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Feasibility Study Report

Suffern Former Manufactured Gas Plant Site
Suffern, New York
Site No. 3-44-045

October 2013

ARCADIS

Certification Statement

I, Terry W. Young, P.E. certify that I am currently a NYS registered professional engineer and that this *Feasibility Study Report* was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the Division of Environmental Remediation *Technical Guidance for Site Investigation and Remediation* (DER-10) (NYSDEC, 2010).

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Feasibility Study Report

Suffern Former MGP Site
Site No. 3-44-045

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Executive Summary

Introduction

This *Feasibility Study Report* (FS Report) presents an evaluation of remedial alternatives to address the environmental impacts identified at the Orange and Rockland Utilities, Inc. (O&R) Suffern former manufactured gas plant (MGP) site located in Suffern, New York. This FS Report has been prepared by ARCADIS of New York, Inc. (ARCADIS) on behalf of O&R in accordance with the Order on Consent Index #D3-0001-98-03 between O&R and the New York State Department of Environmental Conservation (NYSDEC).

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

- Appropriate for site-specific conditions
- Protective of public health and the environment
- Consistent with relevant sections of NYSDEC guidance, the National Contingency Plan (NCP), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

The overall objective of this FS Report is to recommend a reliable remedy that achieves the remedial action objectives (RAOs) established for the site and best balances the evaluation criteria.

Background

The former MGP site is located on Pat Malone Drive in an urban area of the Village of Suffern, New York. For the purposes of this FS Report, the former MGP site is defined by the former MGP area, including the eastern gas holder and MGP plant building and the western gas holder. Off-site areas consist of the State of New Jersey property and the O&R former propane plant property (i.e., current gate station). The former MGP site and off-site areas are collectively referred to herein as the “project area”. As reported in the October 2010 *Remedial Investigation Report* (RI Report) prepared by Geotechnical Engineers, Inc. (GEI) (GEI, 2010), the project area and adjacent properties are located in an area zoned for manufacturing (M) land use.

Portions of the project area are currently owned by O&R and used as a natural gas gate station and a natural gas regulator station. In addition, a portion of the project area (i.e., on the State of New Jersey property) is used as a firing range by the Ramapough Sportsmen's Club and the Village of Suffern Police Department. Access to the natural gas gate station and natural gas regulator stations is limited to O&R employees and landscape contractors. Access to the firing range is limited to members of the shooting club and the police department. The surrounding properties are currently used for recreational and commercial activities.

The Suffern Gas Company MGP began gas manufacturing operations in approximately 1902 using the Lowe carbureted water gas (CWG) process. In general, the plant consisted of a former MGP building that included a coal storage room, a boiler room, a generator room and a storage room, as well as, a meter room and a pump house that were attached to the MGP building. Additionally, a 50,000 cubic foot (cf) gas holder (i.e., eastern gas holder), and 7,000 gallon steel oil storage tank were constructed prior to operations. By the end of 1925, the MGP plant was rebuilt as a coal gas plant and shortly after (August 1926) the ownership was transferred to the Ramapo Gas Corporation. The coal gas plant operated at the former MGP property from 1925 to 1935. In general, the configuration of the MGP plant remained largely unchanged after it was rebuilt as a coal gas plant. In July 1935, manufactured gas production ceased and manufactured gas was replaced with natural gas, which was supplied by the Home Gas Company, the West Shore Gas Company, and Rockland Gas Company.

The Village of Suffern water supply well field is located west of the project area. The well field consists of three wells generally screened from 45 to 100 feet below ground surface (bgs) and a fourth well screened from 100 to 151 feet bgs. On average, the well field extracts approximately 1.8 million gallons per day.

Nature and Extent of Impacts

Non-aqueous phase liquid (NAPL) in the ground beneath the project area, primarily coal tar NAPL, are responsible for most of the environmental impacts resulting from the former MGP operations. The NAPL-related impacts are generally distributed as follows:

- Eastern Gas Holder – NAPL-related impacts were observed inside the foundation of the subsurface portion of the eastern gas holder, and in shallow and deep subsurface soils (i.e., near the surface of the bedrock) adjacent to, and beneath the gas holder foundation. Coal tar, NAPL-blebs and hydrocarbon-stained soil were observed in borings adjacent to the foundation (0 to 10 feet bgs). Physical evidence (e.g., dense non-aqueous phase liquid (DNAPL), sheens, odors) were noted in a deep soil sample collected beneath the eastern gas holder at depths up to 101 feet bgs.

- Gas Oil House – Coal tar DNAPL was observed in the subsurface foundation of the gas oil house located northeast of the former MGP Building at depths up to 13 feet bgs. In addition, trace amounts of a green-colored petroleum-like light non-aqueous phase liquid (LNAPL) material was observed in shallow soil intervals adjacent to the foundation at depths no greater than 22 feet bgs (i.e., SSB67 and MW8).

- MGP Building – DNAPL-related impacts were observed in subsurface soils located at the western end of the MGP building. DNAPL-coated gravel was observed at depths ranging from 14 to 55 feet bgs.

- Gate Station – Coal tar impacts were observed in the eastern portion of the O&R gate station (former propane plant). The coal tar impacts in this area were observed in 1-foot thick laterally continuous lenses at depths no greater than 5 feet bgs. Coal tar impacts were also observed at equivalent elevations beneath a portion of the abandoned railroad berm at monitoring wells MW30 and MW31 and soil boring SSB43 (i.e., 19 to 24 feet bgs). The impacts consist of hardened tar that is not considered grossly impacted, is not mobile, and is not considered a source for dissolved phase impacts (i.e., the tar is located approximately 3 feet above the water table). An estimated 1,200 cubic-yards (cy) of soil containing hardened tar is located below the railroad berm.

- State of New Jersey Property – Coal tar and DNAPL impacts have been observed in an area north of the former MGP building on the State of New Jersey property. In general, impacts in this area are limited to depths no greater than 30 feet bgs. However, DNAPL coated-gravel and/or sheens were observed at a depth of 40 feet bgs at SSB63 and at 87 feet bgs at MW36.

The primary chemical constituents of concern (COCs) associated with coal tar consist of benzene, toluene, ethyl benzene and xylenes (BTEX) and polycyclic aromatic hydrocarbons (PAHs). Per NYSDEC guidance documents a soil cleanup objective (SCO) for total PAHs of 500 milligrams per kilogram (mg/kg) in the subsurface soil is applicable for most sites where the future site use is non-residential (which is consistent with the current and anticipated future site use for this site). Based on a review of borings logs for soil borings and monitoring wells completed/ installed to date, the project area contains an estimated 26,400 cy of visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg. For the purpose of this report, visually impacted material is considered soil that contains NAPL in amounts greater than sheen and blebs. Visually impacted material and/or soil that contain total PAHs at concentrations greater than 500 mg/kg is referred to as "impacted material" for the purposes of discussing the nature and extent of impacts and proposed remedial alternatives at this site.

Approximately 11,500 cy (or 44%) of the total estimated volume of impacted material is located above the water table (i.e., encountered at depths shallower than 12 to 15 feet bgs). This volume estimate does not include approximately 1,200 cy of soil containing hardened tar located beneath the abandoned railroad berm. An additional estimated 10,900 cy of impacted material is located below the water table at depths up to 35 feet bgs. This material located above 35 feet bgs accounts for an estimated 85% of the impacted material in the project area.

An estimated 4,000 cy of impacted material is located at depths greater than 35 feet bgs. Angled soil boring SSB73A (completed below the eastern gas holder) encountered "NAPL mixed with sand and gravel" from approximately 86 to 94 feet bgs. Assuming these impacts are present at a uniform thickness (which is a conservative assumption), an estimated 3,000 cy of impacted material could be located at this deep depth interval beneath the eastern gas holder. The remaining estimated 1,000 cy of impacted material (i.e., at depths greater than 35 feet bgs) is sporadically located throughout the project area (i.e., at non-contiguous locations): below the former MPG building at soil boring SSB74 (NAPL mixed with sand and gravel at depths up to 55 feet bgs); west of the gas oil house at soil boring SSB63 (sheens at 40 feet bgs); and on the State of New Jersey property at monitoring well MW36 (gravel coated with NAPL from 80 to 86 feet bgs).

In addition to the aforementioned areas, LNAPL has been observed at one discrete location northwest of the former MGP building on the State of New Jersey property. Trace amounts of LNAPL comprised of a mixture of carbureted water gas tar and fuel oil were observed to accumulate in monitoring well MW20. These LNAPL impacts are not widespread and appear to be confined to the area around this well. DNAPL has not been observed to accumulate in any of the monitoring wells installed at the project area.

As indicated above, MGP-related COCs include BTEX and PAHs and to a lesser degree cyanide. The distribution of COCs in soil where concentrations exceed individual NYSDEC Part 375 SCOs for commercial use and the total PAHs are greater than 500 mg/kg closely mimics that of the distribution of visually impacted soil (i.e., soil where the presence of NAPL was observed at quantities greater than sheen or blebs) encountered during investigations conducted to date. Additionally, dissolved-phase COCs have been detected in groundwater samples collected from project area monitoring wells at concentrations exceeding New York State standards and guidance values. Based on the results of groundwater monitoring that has been conducted at the project area since 1999, dissolved phase groundwater impacts are stable and do not appear to be migrating toward the Village of Suffern well field.

Remedial Action Objectives

Remedial action objectives (RAOs) are developed to specify the COCs within the project area, and to assist in developing goals for cleanup of COCs in each medium that may require remediation. The RAOs presented in the following table have been developed based on the generic RAOs listed on NYSDEC's website (http://www.dec.ny.gov/regulations/67560.html).

Table ES.1 Remedial Action Objectives

RAOs for Soil
1. Prevent, to the extent practicable, ingestion/direct contact with soil containing MGP-related COCs and/or DNAPL
2. Prevent, to the extent practicable, inhalation of or exposure to MGP-related COCs volatilizing from MGP-impacted soil
3. Prevent, to the extent practicable, migration of MGP-related COCs and/or DNAPL that could result in impacts to groundwater
RAOs for Groundwater
1. Prevent, to the extent practicable, ingestion of groundwater containing MGP-related COCs at concentrations exceeding NYSDEC groundwater quality standards and guidance values
2. Prevent, to the extent practicable, contact with, or inhalation of volatiles, from groundwater containing MGP-related COCs at concentrations exceeding NYSDEC groundwater quality standards and guidance values
3. Restore groundwater quality to pre-disposal/pre-release conditions, to the extent practicable
4. Address, to the extent practicable, the source of groundwater impacts

Potential remedial alternatives are evaluated in this FS to assess their ability to meet the RAOs and be protective of human health and the environment.

Remedial Technology Screening and Development of Remedial Alternatives

The objective of the technology screening is to identify general response actions (GRAs), associated remedial technology types and technology process options, and then narrow the universe of process options to those that have had documented success at achieving similar RAOs at former MGP sites to identify options that are implementable and potentially effective at addressing impacts identified for the project area. Based on this screening, remedial technology types and technology process options were eliminated or retained and subsequently combined into potential remedial alternatives for further, more detailed evaluation. This approach is consistent with the screening and selection process provided in the NYSDEC *Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation* (DER-10) (NYSDEC, 2010).

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

- Alternative 1 – No Action
- Alternative 2 – Excavation of MGP Structures
- Alternative 3 – Excavation of Visually Impacted Soil up to the Water Table
- Alternative 4 – Excavation and Insitu Soil Solidification (ISS)
- Alternative 5 – Excavation to Unrestricted Use SCOs

Detailed Evaluation of Alternatives

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

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

- Cost Effectiveness

Comparative Analysis of Alternatives

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

Preferred Remedial Alternative

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

- Removing shallow hardened tar located west of the abandoned railroad berm (estimated 2,600 cy)

- Conducting pre-ISS excavation activities to remove the former gas house structure, eastern gas holder, shallow obstructions that would potentially damage ISS equipment and/or prevent homogenous mixing, and a minimum of 5 feet of material in ISS areas to allow material bulking (estimated 10,300 cy)

- Treating via ISS, visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg on the former MGP property (i.e., below the eastern gas holder and the western portion of the former MGP building) and impacted soil on the State of New Jersey property (i.e. near monitoring well MW20 and north of the former MGP area) (estimated 18,500 cy) to a maximum depth of approximately 35 feet bgs.

- Transporting and treating/disposing off-site, approximately 20,300 tons of excavated soil and ISS spoils containing MGP-related impacts via low-temperature thermal desorption (LTTD).

- Transporting concrete and asphalt debris for disposal at a construction and demolition (C&D) landfill.

- Backfilling excavation areas with approximately 10,300 cy of imported clean fill

- Conducting periodic groundwater monitoring to verify the extent and concentrations of dissolved phase COCs

- Preparing an annual report to summarize periodic groundwater monitoring activities and results

- Installing and operating a biosparging system near the leading edge of the dissolved phase plume (as a contingency measure if, based on the results of continued groundwater monitoring, dissolved phase impacts appear to be migrating toward the well field).

- Establishing institutional controls on the former MGP site in the form of deed restrictions and environmental easements to control intrusive (i.e., subsurface) activities that could result in potential exposures to subsurface soil and groundwater containing MGP-related impacts at concentrations greater than applicable standards and guidance values, and require compliance with the site management plan (SMP).

- Preparing an SMP to document the following:

  - The institutional controls that have been established and will be maintained for the former MGP site

  - Extent of solidified soil in the project area

  - Nature and extent of impacts that would remain in the project area following implementation of remedial the alternative

  - Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities in the project area and managing potentially impacted material encountered during these activities (including impacted material located beneath the abandoned railroad berm)

  - Protocols and requirements for conducting groundwater monitoring in the project area

  - Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the groundwater monitoring activities

Acronyms and Abbreviations

BTEX	benzene, toluene, ethylbenzene and xylenes
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COCs	constituents of concern
cVOCs	chlorinated volatile organic compounds
CWG	carbureted water gas
DAR	Division of Air Resources
DER	Division of Environmental Remediation
DNAPL	dense non-aqueous phase liquid
DRW	Department of Public Works
DUS/HPO	dynamic underground stripping and hydrous pyrolysis/oxidation
ECL	Environmental Conservation Law
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
FWIA	Fish and Wildlife Impact Analysis
GRA	general response action
HASP	health and safety plan
IHIA	Initial Hazard Investigation and Assessment
IRM	Interim Remedial Measure
ISCO	in-situ chemical oxidation
LDRs	Land Disposal Regulations
LNAPL	light non-aqueous phase liquid
LTTD	low-temperature thermal desorption
MGP	manufactured gas plant
µg/L	micrograms per liter
mg/kg	milligram per kilogram
NAPL	non-aqueous phase liquid

NCP	National Contingency Plan
NYCRR	New York Code of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&R	Orange and Rockland Utilities, Inc.
OSHA	Occupational Safety and Health Administration
PAHs	polycyclic aromatic hydrocarbons
POTW	publicly-owned treatment works
PRB	permeable reactive barrier
PSA	Preliminary Site Assessment
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SCGs	standards, criteria, and guidelines
SCO	soil cleanup objective
SVOCs	semi-volatile organic compounds
TAGM	Technical and Administrative Guidance Memorandum
TCLP	Toxicity Characteristic Leaching Procedure
TOGS	Technical Operation Guidance Series
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
UTSs	Universal Treatment Standards
UV	ultra violet
VOCs	volatile organic compounds

1. Introduction

This *Feasibility Study Report* (FS Report) presents an evaluation of remedial alternatives to address the environmental impacts identified at the Orange and Rockland Utilities, Inc. (O&R) Suffern former manufactured gas plant (MGP) site located in Suffern, New York. This FS Report has been prepared by ARCADIS of New York, Inc. (ARCADIS) on behalf of O&R in accordance with the Order on Consent Index #D3-0001-98-03 between O&R and the New York State Department of Environmental Conservation (NYSDEC).

1.1 Regulatory Framework

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

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

1.2 Purpose

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

- Appropriate for site-specific conditions
- Protective of public health and the environment
- Consistent with relevant sections of NYSDEC guidance, the National Contingency Plan (NCP), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

The overall objective of this FS Report is to recommend a reliable remedy that achieves the remedial action objectives (RAOs) established for the site and best balances the evaluation criteria.

1.3 Report Organization

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

Table 1.1 Report Organization

Section	Purpose
Section 1 – Introduction	Provides background information relevant to the development of remedial alternatives evaluated in this FS Report.
Section 2 – Identification of Standards, Criteria, and Guidelines	Identifies standards, criteria, and guidelines (SCGs) that govern the development and selection of remedial alternatives.
Section 3 – Development of Remedial Action Objectives	Presents a summary of the risk assessment and develops site-specific RAOs that are protective of public health and the environment.
Section 4 – Technology Screening and Development of Remedial Alternatives	Presents the results of a screening process to identify potentially applicable remedial technologies and assembles remedial alternatives that have the potential to meet the RAOs.
Section 5 – Detailed Evaluation of Remedial Alternatives	Presents a detailed description and analysis of each potential remedial alternative using the evaluation criteria presented in the referenced guidance documents.
Section 6 – Comparative Analysis of Alternatives	Presents a comparative analysis of each remedial alternative using the evaluation criteria.
Section 7 – Preferred Remedial Alternative	Identifies the preferred remedial alternative for addressing the environmental concerns.
Section 8 – References	Provides a list of references utilized to prepare this FS Report.

1.4 Background Information

This section summarizes background information relevant to the development and evaluation of remedial alternatives, including site location and physical setting, history and operation, and previous investigations conducted at the site.

1.4.1 Site Location and Physical Setting

The former MGP site is located on Pat Malone Drive in an urban area of the Village of Suffern, New York (Figure 1). For the purposes of this FS Report, the former MGP site is defined by the former MGP area, including the eastern gas holder and MGP building (as identified on Figure 2) and the western gas holder. Off-site areas consist of the State of New Jersey property and the O&R former propane plant property (i.e., current gate station). The former MGP site and off-site areas are collectively referred to herein as the "project area". As reported in the October 2010 *Remedial Investigation Report* (RI Report) prepared by Geotechnical Engineers, Inc. (GEI) (GEI, 2010), the project area and adjacent properties are located in an area zoned for manufacturing (M) land use. In general, the project area is bordered by the following:

- interstate highway 87 (I-87) to the north
- a Village of Suffern right-of-way area along Pat Malone Drive, a parking lot (used by commuters for the New Jersey Transit railroad), and recreational areas (i.e., baseball fields) to the south
- an active New Jersey Transit railroad right-of-way to the east
- Village of Suffern well field and the Bunker Hill Processing Area (materials such as yard and wood waste from the Village of Suffern are transported to this area for shredding, chipping and staging) is located to the immediate west, and the Ramapo River is located further west.

The project area is generally flat, with the exceptions of an abandoned railroad berm located to the west (between the former MGP property and the O&R gate station) and the active railroad located to the east. Portions of the project area currently owned by O&R consist of two parcels separated by the abandoned railroad berm. One of the parcels includes the footprint of the historic MGP operations. A majority of this property is currently vacant with remnants of former building foundations (i.e., concrete slabs). The second O&R owned parcel is used as a natural gas gate station and a natural gas regulator station and includes various buildings and underground piping. In addition, a portion of the project area (i.e., on the State of New Jersey property) is used as a firing range by the Ramapough Sportsmen's Club and the Village of Suffern Police Department. Access to the natural gas gate station and natural gas regulator station is limited to O&R employees. Access to the firing range is limited to members of the shooting club and the police department. The surrounding properties are currently used for recreational and commercial activities.

1.4.2 Project Area History and Operation

The Suffern Gas Company MGP began gas manufacturing operations in approximately in 1902 using the Lowe carbureted water gas (CWG) process. In general, the plant consisted of a former MGP building that included a coal storage room, a boiler room, a generator room and a storage room, as well as, a meter room and a pump house that were attached to the MGP building. Additionally, a 50,000 cubic feet (cf) gas holder (i.e., eastern gas holder), and 7,000 gallon steel oil storage tank were constructed prior to operations. Gas production between 1906 and 1925 ranged between 2.66 and 9.4 million cf per year, averaging approximately 8.1 million cf per year.

By the end of 1925, the MGP plant was rebuilt as a coal gas plant and shortly after (August 1926) the ownership was transferred to the Ramapo Gas Corporation. The coal gas plant operated at the former MGP site from 1925 to 1935. In general, the configuration of the MGP plant remained largely unchanged after it was rebuilt as a coal gas plant. An 8,000 gallon capacity oil storage tank (i.e., Gas Oil House) was added as part of the coal gas plant. The production of manufactured gas increased from 13.7 million cf in 1927 to 81.3 million cf in 1934. During this time, a 150,000 cf telescopic holder (i.e., western gas holder) was added to the plant. In addition, a portion of the Ramapo Gas Corporation was acquired by the General Water, Gas and Electric Company of Philadelphia, Pennsylvania in 1933.

In July 1935, manufactured gas production ceased and manufactured gas was replaced with natural gas, which was supplied by the Home Gas Company, the West Shore Gas Company, and Rockland Gas Company. By the end of 1935, the Ramapo Gas Corporation transferred ownership of the franchise and distribution system to Rockland Gas Company, Inc. Additional known operations at the former MGP site included an electroplating facility during the 1940s and early 1950s, and a bus manufacturing facility that operated at the former MGP site until 2008.

1.4.3 Summary of Previous Investigations

The project area has been subject to several environmental investigations including the following:

- 1987 – Superfund Investigation Suffern Well Field conducted by Environmental Resource Management (ERM).

- 1996 – Initial Hazard Investigation and Assessment (IHIA) conducted by Remediation Technologies, Inc., (RETEC).
- 1997 – Preliminary Site Assessment (PSA) conducted by RETEC.
- 1998-2000 – Remedial Investigation (RI) conducted by GEI.
- 1999-2009 – Groundwater monitoring. Note that quarterly groundwater monitoring is currently conducted at select project area monitoring wells.
- 2001 – Supplemental RI conducted by RETEC.
- 2008 – Due Diligence Evaluation and Interim Remedial Measure (IRM) conducted by ENSR International (ENSR).
- 2009 – RI Addendum Investigation conducted by ENSR.
- 2010 – RI Addendum Investigation conducted by GEI.

Activities and results for the above-listed investigations were presented in the RI Report. The results of these investigations were collectively used to develop the current project area characterization as presented in Section 1.5.

1.5 Project Area Characterization

This section presents an overall characterization of the project area and a summary of the nature and extent of impacted media based on the results obtained during the investigation activities conducted to date (as described in Section 1.4.3). The characterization consists of a summary of geology and hydrogeology and the nature and extent of impacts.

1.5.1 Geology

The overburden strata, in descending order from the ground surface consists of fill; peat; and alluvium underlain by bedrock. The character of these strata is briefly described below:

- Fill – The fill unit is present at the ground surface and is generally 5 feet thick, with a thicker portion (14 feet) located north of the firing range. The fill unit is comprised of a heterogeneous mixture of silt, sand, gravel and cobbles, with varying amounts of ash, coal, coke, bricks, concrete, and metal and glass debris.

- Peat – A peat unit is located in the eastern portion of the project area below the fill and alluvium units at depths ranging from 5 to 7 feet below ground surface (bgs) with a thickness varying from 0.8 to 12 feet.

- Alluvium – The alluvium unit generally lies below the fill unit with a thickness varying from 75 feet (in the eastern portion of the project area) to 134 feet (in the western portion of the project area) and it is encountered at depths ranging from 0 to 19 feet bgs. The alluvium unit is predominantly comprised of a heterogeneous mixture of fine to coarse-grained sand, rounded to sub-rounded gravel, cobbles and boulders and contains trace amounts of silt. The unit is highly permeable and forms an unconfined aquifer.

- Bedrock – The bedrock unit is located beneath the alluvium, at depths ranging between 75 and 135 feet bgs. The bedrock unit is primarily comprised of granitic gneiss of the Byram Formation. The top of the bedrock unit slopes from the east to the west, with an overall change in elevation of 60 feet.

Geologic cross sections previously provided as part of the RI Report are included in Appendix A.

1.5.2 Hydrogeology

Groundwater flow beneath the project area is primarily within the alluvium unit. The unconsolidated alluvial deposits are highly permeable and form an unconfined aquifer. The depth to groundwater beneath the project area ranges from 4 to 25 feet bgs, coinciding with the location of the alluvial unit, but is generally located 10 to 14 feet bgs in the vicinity of the former MGP area and on State of New Jersey property. Groundwater flow direction is generally from the east to the southwest portions of the project area, towards the Ramapo River. Groundwater contour maps previously presented in the RI Report are included in Appendix A. As reported in the RI Report, hydraulic conductivities range from 8.8×10^{-4} to 2.0×10^{-3} centimeters per second (cm/s). and groundwater velocities range from 2.8×10^{-5} cm/s near the former MGP area to 1.12×10^{-3} cm/s near the Ramapo River.

The Village of Suffern water supply well field is located west of the project area. The well field consists of three wells generally screened from 45 to 100 feet bgs and a fourth well screened from 100 to 151 feet bgs. On average, the well field extracts approximately 1.8 million gallons per day.

1.5.3 Nature and Extent of Impacts

MGP byproducts, typically dense non-aqueous phase liquids (DNAPLs) (i.e., coal tar), often accounts for the majority of the impacts at former MGP sites. Principal components of coal tar include benzene, toluene, ethylbenzene, and xlyene (BTEX) compounds, which are volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs), which are semi-volatile organic compounds (SVOCs). Additionally, cyanide was typically removed from manufactured gas as an impurity. Coal tar, BTEX, PAHs and to a lesser degree cyanide have been identified as the constituents of concern (COCs) for the project area. The following subsections present a summary of the nature and extent of MGP-related environmental impacts identified for the project area based on these COCs and the presence of coal tar non-aqueous phase liquid (NAPL).

1.5.3.1 NAPL Distribution and Characterization

NAPLs in the ground beneath the project area, primarily coal tar DNAPL, are responsible for most of the environmental impacts resulting from the former MGP operations. In general, petroleum, coal tar, potentially mobile DNAPL, and light non-aqueous phase liquid (LNAPL) have been observed in overburden materials in five general areas, at depths up to 102 feet bgs in unconsolidated material (with most impacts limited to the top 35 feet, as discussed below). The NAPL-related impacts are generally distributed as follows:

- Eastern Gas Holder – DNAPL-related impacts were observed inside the foundation of the subsurface portion of the eastern gas holder, and in shallow and deep subsurface soils (i.e., near the surface of the bedrock) adjacent to, and beneath the gas holder foundation. Black hydrocarbon staining, sheens, viscous tar and non-viscous black tar were observed in test pits and soil borings inside the gas holder foundation. Coal tar, NAPL-blebs, and hydrocarbon-stained soil were observed in borings adjacent to the foundation (0 to 10 feet bgs). Physical evidence of MGP-related impacts (e.g., DNAPL, sheens, odors) were noted in deep soil samples collected at monitoring well MW38 (98 to 101 feet bgs) and soil borings SSB72 (65 to 66 feet bgs; and 98 to 99 feet bgs), SSB64 (97-101 feet bgs), and SSB73A (86 to 94 feet bgs).

  Based on the presence of NAPL in the bottom of the eastern gas holder foundation, soil borings were not drilled through the foundation floor. Soil boring

SSB73A was drilled at an angle to characterize the soil directly beneath the holder foundation.

Soil samples collected from a depth of 86 to 94 feet bgs at soil boring SSB73A were visually characterized as containing brown NAPL mixed with gravel or sand. Because of the limited soil characterization information available directly below the eastern gas holder foundation, for the purposes of this FS, it is assumed that visually impacted soil (i.e., soil containing NAPL at quantities greater than sheens or blebs) is present directly beneath the holder to a depth of 35 feet bgs.

- Gas Oil House – Coal tar DNAPL was observed in the subsurface foundation of the gas oil house located northeast of the former MGP building at depths up to 13 feet bgs. In addition, trace amounts of a green-colored petroleum-like LNAPL material was observed in shallow soil intervals adjacent to the foundation at depths no greater than 22 feet bgs (i.e., soil boring SSB67 and monitoring well MW8).

- MGP Building – DNAPL-related impacts were observed in subsurface soils located at the western end of the MGP building. DNAPL-coated gravel was observed at depths ranging from 14 to 55 feet bgs (i.e., soil boring SSB74) at the western end of the MGP building.

- Gate Station – Coal tar impacts were observed in the eastern portion of the O&R gate station (former propane plant). The coal tar impacts in this area were observed in 1-foot thick laterally continuous lenses at depths no greater than 5 feet bgs. Coal tar impacts were also observed at equivalent elevations beneath a portion of the abandoned railroad berm at monitoring wells MW30 and MW31 and soil boring SSB43 (i.e., 19 to 24 feet bgs). The impacts consist of hardened tar that is not considered grossly impacted, is not mobile, and is not considered a source for dissolved phase impacts (i.e., the tar is located approximately 3 feet above the water table). An estimated 1,200 cubic-yards (cy) of soil containing hardened tar is located below the railroad berm.

- State of New Jersey Property – Coal tar and DNAPL impacts have been observed in an area north of the former MGP building on the State of New Jersey property. Visual observations of coal tar or DNAPL were observed in 13 of the 27 soil borings completed in this area (i.e., monitoring wells MW32, MW36, and MW37 and soil borings SSB11C, SSB22, SSB23, SSB25, SSB26, SSB29, SSB30, SSB36, SSB37, and SSB63), as well as in 6 of the 14 tests pits excavated in this area (TP7, TP8, TP9A, TP22, TP23, and TP33). In general, impacts in this area are limited to depths no greater than 30 feet bgs. However, DNAPL coated-gravel and/or sheens were observed at a depth of 40 feet bgs at soil boring SSB63 and at 87 feet bgs at monitoring well MW36.

Based on a review of borings logs for soil borings and monitoring wells completed/ installed to date, the project area contains an estimated 26,400 cy of visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg (together referred to as “impacted material” for the purposes of discussing the nature and extent of impacts and proposed remedial alternatives at this site). For the purpose of this report, visually impacted material is considered material that contains NAPL in amounts greater than sheen and blebs.

Approximately 11,500 cy (or 44%) of impacted material is located above the water table (i.e., encountered at depths shallower than 12 to 15 feet bgs). This volume estimate does not include approximately 1,200 cy of soil containing hardened tar located beneath the abandoned railroad berm. An additional estimated 10,900 cy of impacted material is located below the water table at depths up to 35 feet bgs (i.e., 85% of the impacted material is located at depths of 35 feet bgs and shallower).

Approximately 4,000 cy of visually impacted material is located at depths greater than 35 feet bgs. Angled soil boring SSB73A (completed below the eastern gas holder) encountered “NAPL mixed with sand and gravel” from approximately 86 to 94 feet bgs. Assuming these impacts are present at a uniform thickness (which is a conservative assumption), an estimated 3,000 cy of visually impacted material could be located at this deep depth interval beneath the eastern gas holder. The remaining estimated 1,100 cy of visually impacted material (i.e., at depths greater than 35 feet bgs) is sporadically located throughout the project area (i.e., at non-contiguous locations): below the former MPG building at soil boring SSB74 (NAPL mixed with sand and gravel at depths up to 55 feet bgs); west of the gas oil house at soil boring SSB63 (sheens at 40 feet bgs); and on the State of New Jersey property at monitoring well MW36 (gravel coated with NAPL from 80 to 86 feet bgs).

In addition to the aforementioned areas, LNAPL has been observed at one discrete location northwest of the former MGP building on the State of New Jersey property. Trace amounts of LNAPL comprised of a mixture of carbureted water gas tar and fuel oil were observed to accumulate in monitoring well MW20. These LNAPL impacts are not widespread and appear to be confined to the area around this well. DNAPL has not been observed to accumulate in any of the monitoring wells installed at the project area.

1.5.3.2 Soil Quality

The extent of soil containing elevated concentrations of MGP-related COCs has a strong correlation to the observed NAPL distribution across the project area. Soil impacts are distributed primarily in the five areas identified above, with the majority of the impacts located in the top 35 feet of overburden material.

Surface Soil

Surface soil samples were collected from on-site areas, the Village of Suffern Recreational Field property, and background locations in the commercial and residential areas surrounding the project area.

- 13 surface soil samples (0-6 inches bgs) were collected from on-site areas. Seven of these surface soil samples were submitted for laboratory analysis for organic compounds (i.e., VOCs and SVOCs). None of the surface soil samples collected from the former MGP site contained BTEX compounds at concentrations greater than the 6 NYCRR Part 375-6 commercial use soil cleanup objectives (SCOs). Individual PAH compounds were detected in a majority of the surface soil samples at concentrations slightly greater (i.e., generally in the same order of magnitude) than the 6 NYCRR Part 375-6 commercial use SCOs. Total PAH concentrations ranged from 3 to 130 milligrams per kilogram (mg/kg).

- Eight surface soil samples (0-2 inches bgs) were collected from the Village of Suffern recreational field located south of the project area and submitted for laboratory analysis for PAHs. Three of the eight samples contained individual PAH compounds at concentrations greater than the restricted residential use SCOs. The total PAH concentrations ranged from 0.009 to 40 mg/kg. These surface soil samples were not analyzed for BTEX compounds.

- Seven surface soil samples (0-2 inches bgs) were collected at background locations in the Village of Suffern and submitted for laboratory analysis for organic compounds. Five of the seven samples contained individual PAHs at concentrations greater than the commercial use SCOs. The total PAH concentrations for background samples ranged from 2.9 to 89 mg/kg. These surface soil samples were not analyzed for BTEX compounds.

In general, PAH concentrations detected in surface soil samples collected from on-site locations and background areas were greater than those collected from the recreational field south of the project area. These results potentially indicate that the recreational fields were constructed using imported materials. Additionally, PAHs were detected at similar concentrations in surface soil samples collected from both the on-site areas and the background locations. Therefore, the detected PAHs are not necessarily MGP-related (i.e., likely attributed to other anthropogenic sources associated with an urban setting).

Surface sample SS-4 collected adjacent to the western gas holder contained cyanide at a concentration of 288 mg/kg, which exceeds the 6 NYCRR Part 375-6 commercial use SCO (i.e., 27 mg/kg). None of the other surface soil samples contained cyanide at a concentration greater than the 6 NYCRR Part 375-6 SCO.

<u>Subsurface Soil</u>

A total of 186 subsurface samples were collected from soil borings and test pits completed at the project area.

- Only two of the subsurface soil samples contained individual BTEX compounds at concentrations greater than the commercial use SCOs. Total BTEX concentrations ranged from less than 1 mg/kg to 39,000 mg/kg (in soil sample SSB15 (8-10')).

- 47 of the subsurface soil samples contained individual PAH compounds, at concentrations greater than the commercial use SCOs. Total PAH concentrations ranged from less than 1 mg/kg to 65,140 mg/kg (in soil sample SSB15 (8-10')) with a total of 22 of the soil samples containing total PAHs at concentrations greater than 500 mg/kg. Each of the samples containing PAHs at concentrations greater than 500 mg/kg was also visually characterized as containing coal tar NAPL at quantities greater than sheens or blebs.

- A total of nine subsurface soil samples contained cyanide at concentrations exceeding the commercial use SCO of 27 mg/kg (with seven of those samples exceeding the protection of groundwater SCO of 40 mg/kg).

In general, higher concentrations of both BTEX and PAH compounds were detected in soil samples collected from 0 to 35 feet bgs. Additionally, soil samples containing elevated concentrations of COCs were typically collected at locations containing visually impacted soil with quantities of coal tar greater than sheens or blebs (i.e., the eastern gas holder and gas oil house foundations, western end of the MGP building, O&R Gate Station, and the area northeast of the former MGP Building).

1.5.3.3 Groundwater Quality

Similar to the extent of impacted soil, the extent of groundwater affected by the MGP-impacts has a strong correlation to the NAPL distribution across the project area. Dissolved phase BTEX, PAHs, and/or cyanide are present at concentrations greater than the NYSDEC's *Class GA Division of Water, TOGS 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations* (NYSDEC, reissued June 1998 and addended April 2000 and June 2004) in groundwater samples collected downgradient (i.e., west) from the eastern gas holder and gas oil house foundations, western end of the MGP building, O&R Gate Station, and area northeast of the former MGP Building.

For the purpose of this FS Report, the downgradient extent of the dissolved phase MGP-related impacts is defined as the 5 micrograms per liter (µg/L) total PAH concentration contour identified in the RI Report (see Appendix A for RI Report figures). Shallow groundwater (i.e., up to 45 feet bgs) containing total PAHs at concentrations greater than 5 µg/L has been identified at the former MGP property, southern portion of the State of New Jersey property, and minimally within the eastern portion of the O&R gate station. Deep groundwater (i.e., deeper than 45 feet bgs) containing total PAHs at concentrations greater than 5 µg/L is limited to the former MGP property and the State of New Jersey property near the eastern gas holder. As indicated previously, the Village of Suffern public well field draws groundwater from depths greater than 45 feet bgs. Deep groundwater at the O&R gate station (i.e., immediately upgradient of the public well field) does not contain total PAHs at concentrations greater than 5 µg/L.

The greatest concentrations of dissolved phase COCs were observed in the vicinity of the eastern gas holder foundation, and in the eastern portion of the State of New Jersey property.

- Total BTEX concentrations ranged from non-detect to 180 µg/L with the highest concentrations detected in groundwater samples collected from the eastern portion of the State of New Jersey Property (i.e., monitoring well MW32).

- Total PAHs concentrations ranged from non-detect to 2,947 µg/L. Similar to the BTEX results, the highest PAH concentrations were detected in groundwater sampled collected from the eastern portion of the State of New Jersey Property (i.e., monitoring well MW32).

- Cyanide was detected in groundwater samples collected from monitoring wells MW-04, MW-05, MW-08 and MW-09 at concentrations exceeding the Class GA standard of 200 µg/L during initial RI groundwater sampling events conducted during 1999. However, since the June 2007 groundwater monitoring event, only groundwater samples collected from monitoring well MW-09 have contained cyanide exceeding the Class GA standard. Starting in 2007, monitoring wells MW-09 and MW-04 (located hydraulically downgradient of monitoring well MW-09) have been monitored on a quarterly basis. Concentrations of total cyanide at monitoring wells MW-04 and MW-09 have consistently been below the Class GA standard for more than two years.

In addition to the COCs, chlorinated volatile organic compounds (cVOCs) were detected in groundwater samples collected adjacent to and downgradient of a septic tank and septic seepage pit associated with the former US Bus facility. In March 2010, O&R performed an IRM to remove the septic tank, seepage pit, and adjacent soil.

Quarterly or biannual groundwater monitoring has been conducted at the project area since 1999 (and is ongoing) to monitor dissolved phase COC concentrations. Based on the monitoring, dissolved phase groundwater impacts are stable and do not appear to be migrating toward the Village of Suffern well field.

2. Identification of Standards, Criteria, and Guidelines

This FS Report was prepared in general conformance with the applicable guidelines, criteria and considerations set forth DER-10 and 6 NYCRR Part 375 Environmental Remediation Programs. This section presents the SCGs that have been identified for the project area.

2.1 Definition of Standards, Criteria, and Guidelines

"Standards and criteria" are cleanup standards, standards of control and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance.

"Guidance" is non-promulgated criteria, advisories and/or guidance that are not legal requirements and do not have the same status as "standards and criteria;" however, remedial programs should be designed with consideration given to guidance documents that, based on professional judgment, are determined to be applicable to the project (6 NYCRR 375-1.8[f][2][ii]).

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

2.2 Types of Standards, Criteria, and Guidelines

Potential SCGs considered in this FS Report were categorized in the following classifications:

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

- *Action-Specific SCGs* – These SCGs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste management and remediation.

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

2.3 Standards, Criteria, and Guidelines

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

2.3.1 Chemical-Specific SCGs

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

The SCOs presented in 6 NYCRR Part 375-6 are chemical-specific SCGs that are relevant and appropriate to the project area. Specifically, the SCOs for the protection of human health assuming a commercial future site use (commercial use SCOs) are applicable (based on current project area zoning). Additionally, per NYSDEC’s Commissioner’s Policy 51 (CP-51, October 21, 2010), for non-residential use sites (i.e., commercial or industrial use sites), a remedial program that achieves a soil cleanup level of 500 parts per million (ppm) for total PAHs for subsurface soil may also be applicable.

Chemical-specific SCGs that potentially apply to the waste materials generated during remedial activities are the Resource Conservation and Recovery Act (RCRA) and New York State regulations regarding identifying and listing hazardous wastes outlined in 40 Code of Federal Regulations (CFR) 261 and 6 NYCRR Part 371, respectively. Included in these regulations are the regulated levels for the Toxicity Characteristic Leaching

Procedure (TCLP) constituents. The TCLP constituent levels are a set of numerical criteria at which solid waste is considered a hazardous waste by the characteristic of toxicity. In addition, the hazardous characteristics of ignitability, reactivity and corrosivity may also apply, depending upon the results of waste characterization activities.

The NYSDEC has established "contained-in" criteria for environmental media and debris, which are presented in the Technical and Administrative Guidance Memorandum (TAGM) 3028 titled, *"Contained-In Criteria" for Environmental Media; Soil Action Levels* (NYSDEC, 1997) which is consistent with the USEPA's "Contained-in Policy,". TAGM 3028 requires environmental media (soil and groundwater) and debris impacted by a hazardous waste be subject to RCRA hazardous waste management requirements until they no longer contain the hazardous waste.

Groundwater beneath the project area is classified as Class GA and, as such, the New York State Groundwater Quality Standards (6 NYCRR Parts 700-705) and ambient water quality standards presented in the NYSDEC's *Division of Water, TOGS 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations* (NYSDEC, reissued June 1998 and addended April 2000 and June 2004) are potentially applicable. These standards identify acceptable levels of constituents in groundwater based on potable use.

2.3.2 Action-Specific SCGs

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

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

One set of potential action-specific SCGs consists of the land disposal regulations (LDRs), which regulate land disposal of hazardous wastes. LDRs are applicable to alternatives involving the disposal of hazardous waste (if any). Because MGP wastes resulted from historical operations that ended before the passage of RCRA, material containing MGP-related impacts is only considered a hazardous waste in New York if it is removed (generated) and it exhibits a characteristic of a hazardous waste. However, if the impacted material only exhibits the hazardous characteristic of toxicity for benzene (D018), it is conditionally exempt from the hazardous waste management requirements (6 NYCRR Parts 370-374 and 376) when destined for thermal treatment in accordance with the requirements set forth in NYSDEC's TAGM HWR-4061, *Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from Former Manufactured Gas Plants* (DER-4) (NYSDEC, 2002). If MGP-related hazardous wastes are destined for land disposal in New York, the state hazardous waste regulations apply, including LDRs and alternative LDR treatment standards for hazardous waste soil.

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

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

Remedial alternatives conducted within the project area must comply with applicable requirements outlined under the Occupational Safety and Health Administration (OSHA). General industry standards are outlined under OSHA (29 CFR 1910) that specify time-weighted average concentrations for worker exposure to various compounds and training requirements for workers involved with hazardous waste operations. The types of safety equipment and procedures to be followed during remediation are specified under 29 CFR 1926, and record keeping and reporting-related regulations are outlined under 29 CFR 1904.

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

2.3.3 Location-Specific SGS

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

Based on the Federal Emergency Management Agency (FEMA) National Flood Insurance Program Map Number 3606940001B, dated March 28, 1980, the project area is located within the limits of a 100-year floodplain.

Location-specific SCGs also include local requirements, such as local building permit conditions for permanent or semi-permanent facilities constructed during the remedial activities (if any), Village of Suffern Department of Public Works (DPW) street work permits, influent/pre-treatment requirements for discharging water to the Publicly Owned Treatment Works (POTW), Rockland County Stream Control Act Permit, and permits from New Jersey Transit for conducting work within/near the railroad right-of-way.

3. Development of RAOs

This section presents the RAOs for impacted media. These RAOs represent medium-specific goals that are protective of public health and the environment that have been developed through consideration of the results of the investigation activities and with reference to potential SCGs, as well as current and foreseeable future anticipated uses of the project area. RAOs are developed to specify the COCs, and to assist in developing goals for cleanup of COCs in each medium that may require remediation.

3.1 Human Health Exposure Assessment

The human health exposure assessment completed for the RI evaluated the different types of human populations (e.g., resident, workers, recreational visitors, etc.) that may come into contact with impacted media at the project area. The assessment identified potential exposure pathways (e.g., ingestion, inhalation, dermal contact) that may occur for each population to the various media (i.e., soil, groundwater, soil vapor). A summary of the Human Health Exposure Evaluation Assessment is presented in the following table.

Table 3.1 Exposure Assessment Summary

Exposure Group	Exposure Potential			
	Soil Vapor	Surface Soil	Subsurface Soil	Groundwater
On-Site Receptors				
Recreational Users	Low	Low	Low	Low
Utility/Construction Workers	Potential[2]	Potential[1]	Potential[1]	Potential[1]
On-Site Workers	Low	Potential[1]	Low	Low
Outdoor Maint. Workers	Low	Potential[1]	Low	Low
Visitors/Trespassers	Low	Potential[1]	Low	Low
Off-Site Receptors				
Commuters	Low	Low	Low	Low
Recreational Users	Low	Low	Low	Low
Well Field Employees	Low	Low	Low	Low
Bunker Hill Area	Low	Low	Low	Low
NJ Transit Corridor	Low	Low	Low	Low
Public Water Supply	Low	Low	Low	Low

Notes:
1. Dermal contact or ingestion
2. Inhalation

The overall potential for exposure to MGP-related impacts is considered to be low with the potential for exposure to surface soil to most receptor groups. The assessment for the on-site area indicates that subsurface utility or construction workers who may perform subsurface excavation work on the O&R properties, and on portions of the State of NJ property, may contact MGP-related residuals in soil vapor, soil and groundwater. As indicated in Section 1, surface soil is not considered a medium of concern. Although, individual PAHs were detected at concentrations slightly greater than the 6 NYCRR Part 375-6 commercial use SCOs in on-site surface soil samples, PAHs were detected at concentrations that are consistent with those detected in off-site background samples, suggesting that low level PAH concentrations are attributed to other anthropogenic sources associated with an urban setting.

The project area is in close proximity to the Village of Suffern public water supply well field. Based on groundwater data collected since 1999, groundwater containing COCs at concentrations greater than NYSDEC standards and guidance values is limited to the former MGP site, and has not advanced toward the well field area. In the interim period prior to the construction of the remedy, monitoring wells located down gradient of the former MGP site, between the former MGP site and the well field, will continue to be monitored to assess potential dissolved-phase COC concentration trends.

3.2 Fish and Wildlife Impact Analysis

The potential for exposure for an ecological receptor was assessed during the preparation of a Fish and Wildlife Impact Analysis (FWIA). The FWIA indicated that the terrestrial area of the project area is not a high value habitat for wildlife based on the industrial use, and the predominance of ground cover consisting of roadways, gravel driveways, concrete building floors, or asphalt pavement. The Ramapo River is in close proximity to the project area; however, MGP-related impacts in soil and groundwater do not extend to the river area.

3.3 Remedial Action Objectives

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

Table 3.2 Remedial Action Objectives

RAOs for Soil
1. Prevent, to the extent practicable, ingestion/direct contact with soil containing MGP-related COCs and/or DNAPL 2. Prevent, to the extent practicable, inhalation of or exposure to MGP-related COCs volatilizing from MGP-impacted soil 3. Prevent, to the extent practicable, migration of MGP-related COCs and/or DNAPL that could result in impacts to groundwater
RAOs for Groundwater
1. Prevent, to the extent practicable, ingestion of groundwater containing MGP-related COCs at concentrations exceeding NYSDEC groundwater quality standards and guidance values 2. Prevent, to the extent practicable, contact with, or inhalation of volatiles, from groundwater containing MGP-related COCs at concentrations exceeding NYSDEC groundwater quality standards and guidance values 3. Restore groundwater quality to pre-disposal/pre-release conditions, to the extent practicable 4. Address, to the extent practicable, the source of groundwater impacts

Potential remedial alternatives will be evaluated based on their ability to meet the RAOs and be protective of human health and the environment.

4. Technology Screening and Development of Remedial Alternatives

The objective of the technology screening conducted as a part of this FS Report is to present general response actions (GRAs) and associated remedial technology types and technology process options that have documented success at achieving similar RAOs at MGP sites, and to identify options that are implementable and potentially effective at addressing site-specific concerns. Based on this screening, remedial technology types and technology process options were eliminated or retained and subsequently combined into potential remedial alternatives for more detailed evaluation. This approach is also consistent with the screening and selection process provided in DER-10.

This section identifies potential remedial alternatives to address impacted media. As an initial step, GRAs potentially capable of addressing impacted media were identified. GRAs are medium-specific and may include various non-technology specific actions such as treatment, containment, institutional controls, and excavation, or any combination of such actions. Based on the GRAs, potential remedial technology types and process options were identified and screened to determine the technology types and associated technology process options that were the most appropriate. Technology types/process options that were retained through the screening were used to develop potential remedial alternatives. Detailed evaluations of these assembled remedial alternatives are presented in Section 5.

According to DER-10, the term “technology type” refers to a general category of technologies appropriate to the site-specific conditions and impacts, such as chemical treatment, immobilization, biodegradation, capping. The term “technology process option” refers to a specific process within a technology type. For each GRA identified, a number of technology types and associated technology process options were identified. In accordance with the DER-10 guidance document, each remedial technology type and associated technology process options are briefly described and screened, on a medium-specific basis, to identify those that are technically implementable and potentially effective given site-specific conditions. This approach was used to determine if the application of a particular remedial technology type and technology process option is applicable given site-specific conditions for remediation of the impacted media.

4.1 General Response Actions

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

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

4.2 Identification of Remedial Technologies

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

- *Technical Guidance for Site Investigation and Remediation* (DER-10) (NYSDEC, 2010)

- *Presumptive/Proven Remedial Technologies for New York States Remedial Programs* (DER-15) (NYSDEC, 2007)

- “Management of Manufactured Gas Plant Sites” (Gas Research Institute [GRI], 1996)

- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988)

Section 4.3(a)(3)(iv) of DER-10 indicates that GRAs should be established such that they give preference to presumptive remedies. Although each former MGP site offers its own unique site characteristics, the evaluation of remedial technology types and process options that are applicable to MGP-related impacts, or have been implemented at other MGP sites, is well documented. Therefore, this collective knowledge and experience, and regulatory acceptance of previous feasibility studies performed on MGP-related sites with similar impacts, were used to reduce the universe of potentially applicable process options to those with documented success in achieving similar RAOs.

4.3 Remedial Technology Screening Criteria

Potentially applicable remedial technology types and technology process options were identified for each of the GRAs, and were screened on a medium-specific basis to retain the technology types and process options that could be implemented and would potentially be effective at achieving the site-specific RAOs. Screening was conducted to identify potential technologies and technology processes to address soil and groundwater.

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

- *Implementability* – This criterion evaluates the ability to construct and reliably operate the technology process option, as well as the availability of specific equipment and technical specialists to design, install, and operate and maintain the remedy.

- *Effectiveness* – This criterion is focused on the process option's ability to meet the site-specific RAOs, either as single technology or when used in combination with other technologies.

4.4 Remedial Technology Screening

The objective of this FS was to briefly present GRAs and associated technology types; however, quickly focus on the process options/remedial technologies that have documented success at achieving similar RAOs at former MGP sites. The identified remedial technologies for addressing impacted soil and groundwater are presented in the following subsections and in Tables 4 and 5, respectively.

As required by DER-10, the "No Action" technology has been included and retained through the screening evaluation. The "No Action" GRA will serve as a baseline for evaluating the potential overall effectiveness of the other technologies.

4.4.1 Soil

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

No Action

No action would be completed to address impacted soil. The “No Action” alternative is readily implementable and was retained to serve as a baseline against which other alternatives will be compared.

Institutional Controls

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

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

In-Situ Containment/Control

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

None of the capping technology process options were retained for further evaluation. While each of these technology process options is readily implementable, construction of a cap would not provide any significant reduction to potential future exposures to impacts.

In-Situ Treatment

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

- solidification (immobilization)
- dynamic underground stripping and hydrous pyrolysis/oxidation (DUS/HPO) (extraction/in-situ stripping)
- chemical oxidation and surfactant/co-solvent flushing (chemical treatment)
- biodegradation, enhanced biodegradation, and biosparging (biological treatment)

Solidification was retained for further evaluation as this technology process option is an effective means to reduce the mobility of MGP-related COCs, eliminate free liquids, and reduce the hydraulic conductivity of NAPL-impacted soil. The presence of subsurface obstructions (i.e., former MGP structures and utilities) could potentially limit the implementability of soil solidification of soil. In addition, as NAPL-impacted soil is located at depths up to 100 feet bgs, it is not technically practicable to address all impacted soil.

Based on the results of the screening, DUS/HPO, chemical oxidation, surfactant/cosolvent flushing, biodegradation, enhanced biodegradation, and biosparging were not retained for further evaluation due to general ineffectiveness at addressing NAPL-impacted soil. Additionally, each of these processes would require long-term operation and monitoring due to the nature of impacts and technology process options that require chemical injection near a public well field would likely have a strong negative public reaction.

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

Pilot studies conducted at other former MGP sites have shown that in-situ chemical oxidation (ISCO) (including surfactant/co-solvent flushing) is only partially effective in the treatment of NAPL-impacted soil. ISCO has been shown to be effective at treating the dissolved phase impacts associated with the NAPL, but does not effectively treat soil containing NAPL. Multiple applications with large quantities of highly reactive oxidants would be required due to the nature of impacts. Based on the ineffectiveness in addressing impacted soil, oxidant would need to be administrated over the long-term. Additionally, injection of an oxidant or solvents into the subsurface in close proximity to the Village of Suffern well field could impact the public water supply.

<u>Removal</u>

Remedial technology types associated with this GRA consist of measures to recover impacted soil/NAPL from the ground. The remedial technology types evaluated under this GRA consist of excavation and NAPL removal. Technology process options screened under these remedial technology types include:

- excavation
- active removal, passive removal, and hot water/steam injection (NAPL Removal).

Excavation is a proven technology to address impacted material and would achieve several RAOs. When combined with proper handling of the excavated material, this technology process would be effective at minimizing potential risks to current and future site workers and residents. Excavation could be implemented (i.e., equipment and contractors needed to complete soil removal are readily available); however, complete soil removal (i.e., to depths up to 100 feet bgs) may not be technically practicable.

None of the NAPL removal-related processes options were retained through the technology screening. NAPL has not been observed migrating laterally and has not accumulated in any project area wells to date. In addition, hot water/steam injection may facilitate uncontrolled migration of NAPL.

Ex-Situ On-Site Treatment and/or Disposal

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

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

Due to the current and anticipated future uses of the project area and the surrounding areas (i.e., mixed commercial/recreational/residential setting), none of the ex-situ on-site treatment and/or disposal technology types and associated technology process options are considered practicable, technically implementable, or administratively feasible given lack of available space, public acceptance, and potential for exposures during on-site treatment/disposal. None of these process options were retained for further evaluation.

Off-Site Treatment and/or Disposal

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

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

LTTD and off-site disposal at a solid waste landfill were retained for further evaluation. Disposal at an off-site solid waste landfill would be reserved for material that is not suitable for on-site reuse as subsurface fill and that is not appropriate for treatment via LTTD (e.g., concrete, debris). While each of these process options were retained, the final off-site treatment or disposal of waste materials will be evaluated as part of the remedial design for the selected remedy. This will allow for an evaluation of the costs associated with these potential off-site treatment/disposal processes, which can fluctuate significantly based on season, market conditions, and treatment/disposal facility capacity. In addition, multiple off-site treatment technologies could be utilized to treat or dispose of media with different concentrations of COCs. However, for the purpose of preparing this FS Report, LTTD and solid waste landfill are assumed as the off-site treatment/disposal technology process options for hazardous (D018) and non-hazardous materials (respectively) that may be generated during remedial construction.

The asphalt concrete batch plant, brick/concrete manufacturer and co-burn in utility boiler technology processes are not considered implementable. The number of facilities capable of implementing these process and demand for raw materials are limited. Excavated material would require significant processing (e.g., handling, dewatering, and screening) based on the nature of subsurface material. Incineration and Subtitle C landfill technology processes were not retained through the technology screening. The relative cost for incineration is high and although incineration would be an effective means for treating soil containing MGP-related impacts, LTTD is equally effective for treating impacted soil at a lower cost. Disposal at a Subtitle C landfill was not retained as material that is characteristically hazardous would still require pre-treatment to meet New York State Universal Treatment Standards (UTSs)/LDRs prior to disposal.

4.4.2 Groundwater

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

No Action

No action would be completed to address impacted groundwater. The “No Action” alternative is readily implementable and was retained to serve as a baseline against which other alternatives will be compared.

Institutional Controls

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

In-Situ Containment/Control

Remedial technology types associated with this GRA involve addressing impacted groundwater without removal or treatment. The remedial technology type evaluated under this GRA consisted of containment. Technology process options screened under this remedial technology type consisted of sheet pile walls and slurry walls. Based on the presence of subsurface utilities, the absence of a confining unit and the depth to bedrock (i.e., greater than 100 feet bgs), containment options would not be effective at preventing groundwater flow to and from areas containing MGP-related impacts. Therefore, none of the containment process options were retained.

In-Situ Treatment

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

- Groundwater monitoring, enhanced biodegradation, and biosparging (biological treatment)
- Chemical oxidation and permeable reactive barrier (PRB) (chemical treatment)

- Dynamic Underground Stripping and hydrous Pyrolysis/Oxidation (DUS/HPO) (Extraction)

Although groundwater monitoring single-handedly, without source removal, will likely not achieve groundwater RAOs, this technology process was retained as a measure to monitor and document groundwater conditions over time based on implementability. Enhanced biodegradation, biosparging and PRB were all retained as they could be used as a contingency measure to address the leading edge of the dissolved phase plume if the leading edge of the plume is observed to be advancing toward the Village of Suffern well field.

Chemical oxidation and DUS/HPO were not retained as these processes would not be an effective means for treating NAPL (i.e., the source for dissolved phase impacts) or would result in NAPL and/or dissolved plume migration, respectively. Additionally, without a means to address the source for dissolved phase impacts (i.e., NAPL-impacted soil), ongoing treatment of dissolved phase COCs in groundwater (i.e., chemical oxidation and DUS/HPO) would not be a cost-effective means for addressing impacted groundwater over the long-term. As indicated previously, injection of an oxidant or solvents into the subsurface in close proximity to the Village of Suffern well field could impact the public water supply.

Removal

Remedial technology types associated with this GRA consider removal of groundwater containing MGP-related impacts for treatment and/or disposal. The remedial technology type evaluated under this GRA consisted of hydraulic control. Technology process options screened under this remedial technology type included vertical extraction wells and horizontal extraction wells.

In general, hydraulic control, by means of vertical or horizontal extraction wells would generate water that would require treatment over long periods of time. Equipment and tools necessary to install and operate vertical extraction wells are readily available. However, large volumes of water would likely be generated to overcome the hydraulic influence of the nearby public well field. Therefore, extraction wells were not retained for further evaluation.

Ex-Situ On-Site Treatment

Remedial technology types associated with this GRA consider the on-site treatment of extracted impacted groundwater. The remedial technology types evaluated under this GRA consisted of chemical treatment and physical treatment. Technology process options screened under these remedial technology types included:

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

As indicated above, no groundwater extraction technology process options were retained through the technology screening. Therefore, ex-situ on-site treatment technology process options will not be required. Additionally, similar to the ex-situ on-site soil treatment technologies, due to the current and anticipated future uses of the project area and the surrounding areas (i.e., mixed commercial/recreational/residential setting), none of the ex-situ on-site groundwater treatment technology process options are considered practicable given the potential for long-term exposures as a result of the construction and operation of an on-site water treatment system. Note, although not retained, ex-situ on-site treatment technology process options may be used in support of other remedial technology processes (i.e., treatment of groundwater removed during excavation activities).

Off-Site Treatment/Disposal

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

As indicated above, groundwater extraction processes are not considered effective or readily implementable and therefore, were not retained. Potential side-wide remedial alternatives will not require an ongoing discharge/disposal of treated/untreated groundwater removed from the subsurface.

4.5 Summary of Retained Technologies

As indicated previously, results of the remedial technology screening process for soil and groundwater are presented in Tables 4 and 5, respectively. Remedial technologies retained for soil and groundwater are summarized in the following tables.

Table 4.1 Retained Soil Technologies

GRA	Technology Type	Technology Process Option
No Action	No Action	No Action
Institutional Controls	Institutional Controls	Deed restrictions, environmental land use restrictions, enforcement and permit controls, informational devices
In-Situ Treatment	Immobilization	Solidification
Removal	Excavation	Excavation
Off-Site Treatment/Disposal	Extraction Off-Site Disposal	LTTD Solid waste landfill

Table 4.2 Retained Groundwater Technologies

GRA	Technology Type	Technology Process Option
No Action	No Action	No Action
Institutional Controls	Institutional controls	Deed restrictions, environmental land use restrictions, enforcement and permit controls, informational devices
In-Situ Treatment	Biological Treatment Chemical Treatment	Groundwater monitoring, enhanced biodegradation, and biosparging PRB

4.6 Assembly of Remedial Alternatives

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

- The “No-Action” alternative
- An alternative that would restore the project area to pre-disposal conditions

Additional alternatives were developed based on the current, intended and reasonably anticipated future use of the project area, as well as removal of visually impacted soil and soil containing COCs at concentrations above applicable future use guidance values (i.e., commercial use; the 500 mg/mg total PAH provision for non-residential sites under NYSDEC’s CP-51 and unrestricted use).

For the purposes of the FS, based on the site characterization and the intended future site use, the term “impacted material” refers to material containing visual impacts (i.e., coal tar) at amounts greater than sheen or blebs and/or total PAHs at concentrations greater than 500 mg/kg.

These remedial considerations require varying levels of remediation but provide protection of public health and the environment by preventing or minimizing exposure to the COCs through the use of institutional controls; removing COCs to the extent possible thereby minimizing the need for long-term management; and treating COCs, but vary in the degree of treatment employed and long-term management needed.

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

4.6.1 Alternative 1 – No Action

No remedial activities would be completed to address MGP-related impacts to project area soil and/or groundwater. The “No Action” alternative serves as the baseline for comparison of the overall effectiveness of the other remedial alternatives.

4.6.2 Alternative 2 – Excavation of MGP Structures

Under this alternative, shallow MGP-related impacts/sources areas would be addressed through removal. Alternative 2 would include excavation of former MGP structures (i.e., the gas oil house [i.e., 10 feet bgs] and the eastern gas holder [i.e., 6 feet bgs]), structure contents, and visually impacted soil immediately surrounding the structures. Additionally, the shallow hardened tar located west of the abandoned railroad berm would also be excavated (i.e., up to 5 feet bgs).

Alternative 2 would also include conducting periodic groundwater monitoring to document the extent of dissolved phase impacts and potential trends in COC concentrations. Institutional controls (i.e., deed restrictions) and/or an SMP would be established to limit the future development and use of the former MGP site, as well as limit the permissible invasive (i.e., subsurface) activities at the former MGP site. An SMP (described below) would describe the protocols and requirements for conducting invasive activities in off-site areas. An annual report would be submitted to NYSDEC to document that institutional controls are maintained and remain effective.

This alternative would include preparation of an SMP to document the following:

- The institutional controls that have been established and will be maintained for the former MGP property
- The nature and extent of impacts that would remain in the project area following implementation of the remedial alternative
- Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities in the project area and managing potentially impacted material encountered during these activities (including material located beneath the abandoned railroad berm)
- Protocols and requirements for conducting groundwater monitoring in the project area
- Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the groundwater monitoring activities.

Although historic groundwater data (i.e., collected since 1999) indicates that the dissolved phase groundwater impacts are stable and are not advancing toward or impacting the well field, Alternative 2 includes a groundwater contingency that could be implemented if the results of successive monitoring events indicate that dissolved phase COC concentrations are trending upward or if the leading edge of the dissolved phase plume is advancing toward the Village of Suffern well field. Any plan to actively address groundwater will be discussed with and reviewed by NYSDEC prior to implementation.

Prior to implementing the groundwater contingency measure, a pre-design investigation (PDI) and pilot testing would be required to identify the optimal groundwater remedy and to provide necessary information to support the design of the system. Potential groundwater remedies could include, but are not limited to, a biosparging system or PRB that would likely be installed on the O&R gate station property (i.e., at the leading edged of dissolved phase plume). For the purpose of developing the alternative, it has been assumed that the biosparging system would consist of biosparging wells that would be used supply air (or oxygen) to the saturated zone to promote the biodegradation of dissolved phase COCs.

4.6.3 Alternative 3 – Excavation of Visually Impacted Soil up to the Groundwater Table

Alternative 3 would include the same former MGP structure removal, shallow hardened tar excavation, periodic groundwater monitoring, institutional control, and groundwater contingency (i.e., biosparging system) components as Alternative 2. Additionally, Alternative 3 would include excavation of visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg located above the water table throughout the project area. Excavation activities would be completed to depths ranging from 12 to 15 feet bgs at the gas oil house, eastern gas holder, near monitoring well MW20, and on the State of New Jersey property.

4.6.4 Alternative 4 – Excavation and ISS

Alternative 4 would include the same former MGP structure removal, shallow hardened tar excavation, periodic groundwater monitoring, institutional control components, and groundwater contingency (i.e., biosparging system) as Alternatives 2 and 3. Under Alternative 4, excavation and ISS would be utilized to address visually impacted soil at depths up to 35 feet bgs. In addition to the MGP structure removal, each of the ISS treatment areas would be pre-excavated to an approximate depth of 5 to 10 feet bgs to remove physical obstructions. ISS treatment would be conducted using auger mixing and/or bucket mixing methods to solidify impacted soil. To be conservative, soil immediately below the eastern gas holder foundation is assumed to be visually impacted to a depth of at least 35 feet bgs.

4.6.5 Alternative 5 – Excavation to Unrestricted Use SCOs

Alternative 5 would include excavation of soil containing MGP-related COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs (including all visually-impacted soils) to depths up to 102 feet below grade (i.e., to the top of bedrock). Because a vast majority of MGP-related impacts would be removed from the project area, Alternative 5 would not include the institutional control components included under Alternatives 2, 3, and 4. Alternative 5 would include short-term (e.g., up to two years) groundwater monitoring to confirm that groundwater standards and guidance values are achieved.

5. Detailed Evaluation of Remedial Alternatives

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

5.1 Description of Evaluation Criteria

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

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

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

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

5.1.1 Short-Term Impacts and Effectiveness

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

- Potential short-term adverse impacts and nuisances to which the public and environment may be exposed during implementation of the alternative.
- Potential impacts to workers during implementation of the remedial actions and the effectiveness and reliability of protective measures.
- Amount of time required to implement the remedy and the time until the remedial objectives are achieved.
- The sustainability and use of green remediation practices utilized during implementation of the remedy.

5.1.2 Long-Term Effectiveness and Permanence

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

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

5.1.3 Land Use

This criterion evaluates the current and intended future land use of the project area relative to the cleanup objectives of the remedial alternative when unrestricted use cleanup levels would not be achieved. This evaluation considers local zoning laws, proximity to residential property, accessibility to infrastructure, and proximity to natural resources including groundwater drinking supplies.

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

This evaluation criterion addresses the degree to which the remedial alternative will permanently reduce the toxicity, mobility, or volume of the constituents present in the media through treatment.

5.1.5 Implementability

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

- *Technical Feasibility* – This factor considers the remedial alternative's constructability, as well as the ability to monitor the effectiveness of the remedial alternative.

- *Administrative Feasibility* – This factor refers to the availability of necessary personnel and material along with potential difficulties in obtaining approvals for long-term operation of treatment systems, access agreements for construction, and acquiring necessary approvals and permits for remedial construction.

5.1.6 Compliance with SCGs

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

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

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

5.1.7 Overall Protectiveness of Public Health and the Environment

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

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

5.1.8 Cost Effectiveness

This criterion evaluates the overall cost of the alternative relative to the effectiveness of the alternative (i.e., cost compared to long-term effectiveness and permanence, short-term impacts and effectiveness, and reduction of toxicity, mobility, and volume through treatment).

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

5.2 Detailed Evaluation of Remedial Alternatives

This section presents the detailed analysis of each of the alternatives previously identified in Section 4.

- Alternative 1 – No Action
- Alternative 2 – Excavation of MGP Structures
- Alternative 3 – Excavation of Impacted Soil up to the Water Table

- Alternative 4 – Excavation and ISS
- Alternative 5 – Excavation to Unrestricted Use SCOs

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

5.2.1 Alternative 1 – No Action

The "No Action" alternative was retained for evaluation for each of the environmental media to be addressed as required by DER-10. The "No Action" alternative serves as the baseline for comparison of the overall effectiveness of the other remedial alternatives. The "No Action" alternative would not involve implementation of any remedial activities to address MGP-related impacts. The project area would be allowed to remain in its current condition and no effort would be made to change or monitor the current project area conditions.

Short-Term Impacts and Effectiveness – Alternative 1

No remedial actions would be implemented to address impacted environmental media. Therefore, there would be no short-term environmental impacts, nor risks associated with remedial activities would be posed to the community.

Long-Term Effectiveness and Permanence – Alternative 1

Under the "No Action" alternative, the COCs in media or the potential for on-going releases and/or migration of impacts would not be addressed. As a result, this alternative is not considered effective on a long-term basis.

Land Use – Alternative 1

The current zoning for the project area is listed as manufacturing. Areas immediately surrounding the project area are zoned for commercial and recreational use. The current and foreseeable future use of the area surrounding the project area is mixed commercial/recreational. Portions of project area will continue to be used by O&R as natural gas gate and regulator stations. A portion of the State of New Jersey property is used as a firing range. The Village of Suffern well field (i.e., a source for local drinking water) is located immediately west of the project area.

No remedial actions would be completed under this alternative and the project area would remain in its current condition. As routine activities conducted within the project area do not include exposure to MGP-related impacts in soil and groundwater, the "No Action" alternative would not alter the anticipated future intended use of the project area.

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

Under the "No Action" alternative, environmental media would not be treated (other than by natural processes), recycled, or destroyed. Therefore, the toxicity, mobility, and volume of environmental media containing MGP-related impacts would not be reduced.

Implementability – Alternative 1

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

Compliance with SCGs – Alternative 1

- *Chemical-Specific SCGs*: Because removal or treatment is not included as part of this alternative, the chemical-specific SCGs would not be met by this alternative.

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

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

Overall Protection of Public Health and the Environment – Alternative 1

The "No Action" alternative does not address the toxicity, mobility, or volume of impacted environmental media and is not effective on a long-term basis for eliminating potential migration or potential exposure to impacts. Therefore, the "No Action" alternative would not be protective of human health and the environment and would not meet the RAOs.

Cost Effectiveness – Alternative 1

The “No Action” alternative does not involve implementation of any active remedial activities or monitoring conditions; therefore, there are no costs associated with this alternative.

5.2.2 Alternative 2 – Excavation of MGP Structures

The major components of Alternative 2 include the following:

- Removal of the gas oil house structure
- Removal of the eastern gas holder
- Removal of shallow hardened tar west of the abandoned railroad berm
- Conducting long-term groundwater monitoring
- Establishing institutional controls
- Developing a site management plan (SMP)
- Provisions for groundwater treatment contingency

This alternative would consist of removing former MGP structures and visually impacted soil within and immediately surrounding the structures. The excavation limits associated with Alternative 2 are shown on Figure 4. As part of Alternative 2, former MGP structures, structure contents, and visually impacted soil immediately surrounding the structures would be removed. Excavation activities would be conducted to a depth of 10 feet bgs at the gas oil house and to 6 feet bgs at the eastern gas holder (i.e., to remove the foundation of the structures). Additionally, shallow hardened tar located west of the abandoned railroad berm would also be excavated (i.e., up to 5 feet bgs). Coal tar impacts (i.e., hardened tar) observed at similar elevations beneath the abandoned railroad berm at monitoring wells MW30 and MW31 and soil boring SSB43 (i.e., 19 to 24 feet bgs) would not be removed, as the material is not grossly impacted, acting as a source for potentially mobile NAPL (i.e., the tar is located above the water table), or serving as a direct exposure pathway to people (i.e., the material is located 19 to 24 feet below the top of the berm). In addition, excavation of the hardened tar material would require removing and handling approximately 5,700 cy of berm material and reconstruction of the berm, with no additional benefit relative to the protection of human health and the environment. O&R would evaluate addressing additional hardened tar located beneath the railroad berm if future redevelopment activities included removal of the berm.

Alternative 2 would include the excavation of approximately 5,100 cy of material (including 2,600 cy west of the abandoned railroad berm and 2,500 cy on the former MGP property) to address approximately 4,000 cy of visually impacted soil. Based on the anticipated excavation limits of this alternative, subsurface utilities (i.e., water lines, gas lines) would be protected and/or relocated during excavation activities. It is anticipated that an excavation enclosure (e.g., sprung-type structure) equipped with a vapor collection and treatment system would be constructed over the proposed excavation areas to reduce the potential for off-site migration of and exposures to vapors and odors during excavation activities. Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. Based on the proposed extent/depth of excavation activities, excavation support systems may be required for the excavation activities. The final excavation plan would be developed as part of a remedial design.

Excavation areas would be restored with imported clean backfill material to match the previously existing lines and grades. A demarcation layer (e.g., geotextile fabric) would be placed within excavation bottoms. At a minimum, the top one foot of surface cover would meet the allowable constituent levels for imported fill or soil for commercial use (as presented in DER-10) or the surfaces would be restored with gravel or asphalt pavement. Surface restoration details would be developed as part of the remedial design for this alternative.

As indicated in Section 1, groundwater contains BTEX and PAHs at concentrations greater than NYSDEC Class GA groundwater standards and guidance values. This alternative would also include conducting periodic groundwater monitoring to evaluate project area groundwater conditions (i.e., confirm that dissolved phase impacts have not migrated to the Village of Suffern well field). For the purpose of developing a cost, consistent with the current groundwater monitoring program conducted at the project area, it has been assumed quarterly groundwater monitoring would be conducted for the first five years following remedial construction and annual monitoring would be conducted for the following 25 years. Groundwater monitoring activities would include collecting groundwater samples from the existing groundwater monitoring well network at the project area. The specific wells to be sampled would be determined during the remedial design for this alternative. Groundwater samples would be submitted for laboratory analysis for BTEX and PAHs. Analytical results would be used to document the extent of dissolved phase impacts and potential trends in COC concentrations. The results of the groundwater monitoring would be presented to NYSDEC in an annual report. Based on the results of the monitoring activities, O&R may request to modify the quantity of wells sampled or the frequency of sampling events.

Alternative 2 would also include establishing institutional controls for the former MGP site in the form of deed restrictions and/or environmental easements to control intrusive (i.e., subsurface) activities that could result in potential exposures to subsurface soil and groundwater containing COCs at concentrations greater than applicable standards and guidance values. Additionally, an SMP (described below) would be prepared to describe the protocols and requirements for conducting invasive activities in off-site areas. An annual report would be submitted to NYSDEC to document that institutional controls are maintained and remain effective.

This alternative would include preparation of an SMP to document the following:

- The institutional controls that have been established and will be maintained for the former MGP property
- Nature and extent of impacts that would remain in the project area following implementation of the remedial alternative
- Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities in the project area and managing potentially impacted material encountered during these activities (including material located beneath the abandoned railroad berm)
- Protocols and requirements for conducting groundwater monitoring in the project area
- Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the groundwater monitoring activities

Alternative 2 includes a groundwater contingency provision that could be implemented to serve as a protective measure for the Village of Suffern well field. A groundwater monitoring program would be implemented following remedial construction. If the results of successive monitoring events indicate that dissolved phase COC concentrations are trending upward or if the leading edge of the dissolved phase plume is advancing toward the Village of Suffern well field, O&R will formulate a plan of action to implement the groundwater contingency. Any plan to actively address groundwater will be discussed with and reviewed by NYSDEC prior to implementation.

If based on the results of the periodic monitoring, an active groundwater remedial alternative was required, a PDI and pilot testing would be required to identify the optimal groundwater remedy. Potential groundwater remedies would include, but are not limited to, a biosparging system or PRB that would likely be installed on the O&R gate station property (i.e., at the leading edge of dissolved phase plume). As the exact groundwater remedy cannot be determined prior to completion of a PDI and pilot test program, for the purpose of developing a cost estimate, it has been assumed that groundwater contingency would consist of a biosparging system.

Biosparging is an in-situ remedial technology that utilizes microorganisms already present in the subsurface to biodegrade dissolved phase COCs. Air (or oxygen) is injected into the saturated zone to promote the biodegradation process. For the purpose of developing a cost estimate, it is assumed that the biosparging system would consist of 16 biosparging wells installed in two rows, placed 30 to 40 feet on-center along the leading edge of the dissolved phase plume. The wells could consist of PVC raisers and well screens installed at various depth intervals within the saturated zone. The wells would be equipped with vaults with traffic-grade covers. Pumps and control panels would be housed within a central shed and tubing/piping would be installed from the shed to the wells to deliver oxygen/air to the subsurface.

Consistent with the periodic groundwater monitoring activities included as part of the alternative, the biosparging system would operate for an assumed 30-year period. Any periodic groundwater monitoring, institutional controls or SMP components associated with the biosparging system would be covered by the respective components described under this alternative.

<u>Short-Term Impacts and Effectiveness – Alternative 2</u>

Implementation of this alternative could result in short-term exposure of the surrounding community and workers to COCs as a result of excavation, material handling, and off-site transportation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL, impacted soil, and/or groundwater and inhalation of volatile organic vapors or dust containing COCs during remedial construction. Additionally, potential short-term exposures to impacted groundwater could occur during installation of biosparging wells at the leading edge of the dissolved phase plume. Potential exposure mechanisms would include ingestion of or dermal contact with impacted groundwater and/or inhalation of volatile organic compounds. Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and personal protective equipment (PPE), as specified in a site-specific health and safety plan (HASP) that would be developed as part of the remedial design.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the project area and delivery of fill materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices. Community access to the project area would be restricted and the excavation enclosure would minimize the potential for exposure.

Off-site transportation of excavated material and importation of clean fill materials would result in approximately 600 truck round trips (assuming 25 tons per truck). Based on a review of local roadways, due to low bridge clearances on Chestnut Avenue (i.e., 11 feet), vehicles transporting excavated material off-site for treatment/disposal and importing clean fill materials would have to access the project area via Ramapo Avenue, which is located in a residential setting. Remedial construction activities could be conducted during cooler months to minimize disruption to the community (i.e., caused by the heavy amounts of truck traffic near the recreational fields and through residential areas). Alternative 2 does not employ green remediation practices and the relative carbon footprint (as compared to the other alternatives) is considered moderate.

Soil excavation and backfilling activities could be completed in approximately 4 months and groundwater monitoring would be conducted over an assumed 30-year period. If necessary, following completion of a PDI and pilot test, the biosparging system (or other groundwater contingency remedial technology) would require approximately 1 month to install and the system would operate for an assumed 30-year period.

<u>Long-Term Effectiveness and Permanence – Alternative 2</u>

Under Alternative 2, former MGP structures on the former MGP property and shallow hardened tar west of the abandoned railroad berm would be excavated and transported off-site for treatment/disposal. Although shallow MGP-related impacts/ sources areas would be addressed, visually impacted material would still remain both above and below the water table on the former MGP property and the State of New Jersey property. Because this alternative does not address visually impacted material below the water table, dissolved phase COC concentrations would likely not be reduced following remedial construction activities. However, results of the current groundwater monitoring program indicate that the extent of the dissolved phase plume is stable and dissolved phase COCs have not been detected in the most downgradient wells to date. If deemed necessary, the groundwater contingency could be implemented to address dissolved phase impacts near the leading edge of the plume.

Alternative 2 would rely heavily on the institutional controls and associated SMP to reduce the potential for exposures to remaining impacted soil and groundwater on the former MGP property and the State of New Jersey property (which would still be present at depths less than 10 feet bgs). Potential exposures to field personnel and the community during long-term groundwater contingency operation and maintenance (as needed) would also be minimized by following the appropriate procedures established in the SMP. Annual verification of the institutional controls would be completed to document that the controls are maintained and remain effective. Additionally, Alternative 2 would include continued monitoring of groundwater to document the concentrations and extent of dissolved phase impacts (i.e., verify that dissolved phase impacts have not migrated toward the public well field). If the groundwater contingency were implemented, the system would address the leading edge of the dissolved phase plume preventing downgradient migration of dissolved phase impacts.

<u>Land Use – Alternative 2</u>

The current zoning for the project area is listed as manufacturing. Areas immediately surrounding the project area are zoned for commercial and recreational use. The current and foreseeable future use of the area surrounding the project area is mixed commercial/recreational. Portions of project area will continue to be used by O&R as natural gas gate and regulator stations. A portion of the State of New Jersey property is used as a firing range. The Village of Suffern well field (i.e., a source for local drinking water) is located immediately west of the project area.

Implementation of Alternative 2 is not anticipated to alter current or anticipated future use of the project area. Although excavation of the former MGP structures and shallow impacts would cause a short-term disruption to the surrounding community, the disturbed portions of the project area would be restored to match existing conditions. Institutional controls would limit invasive (i.e., subsurface) activities that could be conducted at the former MGP site. Long-term periodic groundwater monitoring would be conducted to verify that impacted groundwater is not migrating toward the Village of Suffern well field. If deemed necessary, the groundwater contingency could be implemented to reduce dissolved phase COC concentrations at the leading edge of the dissolved phase plume.

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

Alternative 2 would include the excavation of approximately 5,100 cy of material to address an estimated 4,000 cy of impacted material, thereby addressing an estimated 15% of the impacted material at the project area. Excavated material would be permanently transported off-site for treatment via LTTD and/or disposal as a non-hazardous waste at a solid waste landfill.

Although Alternative 2 would address potential sources of NAPL (i.e., the former MGP structures), this alternative does not address impacted soil located below the water table. Therefore, Alternative 2 is not anticipated to reduce the concentrations or extent of dissolved phase impacts. Long-term periodic groundwater monitoring would be conducted to document the extent of groundwater impacts (which could be reduced through natural processes). If necessary, based on the results of continued groundwater monitoring, the groundwater contingency could be implemented to address the leading edge of the dissolved phase plume through biodegradation of dissolved phase COCs. The system would likely need to operate indefinitely to address the downgradient extent of dissolved phase COC concentrations.

Implementability – Alternative 2

Alternative 2 would be both technically and administratively implementable. Removal and off-site disposal of former MGP structures and associated impacted soil in the immediate vicinity of these structures, as well as installation of a biosparging system (if necessary), is technically feasible. Remedial contractors capable of performing these remedial activities are readily available.

Potential implementation challenges associated with conducting excavation activities at the O&R gate station include: vehicle/equipment access under the steel bridge associated with the abandoned railroad; conducting excavation activities in close proximity to gate station structures; conducting excavation activities near active rail lines; and excavating in areas where subsurface utilities are present (i.e., gas and water lines). O&R would assess potential options to temporarily bypass or reroute the portions of the gas distribution lines located within the proposed excavation area during the remedial design. Implementation/logistical challenges associated with conducting work on the former MGP property include maintaining access to the firing range during remedial construction activities and routing truck traffic through the nearby recreational fields and residential areas. Based on project area access concerns for transportation vehicles, transportation planning would be conducted prior to the remedial activities as full-size tractor trailers (e.g., 40 ton) may not be able to access the project area and remedial activities could be conducted at a time when the recreational fields are not in use and nearby residents are less likely to be outdoors (i.e., during cooler months). The biosparging wells (if installed) would be secured in lockable subsurface vaults and a shed used to store biosparging equipment and controls would be secured to prevent access by unauthorized personnel.

Administratively, Alternative 2 is implementable. Institutional controls and/or an SMP would be established for the O&R and State of New Jersey properties, which would require coordination with state agencies (i.e., NYSDEC). No access agreements would be required for remedial construction, as excavation activities would be conducted within the limits of the O&R property. Access agreements would be required to conduct periodic groundwater monitoring, if monitoring activities included the sampling of wells not on O&R property (i.e., State of New Jersey or Village of Suffern properties). Access agreements are not anticipated to be required as part of the groundwater contingency, as the system would likely be constructed on the O&R gate station property.

<u>Compliance with SCGs – Alternative 2</u>

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 SCOs, CP-51 *Soil Cleanup Guidance* (NYSDEC, 2010b) total PAH SCO of 500 mg/kg at non-residential sites, and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

  Alternative 2 would include the removal of MGP structures and impacted soil located within and immediately surrounding these structures to facilitate their removal. Approximately 7,000 cy of visually impacted soil and soil containing total PAHs at concentrations greater than 500 ppm located at depths shallower than 15 ft bgs would not be addressed by this alternative. All excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

  Alternative 2 does not address impacted soil located below the water table. Therefore, this alternative would likely not achieve groundwater SCGs within a determinate period of time. Implementation of the groundwater contingency would only be expected to achieve NYSDEC Class GA standards and guidance values at (and downgradient from) the leading edge of the dissolved phase plume (i.e., where the biosparging wells would be located).

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

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

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting remedial activities. Other applicable location-specific SCGs generally include Village of Suffern building/construction codes and ordinances, necessary street work permits, a Rockland County Stream Control Permit, and New Jersey Transit work permits. Local permits would be obtained prior to initiating the remedial activities.

Overall Protection of Public Health and the Environment – Alternative 2

Alternative 2 would address shallow MGP-related impacts/sources areas through the removal of former MGP structures and shallow impacts. Although this alternative includes removal of the former MGP structures on the former MGP property and shallow hardened tar west of the abandoned railroad berm, visually impacted material would still remain in shallow subsurface soil (i.e., 2 feet bgs and deeper) on the former MGP property, as well as the State of New Jersey property. Periodic groundwater monitoring would be conducted to document the extent of dissolved phase groundwater impacts (i.e., confirm that dissolved phase impacts have not migrated to the Village of Suffern well field). If the results of successive groundwater monitoring events indicate that dissolved phase COC concentrations are trending upward or if the leading edge of the dissolved phase plume is advancing toward the Village of Suffern well field, the groundwater contingency could be implemented to reduce dissolved phase COC concentrations at the leading edge of the dissolved phase plume.

Alternative 2 would prevent exposures (i.e., direct contact, ingestion, and inhalation) of MGP-related impacts in soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2) through the excavation of former MGP structures and shallow impacts (west of the abandoned railroad berm) and through the implementation of institutional controls. However, potentially compete exposure pathways would remain under this alternative and the reduction of potential exposures would only be effective by adhering to the institutional controls and the procedures set forth in the SMP.

Alternative 2 would work toward preventing the migration of MGP-related COCs and NAPL (soil RAO #3) and addressing the source of groundwater impacts (groundwater RAO #4) through the removal of approximately 15% of the estimated volume of visually impacted soil and soil containing total PAHs at concentrations exceeding 500 mg/kg. However, impacted material would remain both above and below the water table, and therefore, Alternative 2 is not anticipated to restore groundwater quality to pre-disposal/pre-release conditions (groundwater RAO #3). The groundwater contingency, if implemented, would likely restore groundwater quality to pre-disposal/pre-release conditions at and downgradient from the leading edge of the dissolved phase plume.

<u>Cost Effectiveness – Alternative 2</u>

The estimated costs associated with Alternative 2 are presented in Table 6. The total estimated 30-year present worth cost for this alternative not including capital or O&M costs for the construction or operation of the groundwater contingency is approximately $6,100,000. The estimated capital cost, including costs for conducting soil removal activities is approximately $4,500,000. The estimated capital cost and 30-year present worth cost of O&M activities associated with constructing and operating the biosparge groundwater contingency are approximately $800,000 and $4,200,000, respectively.

5.2.3 Alternative 3 – Excavation of Visually Impacted Soil up to the Groundwater Table

The major components of Alternative 3 include the following:

- Removal of the gas oil house structure
- Removal of the eastern gas holder
- Removal of shallow hardened tar west of the abandoned railroad berm
- Removal of impacted soil to the top of the water table.
- Conducting long-term groundwater monitoring
- Establishing institutional controls
- Developing an SMP
- Provisions for groundwater treatment contingency

Alternative 3 would address visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg located above the water table (i.e., located at approximately 12 to 15 feet bgs across the project area) through excavation and off-site treatment/disposal. The excavation limits associated with Alternative 3 are shown on Figure 5 and consist of the following general areas:

- Similar to Alternative 2, the removal of former MGP structures (i.e., the gas oil house and eastern gas holder), structure contents, and impacted soil immediately surrounding the structures, as well as the impacted soil located west of the abandoned railroad berm (i.e., where hardened tar was encountered in several soil borings). As shown on Figure 5, the gas oil house area would be excavated to 13 feet bgs and the eastern gas holder area would be excavated to 15 feet bgs to address visually impacted soil and soil containing PAHs at concentrations greater than 500 ppm above the water table[1].

- An area immediately surrounding monitoring well MW20 to a depth of 12 feet bgs to address LNAPL previously observed at this location.

- The northeastern portion of the former MGP area and the State of New Jersey property at depths up to 12 feet below grade.

[1] For the purpose of developing this alternative, it has been assumed that visually impacted material is present below the eastern gas holder continuously to a depth of 35 feet bgs. Eastern gas holder limits would be confirmed or refined based on the results of a PDI.

The limits of each of these areas, as well as an area within the limits of the former MGP Building (i.e., near soil boring SSB2) identified as requiring further investigation, would be further refined as part of a pre-design investigation for this alternative.

Alternative 3 would include the excavation of approximately 16,500 cy of material (consisting of 2,600 cy west of the abandoned railroad berm; 4,900 cy on the former MGP property; and 9,000 cy from the State of New Jersey property) to address approximately 11,500 cy of impacted soil. Similar to Alternative 2, based on the anticipated excavation limits of this alternative, subsurface utilities (i.e., water lines, gas lines) would be protected and/or relocated during excavation activities. It is anticipated that an excavation enclosure (e.g., sprung-type structure) equipped with a vapor collection and treatment system would be constructed over the proposed excavation areas to reduce the potential for off-site migration of and exposure to vapors and odors during excavation activities. Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. Based on the proposed extent/depth of excavation activities, excavation support systems would likely be required for the excavation activities. The final excavation plan would be developed as part of a remedial design.

Alternative 3 would include the same groundwater monitoring, institutional control, SMP, and groundwater contingency (e.g., biosparging system) components previously described under Alternative 2.

<u>Short-Term Impacts and Effectiveness – Alternative 3</u>

Implementation of this alternative could result in short-term exposure of the surrounding community and workers to COCs as a result of excavation, material handling, and off-site transportation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL, impacted soil, and/or groundwater and inhalation of volatile organic vapors or dust containing COCs during remedial construction. Additionally, potential short-term exposures to impacted groundwater could occur to site workers during installation of biosparging wells at the leading edge of the dissolved phase plume. Potential exposure mechanisms would include ingestion of or dermal contact with impacted groundwater and/or inhalation of volatile organic compounds. Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the project area and delivery of fill materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices. Community access to the project area would be restricted and the excavation enclosure would minimize the potential for exposures.

Off-site transportation of excavated material and importation of clean fill materials would result in approximately 1,980 truck round trips (assuming 25 tons per truck). Based on a review of local roadways, due to low bridge clearances on Chestnut Avenue (i.e., 11 feet), vehicles transporting excavated material off-site for treatment/disposal and importing clean fill materials would have to access the project area via Ramapo Avenue, which is located in a residential setting. Remedial construction activities could be conducted during cooler months to minimize disruption to the community (i.e., caused by the heavy amounts of truck traffic near the recreational fields and through residential areas). Alternative 3 does not employ green remediation practices and the relative carbon footprint (as compared to the other alternatives) is considered moderate.

Soil excavation and backfilling activities could be completed in approximately 8 months and groundwater monitoring would be conducted over an assumed 30-year period. If necessary, following completion of a PDI and pilot test, the biosparging system (or other groundwater contingency remedial technology) would require approximately 1 month to install and the system would operate for an assumed 30-year period.

<u>Long-Term Effectiveness and Permanence – Alternative 3</u>

Under Alternative 3, visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg located above the water table (including former MGP structures) would be excavated and transported off-site for treatment/disposal. Alternative 3 would address the material most likely to be encountered by workers during future project area construction/redevelopment activities on the former MGP and State of New Jersey properties. Although impacted material above the water table would be addressed (including the former MGP structures), an estimated volume of approximately 15,000 cy of impacted material would still remain below the water table on the former MGP property and the State of New Jersey property. Because this alternative does not address visually impacted material below the water table, dissolved phase COC concentrations would likely not be reduced following remedial construction activities. However, results of the on-going groundwater monitoring program (conducted since 1999) indicate that the extent of the dissolved phase plume is stable and dissolved phase COCs have not been detected in the most downgradient wells to date. If deemed necessary, the groundwater contingency could be implemented to address dissolved phase impacts near the leading edge of the plume.

Alternative 3 would include the establishment of institutional controls and the development of an SMP to reduce the potential for exposures to remaining impacted soil and groundwater on the former MGP property and the State of New Jersey property (i.e., located below the water table). However, the potential for future project area construction activities below the water table (i.e., at depths greater than 12 feet bgs) is low and there would be little to no need to implement protocols established in the SMP (i.e., impacted material would likely not be encountered during future project area activities). Potential exposures to field personnel and the community during long-term groundwater contingency operation and maintenance (as needed) would also be minimized by following the appropriate procedures established in the SMP. Regardless, annual verification of the institutional controls would be completed to document that the controls are maintained and remain effective.

Additionally, Alternative 3 would include continued monitoring of groundwater to document the concentrations and extent of dissolved phase impacts (i.e., verify that dissolved phase impacts have not migrated to the public well field). If the groundwater contingency were implemented, the system would only address the leading edge of the dissolved phase plume and the system would likely need to operate indefinitely. However, the potential for exposures to impacted project area media would be significantly reduced under this alternative.

Land Use – Alternative 3

The current zoning for the project area is listed as manufacturing. Areas immediately surrounding the project area are zoned for commercial and recreational use. The current and foreseeable future use of the area surrounding the project area is mixed commercial/ recreational. Portions of project area will continue to be used by O&R as natural gas gate and regulator stations. A portion of the State of New Jersey property is used as a firing range. The Village of Suffern well field (i.e., a source for local drinking water) is located immediately west of the project area.

Implementation of Alternative 3 is not anticipated to alter current or anticipated future use of the project area. Excavation of the former MGP structures and visually impacted material above the water table would cause a short-term disruption to the surrounding community. Although institutional controls would limit invasive (i.e., subsurface) activities that could be conducted at the former MGP site, restrictions would likely be less stringent based on the removal of visually impacted material above the water table (i.e., to depths up to 15 feet bgs). Long-term periodic groundwater monitoring would be conducted to verify that impacted groundwater is not migrating toward the Village of Suffern well field. If deemed necessary, the groundwater contingency could be implemented to address dissolved phase impacts near the leading edge of the plume.

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

Alternative 3 would include the excavation of approximately 16,500 cy of material to address an estimated 11,500 cy of impacted material, thereby addressing approximately 44% of the estimated volume of visually impacted soil and soil containing total PAHs at a concentration greater than 500 mg/kg. Excavated material would be permanently transported off-site for treatment via LTTD and/or disposal as an appropriate disposal facility.

Although Alternative 3 would address potential sources of NAPL (i.e., the former MGP structures), this alternative does not address impacted soil located below the water table. Therefore, Alternative 3 is not anticipated to significantly reduce the concentrations or extent of dissolved phase impacts. Long-term periodic groundwater monitoring would be conducted to document the extent of groundwater impacts (which could be reduced through natural processes). If necessary, based on the results of continued groundwater monitoring, the groundwater contingency could be implemented to address the leading edge of the dissolved phase plume through biodegradation of dissolved phase COCs. The system would likely need to operate indefinitely to address the downgradient extent of dissolved phase COC concentrations.

Implementability – Alternative 3

Alternative 3 would be both technically and administratively implementable. Removal and off-site disposal of visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg above the water table (including former MGP structures), as well as installation of a biosparging system, is technically feasible. Remedial contractors capable of performing these remedial activities are readily available.

Potential implementation challenges associated with conducting excavation activities at the O&R gate station include: vehicle/equipment access under the steel bridge associated with the abandoned railroad; conducting excavation activities in close proximity to gate station structures; conducting excavation activities near active rail lines; and excavating in areas where subsurface utilities are present (i.e., gas and water lines). O&R would assess potential options to temporarily bypass or reroute the portions of the gas distribution lines located within the proposed excavation area during the remedial design. Implementation/logistical challenges associated with conducting work on the former MGP and State of New Jersey properties include: maintaining access to the firing range; routing truck traffic through the nearby recreational fields and residential areas; and conducting excavation activities at the base of an embankment. Soil loading conditions from the bank would be evaluated as part of the remedial design. Based on project area access concerns for transportation vehicles, transportation planning would be conducted prior to the remedial activities as full-size tractor trailers (e.g., 40 ton) may not be able to access the project area and remedial activities could be conducted at a time when the recreational fields are not in use and nearby residents are less likely to be outdoors (i.e., during cooler months). The biosparging wells (if installed) would be secured in lockable subsurface vaults and a shed used to store biosparging equipment and controls would be secured to prevent access by unauthorized personnel.

Administratively, Alternative 3 is implementable. An access agreement would be required to conduct excavation activities on the State of New Jersey property. Institutional controls and/or and SMP would be established for the O&R and State of New Jersey properties, which would require coordination with state agencies (i.e., NYSDEC). Access agreements would also be required to conduct periodic groundwater monitoring, if monitoring activities included the sampling of wells not on O&R property (i.e., State of New Jersey or Village of Suffern properties). Access agreements are not anticipated to be required as part of the groundwater contingency, as the system would likely be constructed on the O&R gate station property.

<u>Compliance with SCGs – Alternative 3</u>

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 SCOs, CP-51 *Soil Cleanup Guidance* (NYSDEC, 2010b) total PAH SCO of 500 mg/kg at non-residential sites, and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

Alternative 3 would include the removal of MGP structures and impacted soil above the water table. Approximately 15,000 cy of visually impacted soil and soil containing total PAHs at concentrations greater than 500 ppm would remain below the water table following implementation of this alternative. All excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

Alternative 3 does not address impacted soil located below the water table. Therefore, this alternative would likely not achieve groundwater SCGs within a determinate period of time. Implementation of the groundwater contingency would only be expected to achieve NYSDEC Class GA standards and guidance values at (and downgradient from) the leading edge of the dissolved phase plume (i.e., where the biosparging wells would be located).

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

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

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting project area activities. Other applicable location-specific SCGs generally include Village of Suffern building/construction codes and ordinances, necessary street work permits, a Rockland County Stream Control Permit, and New Jersey Transit work permits. Local permits would be obtained prior to initiating the remedial activities.

<u>Overall Protection of Public Health and the Environment – Alternative 3</u>

Alternative 3 would address visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg (including removal of former MGP structures) above the water table on the former MGP and State of New Jersey properties (i.e., at depths ranging from 12 to 15 feet bgs). Therefore, Alternative 3 would address the impacted soil most likely to be encountered by workers during future project area construction/redevelopment activities on the former MGP and State of New Jersey properties. Periodic groundwater monitoring would be conducted to document the extent of dissolved phase groundwater impacts (i.e., confirm that dissolved phase impacts have not migrated to the Village of Suffern well field). If the results of successive groundwater monitoring events indicate that dissolved phase COC concentrations are trending upward or if the leading edge of the dissolved phase plume is advancing toward the Village of Suffern well field, the groundwater contingency could be implemented to reduce dissolved phase COC concentrations at the leading edge of the dissolved phase plume.

Alternative 3 would prevent exposures (i.e., direct contact, ingestion, and inhalation) of MGP-related impacts in soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2) through the removal of visually impacted material above the water table. Although unlikely, if future activities conducted within the project area included work below the water table, the reduction of potential exposures would occur by adhering to the institutional controls and the procedures set forth in the SMP that would be established/prepared as part this alternative.

Alternative 3 would work toward preventing the migration of MGP-related COCs and NAPL (soil RAO #3) and addressing the source of groundwater impacts (groundwater RAO #4) through the removal of approximately 44% of the estimated volume of visually impacted soil and soil containing total PAHs at concentrations exceeding 500 mg/kg. However, impacted material would remain below the water table in the project area, and therefore, Alternative 3 is not anticipated to restore groundwater quality to pre-disposal/pre-release conditions (groundwater RAO #3). The groundwater contingency, if implemented, would likely restore groundwater quality to pre-disposal/pre-release conditions at and downgradient from the leading edge of the dissolved phase plume.

<u>Cost Effectiveness – Alternative 3</u>

The estimated costs associated with Alternative 3 are presented in Table 7. The total estimated 30-year present worth cost for this alternative not including capital or O&M costs for the construction or operation of the groundwater contingency is approximately $11,800,000. The estimated capital cost, including costs for conducting soil removal activities is approximately $10,200,000. The estimated capital cost and 30-year present worth cost of O&M activities associated with constructing and operating the biosparge groundwater contingency are approximately $800,000 and $4,200,000, respectively.

5.2.4 Alternative 4 – Excavation and ISS

The major components of Alternative 4 include the following:

- Removal of the gas oil house structure
- Removal of the eastern gas holder
- Removal of shallow hardened tar west of the abandoned railroad berm
- ISS of impacted soil at depths up to 35 feet bgs
- Conducting long-term groundwater monitoring
- Establishing institutional controls
- Developing an SMP
- Provisions for groundwater treatment contingency

Alternative 4 would address visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg at depths up to 35 feet bgs through excavation and ISS treatment. Prior to conducting ISS treatment, pre-ISS excavation activities would be conducted to remove shallow obstructions and allow for material bulking during soil solidification. Excavation/ISS limits and anticipated depths of excavation and ISS are shown on Figure 6 and consist of the follow general areas:

- Similar to Alternatives 2 and 3, the removal of former MGP structures (i.e., the gas oil house and eastern gas holder[2]), structure contents and impacted soil immediately surrounding the structures, impacted soil located west of the abandoned railroad berm (i.e., where hardened tar was encountered in several soil borings), an area near monitoring well MW20, and on the State of New Jersey property.
- An area beneath the former MGP building.

Alternative 4 would include excavation and ISS treatment of approximately 28,800 cy of material (i.e., excavation of 10,300 cy and ISS of 18,500 cy) to address an estimated 22,400 cy of visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg. It is anticipated that an excavation enclosure (e.g., sprung-type structure) equipped with a vapor collection and treatment system would be constructed to reduce the potential for off-site migration of and exposure to vapors and odors during pre-ISS excavation activities.

The target depth of 35 feet bgs was selected based on the distribution of visual impacts and the relative ability of ISS technologies to effectively solidify impacted soil to this depth (i.e., technology limitations). At depths of 35 feet and shallower, impacts are more contiguous and can be addressed with more certainty by proven ISS technologies (e.g., small and large diameter augers, bucket mixing). Approximately 85% of impacted material would be addressed when excavating/treating to 35 feet bgs, while only 86% of impacted material would be addressed when conducting excavation/ISS activities to depths up to 45 feet below grade (i.e., only an additional 1% of impacted material would be addressed if soil was excavated and/or treated to 45 feet bgs).

In general, the ISS process involves mixing Portland cement (and other pozzolanic materials) with impacted soil to reduce the leachability and mobility of COCs and NAPL present in soil. The resulting mixture is generally a homogeneous mixture of soil, groundwater and grout that hardens to become a weakly-cemented material. The ISS process would solidify media (i.e., soil and groundwater) containing MGP-related

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[2] For the purpose of developing this alternative, it has been assumed that visually impacted material is present below the eastern gas holder continuously to a depth of 35 feet bgs. Eastern gas holder limits would be confirmed or refined based on the results of a PDI.

impacts (micro-encapsulation), as well as soil surrounding MGP-related materials (macro-encapsulation), thereby preventing migration of COCs and NAPL beyond the solidified mass.

Bench-scale testing would be required prior to implementing this alternative. ISS bench-scale testing would consist of an evaluation of various soil solidification mixtures to determine the effectiveness of each mixture at meeting performance goals for permeability and strength to be established as part of the remedial design. ISS mixtures could consist of project area soil and groundwater, blast furnace slag (BFS), Portland cement, bentonite and water. The mixtures would be tested for density, permeability, strength and leachability of COCs to identify an optimal mix design based on site-specific soil conditions (i.e., physical characteristics and quantity of impacts).

Quality assurance/quality control (QA/QC) sampling would be conducted during ISS treatment activities to verify that performance criteria (e.g., strength and permeability.) are met. If performance criteria are not achieved in certain locations, soil would be re-mixed at these locations. In general, ISS spoils (i.e., bulking of solidified material) would be removed (as necessary) such that the solidified material would be below the frost line.

Alternative 4 would include the same groundwater monitoring, institutional control, SMP, and groundwater contingency (e.g., biosparging system) components previously described under Alternative 2. Additionally, the SMP prepared under Alternative 4 would document the extent of solidified soil.

Short-Term Impacts and Effectiveness – Alternative 4

Implementation of this alternative could result in short-term exposure of the surrounding community and workers to site-related COCs as a result of excavation, soil mixing, material handling, and off-site transportation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL, impacted soil, and/or groundwater and inhalation of volatile organic vapors or dust containing COCs during remedial construction. Additionally, potential short-term exposures to impacted groundwater could occur during installation of biosparging wells at the leading edge of the dissolved phase plume. Potential exposure mechanisms would include ingestion of or dermal contact with impacted groundwater and/or inhalation of volatile organic compounds. Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the project area and delivery of fill materials and ISS aggregate. These concerns would be minimized by using engineering controls and appropriate health and safety practices. Community access to the project area would be restricted and the excavation enclosure would minimize the potential for exposures.

Off-site transportation of excavated material and importation of clean fill materials and ISS aggregate would result in approximately 1,540 truck round trips (assuming 25 tons per truck). Based on a review of local roadways, due to low bridge clearances on Chestnut Avenue (i.e., 11 feet), vehicles transporting excavated material off-site for treatment/disposal and importing clean fill materials would have to access the project area via Ramapo Avenue, which is located in a residential setting. Remedial construction activities could be conducted during cooler months to minimize disruption to the community (i.e., caused by the heavy amounts of truck traffic near the recreational fields and through residential areas). ISS would offer some sustainable practices because impacted soil and groundwater would be solidified in place, thereby utilizing a treatment technology to significantly reduce the volume of soil that may otherwise require transportation for off-site treatment and/or disposal. The need to import clean fill (a natural resource) is also significantly reduced when solidifying materials in place. The reduction in volume of material to be transported off-site and the volume of imported fill needed would result in a decrease of truck traffic and non-renewable resources (i.e., fuel) required to export excavated material and to import clean fill that would otherwise be necessary to address the volume of material included in this alternative. The relative carbon footprint of Alternative 4 (as compared to the other alternatives) is considered moderate.

Soil excavation and ISS treatment activities could be completed in approximately 8 months and groundwater monitoring would be conducted over an assumed 30-year period. If necessary, following completion of a PDI and pilot test, the biosparging system (or other groundwater contingency remedial technology) would require approximately 1 month to install and the system would operate for an assumed 30-year period.

<u>Long-Term Effectiveness and Permanence – Alternative 4</u>

Under Alternative 4, visually impacted material and soil containing PAHs at concentrations greater than 500 mg/kg at depths up to 35 feet bgs would be excavated or treated using ISS. Alternative 4 would address the material most likely to be encountered by workers during future project area construction/redevelopment activities on the former MGP and State of New Jersey properties. Excavated material would be transported off-site for treatment/disposal and treated material (including impacted groundwater) would be solidified in place. Although impacted soil and groundwater addressed by ISS treatment would remain at the project area, the impacted materials would be encapsulated by the solidified mass. QA/QC sampling would be completed to confirm that ISS performance criteria are met. If performance criteria are not met in specific areas, soil would be remixed until performance criteria are met.

As part of the remedial design of this alternative, predictive simulations would be prepared (i.e., using a steady-state, three-dimensional MODFLOW groundwater flow model) to evaluate the potential hydraulic impacts caused by the solidification of soils located below the water table. However, implementation of Alternative 4 is not expected to significantly raise water levels in the area upgradient from and within the ISS monoliths based on the current RI Report which depicts a relatively flat groundwater table in the area of the proposed ISS treatment areas. Based on this, it is anticipated that groundwater flow patterns would likely remain relatively consistent with current flow patterns and relatively minimal groundwater mounding would be anticipated following the solidification of project area soils.

Alternative 4 would address approximately 10,900 cy of visually impacted soil and soil containing total PAHs at a concentration greater than 500 mg/kg located below the water table (i.e., the primary source of dissolved phase impacts). This material represents the most concentrated source of impacted soil below the water table. As indicated Section 1.5.3.1, the visually impacted material remaining at depths greater than 35 feet bgs (an estimated 4,000 cy) is more sporadically encountered throughout the project area. Therefore, a reduction in dissolved phase COC concentrations would be expected over time following remedial construction activities. Additionally, results of the current groundwater monitoring program indicate that the extent of the dissolved phase plume is stable and dissolved phase COCs have not been detected in the most downgradient wells to date. If deemed necessary, the groundwater contingency could be implemented to address dissolved phase impacts near the leading edge of the plume.

Alternative 4 would include the establishment of institutional controls and the development of an SMP to reduce the potential for exposures to remaining impacted non-solidified material at depths greater than 35 feet bgs. However, the potential for future project area construction activities that would encounter remaining impacted media is low. To minimize potential future exposures to MGP-related impacts, the SMP would include protocols (including health and safety requirements) for conducting invasive activities and managing the excavated solidified material (i.e., located at depths of 5 feet bgs and greater). Potential exposures to field personnel and the community during long-term biosparging system operation activities would also be minimized by following the appropriate procedures established in the SMP. If subsurface activities (e.g., installation of new utilities/building foundations) were to be conducted at the project area, activities would likely be conducted in areas restored with imported clean fill placed above solidified material. The potential for exposures to impacted media would be significantly reduced under this alternative.

Annual verification of the institutional controls would be completed to document that the controls are maintained and remain effective. Additionally, Alternative 4 would include continued monitoring of groundwater to document the concentrations and extent of dissolved phase impacts (i.e., verify that dissolved phase impacts have not migrated to the public well field). If the groundwater contingency were implemented, the system would only address the leading edge of the dissolved phase plume and the system would likely need to operate indefinitely.

Land Use – Alternative 4

The current zoning for the project area is listed as manufacturing. Areas immediately surrounding the project area are zoned for commercial and recreational use. The current and foreseeable future use of the area surrounding the project area is mixed commercial/recreational. Portions of project area will continue to be used by O&R as natural gas gate and regulator stations. A portion of the State of New Jersey property is used as a firing range. The Village of Suffern well field (i.e., a source for local drinking water) is located immediately west of the project area.

Implementation of Alternative 4 is not anticipated to alter current or anticipated future use of the project area. Although, excavation and ISS treatment of visually impacted material (to depths of 35 feet bgs) would cause a short-term disruption to the surrounding community, the project area would be restored following completion of remedial construction activities. Although material within the approximately top 5 feet of the ground surface would not be solidified, the presence of solidified material may limit the potential future development of the project area. The solidified material would provide a working platform that could support construction of a slab-on-grade structure. Construction of a building with subgrade basement level and foundation may be more difficult based on the nature of the solidified material. However, the design strength of the solidified mass would be low enough to allow for excavation (that would be conducted in accordance with an SMP).

Institutional controls would limit invasive (i.e., subsurface) activities that could be conducted at the project area (i.e., within solidified material) and groundwater use would be restricted. Long-term periodic groundwater monitoring would be conducted to verify that impacted groundwater is not migrating toward the Village of Suffern well field. If deemed necessary, the groundwater contingency could be implemented to address dissolved phase impacts near the leading edge of the plume.

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

Alternative 4 would include the excavation and ISS treatment of approximately 28,800 cy of material to address an estimated 22,400 cy of visually impacted material and groundwater, thereby addressing an estimated 85% of the estimated volume of visually impacted material and soil containing PAHs at a concentration greater than 500 mg/kg. Excavated material would be permanently transported off-site for treatment via LTTD and/or disposal at an appropriate disposal facility. Soil subject to ISS treatment would be solidified in-place to reduce the mobility of NAPL and leachability of COCs. Alternative 4 would remove approximately 7,300 cy of impacted material during pre-ISS excavation. Additionally, the ISS treatment would solidify an estimated additional approximately 15,500 cy of impacted soil and groundwater into a homogenized mass.

Alternative 4 would address potential sources of NAPL (i.e., the former MGP structures), as well as visually impacted material and soil containing total PAHs at a concentration greater than 500 mg/kg located below the water table (to depths of 35 feet bgs), thereby reducing the flux of COCs from source material to groundwater. This is anticipated to effectively reduce the toxicity and volume of residual dissolved phase groundwater impacts. Dissolved phase concentrations of BTEX and PAHs in groundwater downgradient of the ISS areas would be expected to attenuate, to some degree, via natural processes (e.g., biodegradation, sorption, dispersion, dilution, and volatilization). Alternative 4 would include long-term groundwater monitoring to document the extent and likely long-term reduction (i.e., toxicity and volume) of dissolved phase groundwater impacts. If necessary, based on the results of continued groundwater monitoring, the groundwater contingency would address the leading edge of the dissolved phase plume through biodegradation of dissolved phase COCs and the system would likely need to operate indefinitely to address the downgradient extent of dissolved phase COC concentrations.

Implementability – Alternative 4

Alternative 4 would be both technically and administratively implementable. Removal, off-site disposal, and ISS treatment of visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg to depths up to 35 feet bgs, as well as installation of a biosparging system, are technically feasible. Remedial contractors capable of performing these remedial activities are readily available. A number of ISS applications have been completed on MGP sites in New York (as well as other states). As indicated previously, bench-scale testing would be required prior to the implementation of this alternative to identify an optimal mix design that would achieve strength and permeability performance criteria based on site-specific conditions. If auger mixing methods were used for ISS treatment, obstructions greater than six inches in diameter could prevent homogenous mixing and potentially damage ISS equipment. The ISS activities could potentially be limited by subsurface obstructions such as cobbles, debris, historical fill materials and subsurface former building foundations and slabs. Pre-ISS excavation would be conducted to identify obstructions and clear the top 5 to 10 feet of fill material to allow for the expansion of solidified soil. Bucket mixing methods could be used to clear deeper obstructions and treat impacted soil (i.e., at depths up to 35 feet bgs based on equipment limitations).

Potential implementation challenges associated with conducting activities at the O&R gate station include: vehicle/equipment access under the steel bridge associated with the abandoned railroad; conducting excavation activities in close proximity to gate station structures; conducting excavation/soil stabilization activities near active rail lines; and excavating in areas where subsurface utilities are present (i.e., gas and water lines). O&R would assess potential options to temporarily bypass or reroute the portions of the gas distribution lines located within the proposed excavation area during the remedial design. Implementation/logistical challenges associated with conducting work on the former MGP and State of New Jersey properties include: maintaining access to the firing range; routing truck traffic through the nearby recreational fields and residential areas; and conducting excavation and ISS treatment activities at the base of an embankment. Soil loading conditions from the bank would be evaluated as part of the remedial design. Based on project area access concerns for transportation vehicles, transportation planning would be conducted prior to the remedial activities as full-size tractor trailers (e.g., 40 ton) may not be able to access the project area and remedial activities could be conducted at a time when the recreational fields are not in use and nearby residents are less likely to be outdoors (i.e., during cooler months). The biosparging wells (if installed) would be secured in lockable subsurface vaults and a shed used to store biosparging equipment and controls would be secured to prevent access by unauthorized personnel.

Administratively, Alternative 4 is implementable. An access agreement would be required to conduct excavation and ISS activities on the State of New Jersey property. Institutional controls would be established for the O&R and State of New Jersey properties, which would require coordination with state agencies (i.e., NYSDEC). Access agreements would also be required to conduct periodic groundwater monitoring, if monitoring activities included the sampling of wells not on O&R property (i.e., State of New Jersey or Village of Suffern properties). Access agreements are not anticipated to be required as part of the groundwater contingency, as the system would likely be constructed on the O&R gate station property.

<u>Compliance with SCGs – Alternative 4</u>

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 SCOs, CP-51 *Soil Cleanup Guidance* (NYSDEC, 2010b) total PAH SCO of 500 mg/kg at non-residential sites, 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

  Alternative 4 would include the removal of former MGP structures and ISS treatment of visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg up to 35 feet bgs. Although not all soil containing individual COCs at concentrations greater than 6 NYCRR Part 375-6 commercial SCOs would be addressed by this alternative, approximately 85% of visually impacted material and soil containing total PAHs greater than 500 mg/kg would be excavated/treated via ISS. All excavated material and process residuals (i.e., ISS spoils) would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

  Alternative 4 would address approximately 85% of the total volume of impacted material and approximately 75% of the volume of impacted material located below the water table,, which serves as a source of dissolved phase impacts. Following implementation of this alternative, groundwater SCGs may be met over a prolonged period of time via natural attenuation processes. Implementation of the groundwater contingency would only be expected to achieve NYSDEC Class GA standards and guidance values at (and downgradient from) the leading edge of the dissolved phase plume (i.e., where the biosparging wells would be located).

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

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

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting project area activities. Other applicable location-specific SCGs generally include Village of Suffern building/construction codes and ordinances, necessary street work permits, a Rockland County Stream Control Permit, and New Jersey Transit work permits. Local permits would be obtained prior to initiating the remedial activities.

<u>Overall Protection of Public Health and the Environment – Alternative 4</u>

Alternative 4 would address visually impacted material (including former MGP structures) and soil containing total PAHs at concentrations greater than 500 mg/kg at depths up to 35 feet bgs on the former MGP and State of New Jersey properties through excavation and ISS treatment. Although impacted soil and groundwater addressed by ISS treatment would remain, the impacted materials would be encapsulated by the solidified mass. Alternative 4 would address the material most likely to be encountered by workers during future project area construction/ redevelopment activities on the former MGP and State of New Jersey properties. Additionally, periodic groundwater monitoring would be conducted to document the extent of dissolved phase groundwater impacts (i.e., confirm that dissolved phase impacts have not migrated to the Village of Suffern well field). If the results of successive groundwater monitoring events indicate that dissolved phase COC concentrations are trending upward or if the leading edge of the dissolved phase plume is advancing toward the Village of Suffern well field, the groundwater contingency could be implemented to reduce dissolved phase COC concentrations at the leading edge of the dissolved phase plume.

Alternative 4 would prevent exposures (i.e., direct contact, ingestion, and inhalation) of MGP-related impacts in soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2) through the removal and ISS treatment of visually impacted material at depths up to 35 feet bgs. If future intrusive activities were conducted within the project area that would result in removal of solidified material (or construction activities at depths greater than 35 feet bgs), the reduction of potential exposures would occur by adhering to the institutional controls and the procedures set forth in the SMP that would be established/prepared as part this alternative.

Alternative 4 would work toward preventing the migration of MGP-related COCs and NAPL (soil RAO #3) and addressing the source of groundwater impacts (groundwater RAO #4) through the removal/ISS treatment of approximately 85% of the total volume of visually impacted material and soil containing total PAHs at concentrations greater than 500 mg/kg, including approximately 10,900 cy of impacted material below the water table. A reduction in the extent and concentrations of dissolved phase COCs is anticipated following remedial construction activities, as a significant percentage (i.e., approximately 75%) of the material potentially serving as a source of dissolved phase impacts would be removed from below the water table . If Alternative 4 restored groundwater quality to pre-disposal/pre-release conditions (groundwater RAO #3), it would be over a prolonged period of time.

<u>Cost Effectiveness – Alternative 4</u>

The estimated costs associated with Alternative 4 are presented in Table 8. The total estimated 30-year present worth cost for this alternative not including capital or O&M

costs for the construction or operation of the groundwater contingency is approximately $12,200,000. The estimated capital cost, including costs for conducting soil removal and ISS treatment activities is approximately $10,600,000. The estimated capital cost and 30-year present worth cost of O&M activities associated with constructing and operating the biosparge groundwater contingency are approximately $800,000 and $4,200,000, respectively.

5.2.5 Alternative 5 – Excavation to Unrestricted Use SCOs

The major components of Alternative 3 include the following:

- Removal of the gas oil house structure
- Removal of the eastern gas holder
- Removal of soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs
- Conducting short-term groundwater monitoring

Alternative 5 would address soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs through excavation. The excavation limits associated with Alternative 5 are shown on Figure 7. Similar to the other alternatives, Alternative 5 would include the removal of former MGP structures (i.e., the gas oil house and eastern gas holder). As shown on Figure 7, soil excavation activities would be completed at depths up to 102 feet bgs (i.e., to the top of bedrock). Alternative 5 would include the excavation of approximately 63,500 cy, including an estimated 26,400 cy of visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg on the former MGP and State of New Jersey properties, as well as the hardened tar located beneath the abandoned railroad berm.

Similar to Alternatives 2 and 3, based on the anticipated excavation limits of this alternative, subsurface utilities (i.e., water lines, gas lines) would be protected and/or relocated during excavation activities. It is anticipated that an excavation enclosure (e.g., Sprung-type structure) equipped with a vapor collection and treatment system would be constructed over the proposed excavation areas to reduce the potential for off-site migration of and exposures to vapors and odors during excavation activities. Excavation activities would be conducted using conventional construction equipment such as backhoes, excavators, front-end loaders, dump trucks, etc. Conventional excavation support systems (i.e., cantilevered steel sheet pile and/or steel sheet pile equipped with internal bracing) would be used to complete excavation activities from the water table to depths of 30 to 40 feet bgs. To facilitate the removal of deep soil, excavation activities could be conducted using reinforced slurry walls for added excavation support, material could be removed using augers to flight out material, or removal activities could be conducted in the wet via excavations supported with a biopolymer slurry. For the purpose of developing a cost estimate, it has been assumed that excavation activities would be conducted using sheet pile (cantilevered and internally supported), slurry walls, and augers. For deeper excavations (i.e., greater than 40 feet bgs), soil removal would be conducted using cranes to lift material from the excavation bottom. Given the complex nature of conducting deep excavation activities, the final excavation support system(s) would be further evaluated and developed as part of the remedial design for this alternative.

As Alternative 5 would address a vast majority (if not all) visually impacted material, dissolved phase COC concentrations downgradient of the removal areas would be expected to naturally attenuate over a short period of time. Therefore, Alternative 5 does not include long-term groundwater monitoring, institutional control, or groundwater contingency (e.g., biosparging system) components. Following excavation and backfilling activities, groundwater monitoring would be conducted for a short duration (e.g., up to two years) to confirm that groundwater standards and guidance values are achieved.

Short-Term Impacts and Effectiveness – Alternative 5

Implementation of this alternative could result in short-term exposure of the surrounding community and workers to site-related COCs as a result of excavation, material handling, and off-site transportation activities. Potential exposure mechanisms would include ingestion and dermal contact with NAPL, impacted soil, and/or groundwater and inhalation of volatile organic vapors or dust containing COCs during remedial construction. Potential exposure of remedial workers would be minimized through the use of appropriately trained field personnel and PPE, as specified in a site-specific HASP that would be developed as part of the remedial design.

Additional worker safety concerns include working with and around large construction equipment, noise generated from operating construction equipment, and increased vehicle traffic associated with transportation of excavated material from the project area and delivery of fill materials. These concerns would be minimized by using engineering controls and appropriate health and safety practices. Community access to the project area would be restricted and the excavation enclosure would minimize the potential for exposure.

Off-site transportation of excavated material and importation of clean fill materials would result in approximately 7,850 truck round trips (assuming 25 tons per truck). Based on a review of local roadways, due to low bridge clearances on Chestnut Avenue (i.e., 11 feet), vehicles transporting excavated material off-site for treatment/disposal and importing clean fill materials would have to access the project area via Ramapo Avenue, which is located in a residential setting. Alternative 5 would have a significant disruption to the nearby recreational fields and residential areas due to the increased local truck traffic. Alternative 5 does not employ green remediation practices and the relative carbon footprint (as compared to the other alternatives) is considered significant.

Soil excavation and backfilling activities could be completed in approximately 24 months and groundwater monitoring would be conducted over an assumed 2-year period.

Long-Term Effectiveness and Permanence – Alternative 5

Under Alternative 5, soil containing COCs at concentrations greater than unrestricted use SCOs would be excavated from the former MGP and State of New Jersey properties. Excavated material would be transported off-site for treatment/disposal. Alternative 5 would address a vast majority (if not all) visually impacted soil (i.e., the source of dissolved phase impacts). Therefore, dissolved phase COC concentrations would be anticipated to naturally attenuate following remedial construction activities. Short-term groundwater monitoring would be conducted to confirm that groundwater standards and guidance values are achieved. Long-term groundwater monitoring, development of an SMP, establishment of institutional controls would not be required to reduce the potential for long-term exposures, as a vast majority of impacts would be removed under this alternative.

Land Use – Alternative 5

The current zoning for the project area is listed as manufacturing. Areas immediately surrounding the project area are zoned for commercial and recreational use. The current and foreseeable future use of the area surrounding the project area is mixed commercial/recreational. Portions of project area will continue to be used by O&R as natural gas gate and regulator stations. A portion of the State of New Jersey property is used as a firing range. The Village of Suffern well field (i.e., a source for local drinking water) is located immediately west of the project area.

Following the completion of the remedial construction activities associated with Alternative 5, there would be no limitations to the potential future use of the project area. Dissolved phase concentrations of COCs in groundwater beyond excavation limits would be expected to naturally attenuate over a relatively short time period and the use of clean imported fill materials would allow for a variety of potential future uses.

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

Alternative 5 would include the excavation of approximately 63,500 cy of material to address soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs, which includes a vast majority (if not all) visually impacted soil. Excavated material would be permanently transported off-site for treatment via LTTD and/or disposal as a non-hazardous waste at a solid waste landfill.

As a vast majority of soil (including MGP source material) would be permanently removed from the project area, the volume of material that is serving as a source to dissolved phase groundwater would be addressed. Dissolved phase concentrations of BTEX and PAHs in groundwater downgradient of the excavation areas would be expected to attenuate via natural processes (e.g., biodegradation, sorption, dispersion, dilution, and volatilization). Alternative 5 includes short-term (e.g., up to two years) periodic groundwater monitoring to document the extent and likely reduction (i.e., toxicity and volume) of dissolved phase groundwater impacts.

Implementability – Alternative 5

Although administratively feasible, Alternative 5 has potentially significant implementation challenges from a technical standpoint. While conducting excavation activities to depths ranging from 30 to 40 feet bgs is feasible, conducting excavation activities to the top of bedrock (i.e., greater than 100 feet bgs) presents numerous implementation challenges: treatment and disposal of large volumes of groundwater removed from excavations; heaving of excavation bottoms; and stability of excavation support sidewalls. Excavation of deeper soils could be conducted using reinforced slurry walls to serve as excavation support or excavation activities could be conducted in the wet (i.e., using a biopolymer slurry to maintain excavation support). Additionally, augers could be used to remove material from deeper depths, but auger removal equipment has an approximately 60 feet bgs operating limit. As the excavation support systems associated with this alternative would be highly complex and excavation activities would be difficult, excavation limits would need to be well defined and soil loading conditions from the active railroad embankment and other hydrogeologic forces (i.e., groundwater pressure) would be evaluated as part of the remedial design.

Additional implementation/logistical challenges associated with conducting work on the former MGP and State of New Jersey properties include: maintaining access to the firing range; routing truck traffic through the nearby the recreational fields and residential areas; and conducting excavation activities at the base of an embankment near active rail lines. Based on project area access concerns for transportation vehicles, transportation planning would be conducted prior to the remedial activities as full-size tractor trailers (e.g., 40 ton) may not be able to access the project area and remedial activities could be conducted at a time when the recreational fields are not in use and nearby residents are less likely to be outdoors (i.e., during cooler months). However, dewatering activities would be difficult to conduct during the winter months.

Potential implementation challenges associated with conducting activities at the O&R gate station include: vehicle/equipment access under the steel bridge associated with the abandoned railroad; conducting excavation activities in close proximity to the gate station structure; and excavating in areas where subsurface utilities are present (i.e., gas and water lines). O&R would assess potential options to temporarily bypass or reroute the portions of the gas distribution lines located within the proposed excavation area during the remedial design.

Administratively, Alternative 5 is implementable. An access agreement would be required to conduct excavation activities on the State of New Jersey property. Access agreements would also be required to conduct short-term periodic groundwater monitoring, if monitoring activities included the sampling of wells not on O&R property (i.e., State of New Jersey or Village of Suffern properties).

<u>Compliance with SCGs – Alternative 5</u>

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 soil cleanup objectives and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

  Alternative 5 would include the removal soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs. All excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/ disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

As Alternative 5 would address a vast majority visually impacted material, the groundwater SCGs would likely be achieved over a short period of time.

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

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

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting project area activities. Other applicable location-specific SCGs generally include Village of Suffern building/construction codes and ordinances, necessary street work permits, a Rockland County Stream Control Permit, and New Jersey Transit work permits. Local permits would be obtained prior to initiating the remedial activities.

Overall Protection of Public Health and the Environment – Alternative 5

Alternative 5 would address soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs on the former MGP and State of New Jersey properties. Alternative 5 would eliminate exposures (i.e., direct contact, ingestion, and inhalation) to MGP-related impacts in soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2) through the removal of soil containing MGP-related impacts. Therefore, institutional controls and an SMP would not be required to limit potential future exposures to MGP-related impacts.

Additionally, Alternative 5 would prevent the migration of MGP-related COCs and NAPL (soil RAO #3) and address the source of groundwater impacts (groundwater RAO #4) through the removal of MGP-related impacts. Alternative 5 is anticipated to restore groundwater quality to pre-disposal/pre-release conditions (groundwater RAO #3), which would be confirmed by the results of the short-term periodic groundwater monitoring that would be conducted following the completion of remedial construction activities.

Cost Effectiveness – Alternative 5

The estimated costs associated with Alternative 5 are presented in Table 9. The total estimated 30-year present worth cost for this alternative is approximately $57,000,000. The estimated capital cost, including costs for conducting soil removal activities, is approximately $56,700,000. The estimated 30-year present worth cost of O&M activities associated with this alternative, including conducting short-term periodic groundwater monitoring, is approximately $300,000.

6. Comparative Analysis of Alternatives

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

6.1 Comparative Analysis

The alternatives evaluated in Section 5 consist of the following:

- Alternative 1 – No Action
- Alternative 2 – Excavation of MGP Structures
- Alternative 3 – Excavation of Visually Impacted Soil up to the Groundwater Table
- Alternative 4 – Excavation and ISS
- Alternative 5 – Excavation to Unrestricted Use SCOs

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

6.1.1 Short-Term Impacts and Effectiveness

Alternative 1 would not include any active remediation and subsequently would not present potential short-term impacts to remedial workers, the public, or the environment. Alternatives 2 through 5 each include intrusive activities (i.e., excavation and ISS treatment) to address visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg. Alternatives 2, 3, and 4 each include provisions for a groundwater contingency that could be implemented if the results of successive groundwater monitoring events indicate that dissolved phase COC concentrations are trending upward or if the leading edge of the dissolved phase plume is advancing toward the Village of Suffern well field. Each of these alternatives would pose potential short-term risks to remedial workers and the public from potential exposure to impacted soil and NAPL during soil excavation/ISS treatment, off-site transportation of excavated material, and backfilling. Additionally, the excavation activities conducted under these alternatives would pose short-term risks from the operation of construction equipment, and generation of noise and dust. Potential short-term exposures to impacted groundwater could occur during installation of biosparging wells at the leading edge of the dissolved phase plume.

Nuisances to the surrounding community would include noise from driving sheeting and operating construction equipment as well as an increase in local truck traffic near recreational fields and through residential areas associated with importing backfill materials and transportation of excavated materials for off-site treatment/disposal. Estimated durations to implement each of the alternatives and number of truck trips required for each alternative are presented below.

- Alternative 1 – no time required and no truck trips
- Alternative 2 – 4 months and 600 truck trips
- Alternative 3 – 8 months and 1,980 truck trips
- Alternative 4 – 8 months and 1,540 truck trips
- Alternative 5 – 24 months and 7,850 truck trips

Additionally, under Alternatives 2, 3, and 4, if deemed necessary, installation of a biosparging system would require approximately 1 month to complete and the system would operate for an assumed 30-year period.

Potential exposures during remedial construction of these alternatives would be mitigated, to the extent practicable, by using appropriate PPE, air and work space monitoring, implementation of dust control and noise mitigation measures (as appropriate and if necessary based on monitoring results), and proper planning and training of remedial workers. Additionally, temporary enclosures would be utilized, to the extent practicable, to minimize the potential for exposures to the surrounding community during excavation activities.

Alternative 1 would have no carbon footprint. While Alternatives 2, 3, and 4 are considered to have moderate carbon footprints, Alternative 4 would address (i.e., through excavation and ISS treatment) a greater quantity of impacted soil with smaller carbon footprint, when compared to Alternative 3 (based on the number of truck trips). Alternative 5 has the greatest carbon footprint compared to the other alternatives. The greatest contribution to greenhouse gases would occur as a result of equipment operation during excavation, backfilling, and transportation activities.

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

6.1.2 Long-Term Effectiveness and Permanence

Although routine activities conducted within the project area do not include intrusive activities that could result in exposure to soil and groundwater containing MGP-related impacts, MGP-related impacts are present at depths greater than 2 feet bgs and groundwater is encountered at depths ranging from 12 to 15 feet bgs. Alternative 1 would not include the implementation of any remedial activities and therefore, would not address potential long-term exposures to or impacts from media that contain MGP-related impacts.

Alternatives 2, 3, and 4 each include periodic groundwater monitoring to document the extent and concentrations of dissolved phase impacts (i.e., confirm that concentrations of dissolved phase COCs continue to be stable and are not migrating toward the Village of Suffern well field). If, deemed necessary, the groundwater contingency could be implemented to address dissolved phase impacts near the leading edge of the plume.

Alternatives 2, 3, and 4 each include the establishment of institutional controls and development of an SMP to limit the potential for future exposures to MGP-related impacts. Although Alternative 2 would address the presence of former MGP structures (on the former MGP property) and shallow hardened tar (west of the abandoned railroad berm), relatively shallow (i.e., depths less than 10 feet bgs) visually impacted material would still remain on the former MGP property and the State of New Jersey property. Alternatives 3 and 4 would address the material most likely to be encountered by workers during future project area construction/redevelopment activities. However, solidified impacted material would remain (at depths greater than 5 feet bgs) under Alternative 4. The potential for future project area construction activities below the water table or the solidified mass is low. Therefore, Alternative 2 would rely more on the institutional controls and the SMP to mitigate future exposures, compared to Alternatives 3 and 4.

As Alternatives 2 and 3 do not address material below the water table, dissolved phase COC concentrations would likely not be reduced under these alternatives. Alternative 4 would address visually impacted material and soil containing total PAHs at concentrations greater than 500 mg/kg to depths up to 35 feet bgs. This alternative would address a significant percentage (approximately 75%) of the visually impacted material located below the water table (i.e., approximately 10,900 cy of the estimated 14,900 cy). Because the visually impacted material below the water table serves as a source of dissolved phase impacts, dissolved phase COC concentrations would likely be reduced over time following the ISS treatment activities, as the remaining visually impacted material is sporadically located throughout the project area. Under Alternatives 2, 3, and 4, the groundwater contingency (if implemented) would address the leading edge of the dissolved phase plume. Alternative 5 would likely restore groundwater quality, as all soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs would be excavated.

Alternative 5 would have the greatest degree of long-term effectiveness based on the removal of a vast majority of (if not all) visually impacted soil. However, Alternative 4 is also considered effective on a long-term basis. Under Alternative 4, visually impacted soil and soil containing total PAHs at a concentration greater than 500 mg/kg to depths up to 35 feet bgs would be removed or solidified in place. QA/QC sampling would be conducted to confirm that performance criteria are met (and material would be remixed if the criteria were not achieved). Additionally, through ISS treatment, Alternative 4 would likely reduce the concentrations of dissolved phase COCs (i.e., by solidifying materials serving as a source of dissolved phase impacts). Although concentrations would not be reduced to pre-release/pre-disposal conditions, as indicated above, groundwater monitoring would be conducted to document the extent and concentrations of dissolved phase impacts (which have not been detected in the Village of Suffern well field to date) and the groundwater contingency could be implemented, if necessary.

6.1.3 Land Use

The current zoning for the project area is listed as manufacturing. Areas immediately surrounding the project area are zoned for commercial and recreational use. The current and foreseeable future use of the area surrounding the project area is mixed commercial/recreational. Portions of project area will continue to be used by O&R as natural gas gate and regulator stations. A portion of the State of New Jersey property is used as a firing range. The Village of Suffern well field (i.e., a source for local drinking water) is located immediately west of the project area.

Implementation of Alternatives 1 through 5 is not anticipated to alter current or anticipated future use of the project area. Under each of the alternatives, the project area would be restored following the completion of remedial construction activities. As part of Alternatives 3, 4, and 5, the firing range currently located on the State of New

Jersey property would have to be relocated (i.e., either temporarily or permanently). Under Alternative 4, solidified material would remain at depths of 5 feet bgs and deeper, which may prohibit the construction of buildings with full basement levels. However, the slab-on-grade buildings could still be constructed at the project area and the design strength of the solidified mass would be low enough to allow for excavation (that would be conducted in accordance with an SMP).

As indicated previously, results of the on-going groundwater monitoring program (conducted since 1999), indicate that the dissolved phase COCs have not been detected at the most downgradient monitoring wells (and have not been detected in the Village water supply wells). Periodic groundwater monitoring would be continued under Alternatives 2, 3, and 4 to confirm that dissolved phase plume remains stable and does not migrate toward the well field. If the results of successive groundwater monitoring events indicate that dissolved phase COC concentrations are trending upward or if the leading edge of the dissolved phase plume is advancing toward the Village of Suffern well field, the groundwater contingency could be implemented as part of any of these alternatives to reduce dissolved phase COC concentrations at the leading edge of the dissolved phase plume.

6.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 1 would not actively treat, remove, recycle, or destroy impacted media and therefore, is considered the least effective for this criterion. Alternatives 2 through 5 each include the removal of former MGP structures (which serve as source of potentially mobile NAPL) and shallow hardened tar west of the abandoned railroad berm. Alternatives 2 and 3 would address visually impacted material and soil containing total PAHs at concentrations greater than 500 mg/kg through excavation and off-site transportation and treatment/disposal of excavated material, while Alternative 4 would address impacted material through a combination of excavation and ISS treatment that would solidify the impacted material in place. Alternative 5 would address visually impacted material through the removal of soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs. The total volume of soil and the volume of visually impacted soil addressed under each alternative are summarized in the following table.

Table 6.1 Soil Volumes

Alternative	Volume of Impacted Material[1] Addressed (cy)	Estimated % of Impacted Material Addressed (by volume)	Total Volume of Soil Addressed (cy)
Alternative 1 – No Action	0	0	0
Alternative 2 – Excavation of MGP Structures	4,000	15%	5,100
Alternative 3 – Excavation of Visually Impacted Soil up to the Groundwater Table	11,500	44%	16,500
Alternative 4 – Excavation and ISS	22,400	85%	28,800
Alternative 5 – Excavation to Unrestricted use SCOs	26,400	100%	63,500

Note:

1. Impacted material is defined as material containing visual impacts greater than sheen and blebs and material containing total PAHs at a concentration greater than 500 mg/kg.

Although Alternative 5 would address soil containing MGP-related COCs at concentrations greater than unrestricted use SCOs (through excavation), Alternative 4 would address approximately 85% of visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg (through excavation and ISS treatment). Alternatives 1, 2, and 3 are not anticipated to restore groundwater quality to pre-release conditions, as these alternatives do not address impacted soil located below the water table. However, a significant percentage (approximately 75%) of the material serving as a source of dissolved phase impacts would be addressed under Alternative 4. Alternative 5 would be expected to restore groundwater quality to pre-disposal/pre-release conditions due to the removal of a vast majority of (if not all) visually impacted soil.

Under Alternatives 2, 3, and 4, if necessary, based on the results of continued groundwater monitoring, the groundwater contingency would address the leading edge of the dissolved phase plume through biodegradation of dissolved phase COCs.

6.1.5 Implementability

No remedial activities would be conducted as part of Alternative 1 and therefore, Alternative 1 is considered the most implementable. Alternatives 2, 3, and 4 would include long-term groundwater monitoring, preparation of an SMP, and implementation of institutional controls on the former MGP and State of New Jersey properties, and potentially construction and operation of a biosparging system. From a technical implementability standpoint, these activities do not require highly specialized equipment or personnel and could be easily implemented. Administratively, establishing institutional controls would require coordination with state agencies (i.e., NYSDEC). Access agreements would be required to conduct downgradient groundwater monitoring activities on property not owned by O&R, However, the biosparging system would likely be constructed on the O&R gate station property.

Alternatives 2 through 5 each include the treatment or excavation of subsurface soil. ISS, removal, and transportation for off-site treatment/disposal are technically feasible remedial construction activities. Potential implementation challenges associated with conducting excavation activities at the O&R gate station include: vehicle/equipment access under the steel bridge associated with the abandoned railroad; conducting excavation activities in close proximity to gate station structures; conducting excavation and ISS activities near active rail lines; and excavating in areas where subsurface utilities are present (i.e., gas and water lines). O&R would assess potential options to temporarily bypass or reroute the portions of the gas distribution lines located within the proposed excavation area during the remedial design. Implementation/logistical challenges associated with conducting work on the former MGP and State of New Jersey properties include: maintaining access to the firing range (for Alternatives 3, 4, and 5); routing truck traffic near the recreational fields and residential areas; and conducting excavation and ISS treatment activities at the base of an embankment. Soil loading conditions from the embankment would be evaluated as part of the remedial design. Based on project area access concerns for transportation vehicles, transportation planning would be conducted prior to the remedial activities as full-size tractor trailers (e.g., 40 ton) may not be able to access the project area and remedial activities could be conducted at a time when the recreational fields are not in use and nearby residents are less likely to be outdoors (i.e., during cooler months).

Under Alternative 4, the ISS activities could potentially be limited by subsurface obstructions such as cobbles, debris, historical fill materials and subsurface former building foundations and slabs. Pre-ISS excavation would be conducted to identify obstructions and clear a minimum of the top 5 feet of fill material to allow for the expansion of solidified soil. Bucket mixing methods could be used to clear deeper obstructions and treat impacted soil (i.e., at depths up to 35 feet bgs based on equipment limitations).

Alternative 5 has the most significant implementation challenges based on the removal depths associated with the alternative (i.e., up to 102 feet bgs). Excavation of deeper soils could be conducted using reinforced slurry walls to serve as excavation support or excavation activities could be conducted in the wet (i.e., using a biopolymer slurry to maintain excavation sidewall support). Additionally, soil excavation activities could be conducted using augers to remove material at depths up to 60 feet bgs. Given the complex nature of conducting deep excavation activities (including water management), the final excavation support system(s) would be further evaluated and developed as part of the remedial design (if Alternative 5 was implemented).

6.1.6 Compliance with SCGs

- *Chemical-Specific SCGs*: Chemical-specific SCGs are presented in Table 1. Potentially applicable chemical-specific SCGs for soil include 6 NYCRR Part 375-6 SCOs, CP-51 *Soil Cleanup Guidance* (NYSDEC, 2010b) total PAH SCO of 500 mg/kg at non-residential sites, and 40 CFR Part 261 and 6 NYCRR Part 371 regulations for the identification of hazardous materials. Potentially applicable chemical-specific SCGs for groundwater include NYSDEC Class GA standards and guidance values.

  Alternative 4 would address visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg to a depth of up to 35 feet bgs using a combination of excavation and ISS. Alternative 5 would address soil containing COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs. Under each alternative, excavated material and process residuals would be managed and characterized in accordance with 40 CFR 261 and 6 NYCRR Part 371 regulations to determine off-site treatment/disposal requirements. NYS LDRs would apply to any materials that are characterized as a hazardous waste.

  As Alternatives 1, 2 and 3 do not address impacted soil below the water table, these alternatives would not be expected to achieve the groundwater SCGs within a determinate period of time. Alternative 4 would address soil containing visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg to depths up to 35 feet bgs. Because this material represents the majority of the source to dissolved phase impacts, residual dissolved phase impacts would likely be reduce by natural attenuation and Alternative 4 could achieve groundwater SCGs over a prolonged period of time. Alternative 5 would address a vast majority of (if not all) visually impacted material (i.e., which serves as a source for dissolved phase impacts), therefore groundwater SCGs would likely be achieved over a shorter period of time when compared to the other alternatives. If necessary under Alternatives 2, 3, and 4, implementation of the groundwater contingency would only be expected to achieve NYSDEC Class GA standards and guidance values at (and downgradient from) the leading edge of the dissolved phase plume (i.e., where the biosparging wells would be located).

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

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

- *Location-Specific SCGs*: Location-specific SCGs are presented in Table 3. Potentially applicable location-specific SCGs generally include regulations on conducting construction activities on flood plains. Compliance with these SCGs would be achieved by obtaining a joint USACE and NYSDEC permit prior to conducting project area activities under any alternative. Other applicable location-specific SCGs generally include Village of Suffern building/construction codes and ordinances, necessary street work permits, a Rockland County Stream Control Permit, and New Jersey Transit work permits. Local permits would be obtained prior to initiating any of the alternatives.

6.1.7 Overall Protection of Public Health and the Environment

As Alternative 1 does not include any active remedial measures or administrative controls, Alternative 1 is not considered protective of human health and the environment. Alternatives 2, 3, 4, and 5 would prevent exposure (i.e., direct contact, ingestion, and inhalation) to MGP-related impacts in soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2). Additionally, if dissolved phase groundwater impacts were observed to be migrating toward the well field, the groundwater contingency could be implemented under Alternatives 2, 3 and 4 to reduce dissolved phase COC concentrations at the leading edge of the dissolved phase plume. Alternative 2 would only include the removal of former MGP structures (on the former MGP property) and shallow hardened tar (west of the abandoned railroad berm) and would rely heavily on institutional controls and the protocols established by an SMP to reduce the potential for future exposures. Alternative 3 would include the excavation of visually impacted material and soil containing total PAHs at concentrations greater than 500 mg/kg above the water table (i.e., to depths of 12 to 15 feet bgs) and Alternative 4 would include excavation and ISS treatment of soil containing visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg to depths up to 35 feet bgs. Alternatives 3 and 4 would address (through removal and treatment) the material most likely to be encountered (i.e., impacted material above the water table) by workers during future project area construction/redevelopment activities on the former MGP and State of New Jersey properties. Relative to Alternative 2, Alternatives 3 and 4 would rely less on institutional controls to prevent future exposures to remaining impacts. Alternative 5 would prevent exposures to MGP-related impacts through the removal of soil containing COCs at concentrations greater than unrestricted use SCOs, thereby eliminating the need for institutional controls and an SMP.

Alternatives 2, 3, and 4 each work toward preventing the migration of MGP-related COCs and NAPL (soil RAO #3) and addressing the source of groundwater impacts (groundwater RAO #4) by excavating/treating varying amounts of visually impacted material (i.e., the dissolved phase plume would be expected to remain stable). However, Alternatives 2 and 3 do not address impacted soil below the water table. Therefore, Alternatives 2 and 3 are not anticipated to restore groundwater quality to pre-disposal/pre-release conditions (groundwater RAO #3). Alternative 4 addresses approximately 85% of the total estimated volume of visually impacted material and soil containing total PAHs at concentrations greater than 500 mg/kg. This includes a significant percentage (approximately 75%) of the impacted material located below the water table, which serves as the source of dissolved phase impacts. The remaining impacted material below the water table (i.e., that would not be addressed by Alternative 4) is sporadically located at depths greater than 35 feet bgs. If Alternative 4 restored groundwater quality to pre-disposal/pre-release conditions (groundwater RAO #3), it would be anticipated to occur over a prolonged period of time. However, based on the results of groundwater monitoring conducted at the project area since 1999, the extent of the dissolved phase plume is stable and dissolved phase COCs have not been detected in the most downgradient wells to date. As part of Alternatives 2, 3, and 4, if implemented, the groundwater contingency would only restore groundwater quality to pre-disposal/pre-release conditions at and downgradient of the leading edge of the dissolved phase plume (i.e., where the biosparging wells would be located).

Only Alternative 5 would be expected to restore groundwater quality to pre-disposal/pre-release conditions (groundwater RAO #3), prevent the migration of MGP-related COCs and NAPL (soil RAO #3) and address the source of groundwater impacts (groundwater RAO #4) through the removal of majority of soil (including visually impacted material).

6.1.8 Cost Effectiveness

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

Table 6.2 Estimated Costs

Alternative	Estimated Capital Cost	Estimated Present Worth Cost of O&M	Total Estimated[3] Cost
Alternative 1 – No Action	$0	$0	$0
Alternative 2 – Excavation of MGP Structures	$4,500,000	$1,600,000[1]	$6,100,000
Alternative 3 – Excavation of Visually Impacted Soil up to the Groundwater Table	$10,200,000	$1,600,000[1]	$11,800,000
Alternative 4 – Excavation and ISS	$10,600,000	$1,600,000[1]	$12,200,000
Alternative 5 – Excavation to Unrestricted use SCOs	$56,700,000	$300,000[2]	$57,000,000

Notes:
1. Estimated present worth of O&M cost is over an assumed 30-year period.
2. Estimated present worth of O&M cost is over an assumed 2-year period.
3. Assumes that groundwater contingency would not be implemented. Groundwater contingency would add an estimated $800,000 in capital costs and $4,200,000 in estimated present worth cost for O&M (assuming 30 years of O&M) for Alternatives 2, 3 and 4.

The capital cost to implement Alternative 5 is significantly greater relative to the other alternatives. As shown in Table 6.1, Alternative 5 includes the removal of more than two times the volume of soil addressed under Alternative 4 while only addressing 15% more visually impacted material. Although the high cost for Alternative 5 corresponds to the greatest removal volume, approximately 59% of the soil removed under Alternative 5 does not contain visual impacts or total PAHs at concentrations greater than 500 mg/kg. Additionally, Alternative 5 corresponds to the greatest disruption to the surrounding community and has greatest potential for exposures during implementation of the alternative. Therefore, Alternative 5 is considered the least cost effective compared to the short-term effectiveness; reduction of toxicity, mobility, and volume; and long-term effectiveness.

The capital cost to implement Alternative 4 is approximately $400,000 more than Alternative 3, while Alternative 4 addresses visually impacted material at depths up to 35 feet bgs and Alternative 3 only address visually impacted material to the top of the water (i.e., 12 to 15 feet bgs). Alternative 4 would address an additional 41% of visually impacted material (at a lesser cost) compared to Alternative 3. As indicated by the cost summary presented in Table 6.2, stabilizing impacted material in place is notably less expensive than excavating the impacted material, transporting the material off-site for treatment/disposal, and backfilling the excavation with imported material.

Although impacted material would remain under Alternative 4, visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg would be addressed at depths to depths up to 35 feet bgs (i.e., approximately 85% of the estimated total volume of visually impacted material) and visually impacted soil at depths greater than 35 feet bgs (i.e., approximately 15% of visually impacted material) is more sporadically distributed, not considered accessible, would be located below a minimum of 35 feet of imported fill and solidified material, and would not likely be encountered during future project area activities. As indicated previously, dissolved phase groundwater impacts have not migrated to the Village of Suffern well field to date and a significant volume of materials serving as a potential source to dissolved phase impacts would be addressed under Alternative 4. Alternative 4 would include periodic groundwater monitoring to confirm the extent of dissolved phase impacts. Additionally, the reduction of dissolved phase COC concentrations would be expected following ISS treatment activities. Therefore, Alternative 4 is considered the most cost effective.

6.2 Comparative Analysis Summary

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

Table 6.3 – Comparative Analysis Summary

Criteria	Alternative No.				
	1	2	3	4	5
Overall Protection (RAOs)					
Soil RAO 1	No	Yes	Yes	Yes	Yes
Soil RAO 2	No	Yes	Yes	Yes	Yes
Soil RAO 3	No	Limited	Limited	Likely	Yes
Groundwater RAO 1	No	Yes	Yes	Yes	Yes
Groundwater RAO 2	No	Yes	Yes	Yes	Yes
Groundwater RAO 3	No	No	No	Potentially	Likely
Groundwater RAO 4	No	Limited	Limited	Moderate	Yes
Reduction of Toxicity, Mobility, and Volume					
Volume and % of Visually Impacted Material Addressed	0 cy 0%	5,100 cy 15%	16,500cy 44%	28,800 cy 85%	63,500 cy 100%
Short Term Impacts					
Length of Disruption	None	4 Months	8 Months	8 Months	24 Months
Cost					
Total Cost[1]	$0	$6,100,000	$11,800,000	$12,200,000	$57,000,000

1. Assumes that the groundwater contingency would not be implemented. Groundwater contingency would add a total cost (i.e., capital plus O&M – present worth) of approximately $5,000,000 to Alternatives 2, 3 and 4) if implemented.

7. Preferred Remedial Alternative

The results of the comparative analysis (presented in Section 6) were used as a basis for identifying a preferred remedial alternative for the project area. The components of the preferred remedial alternative are presented in the following subsections.

7.1 Summary of Preferred Alternative

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

As described in Section 5 and presented in Table 8, the primary components of the Alternative 4 consist of the following:

- Removing shallow hardened tar located west of the abandoned railroad berm (estimated 2,600 cy).
- Conducting pre-ISS excavation activities to remove the former gas house structure, eastern gas holder, shallow obstructions that would potentially damage ISS equipment and/or prevent homogenous mixing, and a minimum of 5 feet of material in ISS areas allow material bulking (estimated 10,300 cy).
- Treating via ISS, visually impacted soil and soil containing total PAHs at concentrations greater than 500 mg/kg at depths up to 35 feet bgs (estimated 18,500 cy).
- Transporting and treating/disposing off-site, approximately 20,300 tons of excavated soil containing MGP-related impacts via LTTD.
- Backfilling excavation areas with approximately 10,300 cy of imported clean fill.
- Conducting periodic groundwater monitoring to document the extent and concentrations of dissolved phase COCs.
- Preparing an annual report to summarize periodic groundwater monitoring activities and results.

- Installing and operating a biosparging system near the leading edge of the dissolved phase plume (as a contingency measure if based on the results of continued groundwater monitoring, dissolved phase impacts appear to be migrating toward the well field).

- Establishing institutional controls on the former MGP site in the form of deed restrictions and environmental easements to control intrusive (i.e., subsurface) activities that could result in potential exposures to subsurface soil and groundwater containing MGP-related impacts at concentrations greater than commercial use SCOs.

- Preparing an SMP to document the following:

  - The institutional controls that have been established and will be maintained for the former MGP site

  - Extent of solidified soil in the project area

  - The nature and extent of impacts that would remain in the project area following implementation of the remedial alternative

  - Protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities in the project area and managing potentially impacted material encountered during these activities (including impacted material located beneath the abandoned railroad berm)

  - Protocols and requirements for conducting groundwater monitoring at the project area

  - Protocols for addressing significant changes in COC concentrations in groundwater based on the results of the groundwater monitoring activities

ISS is the primary component of the preferred alternative. ISS is a proven technology for addressing soil that contains MGP-related impacts, has been successfully implemented at other MGP sites, and is considered technically and administratively implementable. Implementation challenges associated with preferred remedial alternative are primarily related to conducting ISS treatment on the former MGP and State of New Jersey properties and excavation at the O&R gate station. Bench-scale testing would be required prior to the implementation of this alternative to identify an optimal mix design based on site-specific conditions. When using auger mixing methods, obstructions greater than six inches in diameter could prevent homogenous mixing and potentially damage ISS equipment. The ISS activities could potentially be limited by subsurface obstructions such as cobbles, debris, historical fill materials and subsurface former building foundations and slabs. Pre-ISS excavation would be conducted to identify obstructions and clear the top 5 to 10 feet of fill material to allow for the expansion of solidified soil. Bucket mixing methods could be used to clear deeper obstructions and treat impacted soil (i.e., at depths up to 35 feet bgs based on equipment limitations).

Additional implementation/logistical challenges associated with conducting work on the former MGP and State of New Jersey properties include: maintaining access to the firing range; routing truck traffic through the nearby recreational fields and residential area; and conducting excavation and ISS treatment activities at the base of an embankment. Soil loading conditions from the bank would be evaluated as part of the remedial design. Based on project area access concerns for transportation vehicles, transportation planning would be conducted prior to the remedial activities as full-size tractor trailers (e.g., 40 ton) may not be able to access the project area and remedial activities could be conducted at a time when the recreational fields are not in use and nearby residents are less likely to be outdoors (i.e., during cooler months). Potential implementation challenges associated with conducting activities at the O&R gate station include: vehicle/equipment access under the steel bridge associated with the abandoned railroad; conducting excavation activities in close proximity to gate station structures; conducting ISS activities near active rail lines; and excavating in areas where subsurface utilities are present (i.e., gas and water lines). O&R would assess potential options to temporarily bypass or reroute the portions of the gas distribution lines located within the proposed excavation area during the remedial design.

Potential short-term impacts to the surrounding community and workers would include potential exposure to soil and groundwater containing MGP-related COCs during excavation, soil mixing, material handling, and off-site transportation activities, as well as potential short-term exposures to impacted groundwater could occur during installation of biosparging wells at the leading edge of the dissolved phase plume (if necessary). The potential for exposure would be minimized through the use of appropriate field personnel, PPE, and by conducting work activities and air monitoring in accordance with a site-specific HASP that would be prepared as part of the remedial design.

Alternative 4 would prevent exposures (i.e., direct contact, ingestion, and inhalation) of MGP-related impacts in soil and groundwater (soil RAOs #1 and #2 and groundwater RAOs #1 and #2) through the removal and ISS treatment of visually impacted material at depths up to 35 feet bgs. If future intrusive activities were conducted within the project area that would result in removal of solidified material (or construction activities at depths greater than 35 feet bgs), the reduction of potential exposures would occur by adhering to the institutional controls and the procedures set forth in the SMP that would be established/prepared as part this alternative.

Alternative 4 would work toward preventing the migration of MGP-related COCs and NAPL (soil RAO #3) and addressing the source of groundwater impacts (groundwater RAO #4) through the removal/ISS treatment of approximately 85% of the visually impacted material, including material below the water table. While a reduction in the extent and concentrations of dissolved phase COCs is anticipated following remedial construction activities, because visually impacted material would remain below the water table (at depths greater than 35 feet bgs), Alternative 4 is not anticipated to restore groundwater quality to pre-disposal/pre-release conditions (groundwater RAO #3) in the short-term, but groundwater could potentially be restored over a prolonged period of time. The groundwater contingency, if implemented, would only restore groundwater quality to pre-disposal/pre-release conditions at the leading edge of the dissolved phase plume (i.e., where the biosparging wells would be located).

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

- An estimated 85% of the total volume of visually impacted material and material containing total PAHs at concentrations greater than 500 mg/kg would be addressed through excavation and ISS treatment. This includes a significant percentage (approximately 75%) of the impacted material located below the water table, which serves as the source of dissolved phase impacts.

- Alternative 4 would address more visually impacted material than Alternative 3 (which would address an estimated 44% of visually impacted material) at a lower cost than Alternative 3.

- Alternative 4 has a lower carbon footprint than Alternatives 3 and 5 based on the number of truck trips.

- Remedial construction activities associated with Alternative 4 would require 8 months to implement, compared to Alternative 5 which would require approximately 24 months to complete, and is thereby less disruptive to the surrounding community.

- Alternative 5 is not a cost-effective alternative, given the duration of remedial construction activities, potential for exposure during remediation, and associated duration of disruption to the surrounding community.

- From a sustainability perspective, through the stabilization of impacted soil, Alternative 4 significantly reduces the volume of excavated soil that may otherwise require transportation for off-site treatment/disposal and reduces the volume of imported material that would be required to backfill excavation areas.

- Based on current project area groundwater monitoring activities, dissolved phase impacts are stable and have not migrated to the Village of Suffern well field to date. Through ISS treatment, dissolved phase COC concentrations are anticipated to reduce to some degree (which would be documented through continued periodic groundwater monitoring as part of Alternative 4). As indicated previously, if the results of the periodic monitoring indicate that concentrations of dissolved phase COCs are trending upward or the dissolved phase plume is migrating toward the well field, the groundwater contingency could be implemented. A PDI and pilot testing would be required prior to constructing the groundwater contingency to determine design components. As described in Section 5, the groundwater remedy could potentially consist of a biosparging system that would be used to facilitate biodegradation of dissolved phase COCs at the leading edge of the plume.

7.2 Estimate Cost of Preferred Alternative

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

Table 7.1 Cost Estimate for the Preferred Remedial Alternative

Alternative	Estimated Capital Cost	Estimated Present Worth Cost of O&M[1]	Total Estimated Cost
Alternative 4 – Excavation and ISS	$10,600,000	$1,600,000	$12,200,000

1. Assumes that the groundwater contingency would not be implemented. Groundwater contingency would add a total cost (i.e., capital plus O&M – present worth) of approximately $5,000,000 to Alternative 4) if implemented.

8. References

ERM, 1987. Remedial Investigation Report, Suffern Well Field, Contract No. D001234.

RETEC, 1996. Initial Hazard Investigation and Assessment: Suffern, Middletown-Fulton Street, and Haverstraw Former Manufactured Gas Plant Sites, prepared for Orange and Rockland Utilities.

RETEC, 1997. Preliminary Site Assessment for Suffern, New York Former Manufactured Gas Plant Site, prepared for Orange and Rockland Utilities.

GEI, 1998. Remedial Investigation Work Plan for the Suffern Former Manufactured Gas Plant Site, Suffern, New York, prepared for Orange and Rockland Utilities. September 1998.

GEI, 2010. *Remedial Investigation Report* Suffern Former MGP Site, prepared for Orange and Rockland Utilities. October, 2010.

NYSDEC, 1998. Ambient Water Quality Standards and Guidance Values, Division of Water Technical and Operational Guidance Series (TOGS 1.1.1), October, and addendums added: January, 1999, April 2000, and June 2004.

GEI, 2000. Remedial Investigation Work Plan for the Suffern Former Manufactured Gas Plant Site, Suffern, New York, prepared for Orange and Rockland Utilities. September 2000.

GRI, 1996. *Management of Manufactured Gas Plant Sites: The Gas Research Institute's Two Volume Practical Reference Guide, Volumes I & 2* GRI-96/0470.1 & GRI-96/0470.2, Chicago, IL, June 1996.

RETEC, 2001. Supplemental Remedial Investigation Work Plan for Suffern Former Manufactured Gas Plant Site, Suffern, NY, prepared for Orange and Rockland Utilities. November 2001.

NYSDEC, 2002. *Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from Former Manufactured Gas Plants* (DER-4), January 11, 2002.

NYSDEC, 2004. *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations* (TOGS 1.1.1), Reissued June 1998 and addended April 2000 and June 2004.

NYSDEC, 2006a. Rules and Regulations, 6 NYCRR Subpart 375-6, Remedial Program Soil Cleanup Objectives, dated December 14, 2006.

NYSDEC, 2010. DER-10 Technical Guidance for Site Investigation and Remediation. May 3, 2010.

NYSDEC, 2010, CP-51 Soil Cleanup Guidance, October 21, 2010

USEPA, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, October 1988.

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Tables

Table 1
Summary of Chemical-Specific SCGs

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
National Primary Drinking Water Standards	40 CFR Part 141	S	Establishes maximum contaminant levels (MCLs) which are health-based standards for public water supply systems.	These standards are potentially applicable if an action involves future use of ground water as a public supply source.
RCRA-Regulated Levels for Toxic Characteristics Leaching Procedure (TCLP) Constituents	40 CFR Part 261	S	These regulations specify the TCLP constituent levels for identification of hazardous wastes that exhibit the characteristic of toxicity.	Excavated materials may be sampled and analyzed for TCLP constituents prior to disposal to determine if the materials are hazardous based on the characteristic of toxicity.
Universal Treatment Standards/Land Disposal Restrictions (UTS/LDRs)	40 CFR Part 268	S	Identifies hazardous wastes for which land disposal is restricted and provides a set of numerical constituent concentration criteria at which hazardous waste is restricted from land disposal (without treatment).	Applicable if waste is determined to be hazardous and for remedial alternatives involving off-site land disposal.
New York State				
NYSDEC Guidance on Remedial Program Soil Cleanup Objectives	6 NYCRR Part 375	G	Provides an outline for the development and execution of the soil remedial programs. Includes soil cleanup objective tables.	These guidance values are to be considered, as appropriate, in evaluating soil quality.
Soil Cleanup Guidance	CP-51	G	Provides the framework and policies for the selection of soil cleanup levels.	Guidance would be used to develop site-specific soil cleanup objectives (SCOs).
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	S	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 6 NYCRR Parts 371-376.	Applicable for determining if materials generated during implementation of remedial activities are hazardous wastes. These regulations do not set cleanup standards, but are considered when developing remedial alternatives.
"Contained-In" Criteria for Environmental Media: Soil Action Levels	TAGM 3028	G	May eliminate need for management of waste as hazardous waste based on established generic health-based "contained-in" levels for listed hazardous wastes.	May be appropriate and relevant for certain remedial alternatives.
NYSDEC Ambient Water Quality Standards and Guidance Values	Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1	G	Provides a compilation of ambient water quality standards and guidance values for toxic and non-conventional pollutants for use in the NYSDEC programs.	These standards are to be considered in evaluating groundwater and surface water quality.
New York State Surface Water and Groundwater Quality Standards	6 NYCRR Parts 700-705	S	Establishes quality standards for surface water and groundwater.	Potentially applicable for assessing water quality at the site during remedial activities.

Table 2
Summary of Action-Specific SCGs

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
Occupational Safety and Health Act (OSHA) - General Industry Standards	29 CFR Part 1910	S	These regulations specify the 8-hour time-weighted average concentration for worker exposure to various compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is not possible to maintain the work atmosphere below required concentrations. Appropriate training requirements will be met for remedial workers.
OSHA - Safety and Health Standards	29 CFR Part 1926	S	These regulations specify the type of safety equipment and procedures to be followed during site remediation.	Appropriate safety equipment will be on-site and appropriate procedures will be followed during remedial activities.
OSHA - Record-keeping, Reporting and Related Regulations	29 CFR Part 1904	S	These regulations outline record-keeping and reporting requirements for an employer under OSHA.	These regulations apply to the company(s) contracted to install, operate and maintain remedial actions at hazardous waste sites.
RCRA - Preparedness and Prevention	40 CFR Part 264.30 - 264.31	S	These regulations outline requirements for safety equipment and spill control when treating, handling and/or storing hazardous wastes.	Safety and communication equipment will be installed at the site as necessary. Local authorities will be familiarized with the site.
RCRA - Contingency Plan and Emergency Procedures	40 CFR Part 264.50 - 264.56	S	Provides requirements for outlining emergency procedures to be used following explosions, fires, etc. when storing hazardous wastes.	Emergency and contingency plans will be developed and implemented during remedial design. Copies of the plan will be kept on-site.
90 Day Accumulation Rule for Hazardous Waste	40 CFR Part 262.34	S	Allows generators of hazardous waste to store and treat hazardous waste at the generation site for up to 90 days in tanks, containers and containment buildings without having to obtain a RCRA hazardous waste permit.	Potentially applicable to remedial alternatives that involve the storing or treating of hazardous materials on-site.
Land Disposal Facility Notice in Deed	40 CFR Parts 264 and 265 Sections 116-119(b)(1)	S	Establishes provisions for a deed notation for closed hazardous waste disposal units, to prevent land disturbance by future owners.	The regulations are potentially applicable because closed areas may be similar to closed RCRA units.
Federal Power Act of 1920	16 USC 79la et.seq. 18 CFR 1-149	S	Authorizes the Federal Energy Regulatory Agency (FERC) to issue licenses for hydropower dams.	Remedial alternatives involving alteration of dam operations would require consideration of existing permits.
RCRA - General Standards	40 CFR Part 264.111	S	General performance standards requiring minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products. Also requires decontamination or disposal of contaminated equipment, structures and soils.	Decontamination actions and facilities will be constructed for remedial activities and disassembled after completion.
Standards Applicable to Transporters of Applicable Hazardous Waste - RCRA Section 3003	40 CFR Parts 170-179, 262, and 263	S	Establishes the responsibility of off-site transporters of hazardous waste in the handling, transportation and management of the waste. Requires manifesting, recordkeeping and immediate action in the event of a discharge.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
United States Department of Transportation (USDOT) Rules for Transportation of Hazardous Materials	49 CFR Parts 107 and 171.1 - 172.558	S	Outlines procedures for the packaging, labeling, manifesting and transporting of hazardous materials.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
Clean Air Act-National Ambient Air Quality Standards	40 CFR Part 60	S	Establishes ambient air quality standards for protection of public health.	Remedial operations will be performed in a manner that minimizes the production of benzene and particulate matter.
USEPA-Administered Permit Program: The Hazardous Waste Permit Program	RCRA Section 3005; 40 CFR Part 270.124	S	Covers the basic permitting, application, monitoring and reporting requirements for off-site hazardous waste management facilities.	Any off-site facility accepting hazardous waste from the site must be properly permitted. Implementation of the site remedy will include consideration of these requirements.
Land Disposal Restrictions	40 CFR Part 368	S	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes Universal Treatment Standards (UTSs) to which hazardous waste must be treated prior to land disposal.	Excavated materials that display the characteristic of hazardous waste or that are decharacterized after generation must be treated to 90% constituent concentration reduction capped at 10 times the UTS.
RCRA Subtitle C	40 U.S.C. Section 6901 et seq.; 40 CFR Part 268	S	Restricts land disposal of hazardous wastes that exceed specific criteria. Establishes UTSs to which hazardous wastes must be treated prior to land disposal.	Potentially applicable to remedial activities that include the dredging and disposal waste material from the site.

Table 2
Summary of Action-Specific SCGs

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
New York State				
NYSDEC's Monitoring Well Decommissioning Guidelines	NPL Site Monitoring Well Decommissioning dated May 1995	G	This guidance presents procedure for abandonment of monitoring wells at remediation sites.	This guidance is applicable for soil or groundwater alternatives that require the decommissioning of monitoring wells onsite.
Guidelines for the Control of Toxic Ambient Air Contaminants	DAR-1 (Air Guide 1)	G	Provides guidance for the control of toxic ambient air contaminants in New York State and outlines the procedures for evaluating sources of air pollution.	This guidance may be applicable for soil or groundwater alternatives that results in certain air emissions.
New York Permits and Certificates	6 NYCRR Part 201	G	Provides instructions and regulations for obtaining a permit to operate air emission source.	Permits are not required for remedial actions taken at hazardous waste sites; however, documentation for relevant and appropriate permit conditions would be provided to NYSDEC prior to and during implementation of this alternative.
New York State Air Quality Classification System	6 NYCRR Part 256	G	Outlines the air quality classifications for different land uses and population densities.	Air quality classification system will be referenced during the treatment process design.
New York Air Quality Standards	6 NYCRR Part 257	G	Provides air quality standards for different chemicals (including those found at the site), particles, and processes.	Emissions from the treatment process will meet the air quality standards.
Discharges to Public Waters	New York State Environmental Conservation Law, Section 71-3503	S	Provides that a person who deposits gas tar, or the refuse of a gas house or gas factory, or offal, refuse, or any other noxious, offensive, or poisonous substances into any public waters, or into any sewer or stream running or entering into such public waters, is guilty of a misdemeanor.	During the remedial activities, MGP-impacted materials will not be deposited into public waters or sewers.
New York Hazardous Waste Management System - General	6 NYCRR Part 370	S	Provides definitions of terms and general instructions for the Part 370 series of hazardous waste management.	Hazardous waste is to be managed according to this regulation.
Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	S	Outlines criteria for determining if a solid waste is a hazardous waste and is subject to regulation under 6 NYCRR Parts 371-376.	Applicable for determining if solid waste generated during implementation of remedial activities are hazardous wastes. These regulations do not set cleanup standards, but are considered when developing remedial alternatives.
Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities	6 NYCRR Part 372	S	Provides guidelines relating to the use of the manifest system and its recordkeeping requirements. It applies to generators, transporters and facilities in New York State.	This regulation will be applicable to any company(s) contracted to do treatment work at the site or to transport or manage hazardous material generated at the site.
New York Regulations for Transportation of Hazardous Waste	6 NYCRR Part 372.3 a-d	S	Outlines procedures for the packaging, labeling, manifesting and transporting of hazardous waste.	These requirements will be applicable to any company(s) contracted to transport hazardous material from the site.
Waste Transporter Permits	6 NYCRR Part 364	S	Governs the collection, transport and delivery of regulated waste within New York State.	Properly permitted haulers will be used if any waste materials are transported off-site.
NYSDEC Technical and Administrative Guidance Memorandums (TAGMs)	NYSDEC TAGMs	G	TAGMs are NYSDEC guidance that are to be considered during the remedial process.	Appropriate TAGMs will be considered during the remedial process.
New York Regulations for Hazardous Waste Management Facilities	6 NYCRR Part 373.1.1 - 373.1.8	S	Provides requirements and procedures for obtaining a permit to operate a hazardous waste treatment, storage and disposal facility. Also lists contents and conditions of permits.	Any off-site facility accepting waste from the site must be properly permitted.
Land Disposal of a Hazardous Waste	6 NYCRR Part 376	S	Restricts land disposal of hazardous wastes that exceed specific criteria.	New York defers to USEPA for UTS/LDR regulations.
NYSDEC Guidance on the Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from Former Manufactured Gas Plants	TAGM 4061 (DER-4)	G	Outlines the criteria for conditionally excluding coal tar waste and impacted soils from former MGPs which exhibit the hazardous characteristic of toxicity for benzene (D018) from the hazardous waste requirements of 6 NYCRR Parts 370 - 374 and 376 when destined for thermal treatment.	This guidance will be used as appropriate in the management of MGP-impacted soil and coal tar waste generated during the remedial activities.
National Pollutant Discharge Elimination System (NPDES) Program Requirements, Administered Under New York State Pollution Discharge Elimination System (SPDES)	40 CFR Parts 122 Subpart B, 125, 301, 303, and 307 (Administered under 6 NYCRR 750-758)	S	Establishes permitting requirements for point source discharges; regulates discharge of water into navigable waters including the quantity and quality of discharge.	Removal activities may involve treatment/disposal of water. If so, water generated at the site will be managed in accordance with NYSDEC SPDES permit requirements.

Table 3
Summary of Location-Specific SCGs

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

Regulation	Citation	Potential Standard (S) or Guidance (G)	Summary of Requirements	Applicability to the Remedial Design/Remedial Action
Federal				
National Environmental Policy Act Executive Orders 11988 and 11990	40 CFR 6.302; 40 CFR Part 6, Appendix A	S	Requires federal agencies, where possible, to avoid or minimize adverse impact of federal actions upon wetlands/floodplains and enhance natural values of such. Establishes the "no-net-loss" of waters/wetland area and/or function policy.	Remedial activities are conducted within the 100-year floodplain.
Historical and Archaeological Data Preservation Act	16 USC 469a-1	S	Provides for the preservation of historical and archaeological data that might otherwise be lost as the result of alteration of the terrain.	The National Register of Historic Places website indicated two records present for historical sites in the immediate vicinity of the MGP site (i.e., US Post Office and Washington Avenue Soldier's Monument and Triangle).
National Historic and Historical Preservation Act	16 USC 470; 36 CFR Part 65; 36 CFR Part 800	S	Requirements for the preservation of historic properties.	The National Register of Historic Places website indicated several historic sites are present within 0.4 miles of the MGP site (i.e., US Post Office and Washington Avenue Soldier's Monument and Triangle).
Hazardous Waste Facility Located on a Floodplain	40 CFR Part 264.18(b)	S	Requirements for a treatment, storage and disposal (TSD) facility built within a 100-year floodplain.	Hazardous waste TSD activities (if any) will be designed to comply with applicable requirements cited in this regulation.
Floodplains Management and Wetlands Protection	40 CFR 6 Appendix A	S	Activities taking place within floodplains and/or wetlands must be conducted to avoid adverse impacts and preserve beneficial value. Procedures for floodplain management and wetlands protection provided.	Remedial activities will be conducted within the 100-year floodplain.
New York State				
New York State Floodplain Management Development Permits	6 NYCRR Part 500	S	Provides conditions necessitating NYSDEC permits and provides definitions and procedures for activities conducted within floodplains.	Potentially applicable to remedial activities conducted within the 100-year flood plain (i.e., the site).
New York State Freshwater Wetlands Act	ECL Article 24 and 71; 6 NYCRR Parts 662-665	S	Activities in wetlands areas must be conducted to preserve and protect wetlands.	Does not appear to be applicable as the site is not located in a wetlands area.
New York State Parks, Recreation, and Historic Preservation Law	New York Executive Law Article 14	S	Requirements for the preservation of historic properties.	The National Register of Historic Places website indicated two records present for historical sites in the immediate vicinity of the MGP site (i.e., US Post Office and Washington Avenue Soldier's Monument and Triangle).
Floodplain Management Criteria for State Projects	6 NYCRR Part 502	S	Establishes floodplain management practices for projects involving state-owned and state-financed facilities.	The area to be remediated is located within the 100-year floodplain. Therefore activities conducted at the site would be performed in accordance with this regulation.
Local				
Local Building Permits	N/A	S	Local authorities may require a building permit for any permanent or semi-permanent structure, such as an on-site water treatment system building or a retaining wall.	Substantive provisions are potentially applicable to remedial activities that require construction of permanent or semi-permanent structures.
Local Street Work Permits	N/A	S	Local authorities will require a permits for conducting work within and closing local roadways.	Street work permits will be required to conduct remedial activities within public roadways.
Rockland County Stream Control Act Permit	N/A	S	Permits are required for construction activity within 100 feet of the channel lines of any Official Regulated Stream.	Stream control permit may be required to conduct remedial construction activities.
New Jersey Transit Permit	N/A	S	Railroads typically require permits for conducting excavation/invasive activities within or near railroad right-of-ways.	NJ Transit permits may be required for conducting work within/near the railroad right-of-way.

Table 4
Remedial Technology Screening Evaluation for Soil

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
No Action	No Action	No Action	Alternative would not include any remedial action. A No Action alternative serves as a baseline for comparison of the overall effectiveness of other remedial alternatives. Consideration of a No Action alternative is required by the NYSDEC DER-10.	Implementable.	Would not achieve the RAOs for soil in an acceptable time frame.	Yes
Institutional Controls	Institutional Controls	Deed Restrictions, Environmental Land Use Restrictions, Enforcement and Permit Controls, Informational Devices	Institutional controls would include legal and/or administrative controls that mitigate the potential for exposure to impacted soils and/or jeopardize the integrity of a remedy. Examples of potential institutional controls include establishing land use restrictions, health and safety requirements for subsurface activities.	Implementable.	When properly implemented and followed, this technology could reduce potential human exposures, and may be effective when combined with other technology processes. Would help to meet the RAO of reducing human exposure to impacted soil. May not achieve RAOs for environmental protection.	Yes
In-Situ Containment/ Control	Capping	Soil Cap	Placing and compacting soil/gravel material over impacted soil to provide a physical barrier to human and biota exposure to impacted soil at the site.	Implementable. Equipment and materials necessary to construct the cap are readily available.	Although construction of a cap is readily implementable, the presence of a surface cap would not achieve a majority of the site-specific RAOs.	No
		Asphalt/Concrete Cap	Application of a layer of asphalt or concrete over impacted soils.			No
		Multi-Media Cap	Application of a combination of clay/soils and synthetic membrane(s) over impacted soil.			No
In-Situ Treatment	Immobilization	Solidification/ Stabilization	Addition of material to the impacted soil that limits the solubility and mobility of NAPL and COCs in soil and groundwater. Involves treating soil to produce a stable material with low leachability that physically and chemically locks NAPL and COCs in the solidified matrix.	Potentially implementable. Solidification/stabilization materials are readily available. The presence of subsurface obstructions (i.e., former MGP structures and utilities) could hinder the ability for implementation of this technology process. Localized changes in hydrogeology could cause changes in groundwater flow paths and water table elevations. Depth of impacted soils (>90 feet below grade) would limit the implementability of this technology.	Technology has been successfully implemented at other MGP sites. Overall effectiveness of this process would need to be confirmed during a bench-scale treatability study. Assuming an effective stabilization mix could be developed, this technology would effectively address each of the RAOs for soil.	Yes
	Extraction/In-Situ Stripping	Dynamic Underground Stripping and Hydrous Pyrolysis/Oxidation (DUS/HPO)	Steam is injected into the subsurface to mobilize contaminants and NAPLs. The mobilized contaminants are captured and constituents are recondensed, collected, and treated. In addition, HPO can degrade contaminants in subsurface heated zones. In most cases, this technology requires long-term operation and maintenance of on-site injection, collection and/or treatment systems.	Technically implementable. This option would require a pilot scale study to determine effectiveness. Process may result in uncontrolled NAPL migration. Limited space for vapor recovery system and treatment. Not a preferred technology process due to risks and potential technical implementability issues.	Could potentially promote NAPL mobilization. Focused on saturated zone. Alone, this technology would not effectively address the RAO of preventing direct exposure to impacted soil.	No

Table 4
Remedial Technology Screening Evaluation for Soil

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
In-Situ Treatment	Chemical Treatment	Chemical Oxidation	Oxidizing agents are added to oxidize and reduce the mass of organic constituents In-situ chemical oxidation involves the introduction of chemicals such as ozone, hydrogen peroxide, magnesium peroxide, sodium persulfate or potassium permanganate. A pilot study would be required to evaluate/determine oxidant application requirements. May not effectively oxidize NAPL.	Implementable. Equipment and materials necessary to inject/apply oxidizing agents are readily available. May require special provisions for storage of process chemicals.	Would require multiple treatments of chemicals to reduce COCs. Would not be effective at treating NAPL and NAPL-containing soil. May not be a cost effective means to achieve the RAOs. Chemical injection near a public well would likely result in a negative public reaction.	No
	Chemical Treatment (cont'd)	Surfactant/Cosolvent Flushing	A surfactant or cosolvent solution is delivered and extracted by a network of injection and extraction wells to flush the NAPL source area. Reduction of the NAPL mass occurs by increasing the dissolution of the NAPL or selected constituents or by increasing the NAPL mobility with reduction of the interfacial tension between the NAPL and groundwater and/or reduction of the NAPL viscosity. A bench scale and treatability study would be required to determine surfactant/cosolvent solution.	Implementable. Equipment and materials necessary to inject/apply oxidizing agents are readily available. May require special provisions for storage of process chemicals.	Overall effectiveness of this process would need to be evaluated during a bench and field-scale pilot test to determine the site-specific design. Would not be effective at treating all NAPL and NAPL-containing soil. Has the ability to achieve the RAOs. Chemical injection near a public well would likely result in a negative public reaction and could impact drinking water supply.	No
	Biological Treatment	Biodegradation	Natural biological and physical processes that, under favorable conditions, act without human intervention to reduce the mass, volume, concentration, toxicity, and/or mobility of COCs. This process relies on long-term monitoring to demonstrate the reduction of impacts.	Implementable.	Less effective for PAHs; not effective for NAPLs; would not achieve RAOs in an acceptable time frame.	No
		Enhanced Biodegradation	Addition of amendments (e.g., oxygen, nutrients) and controls to the subsurface to enhance indigenous microbial populations to improve the rate of natural degradation.	Implementable.	May not achieve RAOs for soil. Not effective for NAPLs.	No
		Biosparging	Air/oxygen injection wells are installed within the impacted regions to enhance biodegradation of constituents by increasing oxygen availability. Low-flow injection technology may be incorporated. This technology requires long-term monitoring.	Implementable.	May not achieve RAOs for soil. Not effective for NAPLs.	No
Removal	Excavation	Excavation	Physical removal of impacted soil. Typical excavation equipment would include excavators, backhoes, loaders, and/or dozers. Extraction wells and pumps or other methods may be used to obtain hydraulic control to facilitate use of typical excavation equipment to physically remove soil.	Implementable. Equipment capable of excavating the soil is readily available. However, complete soil removal (i.e., to depths up to 100 feet below grade) may not be technically practicable.	Would achieve RAOs. Proven process for effectively removing impacted soil.	Yes
	NAPL Removal	Active Removal	Process by which automated pumps are utilized to remove DNAPL from recovery wells.	Technically implementable.	NAPL does not appear to be migrating laterally and has not accumulated in any site wells to date and therefore, NAPL removal would not be effective.	No
		Passive Removal	NAPL is passively collected in vertical wells and periodically removed (i.e., via bottom-loading bailers, manually operated pumps, etc.).	Technically implementable.		No

Table 4
Remedial Technology Screening Evaluation for Soil

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
Removal		Hot Water/Steam Injection	Process involves the injection of hot water and/or steam to heat groundwater and decrease the viscosity of DNAPL to facilitate mobilization and removal. Used in conjunction with one (or more) of the above recovery technologies.	Technically feasible.	This process may facilitate uncontrolled migration of NAPL. Would not meet the RAOs as a stand-alone technology.	No
Ex-Situ On-Site Treatment/Disposal	Immobilization	Solidification/ Stabilization	Addition of material to excavated soil that limits the solubility or mobility of the constituents present. Involves treating soil to produce a stable material with low leachability, that physically and chemically locks the constituents within the solidified matrix.	Technically implementable. Limitations of space and public concerns due to the proximity of recreational fields limits the implementability of this technology. Pilot study would be needed to verify implementability.	May achieve RAOs. Proven process for effectively reducing mobility and toxicity of NAPL and organic and inorganic constituents. Overall effectiveness of this process would need to be evaluated during a bench-scale study.	No
	Extraction	Low-Temperature Thermal Desorption	Process by which soils containing organics with boiling point temperatures less than 800° Fahrenheit are excavated, conditioned, and heated; the organic compounds are desorbed from the soils into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction. Treated soils are returned to the subsurface. Treatment is conducted in a thermal treatment unit that is mobilized or constructed on-site.	Not considered implementable due to close proximity of populated areas. Potential issues with processing soil given site setting near public recreational fields.	Proven process for effectively removing organic constituents from excavated soil. The efficiency of the system and rate of removal of organic constituents would require evaluation during bench-scale and/or pilot-scale testing.	No
	Thermal Destruction	Incineration	Use of a mobile incineration unit installed on-site for high temperature thermal destruction of the organic compounds present in the media. Soils are excavated and conditioned prior to incineration. Treated soils are returned to the subsurface.	Not considered implementable due to close proximity of populated areas. Potential issues with processing soil given site setting near public recreational fields.	Proven process for effectively addressing organic constituents. The efficiency of the system and rate of removal of organic constituents would need to be verified during bench-scale and/or pilot-scale testing.	No
	Chemical Treatment	Chemical Oxidation	Addition of oxidizing agents to degrade organic constituents to less-toxic by-products.	Implementable. Equipment and materials necessary to apply oxidizing agents are available. Large amounts of oxidizing agents may be required. Limited space for soil management and application of the chemical oxidation. May require special provisions for storage of process chemicals.	Not known to be effective for NAPL.	No
	On-Site Disposal	RCRA Landfill	Construction of a landfill that would meet RCRA requirements.	Space limitations make on-site disposal infeasible.	This technology process would be effective at meeting the RAOs for soil. Excavated material would be contained in an appropriately constructed soil management cell. Long-term effectiveness requires ongoing maintenance and monitoring.	No
		Solid Waste Landfill	Construction of a landfill that would meet NYSDEC solid waste requirements.			No

Table 4
Remedial Technology Screening Evaluation for Soil

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
Off-Site Treatment/Disposal	Recycle/ Reuse	Asphalt Concrete Batch Plant	Soil is used as a raw material in asphalt concrete paving mixtures. The impacted soil is transported to an off-site asphalt concrete facility and can replace part of the aggregate and asphalt concrete fraction. The hot-mix process melts asphalt concrete prior to mixing with aggregate. During the cold-mix process, aggregate is mixed at ambient temperature with an asphalt concrete/water emulsion. Organics and inorganics are bound in the asphalt concrete. Some organics may volatilize in the hot-mix.	Permitted facilities and demand are limited.	Effective for treating organics and inorganics through volatilization and/or encapsulation. Thermal pre-treatment may be required to prevent leaching. Limited number of projects to support comparison of effectiveness.	No
		Brick/Concrete Manufacture	Soil is used as a raw material in manufacture of bricks or concrete. Heating in ovens during manufacture volatilizes organics and some inorganics. Other inorganics are bound in the product.	The site does not have the adequate space necessary to conduct the amount of screening of the material required to be performed prior to being utilized in brick/concrete manufacture.	Effective for treating organics and inorganics through volatilization and/or vitrification. A bench-scale/pilot study may be necessary to determine effectiveness.	No
		Co-Burn in Utility Boiler	Soil is blended with feed coal to fire a utility boiler used to generate steam. Organics are destroyed.	Permitted facilities available for burning MGP soils are limited.	Effective for treating organic constituents. Soil would be blended with coal prior to burning. Overall effectiveness of this process would need to be evaluated during a trial burn.	No
	Extraction	Low-Temperature Thermal Desorption	Process by which soils containing organics with boiling point temperatures less than 800o Fahrenheit are heated and the organic compounds are desorbed from the soils into an induced airflow. The resulting gas is treated either by condensation and filtration or by thermal destruction. Would be used on materials that are determined to be characteristically hazardous based on TCLP analysis.	Implementable. Treatment facilities are available.	Effective means for treatment of materials that are characteristically hazardous due to the presence of organic compounds (i.e., benzene).	Yes
	Thermal Destruction	Incineration	Soils are incinerated off-site for high temperature thermal destruction of the organic compounds present in the media. Soils are excavated and conditioned prior to incineration.	Not a cost effective means for treating impacted soil. Limited number of treatment facilities. LTTD is a more appropriate technology process for thermally treating MGP-impacted media.	Proven process for effectively addressing organic constituents. The efficiency and effectiveness of the system and rate of removal of organic constituents would need to be verified during bench-scale and/or pilot-scale testing.	No
	Off-Site Disposal	Solid Waste Landfill	Disposal of non-hazardous soil and C&D debris in an existing permitted non-hazardous landfill.	Implementable.	Proven process that, in conjunction with excavation, can effectively achieve the RAOs.	Yes
		Subtitle C Landfill	Disposal of impacted soil in an existing Subtitle C landfill facility.	Not implementable. Hazardous material would not meet New York State LDRs and UTSs without pre-treatment. Effective pre-treatment would be cost prohibitive when considering DER-4 exemption of D018 characteristically hazardous material.	Proven process that, in conjunction with excavation, can effectively achieve the RAOs.	No

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

Table 5
Remedial Technology Screening Evaluation for Groundwater

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
No Action	No Action	No Action	Alternative would not include any remedial action. A No Action alternative serves as a baseline for comparison of the overall effectiveness of other remedial alternatives. Consideration of a No Action alternative is required by the NYSDEC DER-10.	Implementable.	Would not achieve the RAOs for groundwater in an acceptable time frame.	Yes
Institutional Controls	Institutional Controls	Deed Restrictions, Groundwater Use Restriction, Enforcement and Permit Controls, Informational Devices	Institutional controls would include legal and/or administrative controls that mitigate the potential for exposure to impacted materials and/or jeopardize the integrity of a remedy. Examples of potential institutional controls include establishing land use restrictions, health and safety requirements for subsurface activities, and restrictions on groundwater use and/or extraction.	Implementable.	May be effective for reducing the potential for human exposure. This option would not meet the RAO for restoring groundwater, to the extent practicable, the quality of groundwater. This option may be effective when combined with other process options.	Yes
In-Situ Containment/ Control	Containment	Sheet Pile	Steel sheet piles are driven into the subsurface to contain impacted soils, groundwater, and NAPLs. The sheet pile wall is typically keyed into a confining unit and could be permeable or impermeable to groundwater flow.	Presence of subsurface utilities in some areas of the site could limit the implementability of this alternative. Hydraulic effects on-site groundwater would have to be evaluated. Equipment and materials required to install slurry walls are readily available. Implementability would be made significantly more difficult based on the absence of a confining unit and the depth to bedrock (> 100' below grade). There is no confining unit at this site prior to bedrock, which may not effectively seal off the bottom of a containment wall.	Could further reduce mobility of NAPL and dissolved phase COCs in groundwater. May be effective at reducing the potential for exposure to humans. In order to control dissolved phase migration, would require areas to be completely surrounded. Groundwater modeling would be recommended to determine the potential effects of a low-permeability wall on the hydrogeology. May require maintaining an inward gradient to the contained area. May not be effective if the wall cannot be keyed into bedrock and sealed at the bottom.	No
		Slurry Walls/Jet Grout Wall	Involves excavating a trench and adding a slurry (e.g., soil/cement-bentonite mixture) to control migration of groundwater and NAPL from an area. Slurry walls are typically keyed into a low permeability unit (e.g., an underlying silt/clay layer).			No
In-Situ Treatment	Biological Treatment	Groundwater Monitoring	Natural biological, chemical, and physical processes that under favorable conditions, act without human intervention to reduce the mass, volume, concentration, toxicity, and mobility of chemical constituents. Long-term monitoring is required to demonstrate the reduction of COCs.	Easily implemented. Would require monitoring to demonstrate reduction of COCs. Groundwater monitoring currently used to document that public water supply wells are not impacted by MGP-related waste materials.	Could achieve RAOs for groundwater over an extended period of time.	Yes
		Enhanced Biodegradation	Addition of amendments (e.g., nutrients, oxygen) to the subsurface to enhance indigenous microbial populations to improve the rate of natural biodegradation of constituents.	Would be difficult to sufficiently oxygenate the soil using amendments due to the thickness of the saturated zone and depth of impacts.	May not be effective if the subsurface conditions cannot be made and maintained aerobic. Would not be effective at restoring groundwater to pre-release/pre-disposal conditions unless MGP source materials are addressed (i.e., through containment, excavation, or stabilization).	Yes
		Biosparging	Air/oxygen injection wells are installed within the dissolved plume to enhance biodegradation of constituents by increasing oxygen availability. Low-flow injection technology may be incorporated. This technology requires long-term operation, monitoring, and maintenance of air/oxygen delivery system.	Implementable. Equipment for installing wells and injecting air/oxygen is readily available.	Could be used to control the leading edge of the dissolved phase plume, if plume was migrating to the Village of Suffern well field. Could require a significant amount of oxygen to enhance aerobic degradation. Could be effective at addressing dissolved-phase impacts in combination with source material mass reduction.	Yes

Table 5
Remedial Technology Screening Evaluation for Groundwater

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
In-Situ Treatment (cont'd)	Chemical Treatment	Chemical Oxidation	Oxidizing agents are added to oxidize and reduce the mass of organic constituents. In-situ chemical oxidation involves the introduction of chemicals such as ozone, hydrogen peroxide, magnesium peroxide, sodium persulfate, or potassium permanganate. Large amounts of oxidizing agents are needed to oxidize NAPL.	Implementable. Equipment and materials necessary to inject/apply oxidizing agents are readily available. May require special provisions for storage of process chemicals.	Assuming removal of source materials, this technology could meet the RAOs for groundwater. However, may not be a cost effective means to achieve the RAOs. Chemical injection near a public well would likely result in a negative public reaction.	No
	Chemical Treatment (cont'd)	Permeable Reactive Barrier (PRB)	PRBs are installed in or down gradient from the flow path of a contaminant plume. The contaminants in the plume react with the media inside the barrier to either break the compound down into harmless products or immobilize contaminants by precipitation or sorption.	Based on the depth ranges of potential source material may require a substantial wall. Could be incorporated as part of a low permeability wall (i.e., funnel and gate or "spill-over" wall	Based on the limited lateral migration of NAPL and good understanding of the dissolved phase constituents nature and extent, this could be effective at controlling the leading edge of the dissolved-phase plume.	Yes
	Extraction	Dynamic Underground Stripping and Hydrous Pyrolysis/Oxidation (DUS/HPO)	Steam is injected into the subsurface to mobilize contaminants and NAPLs. The mobilized contaminants are captured and constituents are recondensed, collected and treated. In addition, HPO can degrade contaminants in subsurface heated zones. In most cases, this technology requires long-term operation and maintenance of on-site injection, collection, and/or treatment systems.	Technically implementable. This option would require a pilot scale study to determine effectiveness. Process may result in uncontrolled NAPL migration. Not a preferred technology process due to risks and potential technical implementability issues.	This option would require a pilot scale study to determine effectiveness. Process may result in NAPL and/or dissolved plume migration. Not certain in the ability of this alternative to meet the RAOs.	No
Removal	Hydraulic Control	Vertical Extraction Wells	Vertical wells are installed and utilized to recover groundwater for treatment/disposal and containment/migration control. Typically requires extensive design/testing to determine required hydraulic gradients and feasibility of achieving those gradients.	Equipment and tools necessary to install and operate vertical extraction wells are readily available. Would require operation for an extended period of time.	Could be used to provide hydraulic containment/migration control of dissolved phase plume. Would not meet RAOs as a stand alone technology. Would likely be used in conjunction with an ex-situ treatment system (i.e., pump and treat). Pumping would be required over a prolonged period of time. Additionally, large volumes of water would likely be generated to overcome the hydraulic influence of the nearby public well field.	No
		Horizontal Extraction Wells	Horizontal wells are utilized to replace conventional well clusters in soil and containment/migration control.	Requires specialized horizontal drilling equipment. Not implementable.	Proven process for effectively extracting groundwater. Not likely to meet RAOs in an acceptable amount of time.	No
Ex-Situ On-Site Treatment	Chemical Treatment	Ultra-violet (UV) Oxidation	Oxidation by subjecting groundwater to UV light and ozone. If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts.	Potentially implementable. Limited space for a full-scale treatment system. Not typically used in MGP-impacted groundwater treatment train. Not effective on NAPL.	Proven process for effectively treating organic compounds. Use of this process may effectively achieve the RAOs. A bench-scale treatability study may be required to evaluate the efficiency of this process and to make project-specific adjustments to the process.	No
		Chemical Oxidation	Addition of oxidizing agents to degrade organic constituents to less-toxic byproducts.	Potentially implementable. Not effective on NAPL.	A bench-scale treatability study may be required to evaluate the efficiency of this process and to make project-specific adjustments to the process. Large amounts of oxidizing agents are needed to oxidize NAPL.	No
	Physical Treatment	Carbon Adsorption	Process by which organic constituents are adsorbed to the carbon as groundwater is passed through carbon units.	Potentially implementable.No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Effective at removing organic constituents. Use of this treatment process may effectively achieve the RAOs when combined with groundwater extraction.	No

Table 5
Remedial Technology Screening Evaluation for Groundwater

Feasibility Study Report
Orange & Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Response Action	Remedial Technology Type	Technology Process Option	Description	Implementability	Effectiveness	Retained?
Ex-Situ On-Site Treatment (cont)		Filtration	Extraction of groundwater and treatment using filtration. Process in which the groundwater is passed through a granular media in order to removed suspended solids by interception, straining, flocculation, and sedimentation activity within the filter.	Potentially implementable.No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Effective pre-treatment process to reduce suspended solids. Use of this process along with other processes (i.e., that address organic constituents) could effectively achieve the RAOs.	No
	Physical Treatment (cont'd)	Air Stripping	A process in which VOCs are removed through volatilization by increasing the contact between the groundwater and air.	Potentially implementable.No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	This technology process would be effective at removing VOCs from water. Process would potentially be used as part of a treatment train to treat groundwater removed from excavation areas. Has potential to be used as part of a treatment system to meet the RAOs.	No
		Precipitation/ Coagulation/ Flocculation	Process which precipitates dissolved constituents into insoluble solids and improves settling characteristics through the addition of amendments to water to facilitate subsequent removal from the liquid phase by sedimentation/filtration.	Potentially implementable.No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Process which transforms dissolved constituents into insoluble solids by adding coagulating agents to facilitate subsequent removal from the liquid phase by sedimentation/filtration. Has potential to be used as part of a treatment system to meet the RAOs.	No
		Oil/Water Separation	Process by which insoluble oils are separated from water via physical separation technologies, including gravity separation, baffled vessels, etc.	Potentially implementable.No groundwater extraction process is retained, therefore groundwater treatment is not necessary.	Effective at separating insoluble oil from groundwater. This process could be used as part of the groundwater treatment train if needed to address separate-phase liquids. Has potential to be used as part of a treatment system to meet the RAOs.	No
Off-site Treatment/Disposal	Groundwater Disposal	Discharge to a local Publicly-Owned Treatment Works (POTW)	Treated or untreated water is discharged to a sanitary sewer and treated at a local POTW facility.	Implementable. Equipment and materials necessary to extract, pretreat (if necessary), and discharge the water to the sewer system are readily available. Discharges to the sewer will require a POTW-issued discharge permit.	Proven process for effectively disposing of groundwater. Typically requires little pre-treatment because the discharged water will be subjected to additional treatment at the POTW. Could be used as a component of an overall remedy to meet the RAOs for groundwater. May be used in conjunction with a containment technology to maintain an inward hydraulic gradient.	No
		Discharge to Surface Water	Treated or untreated water is discharged to surface water, provided that the water quality and quantity meet the allowable discharge requirements for surface waters (NYSDEC SPDES compliance).	Discharges to surface water must meet substantive requirements of a SPDES permit. Cleanup objectives and sampling requirements may be restrictive.	This technology process would effectively dispose of groundwater. Impacted groundwater would require treatment to achieve water quality discharge limits. Helps in the management of treated water, but does not directly lend to achieving the RAOs for groundwater.	No
		Discharge to a privately-owned treatment/disposal facility.	Treated or untreated water is collected and transported to a privately-owned treatment facility.	Equipment and materials to pretreat the water at the site are readily available on a commercial basis. Facilities capable of transporting and disposing of the groundwater are available. Treatment may be required prior to discharge.	Proven process for effectively disposing of groundwater. Typically requires the least amount of pre-treatment because the discharged water will be subjected to additional treatment at the disposal facility. Could be used as a component of an overall remedy to meet the RAOs for groundwater.	No

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

Table 6
Cost Estimate for Alternative 2 - Excavation of MGP Structures

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs - Excavation					
1	Pre-Design Investigation	1	LS	$150,000	$150,000
2	Permitting	1	LS	$50,000	$50,000
3	Mobilization/Demobilization	1	LS	$200,000	$200,000
4	Concrete Pad Demolition, Removal, Disposal	12,100	SF	$10	$121,000
5	Utility Markout, Protection, and Relocation	1	LS	$100,000	$100,000
6	Construct and Remove Decontamination Pad	1	LS	$10,000	$10,000
7	Open Span Structure and Air Treatment	1	LS	$1,190,000	$1,190,000
8	Install and Remove Temporary Sheet Pile	3,000	SF	$40	$120,000
9	Soil Excavation and Handling	5,100	CY	$50	$255,000
10	Community Air Monitoring and Vapor/Odor Control	11	WEEK	$5,000	$55,000
11	Demarcation Layer	2,600	SY	$5	$13,000
12	Backfill	5,100	CY	$40	$204,000
13	Solid Waste Characterization	16	EACH	$1,200	$19,200
14	Solid Waste Transportation and Disposal - LTTD	7,600	TON	$85	$646,000
15	Site Management Plan	1	EACH	$50,000	$50,000
16	Institutional Controls	1	LS	$100,000	$100,000
	Subtotal Capital Cost				$3,283,200
17	Administration & Engineering (10%)				$263,720
	Construction Management (10%)				$263,720
	Contingency (20%)				$656,640
	Total Capital Cost				$4,467,280
Groundwater Contingency					
18	Groundwater Contingency - Biosparging System Installation	1	LS	$600,000	$600,000
	Subtotal Capital Cost				$600,000
19	Administration & Engineering (10%)				$60,000
	Construction Management (10%)				$60,000
	Contingency (20%)				$120,000
	Total Capital Cost				$840,000
Operation and Maintenance Costs (Years 1 through 5)					
20	Annual Permitting/Access Agreements	1	LS	$10,000	$10,000
21	Annual Verification of Institutional Controls	1	LS	$10,000	$10,000
22	Quarterly Groundwater Monitoring	4	EACH	$11,000	$44,000
23	Laboratory Analysis of Groundwater Samples	56	EACH	$500	$28,000
24	Waste Disposal	8	DRUM	$750	$6,000
25	Annual Summary Report	1	LS	$30,000	$30,000
26	Groundwater Contingency - Biosparging System O&M	1	LS	$126,000	$126,000
	Subtotal O&M Cost				$254,000
	Contingency (20%)				$50,800
	Total Annual O&M Cost				$304,800
27	5-Year Total Present Worth Cost				$1,356,915
Operation and Maintenance Costs (Years 6 through 30)					
28	Annual Permitting/Access Agreements	1	LS	$10,000	$10,000
29	Annual Verification of Institutional Controls	1	LS	$10,000	$10,000
30	Annual Groundwater Monitoring	1	EACH	$11,000	$11,000
31	Laboratory Analysis of Groundwater Samples	14	EACH	$500	$7,000
32	Waste Disposal	2	DRUM	$750	$1,500
33	Annual Summary Report	1	LS	$20,000	$20,000
34	Groundwater Contingency - Biosparging System O&M	1	LS	$126,000	$126,000
	Subtotal O&M Cost				$185,500
	Contingency (20%)				$37,100
	Total Annual O&M Cost				$222,600
35	30-Year Total Present Worth Cost				$2,858,231
	Total O&M Cost				$4,215,146
	Total Estimated Cost w/o Groundwater Contingency:				**$6,067,871**
	Total Estimated Cost w/ Groundwater Contingency:				**$10,879,342**

Table 6
Cost Estimate for Alternative 2 - Excavation of MGP Structures

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Notes:

1. Cost estimate is based on ARCADIS of New York's (ARCADIS') past experience and vendor estimates using 2013 dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended.

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

4. Cost estimate assumes remedial activities are conducted in one continuous effort. As such, costs for delays or demobilization and remobilization to the site are not included.

Assumptions:

1. Pre-design investigation cost estimate includes all labor and equipment necessary to conduct pre-design investigation (PDI) activities in support of the remedial design of this alternative. PDI activities may include, but are not limited to, completion of soil borings and test pits to refine excavation limits and the collection and chemical/geotechnical analysis of soil samples. Cost includes preparation of PDI Work Plan and PDI Summary Report.

2. Permitting cost estimate includes all costs necessary to obtain appropriate permits and access agreements to complete the remedial construction activities associated with this alternative.

3. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to conduct the remedial construction activities associated with this alternative.

4. Concrete pad demolition, removal, and disposal cost estimate includes all labor and equipment necessary to demolish the existing concrete pad associated with the former bus manufacturing facility. Estimate includes cost to demolish, transport and dispose of material at an off-site C&D landfill.

5. Utility markout, protection, and relocation cost estimate includes all labor, equipment, and materials necessary to markout and clear utilities within the proposed excavation areas. Estimate includes costs for relocating water lines and gas lines located on the O&R gate station property.

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

7. Open span structure and air treatment cost estimate includes rental of an approximately 100-foot by 100-foot Sprung-type structure to enclose the excavation area on the former MGP property. Cost estimate assumes structure is equipped with overhead doors for truck and excavator access. Final structure construction details to be determined as part of the remedial design. Cost estimate based on assumed $240,000 for mobilization and setup; $83,000 for decontamination, breakdown, and demobilization; and $7,000 per week for rental (assumed 15 weeks). Cost estimate includes lease of all vapor collection and treatment equipment, delivery and set-up fees, and filter media change out. Cost estimate assumes structure will be moved one time during excavation activities at assumed cost of $10,000 per move.

8. Install and remove temporary sheet pile cost estimate includes all labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile will be installed at an average depth of 25 feet bgs to facilitate removal of the gas oil house. Sheet pile to be removed following site restoration activities. Final excavation support system to be determined as part of the remedial design. Cost estimate assumes sheet pile would be installed prior to erection of open span structure.

9. Soil excavation and handling includes all labor, equipment, and materials necessary to excavate former MGP structures to a maximum depth of 10 feet bgs on the former MGP property and shallow hardened tar to a maximum depth of 5 feet bgs west of the abandoned railroad berm. Cost estimate is based on in-place soil volume. Cost estimate is conservatively high to be inclusive of ancillary excavation costs (e.g., survey) and based on the likely presence of former MGP structures and other subsurface obstructions located within the excavation areas.

10. Community air monitoring and vapor/odor control cost estimate includes all labor, equipment, and materials necessary to monitor vapor/odor emission during intrusive site activities and applying vapor/odor suppressing foam to open

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

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

13. Solid waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.

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

15. Site management plan cost estimate includes all labor necessary to prepare a site management plan to document: the institutional controls that have been established and will be maintained for the former MGP site; known locations of remaining soil that contains COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs in the project area; protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities (including material located beneath the abandoned railroad berm); protocols and requirements for conducting groundwater monitoring in the project area; and protocols for addressing significant changes in COC concentrations in groundwater based on the results obtained from the groundwater monitoring activities.

16. Institutional controls cost estimate includes all legal expenses to institute environmental easements and deed restrictions for the former MGP site to control intrusive activities that could result in exposure to impacted soil and groundwater. Such institutional controls may include governmental controls, proprietary controls, enforcement tools, and/or informational devices.

17. Groundwater contingency - biosparging system installation cost estimate includes labor, equipment, and materials necessary to construct a biosparging well field if dissolved phase COCs trend upward or appear to be migrating toward the Village of Suffern well field. Estimate includes costs associated with a pre-design investigation, pilot testing program, installation of biosparging wells and supporting equipment and infrastructure, and system startup and troubleshooting.

19. Administration and engineering and construction management costs are based on an assumed 10% of the total capital

20. Annual permitting/access agreements cost estimate includes all costs necessary to obtain appropriate permits and access agreements to conduct periodic groundwater monitoring activities.

Table 6
Cost Estimate for Alternative 2 - Excavation of MGP Structures

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Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

21. Annual verification of institutional controls cost estimate includes administrative costs for confirming institutional controls to minimize the potential for human exposure to site soil and groundwater. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.

22. Quarterly groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct quarterly groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 12 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require three days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental. Cost estimates includes preparation of a letter report to summarize quarterly groundwater sampling activities and results.

23. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for BTEX and PAHs. Estimate assumes laboratory analysis of groundwater samples from up to 12 groundwater monitoring wells and up to two QA/QC samples per sampling event.

24. Waste disposal cost estimate includes off-site disposal of drummed PPE, disposable sampling equipment, and purge water generated during groundwater monitoring activities. Estimate assumes two drums of material generated per event.

25. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing the quarterly groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.

26. Groundwater contingency - biosparging system O&M cost includes labor, equipment, and materials associated with operation and maintenance of the biosparging system. Estimate includes cost associated with labor for system operation, system electricity usage, periodic equipment replacement/repair, and preparation of annual report to summarize system operation.

27. Present worth is estimated based on a 4% beginning-of-year discount rate . It is assumed that "year zero" is 2013.

28. See note 20.

29. See note 21.

30. Annual groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct annual groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 12 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require three days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental.

31. See note 23.

32. See note 24.

33. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing the annual groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.

34. See note 26.

35. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2013 and present worth is calculated for O&M costs associated with years 5 through 30.

Table 7
Cost Estimate for Alternative 3 - Excavation of Visually Impacted Soil up to the Groundwater Table

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs - Excavation					
1	Pre-Design Investigation	1	LS	$150,000	$150,000
2	Permitting	1	LS	$50,000	$50,000
3	Mobilization/Demobilization	1	LS	$200,000	$200,000
4	Pad Demolition, Removal, Disposal	12,100	SF	$10	$121,000
5	Utility Markout, Protection, and Relocation	1	LS	$100,000	$100,000
6	Construct and Remove Decontamination Pad	1	LS	$10,000	$10,000
7	Open Span Structure and Air Treatment	1	LS	$1,350,000	$1,350,000
8	Install and Remove Temporary Sheet Pile	40,200	SF	$40	$1,608,000
9	Soil Excavation and Handling	16,500	CY	$50	$825,000
10	Community Air Monitoring and Vapor/Odor Control	29	WEEK	$5,000	$145,000
11	Demarcation Layer	5,100	SY	$5	$25,500
12	Backfill	16,500	CY	$40	$660,000
13	Solid Waste Characterization	50	EACH	$1,200	$60,000
14	Solid Waste Transportation and Disposal - LTTD	24,700	TON	$85	$2,099,500
15	Site Management Plan	1	EACH	$50,000	$50,000
16	Institutional Controls	1	LS	$100,000	$100,000
	Subtotal Capital Cost				$7,554,000
17	Administration & Engineering (10%)				$545,450
	Construction Management (10%)				$545,450
	Contingency (20%)				$1,510,800
	Total Capital Cost				$10,155,700
Groundwater Contingency					
18	Groundwater Contingency - Biosparging System Installation	1	LS	$600,000	$600,000
	Subtotal Capital Cost				$600,000
19	Administration & Engineering (10%)				$60,000
	Construction Management (10%)				$60,000
	Contingency (20%)				$120,000
	Total Capital Cost				$840,000
Operation and Maintenance Costs (Years 1 through 5)					
20	Annual Permitting/Access Agreements	1	LS	$10,000	$10,000
21	Annual Verification of Institutional Controls	1	LS	$10,000	$10,000
22	Quarterly Groundwater Monitoring	4	EACH	$11,000	$44,000
23	Laboratory Analysis of Groundwater Samples	56	EACH	$500	$28,000
24	Waste Disposal	8	DRUM	$750	$6,000
25	Annual Summary Report	1	LS	$30,000	$30,000
26	Groundwater Contingency - Biosparging System O&M	1	LS	$126,000	$126,000
	Subtotal O&M Cost				$254,000
	Contingency (20%)				$50,800
	Total Annual O&M Cost				$304,800
27	5-Year Total Present Worth Cost				$1,356,915
Operation and Maintenance Costs (Years 6 through 30)					
28	Annual Permitting/Access Agreements	1	LS	$10,000	$10,000
29	Annual Verification of Institutional Controls	1	LS	$10,000	$10,000
30	Annual Groundwater Monitoring	1	EACH	$11,000	$11,000
31	Laboratory Analysis of Groundwater Samples	14	EACH	$500	$7,000
32	Waste Disposal	2	DRUM	$750	$1,500
33	Annual Summary Report	1	LS	$20,000	$20,000
34	Groundwater Contingency - Biosparging System O&M	1	LS	$126,000	$126,000
	Subtotal O&M Cost				$185,500
	Contingency (20%)				$37,100
	Total Annual O&M Cost				$222,600
35	30-Year Total Present Worth Cost				$2,858,231
	Total O&M Cost				$4,215,146
	Total Estimated Cost w/o Groundwater Contingency:				**$11,756,291**
	Total Estimated Cost w/ Groundwater Contingency:				**$16,567,762**

Table 7
Cost Estimate for Alternative 3 - Excavation of Visually Impacted Soil up to the Groundwater Table

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Notes:

1. Cost estimate is based on ARCADIS of New York's (ARCADIS') past experience and vendor estimates using 2013 dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended.

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

4. Cost estimate assumes remedial activities are conducted in one continuous effort. As such, costs for delays or demobilization and remobilization to the site are not included.

Assumptions:

1. Pre-design investigation cost estimate includes all labor and equipment necessary to conduct pre-design investigation (PDI) activities in support of the remedial design of this alternative. PDI activities may include, but are not limited to, completion of soil borings and test pits to refine excavation limits and the collection and chemical/geotechnical analysis of soil samples. Cost includes preparation of PDI Work Plan and PDI Summary Report.

2. Permitting cost estimate includes all costs necessary to obtain appropriate permits and access agreements to complete the remedial construction activities associated with this alternative.

3. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to conduct the remedial construction activities associated with this alternative.

4. Concrete pad demolition, removal, and disposal cost estimate includes all labor and equipment necessary to demolish the existing concrete pad associated with the former bus manufacturing facility. Estimate includes cost to demolish, transport and dispose of material at an off-site C&D landfill.

5. Utility markout, protection, and relocation cost estimate includes all labor, equipment, and materials necessary to markout and clear utilities within the proposed excavation areas. Estimate includes costs for relocating water lines and gas lines located on the O&R gate station property.

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

7. Open span structure and air treatment cost estimate includes rental of an approximately 100-foot by 100-foot Sprung-type structure to enclose the excavation area on the former MGP property. Cost estimate assumes structure is equipped with overhead doors for truck and excavator access. Final structure construction details to be determined as part of the remedial design. Cost estimate based on assumed $240,000 for mobilization and setup; $83,000 for decontamination, breakdown, and demobilization; and $7,000 per week for rental (assumed 29 weeks). Cost estimate includes lease of all vapor collection and treatment equipment, delivery and set-up fees, and filter media change out. Cost estimate assumes structure will be moved up to 4 times during excavation activities at assumed cost of $10,000 per move.

8. Install and remove temporary sheet pile cost estimate includes all labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile will be installed at a depth of 32 feet bgs to facilitate removal of the gas oil house and nearby visually impacted soil, to an average depth of 30 feet bgs to facilitate removal of visually impacted soil from the State of New Jersey property, and to a depth of 38 feet bgs to faclitate removal of visually impacted material in the eastern gas holder area. Sheet pile to be removed following site restoration activities. Final excavation support system to be determined as part of the remedial design. Cost estimate assumes sheet pile would be installed prior to erection of open span structure.

9. Soil excavation and handling includes all labor, equipment, and materials necessary to excavate former MGP structures to a maximum depth of 10 feet bgs on the former MGP property and shallow hardened tar to a maximum depth of 5 feet bgs west of the abandoned railroad berm. Cost estimate is based on in-place soil volume. Cost estimate is conservatively high to be inclusive of ancillary excavation costs (e.g., survey) and based on the likely presence of former MGP structures and other subsurface obstructions located within the excavation areas.

10. Community air monitoring and vapor/odor control cost estimate includes all labor, equipment, and materials necessary to monitor vapor/odor emission during intrusive site activities and applying vapor/odor suppressing foam to open

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

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

13. Solid waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.

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

15. Site management plan cost estimate includes all labor necessary to prepare a site management plan to document: the institutional controls that have been established and will be maintained for the former MGP site; known locations of remaining soil that contains COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs in the project area; protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities (including material located beneath the abandoned railroad berm); protocols and requirements for conducting groundwater monitoring in the project area; and protocols for addressing significant changes in COC concentrations in groundwater based on the results obtained from the groundwater monitoring activities.

16. Institutional controls cost estimate includes all legal expenses to institute environmental easements and deed restrictions for the former MGP site to control intrusive activities that could result in exposure to impacted soil and groundwater. Such institutional controls may include governmental controls, proprietary controls, enforcement tools, and/or informational devices.

17. Administration and engineering and construction management costs are based on an assumed 10% of the total capital costs, not including costs for off-site transportation and treatment/disposal of excavated material.

18. Groundwater contingency - biosparging system installation cost estimate includes labor, equipment, and materials necessary to construct a biosparging well field if dissolved phase COCs trend upward or appear to be migrating toward the Village of Suffern well field. Estimate includes costs associated with a pre-design investigation, pilot testing program, installation of biosparging wells and supporting equipment and infrastructure, and system startup and troubleshooting.

19. Administration and engineering and construction management costs are based on an assumed 10% of the total capital

20. Annual permitting/access agreements cost estimate includes all costs necessary to obtain appropriate permits and access agreements to conduct periodic groundwater monitoring activities.

21. Annual verification of institutional controls cost estimate includes administrative costs for confirming institutional controls to minimize the potential for human exposure to site soil and groundwater. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.

22. Quarterly groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct quarterly groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 12 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require three days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental. Cost estimates includes preparation of a letter report to summarize quarterly groundwater sampling activities and results.

23. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for BTEX and PAHs. Estimate assumes laboratory analysis of groundwater samples from up to 12 groundwater monitoring wells and up to two QA/QC samples per sampling event.

24. Waste disposal cost estimate includes off-site disposal of drummed PPE, disposable sampling equipment, and purge water generated during groundwater monitoring activities. Estimate assumes two drums of material generated per event.

25. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing the quarterly groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.

26. Groundwater contingency - biosparging system O&M cost includes labor, equipment, and materials associated with operation and maintenance of the biosparging system. Estimate includes cost associated with labor for system operation, system electricity usage, periodic equipment replacement/repair, and preparation of annual report to summarize system operation.

27. Present worth is estimated based on a 4% beginning-of-year discount rate . It is assumed that "year zero" is 2013.

28. See note 20.

29. See note 21.

30. Annual groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct annual groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 12 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require three days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental.

31. See note 23.

32. See note 24.

33. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing the annual groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.

34. See note 26.

35. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2013 and present worth is calculated for O&M costs associated with years 5 through 30.

Table 8
Cost Estimate for Alternative 4 - Excavation and ISS

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs - Excavation and ISS					
1	Pre-Design Investigation	1	LS	$200,000	$200,000
2	Permitting	1	LS	$50,000	$50,000
3	Mobilization/Demobilization	1	LS	$400,000	$400,000
4	Concrete Pad Demolition, Removal, Disposal	12,100	SF	$10	$121,000
5	Utility Markout, Protection, and Relocation	1	LS	$100,000	$100,000
6	Construct and Remove Decontamination Pad	1	LS	$10,000	$10,000
7	Open Span Structure and Air Treatment	1	LS	$1,350,000	$1,350,000
8	Install and Remove Temporary Sheet Pile	3,900	SF	$40	$156,000
9	Soil Excavation and Handling	10,300	CY	$50	$515,000
10	ISS Treatment	18,500	CY	$125	$2,312,500
11	Spoils Handling	2,800	CY	$20	$56,000
12	ISS QA/QC Sampling	37	EACH	$1,000	$37,000
13	Community Air Monitoring and Vapor/Odor Control	29	WEEK	$5,000	$145,000
14	Demarcation Layer	1,600	SY	$5	$8,000
15	Backfill	10,300	CY	$40	$412,000
16	Solid Waste Characterization	41	EACH	$1,200	$49,200
17	Solid Waste Transportation and Disposal - LTTD	20,300	TON	$85	$1,725,500
18	Site Management Plan	1	EACH	$50,000	$50,000
19	Institutional Controls	1	LS	$100,000	$100,000
	Subtotal Capital Cost				$7,797,200
20	Administration & Engineering (10%)				$607,170
	Construction Management (10%)				$607,170
	Contingency (20%)				$1,559,440
	Total Capital Cost				$10,570,980
Groundwater Contingency					
21	Groundwater Contingency - Biosparging System Installation	1	LS	$600,000	$600,000
	Subtotal Capital Cost				$600,000
22	Administration & Engineering (10%)				$60,000
	Construction Management (10%)				$60,000
	Contingency (20%)				$120,000
	Total Capital Cost				$840,000
Operation and Maintenance Costs (Years 1 through 5)					
23	Annual Permitting/Access Agreements	1	LS	$10,000	$10,000
24	Annual Verification of Institutional Controls	1	LS	$10,000	$10,000
25	Quarterly Groundwater Monitoring	4	EACH	$11,000	$44,000
26	Laboratory Analysis of Groundwater Samples	56	EACH	$500	$28,000
27	Waste Disposal	8	DRUM	$750	$6,000
28	Annual Summary Report	1	LS	$30,000	$30,000
29	Groundwater Contingency - Biosparging System O&M	1	LS	$126,000	$126,000
	Subtotal O&M Cost				$254,000
	Contingency (20%)				$50,800
	Total Annual O&M Cost				$304,800
30	5-Year Total Present Worth Cost				$1,356,915
Operation and Maintenance Costs (Years 6 through 30)					
31	Annual Permitting/Access Agreements	1	LS	$10,000	$10,000
32	Annual Verification of Institutional Controls	1	LS	$10,000	$10,000
33	Annual Groundwater Monitoring	1	EACH	$11,000	$11,000
34	Laboratory Analysis of Groundwater Samples	14	EACH	$500	$7,000
35	Waste Disposal	2	DRUM	$750	$1,500
36	Annual Summary Report	1	LS	$20,000	$20,000
37	Groundwater Contingency - Biosparging System O&M	1	LS	$126,000	$126,000
	Subtotal O&M Cost				$185,500
	Contingency (20%)				$37,100
	Total Annual O&M Cost				$222,600
38	30-Year Total Present Worth Cost				$2,858,231
	Total O&M Cost				$4,215,146
	Total Estimated Cost w/o Groundwater Contingency:				**$12,171,571**
	Total Estimated Cost w/ Groundwater Contingency:				**$16,983,042**

Table 8
Cost Estimate for Alternative 4 - Excavation and ISS

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Notes:

1. Cost estimate is based on ARCADIS of New York's (ARCADIS') past experience and vendor estimates using 2013 dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended.

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

4. Cost estimate assumes remedial activities are conducted in one continuous effort. As such, costs for delays or demobilization and remobilization to the site are not included.

Assumptions:

1. Pre-design investigation cost estimate includes all labor and equipment necessary to conduct pre-design investigation (PDI) activities in support of the remedial design of this alternative. PDI activities may include, but are not limited to, completion of soil borings and test pits to refine excavation limits, the collection and chemical/geotechnical analysis of soil samples, and conducting bench-scale treatability study to evaluate ISS mix designs. Cost includes preparation of PDI Work Plan and PDI Summary Report.

2. Permitting cost estimate includes all costs necessary to obtain appropriate permits and access agreements to complete the remedial construction activities associated with this alternative.

3. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to conduct the remedial construction activities associated with this alternative.

4. Concrete pad demolition, removal, and disposal cost estimate includes all labor and equipment necessary to demolish the existing concrete pad associated with the former bus manufacturing facility. Estimate includes cost to demolish, transport and dispose of material at an off-site C&D landfill.

5. Utility markout, protection, and relocation cost estimate includes all labor, equipment, and materials necessary to markout and clear utilities within the proposed excavation and ISS areas. Estimate includes costs for relocating water lines and gas lines located on the O&R gate station property.

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

7. Open span structure and air treatment cost estimate includes rental of an approximately 100-foot by 100-foot Sprung-type structure to enclose the ISS/excavation area on the former MGP property. Cost estimate assumes structure is equipped with overhead doors for truck and excavator access. Final structure construction details to be determined as part of the remedial design. Cost estimate based on assumed $240,000 for mobilization and setup; $83,000 for decontamination, breakdown, and demobilization; and $7,000 per week for rental (assumed 29 weeks). Cost estimate includes lease of all vapor collection and treatment equipment, delivery and set-up fees, and filter media change out. Cost estimate assumes structure will be moved up to 4 times during ISS/excavation activities at assumed cost of $10,000 per move.

8. Install and remove temporary sheet pile cost estimate includes all labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile will be installed at an average depth of 32 feet bgs to facilitate removal of the gas oil house and nearby visually impacted soil. Sheet pile to be removed following site restoration activities. Final excavation support system to be determined as part of the remedial design. Cost estimate assumes sheet pile would be installed prior to erection of open span structure.

9. Soil excavation and handling includes all labor, equipment, and materials necessary to excavate former MGP structures to a maximum depth of 10 feet bgs on the former MGP property, shallow hardened tar to a maximum depth of 5 feet bgs west of the abandoned railroad berm, and to clear obstructions to maximum depth of 5 feet bgs on the State of New Jersey property prior to ISS treatment activities. Cost estimate is based on in-place soil volume. Cost estimate is conservatively high to be inclusive of ancillary excavation costs (e.g., survey) and based on the likely presence of former MGP structures and other subsurface obstructions located within the excavation areas.

10. ISS treatment cost estimate includes all labor, equipment, and materials necessary to conduct in-situ soil stabilization to address visually impacted material. Cost estimate assumes ISS would be conducted to depths of 12 to 35 feet below grade via bucket mixing or small diameter auger. Cost estimate based on in-place soil volume.

11. Spoils handling cost estimate includes all labor, equipment, and material necessary to load partially solidified ISS spoils for off-site transportation and disposal. Cost estimate assumes spoils volumes of 15% of ISS treatment volume.

12. ISS QA/QC sampling cost estimate includes all labor, equipment, and materials necessary to perform quality assurance/quality control testing of ISS treatment area to verify performance criteria have been achieved. Cost estimate assumes QA/QC samples will be collected from a confirmation sample collected from every 500 cubic-yards of wet stabilized material. Cost estimate includes costs for sample collection and laboratory analysis of samples for unconfined compressive strength and permeability.

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

14. Demarcation layer cost estimate includes labor, equipment, and materials necessary to place a woven, light-weight, non-biodegradable, high-visibility demarcation layer within soil excavation area footprints (not including ISS treatment areas).

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

16. Solid waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.

17. Solid waste transportation and disposal - LTTD cost estimate includes labor, equipment, and materials necessary to transport and thermally treat all excavated soil and ISS spoils at a thermal treatment facility. Cost assumes excavated soil will be treated/disposed of via LTTD at an estimated density of 1.5 tons per cubic-yard. Cost estimate includes treatment fee, transportation fuel surcharge, and spotting fees. Cost estimate assumes thermally treated soil does not require subsequent treatment or disposal.

18. Site management plan cost estimate includes all labor necessary to prepare a site management plan to document: the institutional controls that have been established and will be maintained for the former MGP site; known locations of remaining soil that contains COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs in the project area; protocols (including health and safety requirements) for conducting invasive (i.e., subsurface) activities and managing potentially impacted material encountered during these activities (including material located beneath the abandoned railroad berm); protocols and requirements for conducting groundwater monitoring in the project area; and protocols for addressing significant changes in COC concentrations in groundwater based on the results obtained from the groundwater monitoring activities.

19. Institutional controls cost estimate includes all legal expenses to institute environmental easements and deed restrictions for the former MGP site to control intrusive activities that could result in exposure to impacted soil and groundwater. Such institutional controls may include governmental controls, proprietary controls, enforcement tools, and/or informational devices.

20. Administration and engineering and construction management costs are based on an assumed 10% of the total capital costs, not including costs for off-site transportation and treatment/disposal of excavated material.

21. Groundwater contingency - biosparging system installation cost estimate includes labor, equipment, and materials necessary to construct a biosparging well field if dissolved phase COCs trend upward or appear to be migrating toward the Village of Suffern well field. Estimate includes costs associated with a pre-design investigation, pilot testing program, installation of biosparging wells and supporting equipment and infrastructure, and system startup and troubleshooting.

22. Administration and engineering and construction management costs are based on an assumed 10% of the total capital costs.

23. Annual permitting/access agreements cost estimate includes all costs necessary to obtain appropriate permits and access agreements to conduct periodic groundwater monitoring activities.

24. Annual verification of institutional controls cost estimate includes administrative costs for confirming institutional controls to minimize the potential for human exposure to site soil and groundwater. Annual costs associated with institutional controls include verifying the status of institutional controls and preparing/submitting notification to the NYSDEC to demonstrate that the institutional controls are being maintained and remain effective.

25. Quarterly groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct quarterly groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 12 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require three days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental. Cost estimates includes preparation of a letter report to summarize quarterly groundwater sampling activities and results.

26. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for BTEX and PAHs. Estimate assumes laboratory analysis of groundwater samples from up to 12 groundwater monitoring wells and up to two QA/QC samples per sampling event.

27. Waste disposal cost estimate includes off-site disposal of drummed PPE, disposable sampling equipment, and purge water generated during groundwater monitoring activities. Estimate assumes two drums of material generated per event.

28. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing the quarterly groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.

29. Groundwater contingency - biosparging system O&M cost includes labor, equipment, and materials associated with operation and maintenance of the biosparging system. Estimate includes cost associated with labor for system operation, system electricity usage, periodic equipment replacement/repair, and preparation of annual report to summarize system operation.

30. Present worth is estimated based on a 4% beginning-of-year discount rate . It is assumed that "year zero" is 2013.

31. See note 23.

32. See note 24.

33. Annual groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct annual groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 12 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require three days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental.

34. See note 26.

35. See note 27.

36. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing the annual groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.

37. See note 29.

38. Present worth is estimated based on a 4% beginning-of-year discount rate. It is assumed that "year zero" is 2013 and present worth is calculated for O&M costs associated with years 5 through 30.

Table 9
Cost Estimate for Alternative 5 - Excavation to Unrestricted Use SCOs

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

Item #	Description	Estimated Quantity	Unit	Unit Price	Estimated Cost
Capital Costs - Excavation					
1	Pre-Design Investigation	1	LS	$300,000	$300,000
2	Permitting	1	LS	$50,000	$50,000
3	Mobilization/Demobilization	1	LS	$500,000	$500,000
4	Concrete Pad Demolition, Removal, Disposal	12,100	SF	$10	$121,000
5	Utility Markout, Protection, and Relocation	1	LS	$100,000	$100,000
6	Construct and Remove Decontamination Pad	1	LS	$10,000	$10,000
7	Open Span Structure and Air Treatment	1	LS	$1,820,000	$1,820,000
8	Install and Remove Temporary Sheet Pile (w/o bracing)	44,200	SF	$40	$1,768,000
9	Install and Remove Temporary Sheet Pile (w/ bracing)	28,100	SF	$60	$1,686,000
10	Reinforced Slurry Wall	41,700	SF	$300	$12,510,000
11	Temporary Water Treatment System	17	MONTH	$150,000	$2,550,000
12	Soil Excavation and Handling (< 40 feet bgs)	38,900	CY	$50	$1,945,000
13	Soil Excavation and Handling (> 40 feet bgs)	19,800	CY	$150	$2,970,000
14	Soil Excavation and Handling (Auger Removal)	4,800	CY	$300	$1,440,000
15	Community Air Monitoring and Vapor/Odor Control	94	WEEK	$5,000	$470,000
16	Soil Dewatering and Stabilization	35,300	CY	$20	$706,000
	Stabilization Admixture	5,300	TON	$115	$609,500
17	Backfill	63,500	CY	$40	$2,540,000
18	Solid Waste Characterization	201	EACH	$1,200	$241,200
19	Liquid Waste Characterization	127	EACH	$1,000	$127,000
20	Solid Waste Transportation and Disposal - LTTD	100,500	TON	$85	$8,542,500
21	Liquid Waste Disposal	6,350,000	GAL	$0.10	$635,000
				Subtotal Capital Cost	$41,769,632
22				Administration & Engineering (10%)	$3,322,713
				Construction Management (10%)	$3,322,713
				Contingency (20%)	$8,353,926
				Total Capital Cost	$56,768,985
Operation and Maintenance Costs (Years 1 through 2)					
23	Annual Permitting/Access Agreements	1	LS	$10,000	$10,000
24	Quarterly Groundwater Monitoring	4	EACH	$11,000	$44,000
25	Laboratory Analysis of Groundwater Samples	56	EACH	$500	$28,000
26	Waste Disposal	8	DRUM	$750	$6,000
27	Annual Summary Report	1	LS	$30,000	$30,000
				Subtotal O&M Cost	$118,000
				Contingency (20%)	$23,600
				Total Annual O&M Cost	$141,600
28				2-Year Total Present Worth Cost	$267,071
				Total Estimated Cost:	**$57,036,056**
				Rounded To:	**$57,000,000**

Table 9
Cost Estimate for Alternative 5 - Excavation to Unrestricted Use SCOs

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

General Notes:

1. Cost estimate is based on ARCADIS of New York's (ARCADIS') past experience and vendor estimates using 2013 dollars.

2. This estimate has been prepared for the purposes of comparing potential remedial alternatives. The information in this cost estimate is based on the available information regarding the site investigation and the anticipated scope of the remedial alternative. Changes in cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This cost estimate is expected to be within -30% to +50% of the actual projected cost. Utilization of this cost estimate information beyond the stated purpose is not recommended.

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

4. Cost estimate assumes remedial activities are conducted in one continuous effort. As such, costs for delays or demobilization and remobilization to the site are not included.

Assumptions:

1. Pre-design investigation cost estimate includes all labor and equipment necessary to conduct pre-design investigation (PDI) activities in support of the remedial design of this alternative. PDI activities may include, but are not limited to, completion of soil borings and test pits to define final excavation limits, the collection and chemical/geotechnical analysis of soil samples, evaluation of potential excavation support systems, slurry wall bench-scale testing, and collection and laboratory analysis of groundwater samples. Cost includes preparation of PDI Work Plan and PDI Summary Report.

2. Permitting cost estimate includes all costs necessary to obtain appropriate permits and access agreements to complete the remedial construction activities associated with this alternative.

3. Mobilization/demobilization cost estimate includes mobilization and demobilization of labor, equipment, and materials necessary to conduct the remedial construction activities associated with this alternative.

4. Concrete pad demolition, removal, and disposal cost estimate includes all labor and equipment necessary to demolish the existing concrete pad associated with the former bus manufacturing facility. Estimate includes cost to demolish, transport and dispose of material at an off-site C&D landfill.

5. Utility markout, protection, and relocation cost estimate includes all labor, equipment, and materials necessary to markout and clear utilities within the proposed excavation areas. Estimate includes costs for relocating water lines and gas lines located on the O&R gate station property.

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

7. Open span structure and air treatment cost estimate includes rental of an approximately 100-foot by 100-foot Sprung-type structure to enclose the excavation area on the former MGP and State of New Jersey properties. Cost estimate assumes structure is equipped with overhead doors for truck and excavator access. Final structure construction details to be determined as part of the remedial design. Cost estimate based on assumed $240,000 for mobilization and setup; $83,000 for decontamination, breakdown, and demobilization; and $7,000 per week for rental (assumed 98 weeks). Cost estimate includes lease of all vapor collection and treatment equipment, delivery and set-up fees, and filter media change out. Cost estimate assumes structure will be moved up to 6 times during excavation activities at assumed cost of $10,000

8. Install and remove temporary sheet pile (without bracing) cost estimate includes all labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile used as support to excavate areas up to 25 feet bgs will be installed to depths up to 55 feet bgs and does not include internal bracing or other support. Sheet pile to be removed following site restoration activities. Final excavation support system to be determined as part of the remedial design. Cost estimate assumes sheet pile would be installed prior to erection of open span structure.

Table 9
Cost Estimate for Alternative 5 - Excavation to Unrestricted Use SCOs

Feasibility Study Report
Orange and Rockland Utilities, Inc. - Suffern Former MGP Site - Suffern, New York

9. Install and remove temporary sheet pile (with bracing) cost estimate includes all labor, equipment, and materials necessary to install, remove, and decontaminate temporary steel sheet pile. Cost estimate assumes sheet pile used as support to excavate areas up to 40 feet bgs will be installed to depths up to 55 feet bgs. Estimate includes additional costs for internal bracing, tie backs, deadmen or other additional support. Sheet pile to be removed following site restoration activities. Final excavation support system to be determined as part of the remedial design.

10. Reinforced slurry wall cost estimate includes all labor, equipment, and materials necessary to construct a slurry wall to serve as excavation support for deep excavations. Estimate includes cost for steel members installed within wet slurry to serve as additional excavation support. Estimate assumes slurry wall would be left in place following remedial construction activities. Final excavation support system to be determined as part of the remedial design.

11. Temporary water treatment system cost estimate includes installation of sumps within excavation areas and rental of a portable water treatment system capable of operating at 100 gallons-per-minute to dewater excavation areas (to the extent practicable). Some excavation activities may be performed "in the wet". Cost estimate assumes water treatment system includes pumps, influent piping and hoses, frac tank, carbon filters, bag filters, discharge piping and hoses, and flow meter. Cost estimate assumes bag filters will require change out approximately once per day of operation.

12. Soil excavation and handling (less than 40 feet ft bgs) includes all labor, equipment, and materials necessary to excavate soil containing MGP-related COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs at depths up 40 feet bgs using conventional excavation equipment. Cost estimate is based on in-place soil volume. Cost estimate is conservatively high to be inclusive of ancillary excavation costs (e.g., survey) and based on the likely presence of former MGP structures and other subsurface obstructions located within the excavation areas.

13. Soil excavation and handling (greater than 40 feet ft bgs) includes all labor, equipment, and materials necessary to excavate soil containing MGP-related COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs at depths greater than 40 feet bgs. Estimate assumes that removal activities would be completed using cranes or other similar equipment to facilitate deep soil removal. Cost estimate is based on in-place soil volume.

14. Soil excavation and handling (auger removal) includes all labor, equipment, and materials necessary to excavate soil containing MGP-related COCs at concentrations greater than 6 NYCRR Part 375-6 unrestricted use SCOs at depths up to 60 feet bgs. Estimate assumes that removal activities would be completed using augers to flight out subsurface material. Cost estimate is based on in-place soil volume.

15. Community air monitoring and vapor/odor control cost estimate includes all labor, equipment, and materials necessary to monitor vapor/odor emission during intrusive site activities and applying vapor/odor suppressing foam to open

16. Soil dewatering and stabilization and stabilization admixture cost estimate includes the on-site handling of material excavated below the water table and the purchase and importation of stabilizing agents to amend material excavated from the below the water table. Cost estimate assumes stabilization admixture (e.g., Portland cement) will be added at ratio of 10% of the weight of material to be stabilized. Cost estimate assumes that any water generated in association with soil management will be treated by the temporary water treatment system.

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

18. Solid waste characterization cost estimate includes the analysis of soil samples (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals). Costs assumes that waste characterization samples would be collected at a frequency of one sample per every 500 tons of material destined for off-site treatment/disposal.

19. Liquid waste characterization cost estimate includes the analysis (including, but not limited to, PCBs, VOCs, SVOCs, and RCRA Metals) of water collected and treated during remedial construction. Cost estimate assumes one sample collected and analyzed per every 50,000 gallons water requiring treatment and discharge to the POTW.

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

21. Liquid waste disposal cost estimate includes all fees associated with disposing of water collected during remedial construction activities. Volume estimate includes decontamination water and groundwater removed from excavation areas only. Volume estimate based on three saturated pore volume of the excavation areas. Cost estimate assumes water treatment by temporary on-site system would be discharged to the local POTW via a sanitary sewer. Disposal fees and sewer connection details would be evaluated as part of the remedial design.

22. Administration and engineering and construction management costs are based on an assumed 10% of the total capital costs, not including costs for off-site transportation and treatment/disposal of excavated material.

23. Annual permitting/access agreements cost estimate includes all costs necessary to obtain appropriate permits and access agreements to conduct periodic groundwater monitoring activities.

24. Quarterly groundwater sampling cost estimate includes all labor, equipment, and materials necessary to conduct quarterly groundwater sampling activities. Cost estimate assumes groundwater samples will be collected from up to 12 groundwater monitoring wells using low-flow sampling procedures. Cost estimate assumes two workers will require three days to complete the sampling activities. Estimate includes labor, field vehicle, lodging, subsistence, and equipment rental. Cost estimates includes preparation of a letter report to summarize quarterly groundwater sampling activities and results.

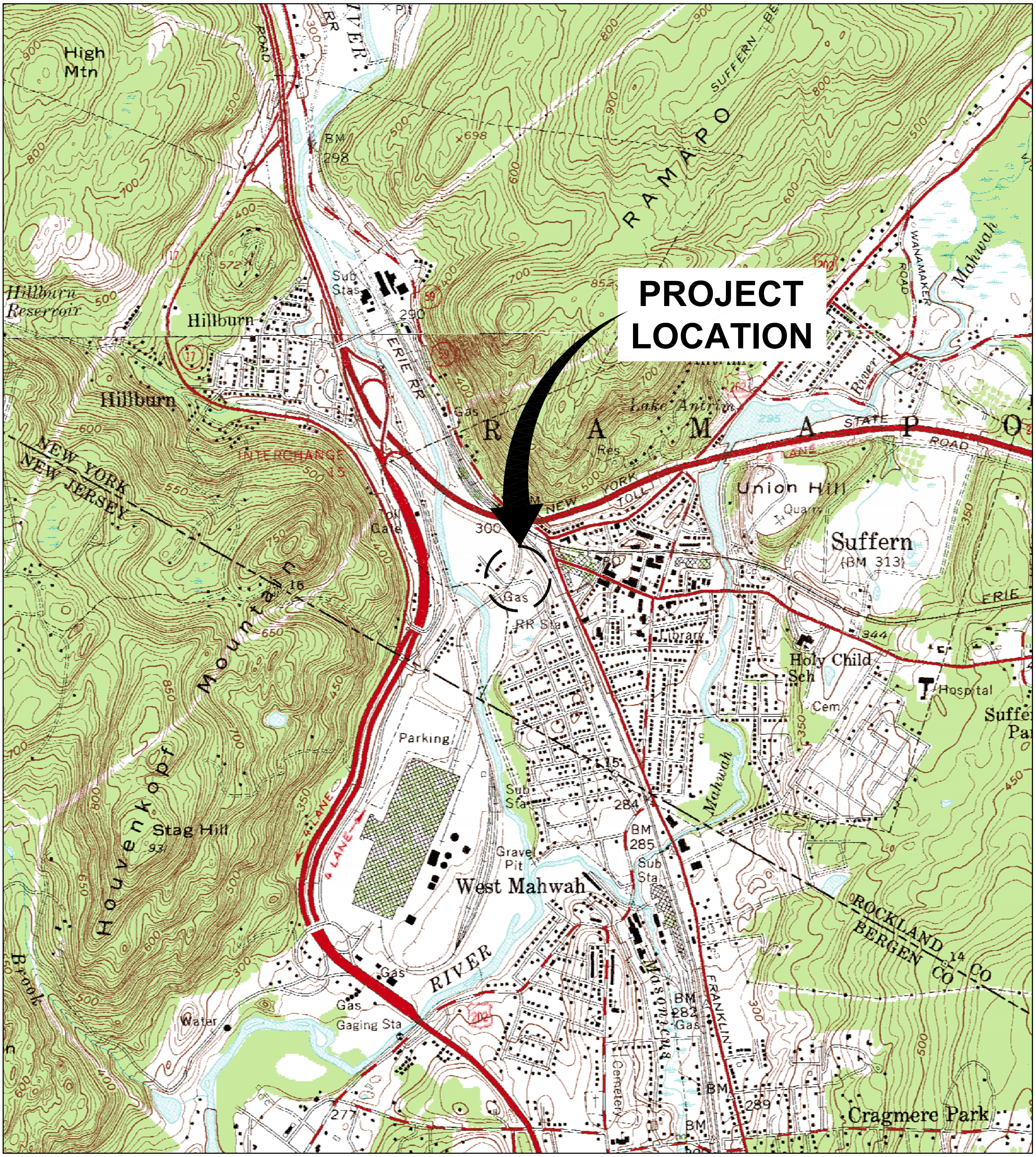
25. Laboratory analysis of groundwater samples cost estimate includes the analysis of groundwater samples for BTEX and PAHs. Estimate assumes laboratory analysis of groundwater samples from up to 12 groundwater monitoring wells and up to two QA/QC samples per sampling event.

26. Waste disposal cost estimate includes off-site disposal of drummed PPE, disposable sampling equipment, and purge water generated during groundwater monitoring activities. Estimate assumes two drums of material generated per event.

27. Annual summary report cost estimate includes all labor necessary to prepare an annual report summarizing the quarterly groundwater monitoring activities and results. Annual report to be submitted to NYSDEC.

28. Present worth is estimated based on a 4% beginning-of-year discount rate . It is assumed that "year zero" is 2013.

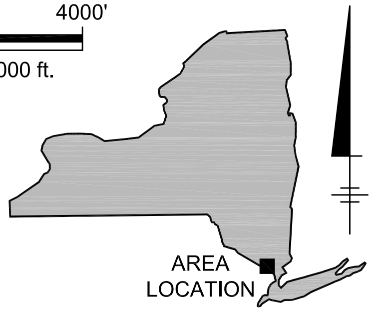
Figures



REFERENCE: BASE MAP USGS 7.5. MIN. TOPO. QUAD., RAMSEY, SLOATSBERG, NY-NJ, 1955.

0 2000' 4000'

Approximate Scale: 1 in. = 2000 ft.

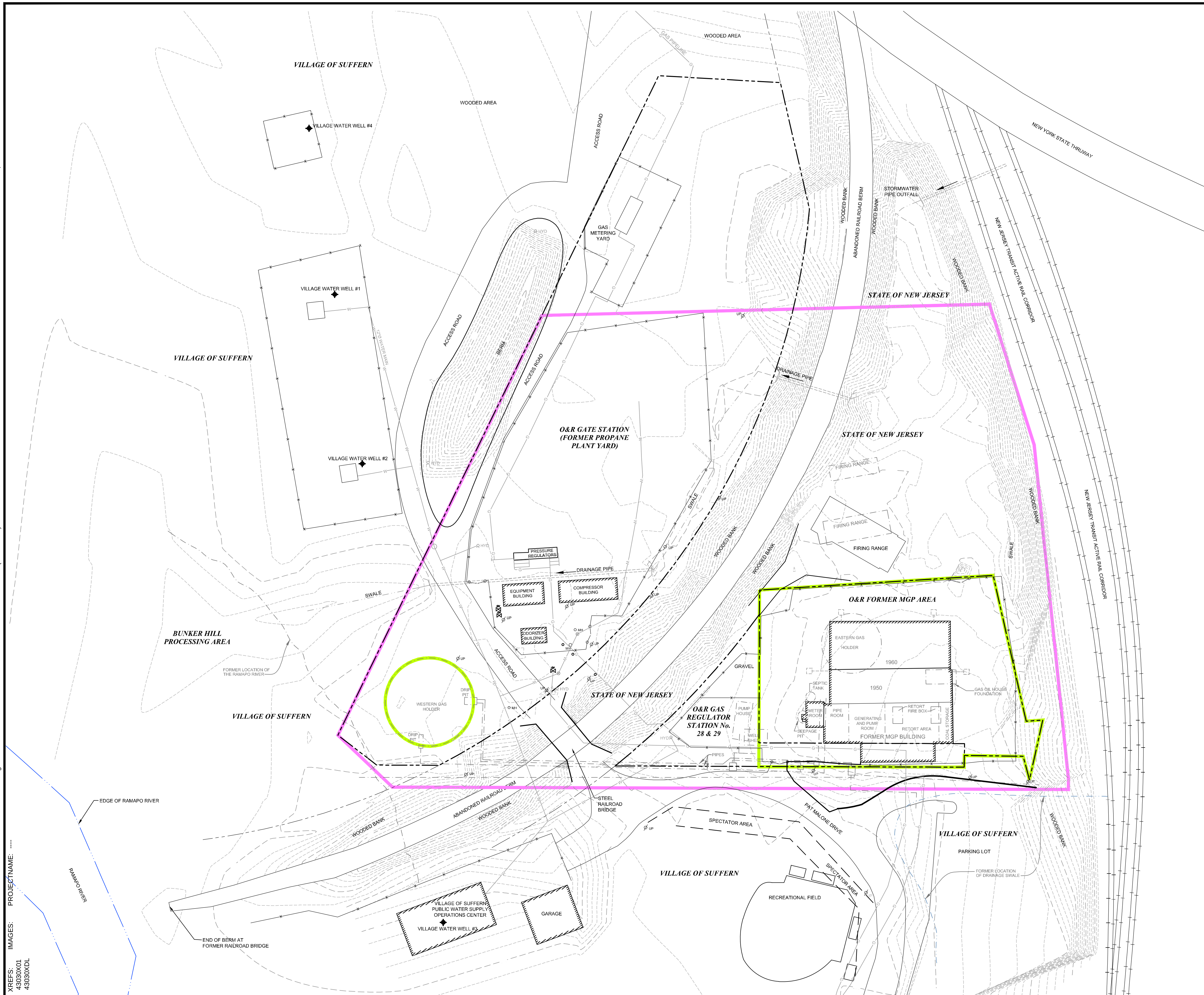


ORANGE & ROCKLAND UTILITIES, INC.
SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK
FEASIBILITY STUDY

SITE LOCATION MAP

ARCADIS

FIGURE
1



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN–LINK FENCE
- SWALE
- RAILROAD TRACK
- PUBLIC SUPPLY WELL LOCATION (VILLAGE WATER WELL #1)
- WATER LINE
- NATURAL GAS LINE
- STORM SEWER
- TOPOGRAPHIC CONTOUR
- FORMER MGP SITE
- PROJECT AREA BOUNDARY

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. FIGURE DEVELOPED BASED ON FIGURES 3 AND 4 OF THE REMEDIAL INVESTIGATION REPORT PREPARED BY GEI (GEI, 2010) AND ELECTRONIC FILES PROVIDED BY GEI ON JULY 9, 2012.

0 50' 100'
GRAPHIC SCALE

ORANGE & ROCKLAND UTILITIES, INC.
SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK
FEASIBILITY STUDY

SITE PLAN

ARCADIS

FIGURE
2

CITY: Syracuse DIV/GROUP: EnvCAD DB:W.JONES, E. KRAHMER, A.Schilling LD:(Opt) PIC: M. CARRILLO-SHERIDAN PM/TM: J. BRIEN TR: D. ALCOCER LYR:(Opt)ON=*;OFF=*REF* G:\ENVCAD\SYRACUSE\ACT\B0043030\0000\00020\DWG\43030B02.dwg LAYOUT: 2 SAVED: 8/16/2013 11:05 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: PDF 11X17 PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 8/16/2013 11:05 AM BY: SCHILLING, ADAM
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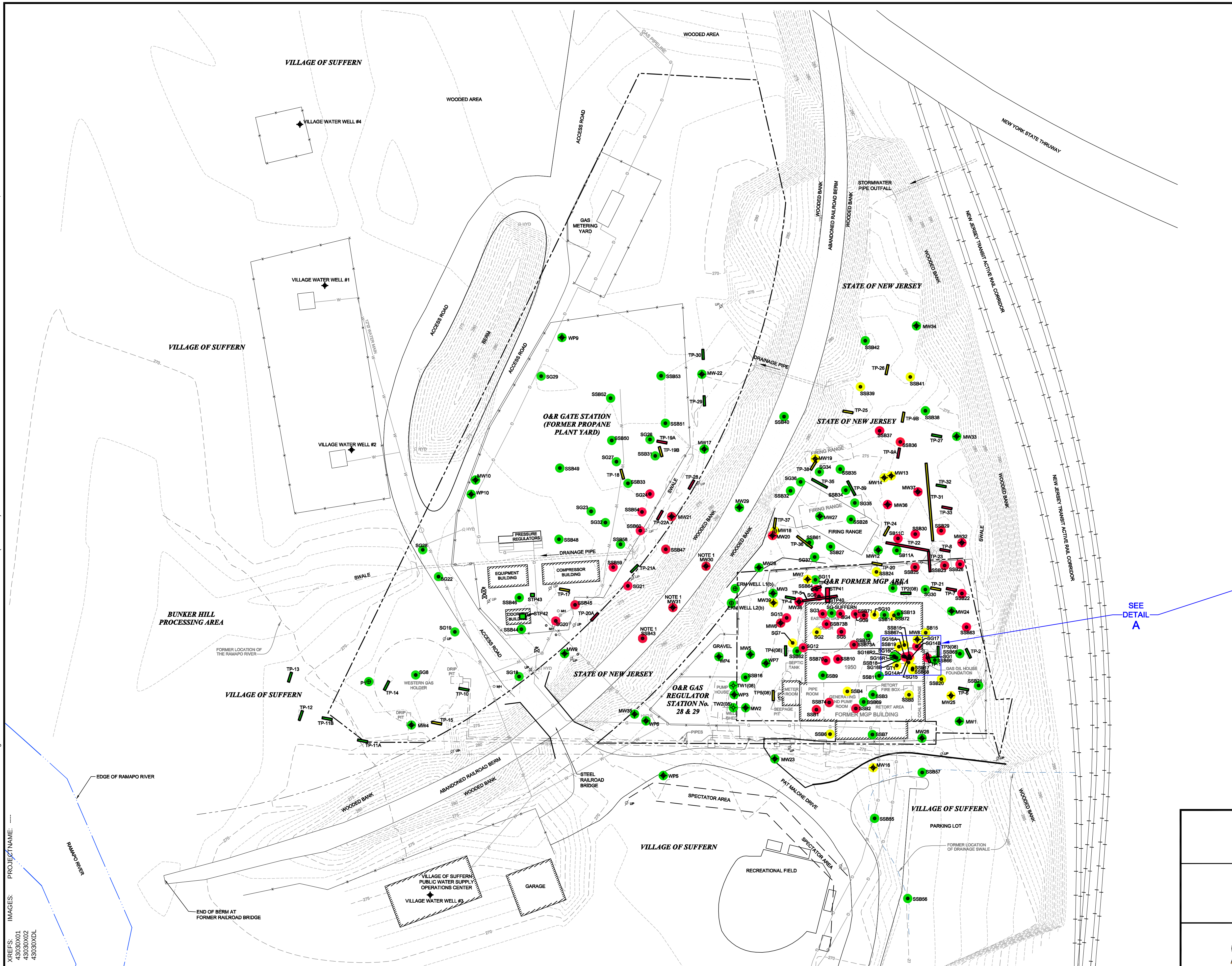


LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN–LINK FENCE
- SWALE
- RAILROAD TRACK
- PUBLIC SUPPLY WELL LOCATION
- WATER LINE
- NATURAL GAS LINE
- STORM SEWER
- TOPOGRAPHIC CONTOUR
- MONITORING WELL LOCATION
- TEMPORARY MONITORING WELL LOCATION
- ABANDONED MONITORING WELL LOCATION
- SOIL BORING LOCATION
- TEST PIT LOCATION
- NO VISIBLE NAPL IMPACTS OBSERVED
- NAPL STAIN: SHEEN OR BLEBS
- NAPL COATED OR SATURATED SOIL

NOTES:

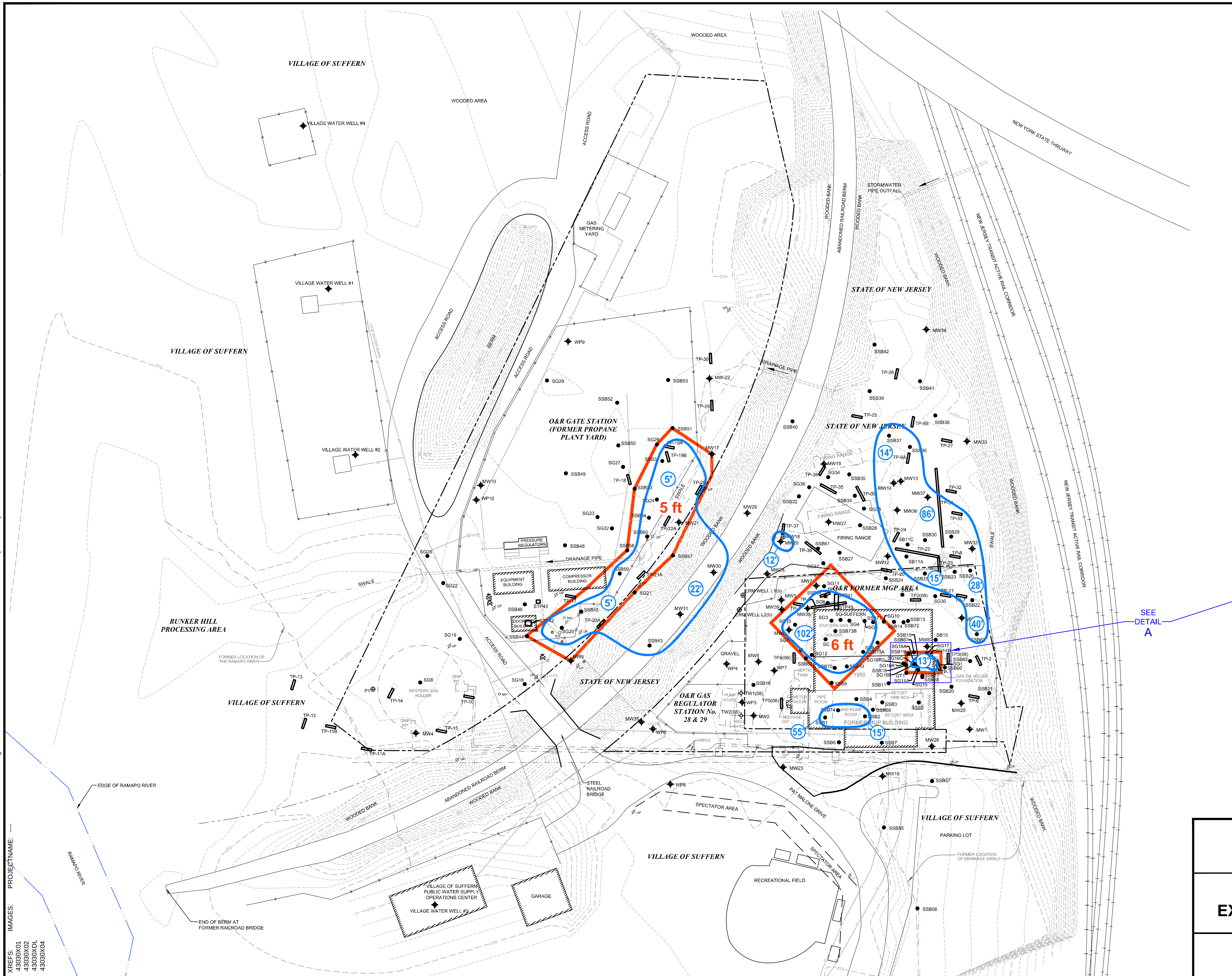
1. ALL LOCATIONS ARE APPROXIMATE.
2. FIGURE DEVELOPED BASED ON FIGURES 3 AND 4 OF THE REMEDIAL INVESTIGATION REPORT PREPARED BY GEI (GEI, 2010) AND ELECTRONIC FILES PROVIDED BY GEI ON JULY 9, 2012.

ORANGE & ROCKLAND UTILITIES, INC.
SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK
FEASIBILITY STUDY

EXTENT OF VISUAL IMPACTS

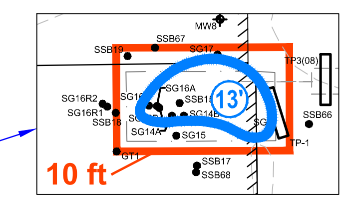
ARCADIS

FIGURE
3



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN–LINK FENCE
- SWALE
- RAILROAD TRACK
- PUBLIC SUPPLY WELL LOCATION
- WATER LINE
- NATURAL GAS LINE
- STORM SEWER
- TOPOGRAPHIC CONTOUR
- MONITORING WELL LOCATION
- TEMPORARY MONITORING WELL LOCATION
- ABANDONED MONITORING WELL LOCATION
- SOIL BORING LOCATION
- TEST PIT LOCATION
- APPROXIMATE HORIZONTAL EXTENT OF VISUALLY IMPACTED MATERIAL (GREATER THAN SHEENS OR BLEBS)
- (13') MAXIMUM DEPTH OF VISUALLY IMPACTED SOIL
- 10 ft LIMITS AND DEPTH OF REMEDIAL AREA



DETAIL A
SCALE: 1" = 20'

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. FIGURE DEVELOPED BASED ON FIGURES 3 AND 4 OF THE REMEDIAL INVESTIGATION REPORT PREPARED BY GEI (GEI, 2010) AND ELECTRONIC FILES PROVIDED BY GEI ON JULY 9, 2012.
3. O & R PLANS TO DEMOLISH COMPRESSOR BUILDING ON THE GATE STATION PROPERTY PRIOR TO IMPLEMENTATION OF REMEDIAL CONSTRUCTION.

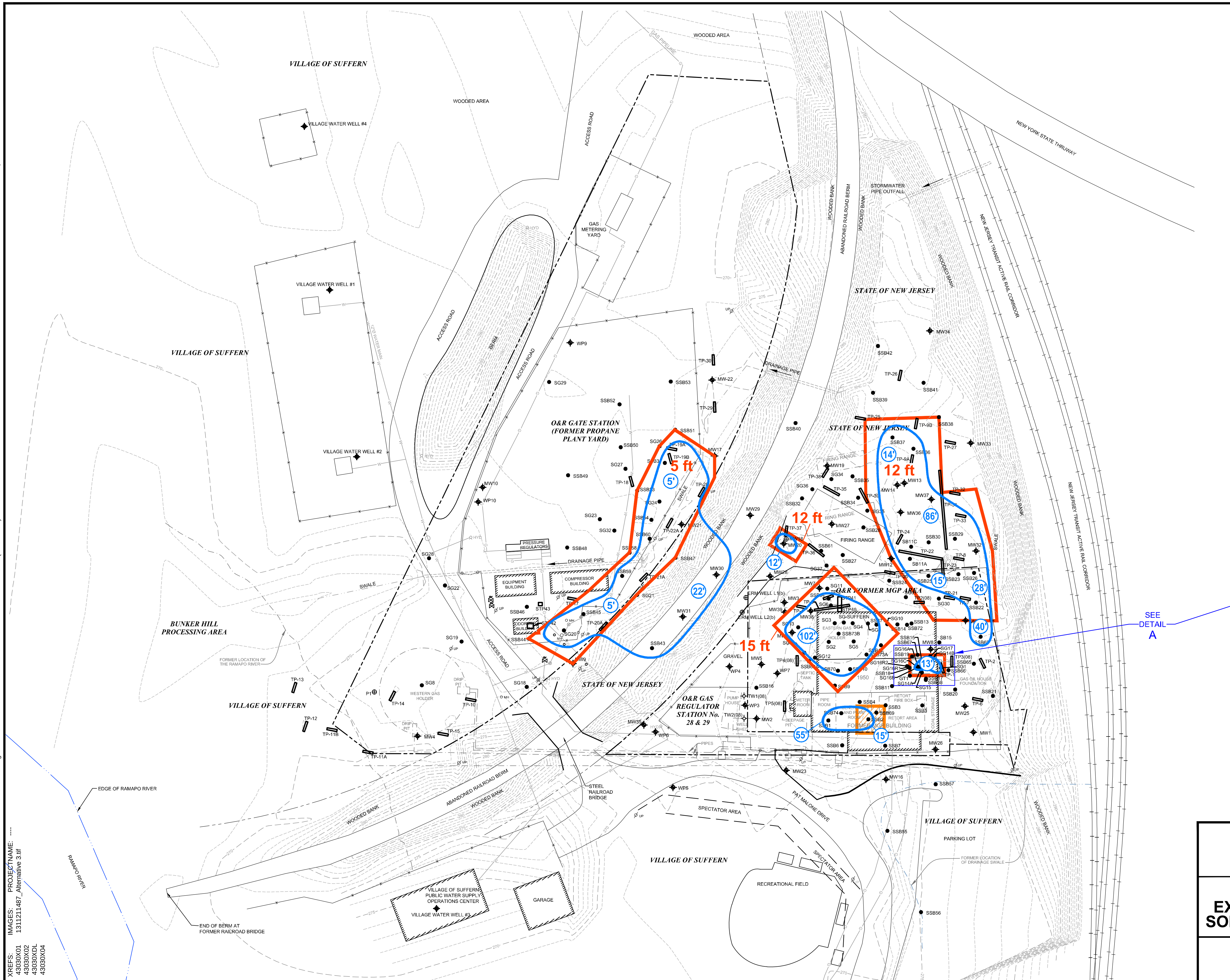
0 50' 100'
GRAPHIC SCALE

ORANGE & ROCKLAND UTILITIES, INC.
SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK
FEASIBILITY STUDY

ALTERNATIVE 2
EXCAVATION OF MGP STRUCTURES

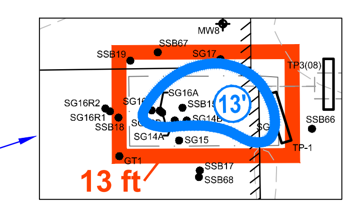
ARCADIS

FIGURE
4



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- PUBLIC SUPPLY WELL LOCATION (VILLAGE WATER WELL #1)
- WATER LINE
- NATURAL GAS LINE
- STORM SEWER
- TOPOGRAPHIC CONTOUR
- MONITORING WELL LOCATION (MW1)
- TEMPORARY MONITORING WELL LOCATION (TW1(08))
- ABANDONED MONITORING WELL LOCATION (ERM WELL L1, TW1(08))
- SOIL BORING LOCATION (SG1, SSB1)
- TEST PIT LOCATION (TP-1)
- APPROXIMATE HORIZONTAL EXTENT OF VISUALLY IMPACTED MATERIAL (GREATER THAN SHEENS OR BLEBS)
- 13' MAXIMUM DEPTH OF VISUALLY IMPACTED MATERIAL
- 12 ft LIMITS AND DEPTH OF REMEDIAL AREA
- AREA TO BE INVESTIGATED FURTHER



DETAIL A

SCALE: 1" = 20'

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. FIGURE DEVELOPED BASED ON FIGURES 3 AND 4 OF THE REMEDIAL INVESTIGATION REPORT PREPARED BY GEI (GEI, 2010) AND ELECTRONIC FILES PROVIDED BY GEI ON JULY 9, 2012.
3. O & R PLANS TO DEMOLISH COMPRESSOR BUILDING ON THE GATE STATION PROPERTY PRIOR TO IMPLEMENTATION OF REMEDIAL CONSTRUCTION.

0 50' 100'

GRAPHIC SCALE

ORANGE & ROCKLAND UTILITIES, INC.
SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK
FEASIBILITY STUDY

ALTERNATIVE 3
EXCAVATION OF VISUALLY IMPACTED SOIL UP TO THE GROUNDWATER TABLE

ARCADIS

FIGURE
5

CITY: Syracuse DIV/GROUP: EnvCAD DB:W.JONES E.KRAHMER A.Schilling LD:(Opt) PIC: M. CARRILLO-SHERIDAN PM/TM: J. BRIEN TR: D. ALCOCER LYR:(Opt)ON=*;OFF=*REF*
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XREFS: IMAGES: PROJECTNAME: ----
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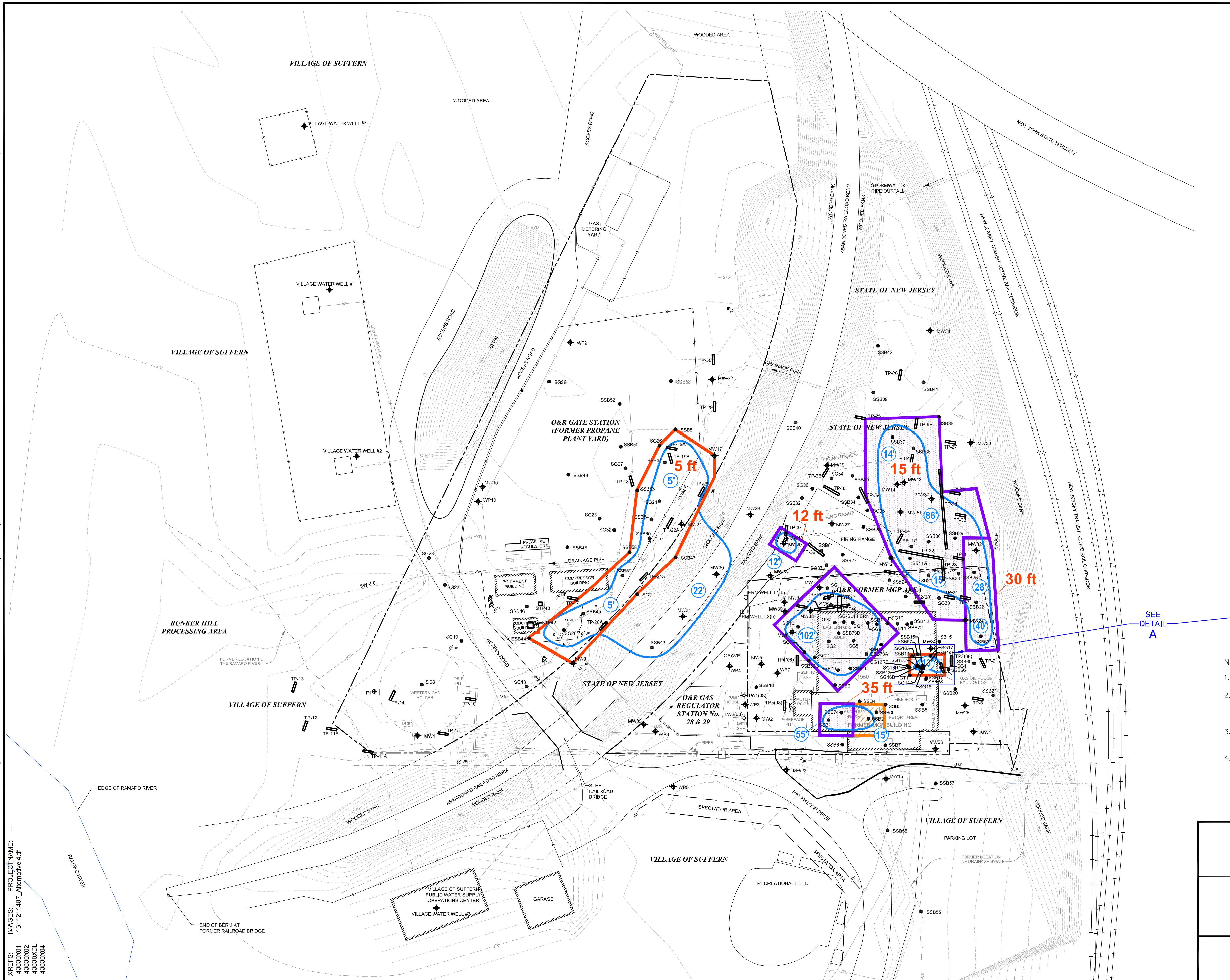
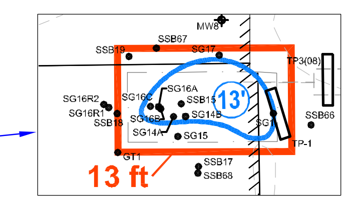
43030X02
43030XDL
43030X04



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- PUBLIC SUPPLY WELL LOCATION
- WATER LINE
- NATURAL GAS LINE
- STORM SEWER
- TOPOGRAPHIC CONTOUR
- MONITORING WELL LOCATION
- TEMPORARY MONITORING WELL LOCATION
- ABANDONED MONITORING WELL LOCATION
- SOIL BORING LOCATION
- TEST PIT LOCATION
- APPROXIMATE HORIZONTAL EXTENT OF VISUALLY IMPACTED MATERIAL (GREATER THAN SHEENS OR BLEBS)
- 13' MAXIMUM DEPTH OF VISUALLY IMPACTED MATERIAL
- 12 ft LIMITS AND DEPTH OF EXCAVATION
- 30 ft LIMITS AND DEPTH OF SOLIDIFICATION
- AREA TO BE INVESTIGATED FURTHER



DETAIL A

SCALE: 1" = 20'

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. FIGURE DEVELOPED BASED ON FIGURES 3 AND 4 OF THE REMEDIAL INVESTIGATION REPORT PREPARED BY GEI (GEI, 2010) AND ELECTRONIC FILES PROVIDED BY GEI ON JULY 9, 2012.
3. PRE-ISS EXCAVATION TO BE CONDUCTED TO DEPTHS OF 5 TO 10 FEET BELOW GRADE AT STABILIZATION AREAS.
4. O & R PLANS TO DEMOLISH COMPRESSOR BUILDING ON THE GATE STATION PROPERTY PRIOR TO IMPLEMENTATION OF REMEDIAL CONSTRUCTION.

0 50' 100'

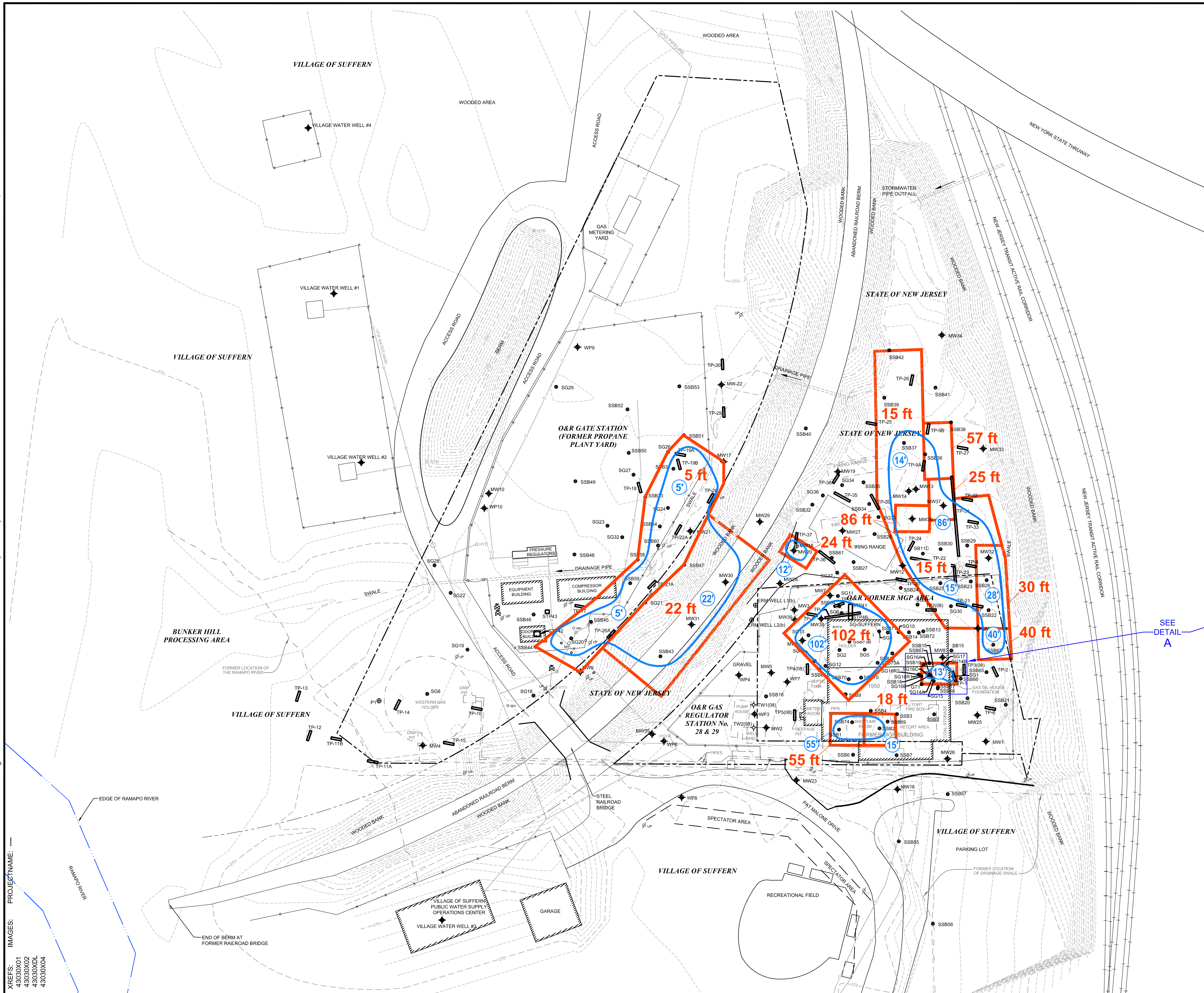
GRAPHIC SCALE

ORANGE & ROCKLAND UTILITIES, INC.
SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK
FEASIBILITY STUDY

ALTERNATIVE 4
EXCAVATION AND ISS

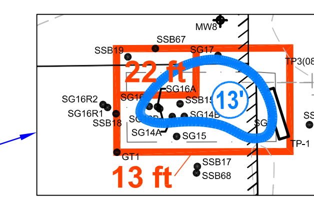
ARCADIS

FIGURE
6



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- PUBLIC SUPPLY WELL LOCATION
- WATER LINE
- NATURAL GAS LINE
- STORM SEWER
- TOPOGRAPHIC CONTOUR
- MONITORING WELL LOCATION
- TEMPORARY MONITORING WELL LOCATION
- ABANDONED MONITORING WELL LOCATION
- SOIL BORING LOCATION
- TEST PIT LOCATION
- APPROXIMATE HORIZONTAL EXTENT OF VISUALLY IMPACTED MATERIAL (GREATER THAN SHEENS AND BLEBS)
- MAXIMUM DEPTH OF VISUALLY IMPACTED MATERIAL
- LIMITS AND DEPTH OF REMEDIAL AREA



DETAIL A

SCALE: 1" = 20'

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.
2. FIGURE DEVELOPED BASED ON FIGURES 3 AND 4 OF THE REMEDIAL INVESTIGATION REPORT PREPARED BY GEI (GEI, 2010) AND ELECTRONIC FILES PROVIDED BY GEI ON JULY 9, 2012.
3. O & R PLANS TO DEMOLISH COMPRESSOR BUILDING ON THE GATE STATION PROPERTY PRIOR TO IMPLEMENTATION OF REMEDIAL CONSTRUCTION.

0 50' 100'

GRAPHIC SCALE

ORANGE & ROCKLAND UTILITIES, INC.
SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK
FEASIBILITY STUDY

ALTERNATIVE 5
EXCAVATION TO UNRESTRICTED USE SCOs

ARCADIS

FIGURE **7**

CITY: SYRACUSE, NY DIV/GROUP: ENVREM-WIM-DV DB: E. KRAHMER, A. SCHILLING, P. LISTER PM/TM: J. BRIEN TR: M.KISER LYR:(Opt)ON=*;OFF=*REF* PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 10/11/2013 12:59 PM BY: PETRIE, RICH
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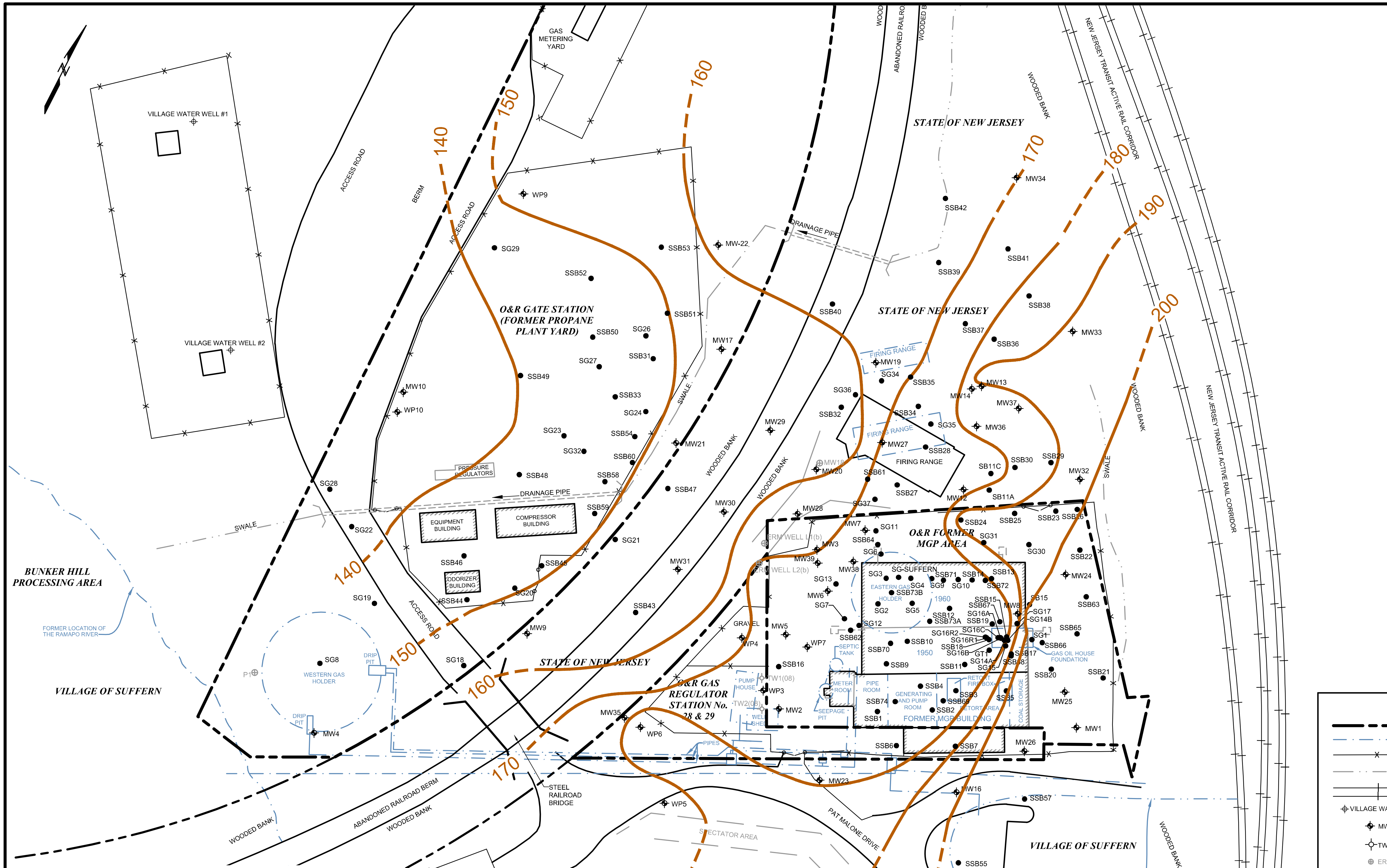
ARCADIS

Appendix A

Select RI Report Figures



W□□□B□r□□□	B□dr□□□ E□□□□t□□□ □F□□t NAVD□□□
SB□□MW□	170.50
SB□□MW□	173.47
SB13□MW13	193.42
SB1□□MW1□	199.47
SB1□□MW1□	154.90
SB1□□MW1□	159.37
SB1□□MW1□	164.18
SB21□MW21	153.32
SB22□MW22	162.05
SB3□□MW3□	183.58
SB3□□MW3□	185.98
SB3□□MW3□	171.42
SB3□□MW3□	167.90
SSB2□	192.73
SSB2□	170.38
SSB3□	180.50
SSB32	159.00
SSB3□	170.74
SSB3□	183.66
SSB3□	171.71
SSB□2	172.08
SSB□□	170.54
SSB□□	203.41
SSB□□	180.37
SSB□□	176.13
SSB□□	169.01
SSB□□	173.31
SSB□1	173.45
SSB□2	179.47
SSB□3	172.45
SSB□□	175.53
SBWP3□WP3	175.37
SBWP□□WP□	169.98
SBWP5□WP5	174.55
SBWP□□WP□	183.13
SBWP□□WP□	173.98
SBWP□□WP□	154.33
SBWP1□□WP1□	139.50
ERM L2	170.71

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- VILLAGE WATER WELL #1 — PUBLIC SUPPLY WELL LOCATION
- MW1 — MONITORING WELL LOCATION
- TW1(08) — TEMPORARY MONITORING WELL LOCATION
- ERM WELL L1, TW1(08) — ABANDONED MONITORING WELL LOCATION
- SG1, SSB1 — SOIL BORING LOCATION
- 150 — TOP OF BEDROCK CONTOUR
- 150 — INFERRED TOP OF BEDROCK CONTOUR

SOURCES:

1. Survey of existing conditions and sample locations conducted by GEI Consultants, Inc. in 1999, 2009 and 2010. Survey by New York state licensed land surveyor number 050146. Horizontal Datum: New York State Plane Coordinate System (East Zone, North American Datum (NAD) 83). Vertical Datum: North American Vertical Datum (NAVD) 88.
2. Drawing titled WELL & SAMPLE SURVEY OF THE FORMER SUFFERN MGP SITE, THE RETEC GROUP, INC., VILLAGE OF SUFFERN, survey conducted by Donald Stedge, L.S., P.C. dated 12/10/2002. Horizontal datum: Assumed. Vertical datum: NAVD 88 from NGS benchmark.
3. Drawing titled BOUNDARY SURVEY, ORANGE AND ROCKLAND UTILITIES, INC. AND ECONOMY-TRUCK BODY AND EQUIPMENT, VILLAGE OF SUFFERN-ROCKLAND COUNTY, NEW YORK, by C.T.Male Associates, P.C., Latham, New York dated 2008.

SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK

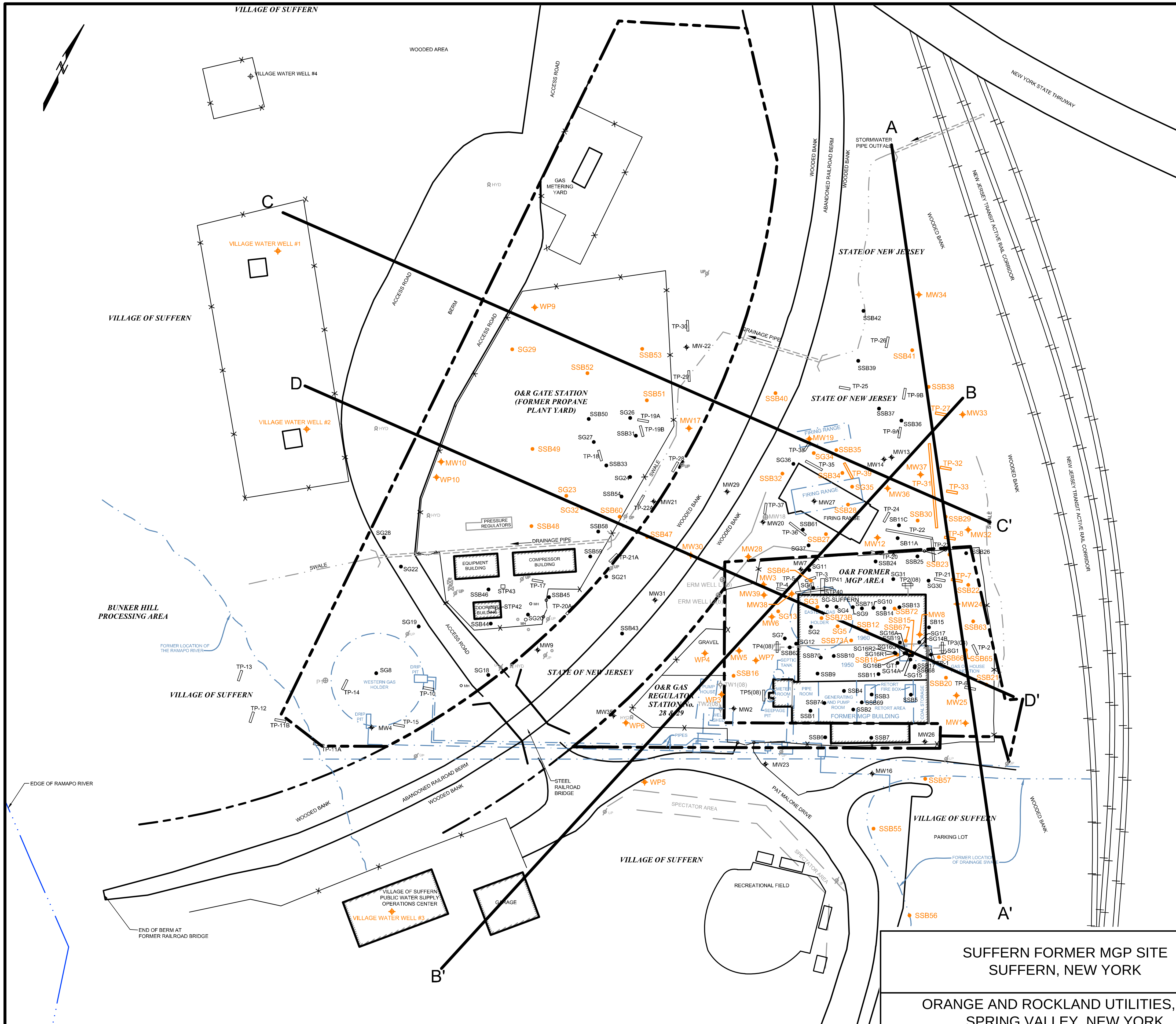
ORANGE AND ROCKLAND UTILITIES, INC.
SPRING VALLEY, NEW YORK

GEI Consultants

TOP OF BEDROC□ CONTOUR MAP

Project 091950-2-1204 | October 2010 | Figure 12

I:\Project\ORANGE & ROCKLAND\Suffern\RI Report\Figures\ SUFFERN FIGURES.dwg \Oct 19, 2010



LEGEND:

(line)	APPROXIMATE PROPERTY BOUNDARY
(line)	HISTORIC STRUCTURE
(line)	CHAIN-LINK FENCE
(line)	SWALE
(line)	RAILROAD TRACK
VILLAGE WATER WELL #1	PUBLIC SUPPLY WELL LOCATION
MW1	MONITORING WELL LOCATION
TW1(08)	TEMPORARY MONITORING WELL LOCATION
ERM WELL L1, TW1(08)	ABANDONED MONITORING WELL LOCATION
SG1, SSB1	SOIL BORING LOCATION
TP-1	TEST PIT LOCATION
A —— A'	**CROSS SECTION LOCATION**
ORANGE	SAMPLE LOCATION USED ON CROSS SECTIONS

0 100 200

SCALE, FEET

SOURCES:

1. Survey of existing conditions and sample locations conducted by GEI Consultants, Inc. in 1999, 2009 and 2010. Survey by New York state licensed land surveyor number 050146. Horizontal Datum: New York State Plane Coordinate System (East Zone, North American Datum (NAD) 83). Vertical Datum: North American Vertical Datum (NAVD) 88.
2. Drawing titled WELL & SAMPLE SURVEY OF THE FORMER SUFFERN MGP SITE, THE RETEC GROUP, INC., VILLAGE OF SUFFERN, survey conducted by Donald Stedge, L.S., P.C. dated 12/10/2002. Horizontal datum: Assumed. Vertical datum: NAVD 88 from NGS benchmark.
3. Drawing titled BOUNDARY SURVEY, ORANGE AND ROCKLAND UTILITIES, INC. AND ECONOMY-TRUCK BODY AND EQUIPMENT, VILLAGE OF SUFFERN-ROCKLAND COUNTY, NEW YORK, by C.T.Male Associates, P.C., Latham, New York dated 2008.

SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK

ORANGE AND ROCKLAND UTILITIES, INC.
SPRING VALLEY, NEW YORK

GEI Consultants

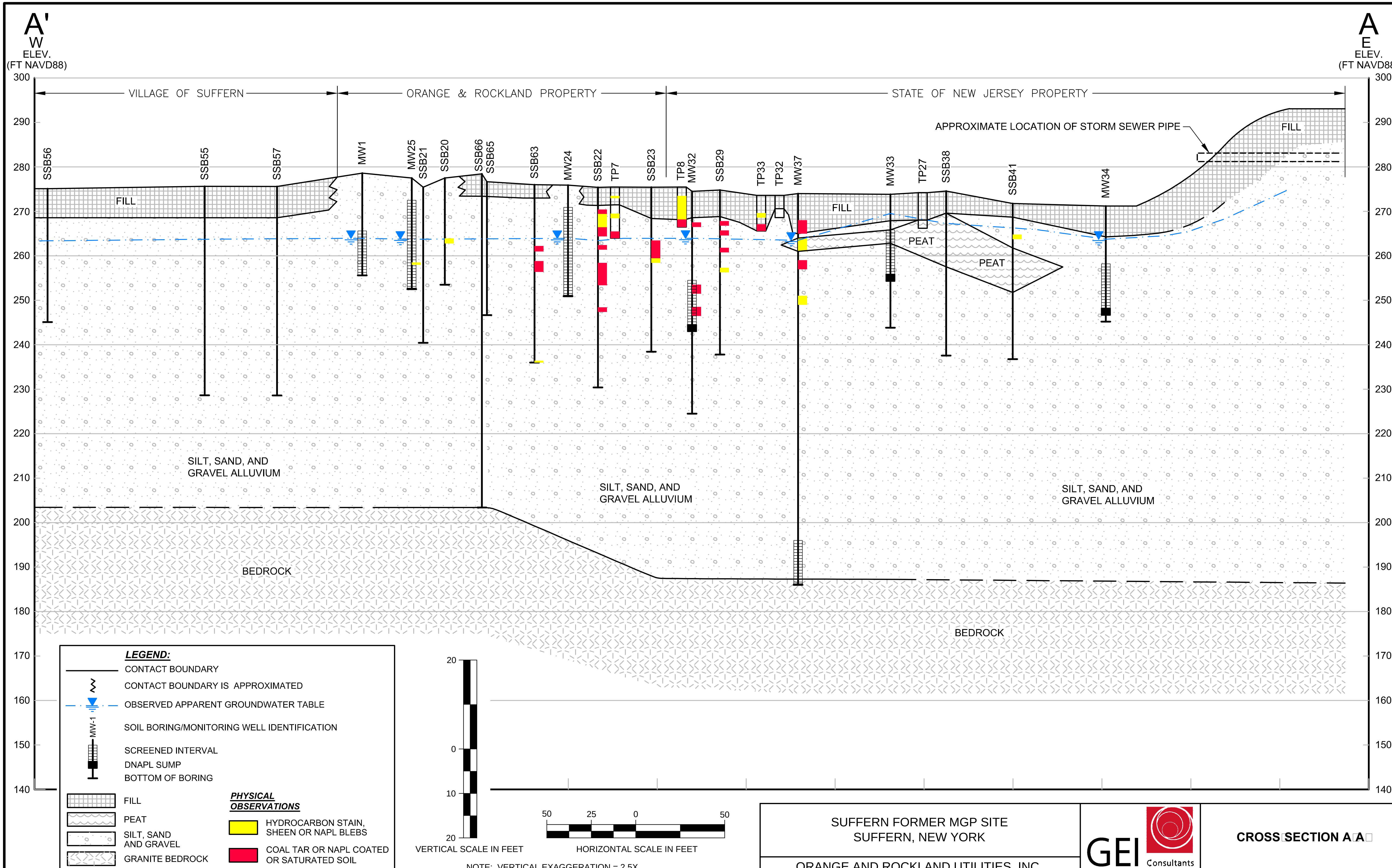
Project 091950-2-1204

CROSS SECTION LOCATION MAP

October 2010

Figure 13

C:\DOCUME~1\SGALLA~1\LOCALS~1\Temp\AcPublish_5096\ SUFFERN CURRENT & HISTORIC.dwg \Oct 19, 2010



SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK

ORANGE AND ROCKLAND UTILITIES, INC.
SPRING VALLEY, NEW YORK

GEI Consultants

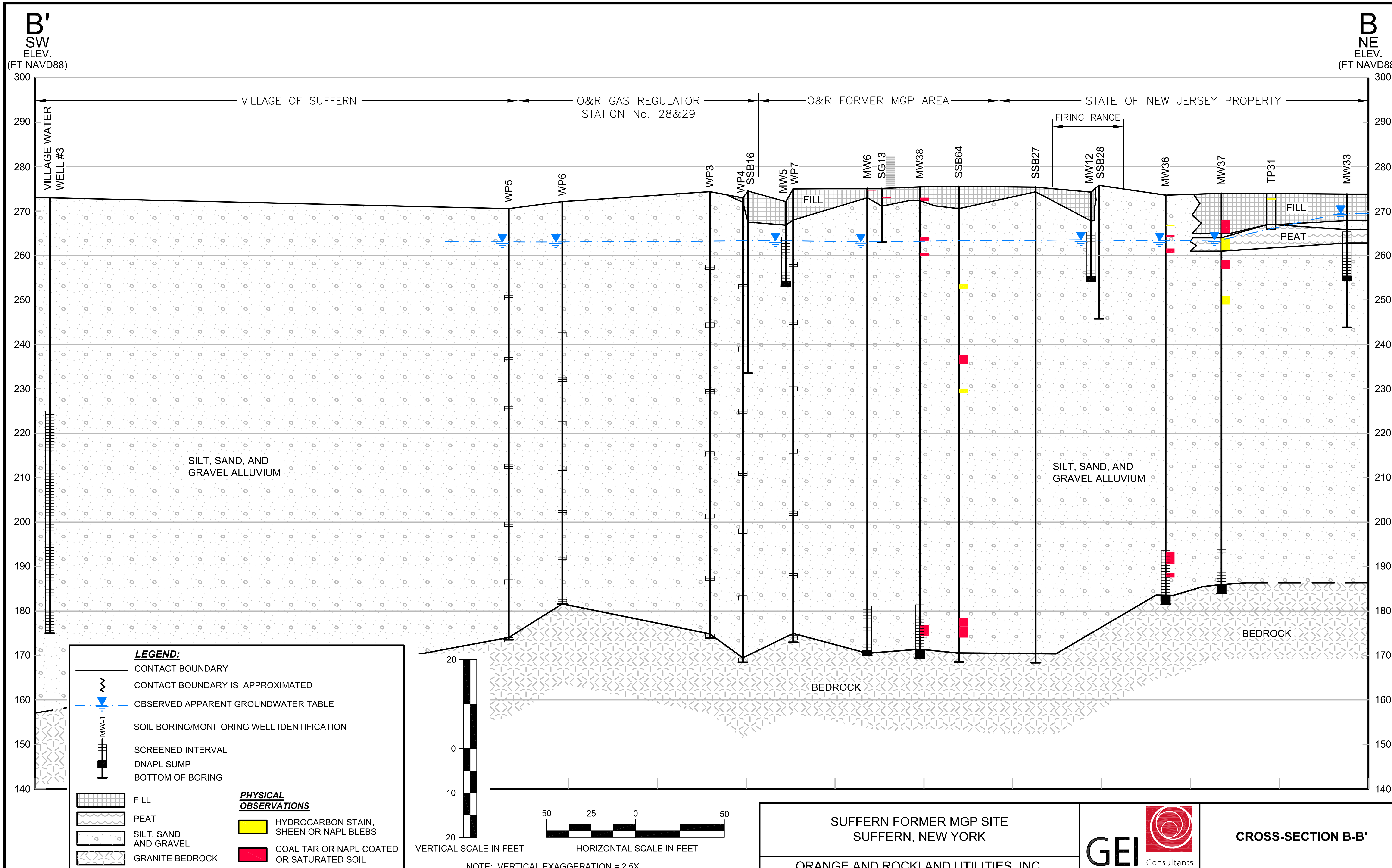
Project 091950-2-1204

CROSS SECTION A A

October 2010

Figure 14

I:\Project\ORANGE & ROCKLAND\Suffern\RI Report\Figures\ SUFFERN FIGURES.dwg \Oct 19, 2010



SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK

ORANGE AND ROCKLAND UTILITIES, INC.
SPRING VALLEY, NEW YORK

GEI Consultants

CROSS-SECTION B-B'

Project 091950-2-1204 | October 2010 | Figure 15

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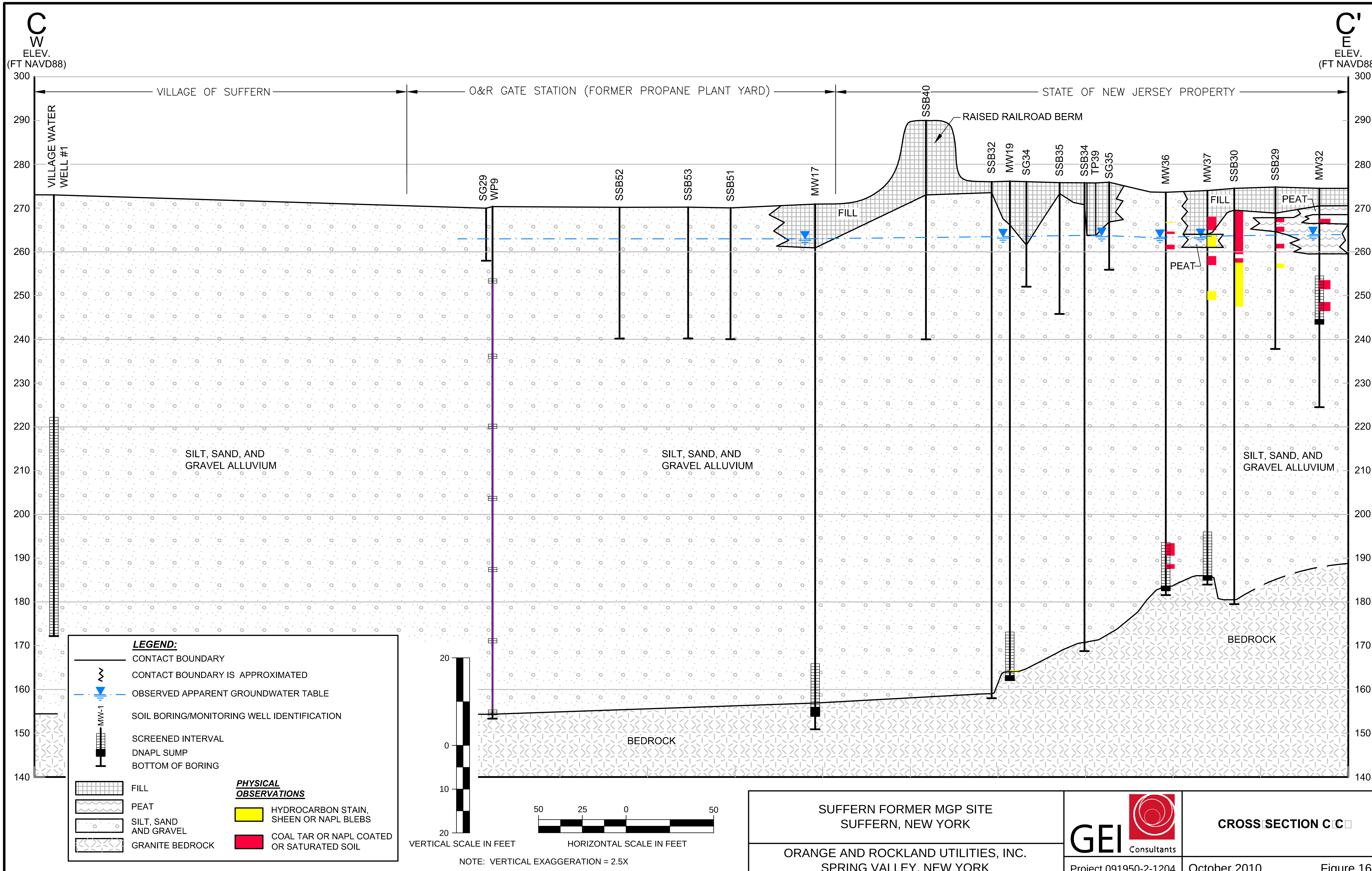

SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK

ORANGE AND ROCKLAND UTILITIES, INC.
SPRING VALLEY, NEW YORK

GEI Consultants

CROSS[illegible]SECTION C[illegible]C[illegible]

Project 091950-2-1204 | October 2010 | Figure 16

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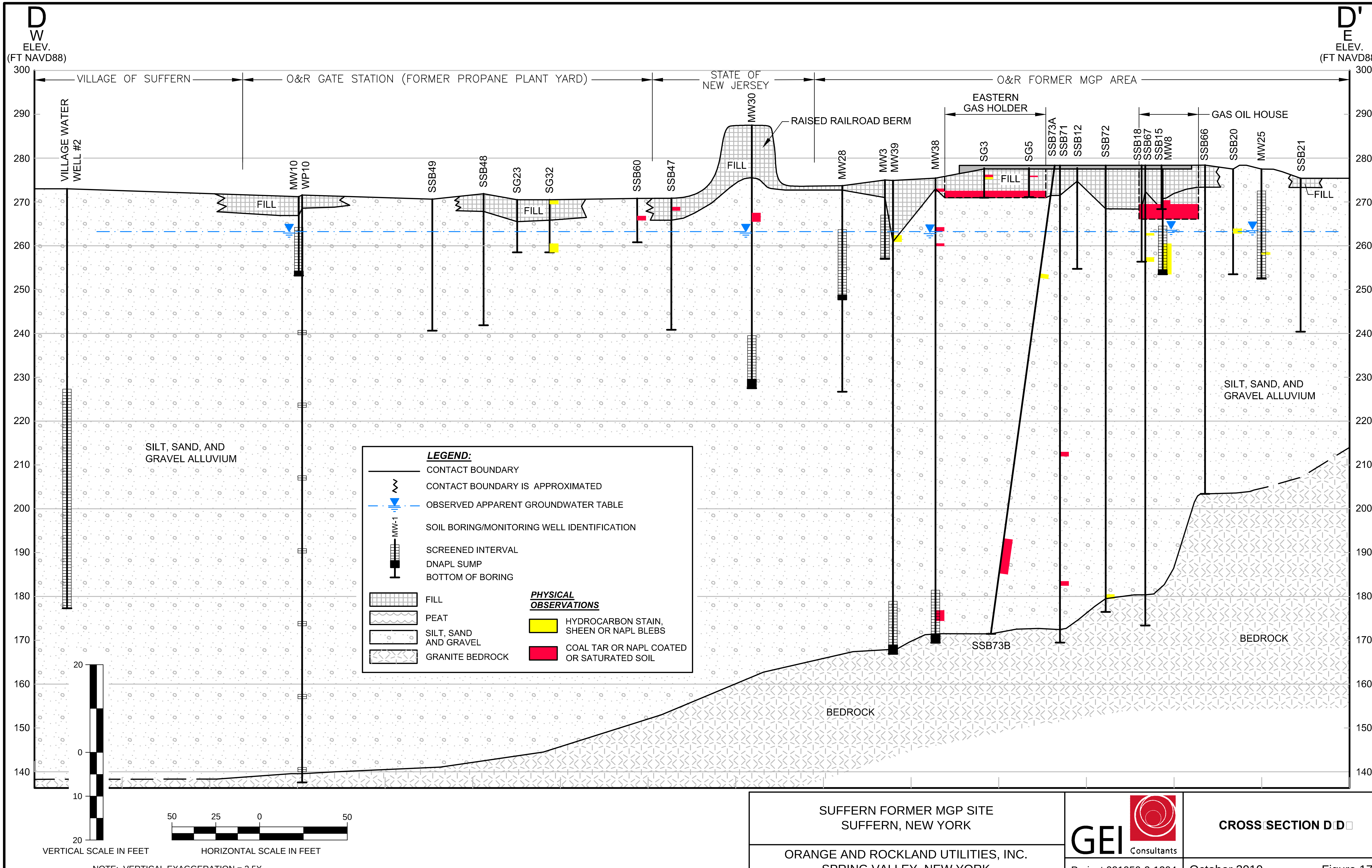

SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK

ORANGE AND ROCKLAND UTILITIES, INC.
SPRING VALLEY, NEW YORK

GEI Consultants

Project 091950-2-1204

CROSS SECTION D-D'

October 2010

Figure 17

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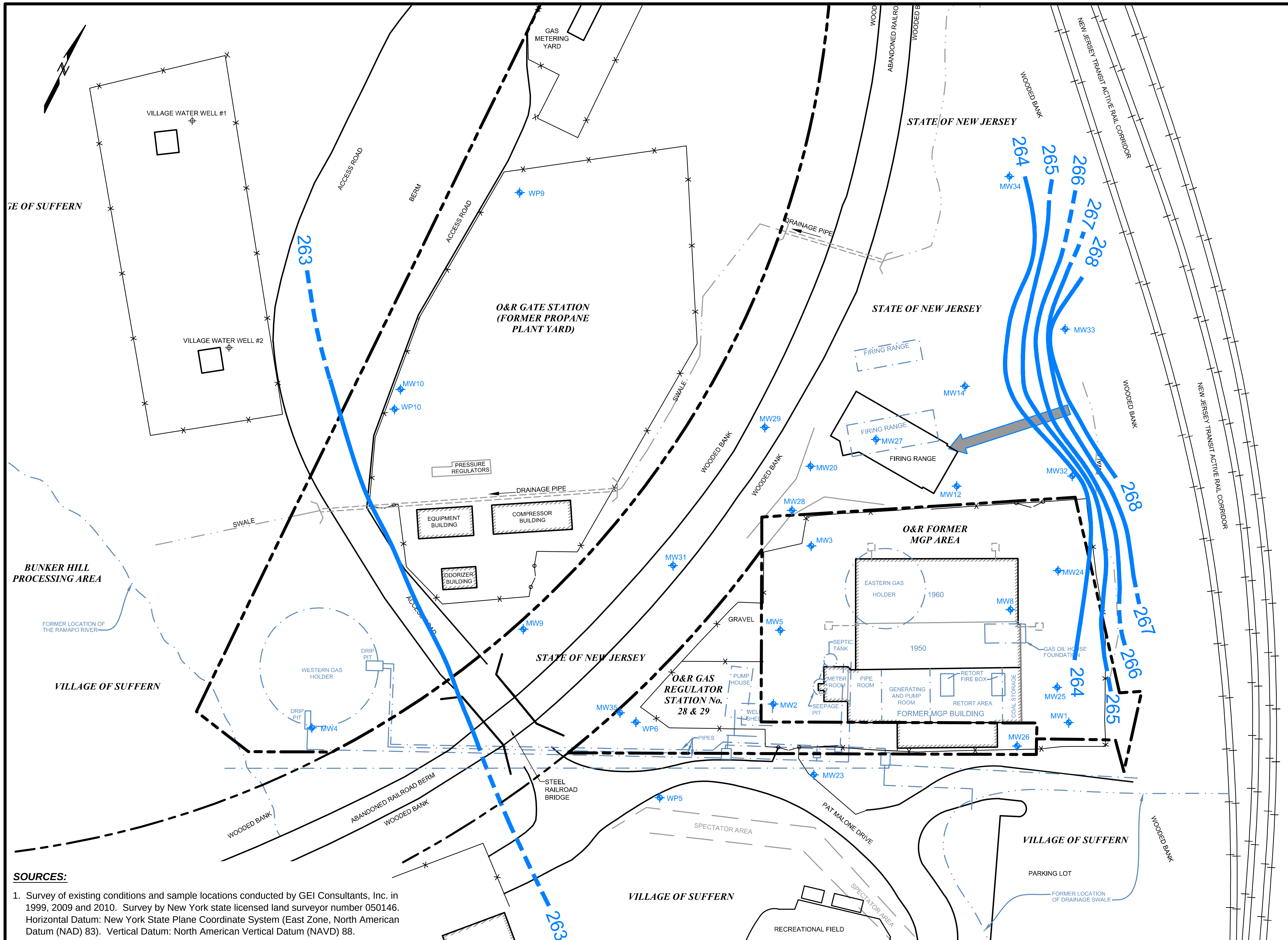

W□□□	Gr□□□d□ □t□r E□□□□t□□ N□□□□ □□r 1□□2□□□ □F□□t NAVD□□□
MW1	263.93
MW2	263.39
MW3	263.29
MW□	262.48
MW5	263.25
MW□	263.85
MW□	263.35
MW1□	263.22
MW12	263.47
MW1□	263.12
MW2□	263.11
MW23	263.58
MW2□	263.80
MW25	263.81
MW2□	263.90
MW2□	263.44
MW2□	263.31
MW2□	263.26
MW31	263.24
MW32	263.83
MW33	269.51
MW3□	263.73
MW35	263.38

NOTE:

HORIZONTAL LOCATIONS ARE REFERENCED TO THE NEW YORK STATE COORDINATE SYSTEM - EAST ZONE. VERTICAL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- VILLAGE WATER WELL #1 — PUBLIC SUPPLY WELL LOCATION
- MW1 — MONITORING WELL LOCATION
- 263 — WATER TABLE GROUNDWATER CONTOUR (FEET NAVD 88)
- DASHED WHERE INFERRED
- INFERRED GROUNDWATER FLOW DIRECTION

0 80 160

SCALE, FEET

SOURCES:

1. Survey of existing conditions and sample locations conducted by GEI Consultants, Inc. in 1999, 2009 and 2010. Survey by New York state licensed land surveyor number 050146. Horizontal Datum: New York State Plane Coordinate System (East Zone, North American Datum (NAD) 83). Vertical Datum: North American Vertical Datum (NAVD) 88.
2. Drawing titled WELL & SAMPLE SURVEY OF THE FORMER SUFFERN MGP SITE, THE RETEC GROUP, INC., VILLAGE OF SUFFERN, survey conducted by Donald Stedge, L.S., P.C. dated 12/10/2002. Horizontal datum: Assumed. Vertical datum: NAVD 88 from NGS benchmark.
3. Drawing titled BOUNDARY SURVEY, ORANGE AND ROCKLAND UTILITIES, INC. AND ECONOMY-TRUCK BODY AND EQUIPMENT, VILLAGE OF SUFFERN-ROCKLAND COUNTY, NEW YORK, by C.T.Male Associates, P.C., Latham, New York dated 2008.

SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK

ORANGE AND ROCKLAND UTILITIES, INC.
SPRING VALLEY, NEW YORK

GEI Consultants

Project 091950-2-1204

WATER TABLE GROUNDWATER CONTOUR MAP

October 2010

Figure 18

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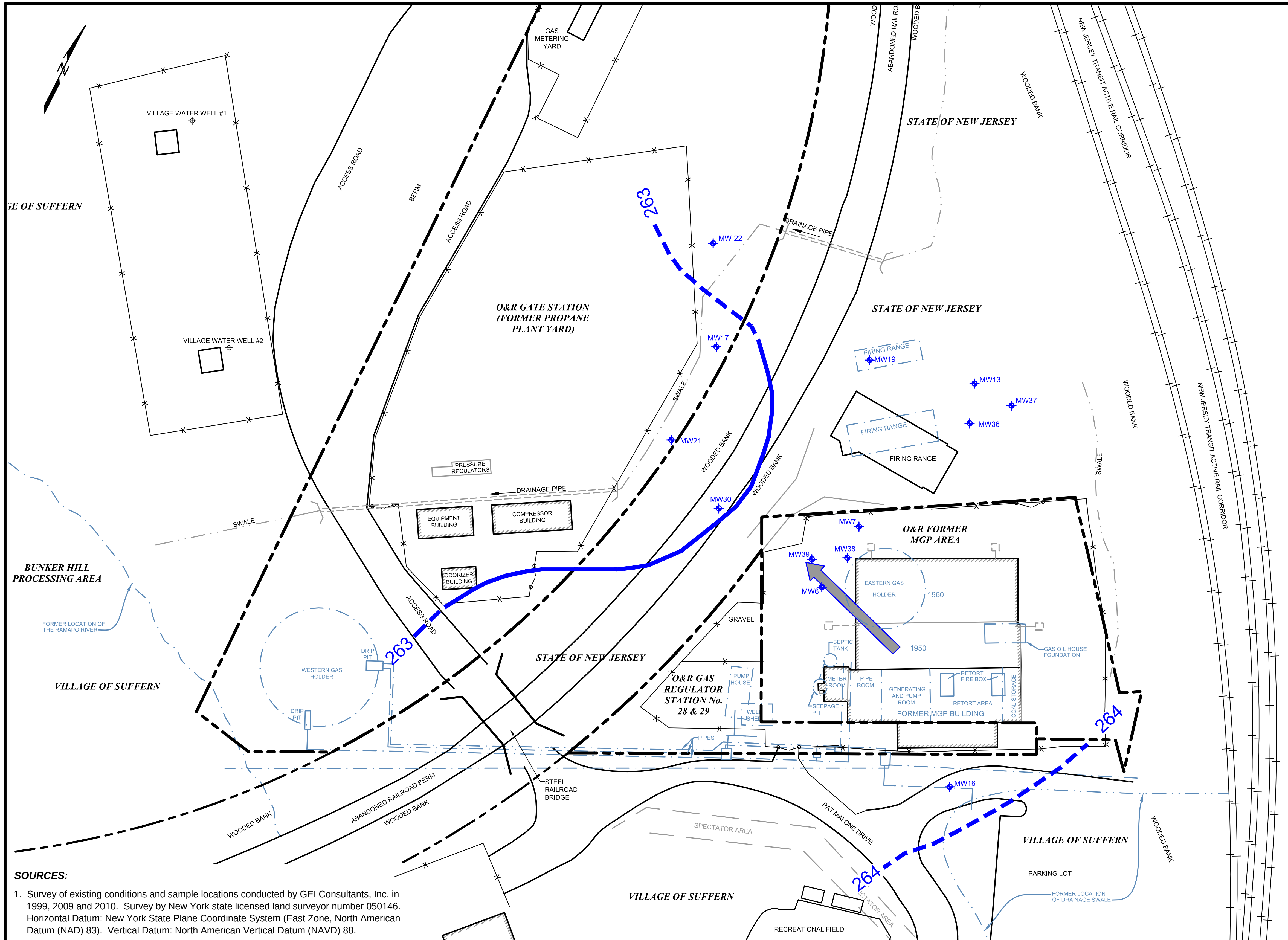

D□□□□□□□t□□□	Gr□□□□d□ □t□r E□□□□□t□□□ N□□□□□ □□r 1□□2□□□ □F□□t NAVD □□□
MW□	263.15
MW□	263.03
MW13	263.27
MW1□	263.89
MW1□	262.96
MW1□	263.45
MW21	262.97
MW22	263.04
MW3□	262.93
MW3□	263.28
MW3□	263.48
MW3□	263.09
MW3□	263.08

NOTE:

HORIZONTAL LOCATIONS ARE REFERENCED TO THE NEW YORK STATE COORDINATE SYSTEM - EAST ZONE. VERTICAL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL NORTH AMERICAN VERTICAL DATUM 1988 (NAVD 88).

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- VILLAGE WATER WELL #1 — PUBLIC SUPPLY WELL LOCATION
- MW6 — MONITORING WELL LOCATION
- 263 — DEEP GROUNDWATER CONTOUR (FEET NAVD 88)
- DASHED WHERE INFERRED
- INFERRED GROUNDWATER FLOW DIRECTION

0 80 160

SCALE, FEET

SOURCES:

1. Survey of existing conditions and sample locations conducted by GEI Consultants, Inc. in 1999, 2009 and 2010. Survey by New York state licensed land surveyor number 050146. Horizontal Datum: New York State Plane Coordinate System (East Zone, North American Datum (NAD) 83). Vertical Datum: North American Vertical Datum (NAVD) 88.
2. Drawing titled WELL & SAMPLE SURVEY OF THE FORMER SUFFERN MGP SITE, THE RETEC GROUP, INC., VILLAGE OF SUFFERN, survey conducted by Donald Stedge, L.S., P.C. dated 12/10/2002. Horizontal datum: Assumed. Vertical datum: NAVD 88 from NGS benchmark.
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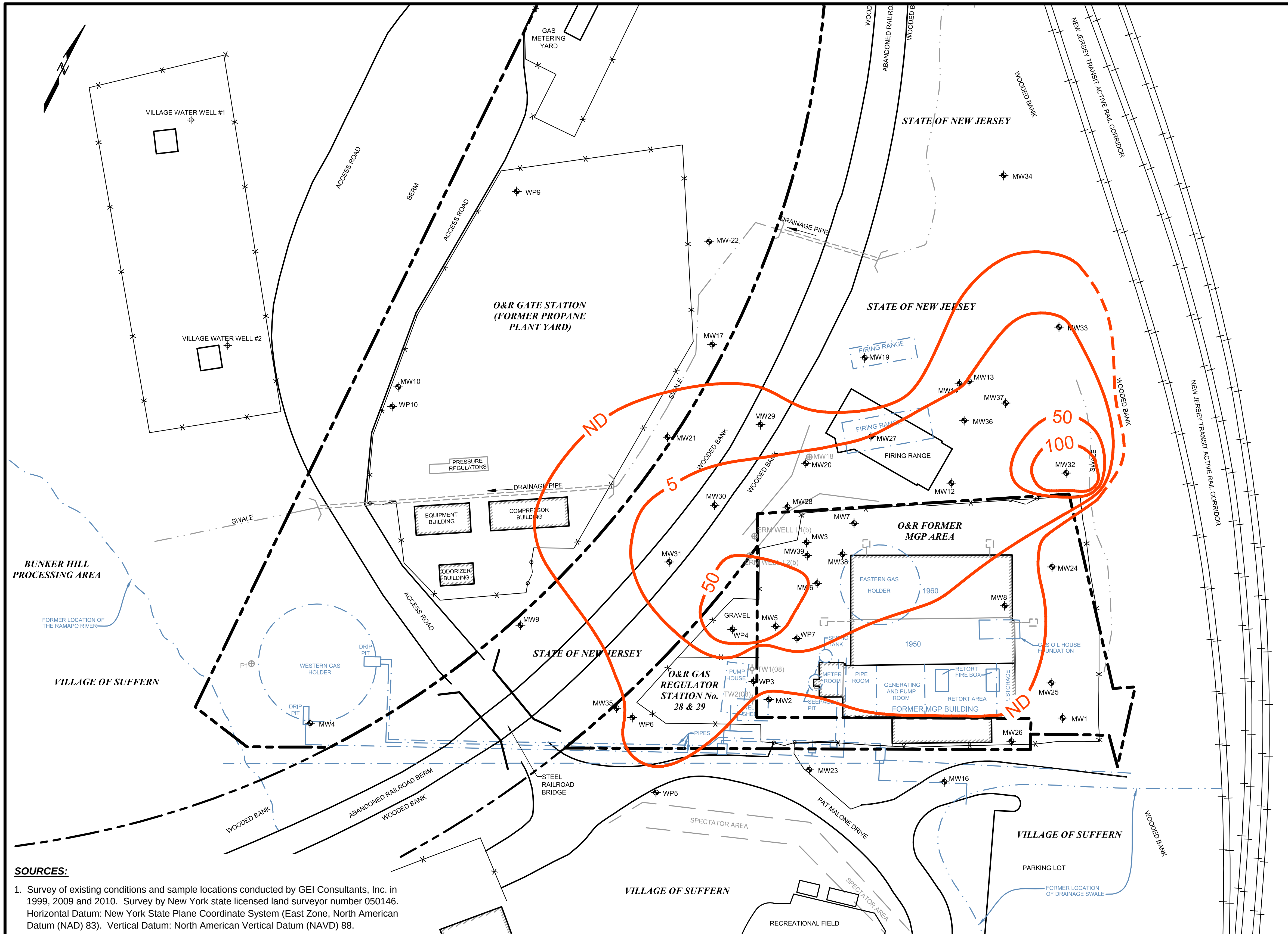
SUFFERN FORMER MGP SITE SUFFERN, NEW YORK	GEI Consultants	GROUNDWATER PIE□OMETRIC SURFACE □DEEP WELLS NOVEMBER 1□□2□□□
ORANGE AND ROCKLAND UTILITIES, INC. SPRING VALLEY, NEW YORK	Project 091950-2-1204	October 2010 Figure 19

I:\Project\ORANGE & ROCKLAND\Suffern\RI Report\Figures\ SUFFERN FIGURES.dwg \Oct 19, 2010



W□□□	BTEX CONCENTRATIONS □□□L
MW1	ND
MW2	ND
MW3	ND
MW□	ND
MW5	ND
MW□	0.29
MW□	ND
MW1□	ND
MW12	ND
MW1□	4.99
MW2□	8.74
MW23	ND
MW2□	ND
MW25	ND
MW2□	ND
MW2□	0.3
MW2□	10.31
MW2□	0.42
MW31	37.4
MW32	180.2
MW33	6.74
MW3□	ND
MW35	ND
WP3□1□□	1.26
WP3□3□□	1.43
WP3□□5□	ND
WP□□2□□	ND
WP□□3□□	55.6
WP5□1□□	ND
WP5□31□	ND
WP5□□5□	ND
WP□□3□□	ND
WP□□□□□	3.6
WP□□1□□	5.8
WP□□31□	1.18
WP□□□5□	ND
WP□□12□	ND
WP□□2□□5□	ND
WP1□□32□	ND

BTEX - Benzene, Toluene, Ethlybenzene, and Xylene
ug/L - Micrograms Per Liter
ND - Not Detected

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- VILLAGE WATER WELL #1 — PUBLIC SUPPLY WELL LOCATION
- MW1 — MONITORING WELL LOCATION
- TW1(08) — TEMPORARY MONITORING WELL LOCATION
- ERM WELL L1 / TW1(08) — ABANDONED MONITORING WELL LOCATION
- 5 — BTEX ISOPLETH
- INFERRED BTEX ISOPLETH

SOURCES:

1. Survey of existing conditions and sample locations conducted by GEI Consultants, Inc. in 1999, 2009 and 2010. Survey by New York state licensed land surveyor number 050146. Horizontal Datum: New York State Plane Coordinate System (East Zone, North American Datum (NAD) 83). Vertical Datum: North American Vertical Datum (NAVD) 88.
2. Drawing titled WELL & SAMPLE SURVEY OF THE FORMER SUFFERN MGP SITE, THE RETEC GROUP, INC., VILLAGE OF SUFFERN, survey conducted by Donald Stedge, L.S., P.C. dated 12/10/2002. Horizontal datum: Assumed. Vertical datum: NAVD 88 from NGS benchmark.
3. Drawing titled BOUNDARY SURVEY, ORANGE AND ROCKLAND UTILITIES, INC. AND ECONOMY-TRUCK BODY AND EQUIPMENT, VILLAGE OF SUFFERN-ROCKLAND COUNTY, NEW YORK, by C.T.Male Associates, P.C., Latham, New York dated 2008.

SUFFERN FORMER MGP SITE
SUFFERN, NEW YORK

ORANGE AND ROCKLAND UTILITIES, INC.
SPRING VALLEY, NEW YORK

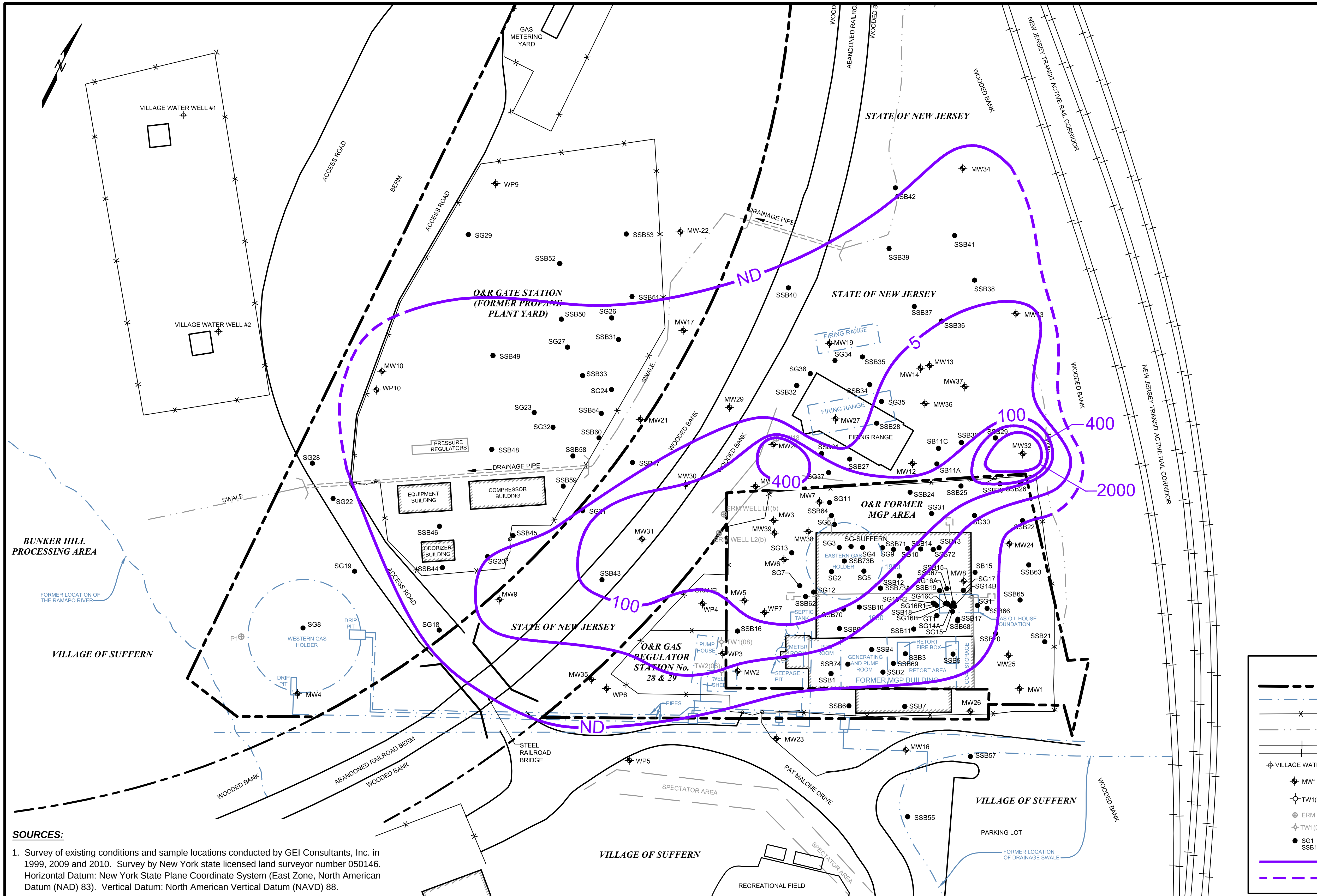
GEI Consultants

Project 091950-2-1204

SHALLOW WELLS □□5□BGS□
TOTAL BTEX CONCENTRATIONS
NOVEMBER 2□□□

October 2010 Figure 20

I:\Project\ORANGE & ROCKLAND\Suffern\RI Report\Figures\ SUFFERN FIGURES.dwg \Oct 19, 2010



W□□□	TPAH CONCENTRATIONS □□□L
MW1	ND
MW2	ND
MW3	0.87
MW□	ND
MW5	ND
MW□	ND
MW□	6.96
MW1□	ND
MW12	ND
MW1□	77.63
MW2□	438
MW23	ND
MW2□	ND
MW25	ND
MW2□	ND
MW2□	1.17
MW2□	135.7
MW2□	0.18
MW31	327.57
MW32	2947.6
MW33	7.47
MW3□	2
MW35	ND
WP3□1□□	61.97
WP3□3□□	22.5
WP3□□5□	ND
WP□□2□□	3.29
WP□□3□□	65.11
WP5□1□□	ND
WP5□32□	ND
WP5□□5□	ND
WP□□3□□	2.76
WP□□□□□	ND
WP□□1□□	162.1
WP□□31□	25.09
WP□□□5□	ND
WP□□12□	ND
WP□□2□□5□	ND
WP1□□32□	0.61

PAHs - Polycyclic Aromatic Hydrocarbons
ug/L - Micrograms Per Liter
ND - Not Detected

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- VILLAGE WATER WELL #1 — PUBLIC SUPPLY WELL LOCATION
- MW1 — MONITORING WELL LOCATION
- TW1(08) — TEMPORARY MONITORING WELL LOCATION
- ERM WELL L1, TW1(08) — ABANDONED MONITORING WELL LOCATION
- SG1, SSB1 — SOIL BORING LOCATION
- 5 — TPAH ISOPLETH
- INFERRED TPAH ISOPLETH

SOURCES:

1. Survey of existing conditions and sample locations conducted by GEI Consultants, Inc. in 1999, 2009 and 2010. Survey by New York state licensed land surveyor number 050146. Horizontal Datum: New York State Plane Coordinate System (East Zone, North American Datum (NAD) 83). Vertical Datum: North American Vertical Datum (NAVD) 88.
2. Drawing titled WELL & SAMPLE SURVEY OF THE FORMER SUFFERN MGP SITE, THE RETEC GROUP, INC., VILLAGE OF SUFFERN, survey conducted by Donald Stedge, L.S., P.C. dated 12/10/2002. Horizontal datum: Assumed. Vertical datum: NAVD 88 from NGS benchmark.
3. Drawing titled BOUNDARY SURVEY, ORANGE AND ROCKLAND UTILITIES, INC. AND ECONOMY-TRUCK BODY AND EQUIPMENT, VILLAGE OF SUFFERN-ROCKLAND COUNTY, NEW YORK, by C.T.Male Associates, P.C., Latham, New York dated 2008.

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SHALLOW WELLS □□5□BGS□
TOTAL PAH CONCENTRATIONS
NOVEMBER 2□□□

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Figure 21

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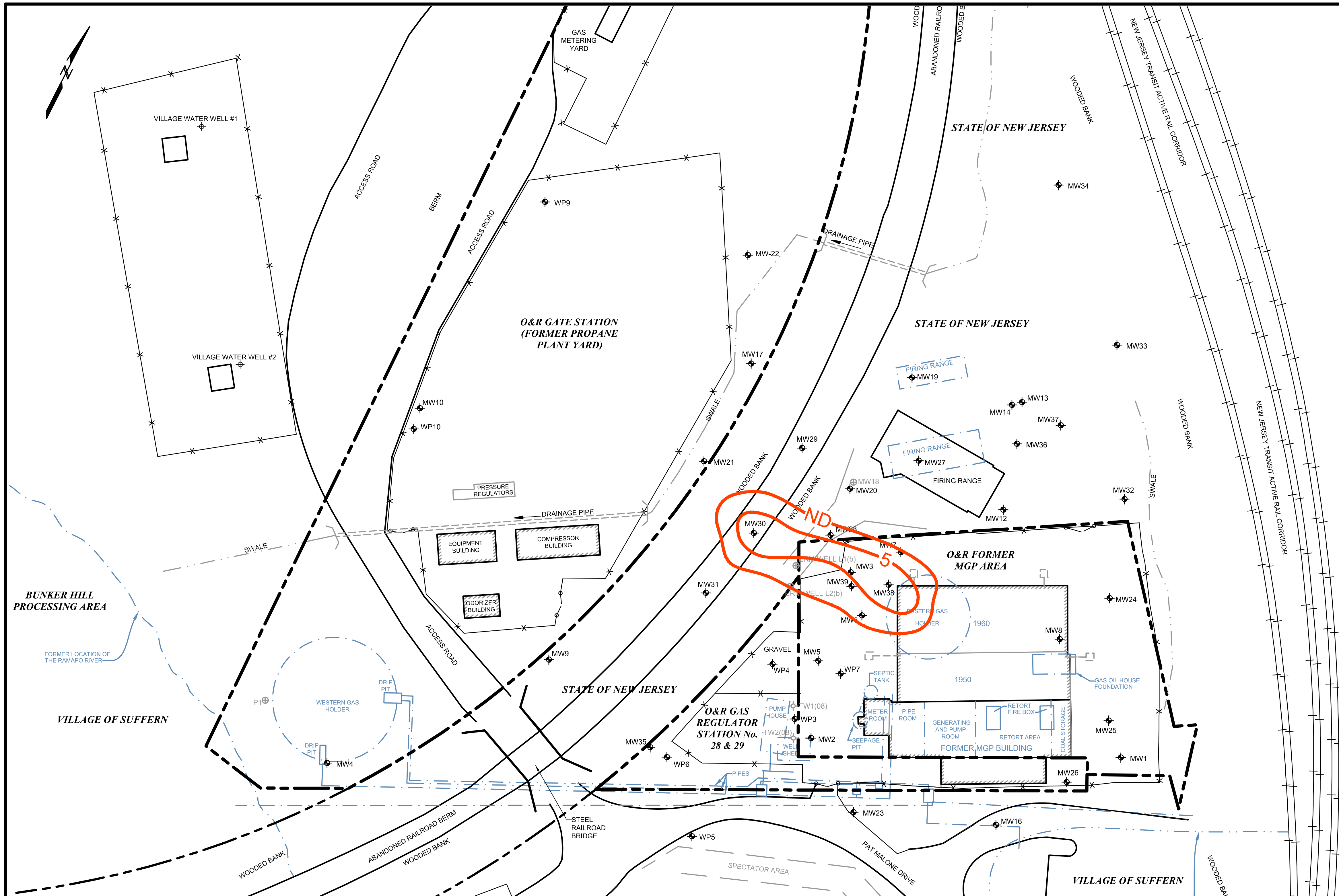

WELL	BTEX CONCENTRATIONS □□□L
MW□	ND
MW□	ND
MW13	ND
MW1□	ND
MW1□	ND
MW1□	ND
MW21	ND
MW22	ND
MW3□	14.34
MW3□	ND
MW3□	ND
MW3□	7.92
MW3□	ND
WP3□5□□	ND
WP3□□3□	ND
WP3□□□□	ND
WP3□1□□□	ND
WP□□□□□	ND
WP□□□2□	ND
WP□□□□□	ND
WP□□□□□	ND
WP□□1□□□	ND

WELL	BTEX CONCENTRATIONS □□□L
WP5□5□□	ND
WP5□□1□	ND
WP5□□□□	ND
WP5□□□□	ND
WP□□5□□	ND
WP□□□□□	ND
WP□□□□□	ND
WP□□□□□	ND
WP□□□□□	ND
WP□□5□□	ND
WP□□□3□	ND
WP□□□□□	ND
WP□□1□1□	ND
WP□□□□□	ND
WP□□□□□5□	ND
WP□□□2□	ND
WP□□□□□5□	ND
WP□□11□□	ND
WP1□□□□□	ND
WP1□□□□□	ND
WP1□□□3□	ND
WP1□□1□□□	ND
WP1□□11□□	ND
WP1□□13□□	ND

BTEX - Benzene, Toluene, Ethlybenzene, and Xylene
ug/L - Micrograms Per Liter
ND - Not Detected

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- VILLAGE WATER WELL #1 — PUBLIC SUPPLY WELL LOCATION
- MW1 — MONITORING WELL LOCATION
- TW1(08) — TEMPORARY MONITORING WELL LOCATION
- ERM WELL L1 / TW1(08) — ABANDONED MONITORING WELL LOCATION
- 5 — BTEX ISOPLETH
- INFERRED BTEX ISOPLETH

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0 80 160
SCALE, FEET

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DEEP WELLS □□□5□□□□□
TOTAL BTEX CONCENTRATIONS
NOVEMBER 2□□□

October 2010 Figure 22

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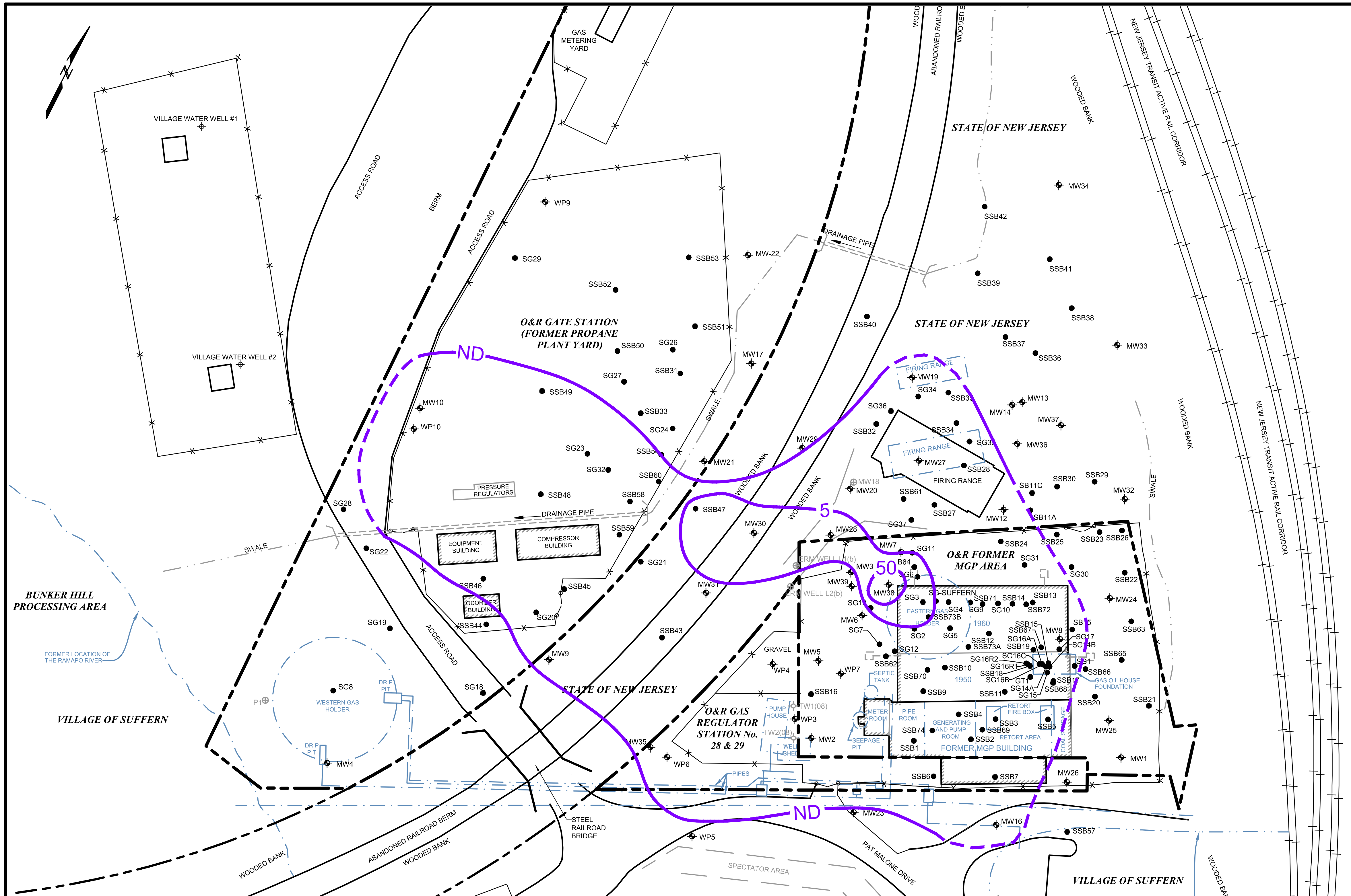

WELL	TPAH CONCENTRATION □□□L
MW□	ND
MW□	ND
MW13	ND
MW1□	0.99
MW1□	ND
MW1□	0.74
MW21	ND
MW22	ND
MW3□	8.45
MW3□	ND
MW3□	ND
MW3□	57.1
MW3□	ND
WP3□5□□	ND
WP3□□3□	ND
WP3□□□□	ND
WP3□1□□□	ND
WP□□□□□	ND
WP□□□2□	ND
WP□□□□□	ND
WP□□□□□	ND
WP□□1□□□	ND

WELL	TPAH CONCENTRATION □□□L
WP5□5□□	ND
WP5□□1□	ND
WP5□□□□	ND
WP5□□□□	ND
WP□□5□□	ND
WP□□□□□	ND
WP□□□□□	0.59
WP□□□□□	ND
WP□□□□□	ND
WP□□5□□	ND
WP□□□3□	ND
WP□□□□□	ND
WP□□1□1□	ND
WP□□□□□	ND
WP□□□□□5□	ND
WP□□□2□	ND
WP□□□□□5□	ND
WP□□11□□	ND
WP1□□□□□	ND
WP1□□□□□	ND
WP1□□□3□	0.65
WP1□□1□□□	1.35
WP1□□11□□	1.6
WP1□□13□□	2.2

PAHs - Polycyclic Aromatic Hydrocarbons
ug/L - Micrograms Per Liter
ND - Not Detected

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- HISTORIC STRUCTURE
- CHAIN-LINK FENCE
- SWALE
- RAILROAD TRACK
- VILLAGE WATER WELL #1 — PUBLIC SUPPLY WELL LOCATION
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DEEP WELLS □□□5□BGS□
TOTAL PAH CONCENTRATIONS
NOVEMBER 2□□□

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Figure 23

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