suitable locations for intrusive remediation because of their sensitive land uses/potential receptors. 37 Front Street is a residential property and 41 Front Street is a Day Care Center. There is currently no exposure to MGP residuals by residents or Day Care Center children at either property. Both properties are supplied with municipal water and indoor air quality has not been affected at either property based on a soil vapor intrusion evaluation conducted by NYSEG. Alternative 11 involves acquiring both properties so that active and/or intrusive remedial alternatives can be considered. NYSEG will negotiate with both property owners to acquire the properties at fair market value. If NYSEG is not successful, NYSEG will confer with NYSDEC regarding options to proceed with these properties. If NYSEG is successful in acquiring the two properties, the existing structures would be razed and ISS would be implemented on those properties.

The general area where ISS is proposed under this alternative is identified on Figure 5-7. A total treatment depth of 24 feet within a surface area of approximately 13,500 square feet has been estimated for evaluation purposes. The delineation of source material would be refined and the planned extent of ISS would be finalized during the remedial design phase. As described with On-Site Alternative 5, ISS technology involves the mixing of impacted soil or DNAPL-containing material with grout reagents using a large-diameter auger to solidify and immobilize constituents of concern, minimizing or eliminating release of constituents in groundwater. The chemical and physical characteristics of the impacted material are altered, and the potential for rain water infiltration or groundwater contact with the immobilized constituents is greatly reduced.

Because the bulk density and volume of the treated material is increased, excess material would need to be addressed. Removal of the surficial 6 feet of material is estimated in advance of the ISS process (approximately 4,500 tons). This removal and stockpiling of overburden soil would also address potential underground structures and obstructions. Based on a treatment depth of 24 feet bgs, an 18-foot vertical interval would be treated via the ISS process (approximately 9,000 cubic yards). Debris or unimpacted excess material would be transported to a local landfill for disposal. Unimpacted material from the excavation of the 6 feet of surficial material would be reused as backfill. For cost estimating purposes, it was assumed that a sufficient volume of material from the stockpile of surficial material would be available for use as backfill to restore the site to final grade, and the remaining stockpile material (estimated at 1,800 tons) would require Off-Site disposal.

Off-site source areas south of Front Street would be addressed initially through the installation of NAPL extraction points, and periodic monitoring and extraction with transport to an Off-Site disposal facility. The general layout of the extraction well network within the Off-Site source material area is depicted on Figure 5-7. The number of extraction wells and their locations are tentative at this time, and would be determined during the remedial design phase. For evaluation purposes, Alternative 11 assumes 12 extraction wells installed to a depth of 25 feet bgs at the locations identified on Figure 5-7. Waste material and fluids generated during installation and development of the wells would be managed appropriately.

Periodic total fluids extraction using mobile high vacuum equipment (e.g., vacuum truck) with Off-Site disposal of the recovered fluids has been assumed for evaluation purposes. The method for extraction and disposal would be evaluated further during the remedial design phase. In-well measurements to check for potential NAPL accumulations would be used to direct the extraction efforts. For costing purposes, monthly monitoring of potential NAPL accumulations, and total fluids extraction and disposal of approximately 2,400 gallons from four locations on a monthly basis, have been assumed for a 3-year period. The primary objective of the extraction would be to remove free-phase NAPL and reduce the constituent mass in advance of ISCO treatment of the Off-Site source material. Criteria for the frequency and duration of extraction would be developed during remedial design.

Following a sufficient period of NAPL removal, ISCO treatment of the remaining Off-Site source material would be conducted. The general approach to application of ISCO technology in this FS is described with On-Site Alternative 6. Alternative 11 assumes 75 single injectors would be installed within the source material area identified on Figure 5-7. Should this alternative be selected, the delineation of source material would be refined, availability of access for injection would be determined, and the planned extent of the treatment area would be finalized during the remedial design. Waste material generated during installation of the injectors would be managed appropriately.

The reagent volume estimate is based on a 20:1 ratio of reagent to constituent mass and approximately 80 percent destruction of constituent mass is targeted by the ISCO treatment process. For cost estimating purposes, the presence of free-phase NAPL is assumed to be minimal following the extraction program, and residual constituent mass is assumed to occur within a 2 to 5 foot interval above the confining layer with concentrations in the 1,000 to 2,000 mg/Kg range. For implementation, two injection crews are assumed to rotate injections throughout the treatment area for a period of approximately six weeks. The injection locations and intervals, reagent types and volumes, laboratory treatability testing, duration of treatment and other details would be evaluated further during the remedial design phase. Additional characterization of the source material may also be appropriate to better estimate the necessary reagent volume. The injection events associated with Alternative 11 have some potential short-term effects that would need to be properly managed. Following completion of the ISCO injections, this alternative should not have adverse effects on land uses.

Biodegradation of dissolved phase constituents may be enhanced following the chemical oxidation injections, and changes in groundwater concentrations would be monitored. Following a sufficient period of monitoring subsequent to ISCO treatment, NYSEG will consult with NYSDEC to determine the need for applying enhanced bioremediation treatment of any remaining Off-Site residual groundwater impacts. If appropriate, Alternative 11 would include enhanced bioremediation of impacted groundwater using *in-situ* treatment. The treatment would involve injection of an oxygen-supplying product using temporary borings. Assuming microbial populations and available nutrients are adequate, this process increases dissolved oxygen concentrations in groundwater and stimulates microbial activity to enhance dissolved constituents biodegradation in the saturated zone.

Areas where enhanced bioremediation may be applicable could be within the treated source material areas, or within untreated areas beyond the source material where dissolved phase constituents appear to persist. For evaluation purposes, this alternative assumes enhanced bioremediation within areas of groundwater impacts beyond the extent of Off-Site source material treated using ISCO technology.

Figure 5-7 depicts the general areas where *in-situ* enhanced bioremediation is potentially applicable. The cost estimate assumes two injection events following a two-year monitoring period after ISCO treatment is complete, with 100 injection locations per event and 30 pounds of oxidant injected per injection location. Details regarding accessible locations, spacing of injection borings, mass of oxidant injected per boring and the number of applications would be developed further during the remedial design phase. The injection events should not have significant adverse effects on land uses. Natural biodegradation of dissolved phase constituents would be supplemented by treatment via the oxygen addition, and the anticipated reduction in dissolved phase constituent concentrations would be monitored.

Institutional controls are also a component of this alternative. The institutional controls may vary for each property within the impacted area depending on the location, and are expected to include a groundwater use restriction at a minimum. Institutional controls would assure continued protection of human health. Exposure to impacted groundwater does not currently exist. Groundwater use restrictions would assure that future exposure will not occur. A soil management plan and land use restriction may also be appropriate at some locations to control potential exposure to residual impacted soil. The soil management plan would address deeper excavations into the saturated zone, where MGP constituents may be present above the confining layer.

The estimated groundwater monitoring costs are based on collection and analyses of groundwater samples at approximately 14 Off-Site locations on an annual basis for a period of 20 years. The well network and monitoring program would be finalized prior to implementation. Groundwater levels would be measured to evaluate groundwater flow directions and assure that an appropriate monitoring well network is maintained.

Overall Protection of Public Health and the Environment

MGP constituent occurrence in the Off-Site area is associated with migration within the saturated zone above the confining layer. Therefore, the potential for surface soil-related exposures is limited. There is no current or anticipated future use of groundwater within the impacted area. ISS, NAPL extraction and ISCO treatment would be used to address Off-Site source material within the saturated zone.

RAOs that involve exposure controls would be achieved, and active remediation of Off-Site source material would occur. Active measures to control potential future migration of On-Site source material to Off-Site areas are addressed with the On-Site alternatives. Alternative 11 reduces the potential for human exposure through groundwater monitoring and groundwater use restrictions, and through the use of institutional controls to address source material and soil, where appropriate. This alternative would be adequately protective of public health and the environment.

Compliance with SCGs

Actions under Alternative 11 would include soil excavation and ISS of source material, installation of extraction wells and periodic total fluids extraction in Off-Site areas, *in-situ* treatment of source material within the saturated zone, potential injection of an oxygen-supplying product (if warranted), institutional controls and groundwater monitoring.

Compliance with SCGs associated with these actions would include proper management of material generated during application of ISS and extraction well or injector installations, fluids generated during extraction and the ISCO treatment process, purge water from sampling activities, and soil segregated from some excavations into the saturated zone, which is expected to be achievable. Compliance with requirements associated with ISS should be achievable with proper design, as well as requirements for the safe and proper extraction of fluids at Off-Site properties. Compliance with NYSDEC and access-related requirements for the safe and proper injection of chemicals during *in-situ* treatment (ISCO or oxidant injection) would be necessary.

Remediation of source material within the saturated zone would occur. The ISS, NAPL removal and ISCO treatment components of this alternative would significantly reduce the mass of MGP material that is a source of groundwater impacts. However, groundwater standards may not be achieved for a considerable time period due to the potential for residual constituents mass to remain. This alternative is considered good in overall acceptability regarding this criterion.

Long-Term Effectiveness and Permanence

The MGP-related source material occurs Off-Site within the saturated zone above the confining layer. Therefore, a soil management plan for Off-Site properties that addresses deeper excavation work and land use restrictions, where appropriate, should provide adequate long-term effectiveness and protection from potential exposures to impacted subsurface soil. Use of groundwater within the impacted area does not currently exist and is not anticipated. Therefore, groundwater use restrictions and monitoring should provide adequate long-term protection from potential exposures to impacted groundwater.

Material within the saturated zone acting as a source of groundwater impacts would be addressed. With proper design and implementation, ISS treatment is expected to be effective in addressing source material in the long-term. Extraction results in a permanent removal of constituents from the subsurface. ISCO treatment results in a permanent destruction of constituents. Risks would be primarily related to residual DNAPL that may remain. Exposure controls would provide additional long-term protection to address the residual risks. Overall, Alternative 8 is good in acceptability regarding this criterion.

Reduction of Toxicity, Mobility or Volume with Treatment

Direct treatment of source material within the saturated zone would occur via *in-situ* stabilization north of Front Street, and NAPL extraction followed by *in-situ* chemical oxidation south of Front Street, resulting in a significant overall reduction in constituent mass and mobility.

Oxygen may be provided within the saturated zone as a by-product of the ISCO process, which may promote biological degradation. Post-treatment groundwater concentrations would be monitored and biodegradation would be enhanced, if appropriate. The acceptability of Alternative 11 regarding this criterion is very good because a significant mass of constituents would be permanently destroyed or immobilized.

Short-Term Effectiveness

Implementation of institutional controls and groundwater monitoring would not have adverse short-term effects on the community or remediation workers. *In-situ* stabilization and the associated excavation component would have some potential short-term effects, such as an increased potential for exposure to constituents that would need proper management. Routine procedures are available to mitigate the potential exposure risks and assure adequate protection.

Installation of the extraction wells would have some potential short-term effects, along with periodic extraction of DNAPL from the wells during the extraction process. Application of ISCO would also involve the potential for some short-term effects. Waste materials and fluids would need to be properly managed, and incidental spills would need to be controlled. Procedures to mitigate the potential risks and assure adequate protection would be required. Injection of oxygen products is a common remediation method that can be safely and reliably implemented. However, careful implementation would be required because of the sensitive land use in the treatment area.

Impacts on the environment during implementation are considered acceptable. Environmental impacts beyond the current extent of constituent occurrence are not expected. This alternative involves a phased approach to remediation. The duration of Alternative 11 would be determined primarily by the timeframes for NAPL recovery and the potential need for enhanced bioremediation following ISCO treatment. Groundwater quality would be monitored for a projected period of 20 years. Overall, Alternative 11 would be fair to moderate in short-term effectiveness, primarily due to the anticipated total time necessary to implement the components of the phased approach.

Implementability

Institutional controls such as land and groundwater use restrictions are commonly adopted where property owner objections are not an issue. Groundwater monitoring and management of soil from excavations are routine tasks. The soil excavation associated with application of ISS is technically implementable, with limited logistical concerns. ISS would involve technical considerations and administrative requirements that would need to be addressed during design for safe and proper implementation.

Installation of extraction wells would be similar to the monitoring well and piezometer installations that were previously installed successfully in the Off-Site source area during the remedial investigation. Following the well installations, this alternative should not adversely impact land uses assuming that access could be maintained for monitoring and periodic extraction. *In-situ* treatment of source material is technically implementable, assuming site-specific procedures for safe implementation are developed during remedial design. Administrative requirements would need to be addressed, particularly access-related issues. Access would also be needed for periodic injection of the oxygen-supplying product, if warranted based on the future monitoring results.

This alternative is not expected to impact current or future land uses except for the two Off-Site properties north of Front Street. Alternative 11 involves NYSEG attempting to acquire those properties (currently a residential property and Day Care Center) to facilitate remediation. Alternative 11 should be implementable, although technical and administrative issues would need to be addressed during each phase of the project.

Cost

The total remediation cost to implement Alternative 11 is estimated at $4,641,700. The total cost estimate includes $2,460,000 for ISS and installation of the NAPL extraction system, along with soil management and groundwater monitoring plans, and preparation of groundwater and land use restrictions. The remediation estimate for ISCO treatment following extraction to address free-phase NAPL is $1,894,000, and the estimate for enhanced bioremediation following ISCO treatment is $287,700 for two applications.

Annual costs for groundwater monitoring, periodic soil management, and monthly monitoring and operation of the extraction system are estimated at $112,000. When extraction is no longer needed, the estimated annual costs are reduced to $36,000. The estimated total present worth cost of Alternative 11 is approximately $4,841,800. The present worth cost estimate assumes that monitoring, management and extraction activities occur over a 3-year period, followed by ISCO treatment after three years of extraction to remove NAPL. Two annual enhanced bioremediation events are assumed following two years of monitoring after ISCO treatment is completed. Groundwater monitoring and management are projected for 17 additional years after extraction is complete (20-year period total). Table 5-5 provides the detailed cost estimate for this alternative. The initial costs and estimated total present worth cost of this alternative are high, although this phased approach would significantly reduce the mass of source material Off-Site.

RECOMMENDED OFF-SITE REMEDY

Alternative 7 (no remedial action) may adequately address the RAOs for Off-Site and be protective of human health and the environment. However, the other alternatives that involve active remediation provide a higher degree of protection. Given the variable nature of land use and MGP-related impacts within the Off-Site area, a phased approach for remediation as described in Alternative 11 is recommended. Alternative 11 combines components of the other alternatives for remediation of the Off-Site impacts.

The initial phase of the Off-Site remediation would include NYSEG efforts to acquire the two Off-Site properties north of Front Street (i.e., 37 and 41 Front Street). NYSEG will negotiate with both property owners to acquire the properties at fair market value. If NYSEG is successful in acquiring the two properties, the existing structures will be razed and ISS will be implemented. If not successful, NYSEG will confer with NYSDEC regarding options to proceed with these properties. Off-site source areas south of Front Street will be addressed initially through the installation of NAPL extraction points, and periodic monitoring and extraction with transport of the extracted liquids to an Off-Site treatment and disposal facility.

Following a sufficient period of NAPL removal, *In-Situ* Chemical Oxidation (ISCO) treatment of the remaining Off-Site source material will be implemented. Biodegradation of dissolved phase constituents may be enhanced following the ISCO treatment, and changes in groundwater concentrations would be monitored. Following a sufficient period of monitoring subsequent to ISCO treatment, the need for enhanced bioremediation treatment of remaining Off-Site residual groundwater impacts will be evaluated. If appropriate, enhanced bioremediation of impacted groundwater using *in-situ* treatment by injecting an oxygen-supplying product will be carried out. Institutional controls and groundwater monitoring are also components of this recommended Off-Site alternative.

This phased remedial approach addresses the Off-Site RAOs by incorporating the following components:

- If implemented, On-Site Alternative 5 (i.e., ISS technology for source material treatment) would control future migration of source material from On-Site to Off-Site areas, and more specifically in this case, it would control future migration of source material within the Off-Site area;

- Potential human exposure to source material is eliminated to the extent practicable through remediation (by ISCO, free-phase NAPL removal, and ISS if implemented) and the use of institutional controls, including land use restrictions and a soil management plan as appropriate for Off-Site properties;
- Potential risks to human health from exposure to groundwater containing MGP constituents are minimized through the use of institutional controls, groundwater monitoring and using enhanced bioremediation (Alternative 9) where appropriate; and
- Potential human exposure to subsurface soil containing MGP constituents is eliminated to the extent practicable through remediation (by ISCO, free-phase NAPL removal and ISS if implemented) and the use of institutional controls, including land use restrictions and a soil management plan as appropriate for each Off-Site property.

ATTACHMENTS

Table 5-5 Comparative Cost Estimates for Off-Site Remedial Alternatives

Figure 5-7 Remedial Approach to Off-Site Area for Alternative 11

TABLE 5-5

COMPARATIVE COST ESTIMATES FOR OFF-SITE REMEDIAL ALTERNATIVES

NYSEG Former MGP Site
Norwich, New York

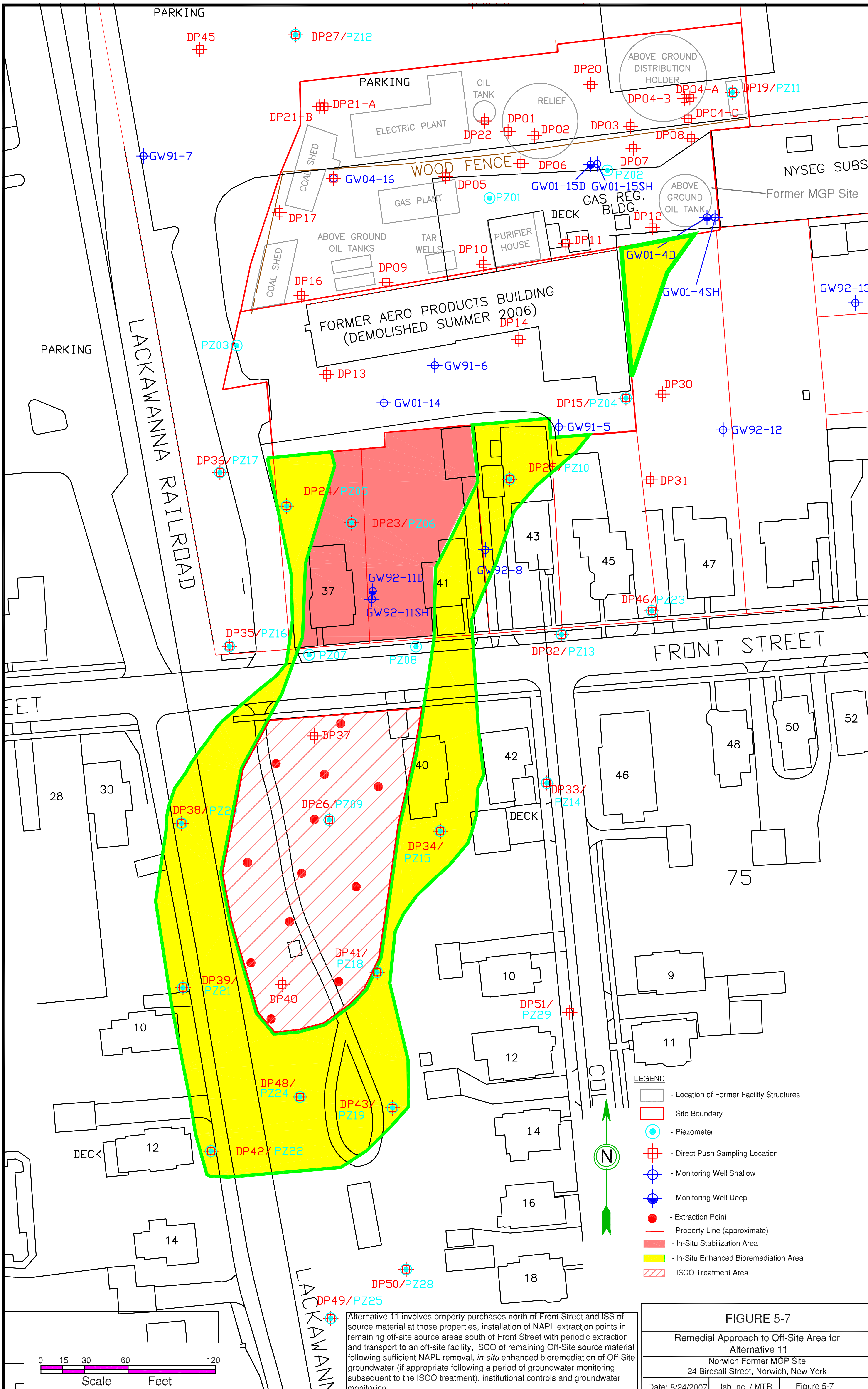
Item	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11
Remediation:					
RD investigation	0	60,000	15,000	0	85,000
RD/RA work plan/design	4,000	84,000	29,000	39,000	154,000
Preconstruction/permitting	0	50,000	27,500	20,000	107,500
Project management	13,000	43,000	22,000	23,000	67,000
Property acquisition	0	0	0	0	500,000
Building demolition	0	0	0	0	60,400
Monitor/recovery wells installation	0	0	0	81,000	54,000
Collection trench or wells waste management	0	0	0	5,600	4,400
Manage obstructions and utilities	0	0	0	0	27,000
Monitoring well replacements	0	0	0	0	2,000
Site restoration	0	59,000	10,000	9,000	87,300
In-situ stabilization	0	0	0	0	720,000
In-situ stabilization material management	0	0	0	0	369,000
ISCO - injector and vent installations	0	327,800	0	0	217,600
Injector waste management	0	24,600	0	0	17,000
ISCO - chemical injections	0	1,920,000	0	0	912,000
ISCO - water management	0	20,240	0	0	11,600
In-situ treatment borings	0	0	60,000	0	60,000
In-situ treatment chemical	0	0	54,000	0	54,000
Oversight	0	108,500	29,200	17,100	153,100
Air monitoring	0	51,100	0	11,800	91,300
Deed restrictions	21,000	21,000	21,000	21,000	21,000
Soil management plan	16,000	16,000	16,000	16,000	16,000
Surveying	0	12,500	0	9,000	21,500
RA Documentation Report	0	25,000	10,000	15,000	55,000
Contingency (approx. 20%)	11,000	565,000	59,000	54,000	774,000
Estimated Remediation Cost:	**65,000**	**3,387,740**	**352,700**	**321,500**	**4,641,700**
Annual Costs					
Groundwater monitoring	14,000	14,000	14,000	14,000	14,000
Groundwater injections	0	0	45,550	0	0
Maintain cap/cover and manage soil	4,000	4,000	4,000	4,000	4,000
Project management and reporting	12,000	12,000	12,000	12,000	12,000
NAPL/total fluids removal	0	0	0	63,000	53,400
Contingency (approx. 20%)	6,000	6,000	15,000	19,000	17,000
Estimated Annual Cost:	**36,000**	**36,000**	**90,550**	**112,000**	**100,400**
Estimated Annual Cost (reduced NAPL removal):				**62,200**	
Estimated Annual Cost (post-NAPL removal):				**36,000**	**36,000**
Estimated NAPL Duration (years):	0	0	0	10	3
Estimated Soil Management Duration (years):	30	20	20	20	20
Estimated Groundwater Duration (years):	30	20	20	20	20
Estimated Total Cost:	**1,145,000**	**4,107,740**	**2,163,700**	**1,452,900**	**5,554,900**
Estimated Present Worth Cost:	**618,410**	**3,836,379**	**1,481,152**	**1,113,049**	**4,841,783**
Estimated Present Worth Cost (-30%):	**432,887**	**2,685,465**	**1,036,807**	**779,134**	**3,389,248**
Estimated Present Worth Cost (+50%):	**927,615**	**5,754,569**	**2,221,728**	**1,669,573**	**7,262,675**

Alternatives:

7) No remedial action (with institutional controls and groundwater monitoring)
8) *In-situ* chemical oxidation (ISCO) for treatment of off-site source material, monitored natural attenuation for groundwater, and institutional controls
9) *In-situ* enhanced bioremediation (injection of oxygen-supplying product) for treatment of off-site groundwater beyond source material areas, institutional controls and groundwater monitoring
10) Installation of extraction points in off-site source areas with periodic total fluids extraction and transport to an off-site facility, with monitored natural attenuation for groundwater, and institutional controls
11) Property purchases and *in-situ* stabilization of source material north of Front Street, installation of NAPL extraction points in remaining off-site source areas with periodic extraction and transport to an off-site facility, ISCO treatment of off-site source material following NAPL recovery, and *in-situ* enhanced bioremediation of off-site groundwater beyond source material areas (if necessary), with groundwater monitoring and institutional controls

Assumptions/Notes:

1) Present worth costs are based on 5% interest rate.
2) Alternative 9 annual costs include 1/2 cost for biannual injections (every 2 years) following initial injection event.
3) Alternative 10 annual and present worth costs based on monthly NAPL monitoring/extraction in years 1 thru 3, quarterly in years 4 thru 10, and none required in years 11 thru 20.
4) Alternative 11 remediation costs include $2,460,000 for ISS and installation of NAPL extraction system, $1,894,000 for ISCO treatment and $287,700 for two enhanced bioremediation events.
5) Alternative 11 present worth costs based on initial ISS, NAPL recovery in years 1 thru 3, ISCO treatment in year 4, monitoring only in years 5 and 6, enhanced bioremediation in years 7 and 8 (if necessary), and post-remediation monitoring in years 9 thru 20.



Alternative 11 involves property purchases north of Front Street and ISS of source material at those properties, installation of NAPL extraction points in remaining off-site source areas south of Front Street with periodic extraction and transport to an off-site facility, ISCO of remaining Off-Site source material following sufficient NAPL removal, *in-situ* enhanced bioremediation of Off-Site groundwater (if appropriate following a period of groundwater monitoring subsequent to the ISCO treatment), institutional controls and groundwater monitoring.

FIGURE 5-7

Remedial Approach to Off-Site Area for Alternative 11

Norwich Former MGP Site
24 Birdsall Street, Norwich, New York

Date: 8/24/2007	Ish Inc. / MTR	Figure 5-7