Environment

Prepared for:
NYSDEC Region 4
1130 N. Westcott Rd
Schenectady, NY 12306

Prepared by:
AECOM
Latham, NY 12110
60272656
May 2018

Former Kenco Chemical Company Operable Unit 02 - Source Property February 27, 2015 Feasibility Study Report

Former Kenco Chemical Company (Site No. 447039)
107 Freemans Bridge Road
Glenville, New York 12302

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ENGINEERING CERTIFICATION

I, Daniel Servetas, certify that I am currently a NYS registered professional engineer and that this Feasibility Study was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

Respectfully submitted,

AECOM Technical Services Northeast, Inc.

STATE OF NEW YORK DANIEL T. SERVETAS 079068 LICENSED PROFESSIONAL ENGINEER

May 15, 2018

Daniel Servetas, PE — Date
Registered Professional Engineer
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List of Acronyms

°C	Degrees Celsius
µg/L	Microgram Per Liter
AECOM	AECOM Technical Services Northeast, Inc.
AMSL	Above Mean Sea Level
AST	Aboveground Storage Tank
bgs	Below Ground Surface
BMPs	Best Management Practices
CAMP	Community Air Monitoring Plan
CBS	Chemical Bulk Storage
COCs	Constituents Of Concern
CVOCs	Chlorinated Volatile Organic Compounds
DAF	Dissolved Air Floatation
DCE	Dichloroethene
DER	Division of Environmental Remediation
DNAPL	Dense Non-Aqueous Phase Liquid
ECL	Environmental Conservation Law
En	Elnora Series loamy fine sand
ERH	Electrical Resistive Heating
FBR	Freemans Bridge Road
FS	Feasibility Study
ft^2	Square Feet
FWIA	Fish and Wildlife Impact Analysis
HASP	Health and Safety Plan
HDPE	High-Density Polyethylene
in^3	cubic inch
IRM	Interim Remedial Measure
Kenco	Former Kenco Chemical Company
lbs	Pounds
LDR	Land Disposal Restriction
MIP	Membrane Interface Probe
MnO_4	Permanganate
mg/kg	Milligrams Per Kilogram
MNA	Monitored Natural Attenuation
NYCRR	New York Codes, Rules and Regulations

NYSDEC	New York State Department of Environmental Conservation
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
OU2	Operable Unit-2
PCE	Perchloroethene or Tetrachloroethene
POTW	Publicly-Owned Treatment Works
PPB	Parts Per Billion
PPM	Parts Per Million
PRAP	Proposed Remedial Action Plan
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RFH	Radio Frequency
RI	Remedial Investigation
ROD	Record of Decision
SCGs	Standards, Criteria and Guidelines
SCOs	Soil Cleanup Objectives
SMP	Site Management Plan
SVE	Soil Vapor Extraction
SVOCs	Semivolatile Organic Compounds
TCE	Trichloroethene
TCH	Thermal Conductive Heating
TOGS	Technical & Operational Guidance Series
UIC	Underground Injection Control
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
UTS	Universal Treatment Standard
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds

1.0 Introduction

This Feasibility Study (FS) Report presents alternatives for the environmental remediation of the Former Kenco Chemical Company (Kenco) source property (Operable Unit-2 [OU2]), Glenville, New York, located in Schenectady County. The Kenco Site (Site) is listed as a Class 2 site on the New York State Department of Environmental Conservation (NYSDEC) Registry of Inactive Hazardous Waste Disposal Sites, Site No. 447039. The general location of the Site is presented on Figure 1-1. This report has been prepared by AECOM Technical Services Northeast, Inc. (AECOM) under work assignment D007626-19 with the NYSDEC.

1.1 Background

The Site is located at 107 Freemans Bridge Road (FBR), Town of Glenville, Schenectady County, New York (see Figure 1-2 for Site Layout). The Site was reportedly used as a chemical warehouse from at least 1988 until circa 1999 and used for the storage and resale of bulk chemicals for redistribution by both Kenco and Voelker Sales. Documentation has been obtained confirming that tetracholorethene (PCE) was stored on-site in bulk between 1965 and 1991. The Kenco Site has been used for general warehousing since that time. Between 2004 and 2009, environmental assessments of the Site and adjacent surroundings were conducted and extensive soil and groundwater contamination was discovered. Between 2004 and 2013, multiple site investigations have been conducted at the Site to determine nature and extent of contamination the results of these investigations are presented in the Site Remedial Investigation (RI) Report (AECOM 2015).

1.2 Report Organization

The purpose of the FS is to identify and evaluate technologies available to remediate the impacted media at the Site as identified in the RI Report. The technologies most appropriate for the Site conditions are developed into Remedial Action Alternatives that are evaluated based on their environmental benefits and cost. The information presented in the FS will be used by NYSDEC to select the most appropriate remedial action(s) for the Site. The remedial action(s) selected for the Site will be summarized by NYSDEC in a Proposed Remedial Action Plan (PRAP), which will be released for public comment. After receipt of public comments, NYSDEC will issue a Record of Decision (ROD) and then implement the Remedial Action(s).

The FS is organized in accordance with the outline provided in Section 4.4 of NYSDEC Division of Environmental Remediation (DER)-10 Technical Guidance for Site Investigation and Remediation (2010):

1. Introduction
2. Site Description and History
3. Summary of Remedial Investigation
4. Remedial Goals and Remedial Action Objectives (RAOs)
5. General Response Actions

6. Identification and Screening of Technologies
7. Development and Analysis of Alternatives (assembly of technologies into alternatives, evaluation of alternatives, and evaluation of institutional/engineering controls for the selected remedy)
8. Comparative Analysis of Alternatives
9. Recommended Remedy and Rationale for Selection

Additional supporting material is provided in the Appendices.

2.0 Site Description and History

2.1 Site Description

The Kenco Site is located at 107 FBR in a mixed commercial, residential, and agricultural area in the Town of Glenville, northeast of the Village of Scotia. The 0.86-acre Site has an approximately 5,135-square foot, one-story metal and block warehouse building, gravel parking area, and a small shed. The remainder of the Site is vegetated, with grassy lawn in the northeast corner, forested wetlands on the northern and western margin, and a strip of vegetation along the southern property boundary. A perennial surface water swale traverses the northern margin of the Site, which flows into a buried pipeline in the northwest corner of the property. In general, the Site is relatively flat, with the lowest elevation present in the surface water swale.

The Site is bound by the Boston and Maine railroad tracks to the north, FBR and commercial properties to the east, undeveloped farmland to the west and a paper street (undeveloped easement) and residential/commercial properties to the south. Operable unit OU2 consists of the Site property and land on both sides of FBR between the railroad tracks to the north and Lowe’s Drive (i.e., Lowe’s entrance) to the south. A NYSDEC-owned remedial treatment system is located on the paper street and farm field.

2.2 Historical Land Use

The Site was reportedly developed for warehouse use circa 1955 and operated as the Kenco Chemical Company between 1955 and 1994. A second company, known as Voelker Sales, also operated out of the property between 1966 and 1994. Both companies were operated by the Site owner, Kenneth Cochrane. The Site was used for the storage and resale of bulk chemicals for redistribution by both Kenco and Voelker Sales.

Evidence of former Chemical Bulk Storage (CBS) Registrations were encountered for both Kenco and Voelker Sales. Kenco operated a 1,000-gallon aboveground storage tank (AST) containing sodium hypochlorite (typical swimming pool chlorination chemical), while Voelker Sales operated a 6,900-gallon AST containing PCE, a common dry cleaner chemical. Empty plastic totes labeled PCE were encountered within the warehouse building in 2010. At the request of the NYSDEC, an Emergency Removal and Response Action was performed by the United States Environmental Protection Agency (USEPA) in 2010 which included transport and disposal of a variety of bulk chemical pails, drums, and totes encountered within the warehouse building. The origin of those chemical containers was not established.

Since 1999, the current Site owner, Ultimate LLC, has operated it as a general warehouse. Current Site activities are limited to storage. No other specific information was encountered regarding current or historical chemical use, storage, and management at OU2. No report of a historical chronic or catastrophic chemical release was identified during Site inquiries.

2.2.1 Topography/Surface Water

The ground elevation at the Site ranges from about 280 to 285 feet above mean sea level (AMSL). The topography in the vicinity of the Site slopes gently to moderately south. Adjacent railroad tracks to the north of the property are at a higher elevation and contribute runoff onto the Site. A drainage swale located on the Kenco Site between the on-site building and northern property boundary serves as surface water drainage control, collects excess surface water runoff, and provides a point of recharge to the shallow groundwater zone. Standing water is perennially present in the bottom of the swale, which most likely represents a surface expression of the water table and/or surface water daylighting at the northeastern corner of the site.

The west side of the Site is occupied by a disturbed palustrine forested wetland. A swale along the north side of the building contains a wetland with a small stream draining surface water to the west and then south via a buried pipe. Currently, the stream is captured and the water is piped to the off-site water treatment facility where it is treated and then released off-Site to the west.

Precipitation that falls on the Site drains into the swale or infiltrates into the moderately well-drained soils.

2.2.2 Local and Site Geology

The Site conceptual geologic model can be generalized to three discrete units. From youngest to oldest (in order of increasing depth) the units are glacial deposits/outwash, glacial till, and bedrock. Bedrock underlying the Site is mapped as the Canajoharie Shale. The bedrock is presumed to be isolated from Site-related impacts beneath glacial till which acts as a low permeability layer beneath the shallow glacial outwash containing contamination associated with the Site.

The glacial deposits/outwash refers to the group of all unconsolidated geologic units in the study area present above the glacial till. Figure 2-1 shows the location of cross sections of the Site showing these deposits (Figures 2-2 and 2-3). In order of increasing depth, the glacial deposits/outwash generally consist of four stratigraphic units: silty fine sand, gravelly course sand, silty clay and deep silty fine sand.

2.2.2.1 Silty Fine Sand

The shallow silty fine sand unit is potentially contiguous across the OU2 study area. These deposits start at the ground surface and are sporadically mixed with general fill material. These deposits vary in thickness from approximately 4 to 16 feet and appear to pinch out to the north of the Site. This deposit is generally characterized as a dry to moist, brown, silty fine-grained sand with infrequent and varying amounts of clay and gravel.

2.2.2.2 Gravelly Coarse Sand

Below the shallow silty fine sand unit is a contiguous deposit of gravelly coarse sand. The unit was encountered at depths ranging from 6 to 16 feet below ground surface (bgs) across the OU2 study area. The deposit was generally observed to be less than 6 feet thick and in some instances as thin as 6 inches. It was observed at shallower depths in borings on the north side of the Kenco Site, and appears to extend upward toward the ground surface northward from the Site.

The grain size composition of this unit, on average, was observed to contain mostly fine- to coarse-grained sand, with trace silt, and some gravel. The gravel fraction is predominantly fine-grained with some medium-grained fraction. The deposit is an unconfined water-bearing deposit and represents a flow path for significant groundwater flow resulting in transport of contaminants. Soil descriptions suggest a relatively high hydraulic conductivity value when compared to other deposits in the investigation area.

2.2.2.3 Silty Clay

Below the gravelly coarse sand unit is a deposit of glaciolacustrine silty clay that acts as an effective aquitard. The silty clay varies in thickness from approximately 1 foot to approximately 17.5 feet. The silty clay is generally characterized as clay with varying amounts of silt and fine- to medium-grained sand with occasional gravel.

2.2.2.4 Deep Silty Fine Sand

Below the silty clay is another layer of silty fine sand which varies in thickness from 3.5 feet to at least 12 feet thick. This deposit is characterized as silty, fine- to medium-grained sand, with occasional occurrences of coarse sand and fine gravel. The lithology is similar to the upper silty sand unit.

2.2.3 Groundwater Hydrogeology

The Kenco Site is situated within the General Aquifer Recharge Area (Aquifer Protection Zone 3) of the Schenectady Aquifer, the source of potable water to five municipalities and approximately ninety percent (90%) of Schenectady County residents. Within this zone, runoff and precipitation flow directly and rapidly into the ground; thereby, recharging the aquifer, but not necessarily a specific well field. All of the municipal well fields tapping the Schenectady Aquifer are located two or more miles from the Site and are not immediately downgradient of the Site. Based on the distance to the public water supply well fields, and the prevailing groundwater flow direction, the groundwater recharge in the investigation area is not likely to affect the public water supply.

The Site property is situated in a mixed commercial and residential area that is served primarily by public water. However, shallow private wells provide residential drinking water approximately 0.6-mile southeast of the Site, along Sunnyside Road and adjoining streets. The leading edge of the off-site groundwater contaminant plume is located in the vicinity of Sunnyside Road. Off-site groundwater impacts will be addressed in a separate OU1 FS.

The Site's hydrogeology is characterized by a shallow and deep water-bearing zone separated by a clay aquitard. Average depths to groundwater for the shallow and deep zones were recorded at approximately 5.7 and 12.6 feet bgs, respectively.

The four stratigraphic units identified at the Site (i.e., silty fine sand, gravelly coarse sand, silty clay, and deep silty fine sand) comprise three hydrogeologic units. Together, the silty fine sand and gravelly coarse sand form the shallow unconfined water-bearing zone, and the deep silty fine sand forms the deep semi-confined water-bearing zone. The intermediate silty clay deposit forms a low-permeability semi-confining aquitard between the two water-bearing zones.

The overall thickness of the silty clay aquitard is variable within the Study Area and there are seams and thin layers of sandy silt within the unit. As a result, while the permeability of the silty clay deposit is low (i.e., MW-116D vertical permeability = 2.2×10^{-7} cm/sec), the thickness variability and presence of relatively coarser (sandy silt) zones within the unit likely cause the deposit to serve as a semi-confining aquitard to the underlying silty fine sand water-bearing zone. Even so, the silty clay deposit is substantial enough to cause appreciable groundwater elevation differences between the shallow and deep water-bearing zones, demonstrating the confining properties of this unit.

The depth to groundwater at the Site ranges between about 4 and 7 feet bgs. Groundwater flow in the shallow water-bearing zone is towards the south-southeast, and the horizontal hydraulic gradient across the mapped Study Area is approximately 0.05 ft/ft.

The deep water-bearing zone is comprised of groundwater in the deep silty fine sand unit. Groundwater in this zone occurs under semi-confined conditions beneath the low permeability silty clay. Groundwater flow in the deep water-bearing zone is towards the southeast under a hydraulic gradient of approximately 0.035 ft/ft. A strong downward hydraulic gradient is present from the shallow to deep water-bearing zones.

3.0 Summary of Remedial Investigation

This section summarizes the findings of the RI conducted at the Site (AECOM, 2014). The RI was conducted to determine the sources of contamination within the Site and its threat to human health and the environment. The scope and execution of the RI is discussed below.

3.1 Nature and Extent of VOC Contamination

3.1.1 Soils

Although trace amounts of volatile organic compounds (VOCs) were detected in surface soil on-site, they were present below the SCGs. One exceedance of the PCE SCG was located off-site adjacent to the discharge pipe behind 101 FBR, prior to interception and treatment of surface water. The sample from this location was originally classified as a sediment sample; however, it is more appropriately characterized as a surface soil sample since there is no longer continuous contaminant loading. The extent of contamination to surface soil is expected to be confined to the area immediately surrounding the buried pipe.

The footprint of unsaturated soil impacts above SCGs (0.2 to 4 feet) was inferred from the extensive real-time field screening results (MIP, PID) and limited analytical data.

Due to the shallow water table in the Study Area and permeable nature of the sandy units, subsurface soils have been extensively impacted by Site constituents of concern (COCs) as they have migrated within the water-bearing zone. Significant CVOC concentrations were reported in saturated soil from 4 to 15 feet bgs over approximately 75% of the Site, extending beneath the Site building, off-site to 99 FBR, and across the road, where the gravelly coarse sand is closer to the surface. Although these concentrations to some extent represent groundwater quality in the interstitial pore space, contamination is believed to have adsorbed onto soil particles and now represents source material for the dissolved-phase groundwater plume. Where PCE concentrations exceeded the SCGs, levels ranged from 1.4 milligrams per kilogram (mg/kg) to 77 mg/kg. The observed soil impacts appear to abate rapidly at the northern, western and eastern property boundaries.

Deeper soil at the interface between the gravelly coarse sand and silty clay (15 to 25 feet bgs) is impacted over the majority of the Site, extending beneath the Site building and onto the immediately adjacent undeveloped property to the south. Evidence of solvent odor and NAPL was observed at approximately 20 feet bgs at three boring locations within the Kenco property. Numerous soil samples across the entire OU2 Study Area were analyzed from this zone and PCE concentrations of greater than 10,000 mg/kg were observed at the majority of locations on-site. Based on field observations, NAPL thickness is limited to an inch or less across the Site on top of the silty clay at the base of the coarse sand unit.

Laboratory analysis of soil deeper than 25 feet was limited to one sample at MW-102D (38 to 40 feet bgs), which exhibited PCE at 13 mg/kg. Field screening results did not indicate soil deeper than 25 feet bgs was a significant source. The membrane interface probe (MIP) screening was inconclusive with respect to the vertical extent of contamination due to instrument saturation from NAPL-impacted soil.

3.1.2 Groundwater

Analytical data collected by AECOM during the RI, along with historical data, indicates that chlorinated volatile organic compounds (CVOCs) in excess of SCGs are present in the shallow aquifer zone at significant concentrations across the majority of OU2, extending further off-site onto OU1. Figure 5-3 provides the estimated footprint of shallow groundwater impacts. According to the data, a significant area is impacted by PCE and its breakdown products at concentrations greater than 1,000 micrograms per liter (µg/L). The highest reported concentration of PCE in the Site vicinity is 110,000 µg/L.

The preferential pathway for plume migration appears to be the gravelly coarse sand unit. Although measurable NAPL was not encountered in any of the monitoring well screens, evidence of NAPL was documented in soils at the base of this unit, at the contact with the silty clay aquitard.

Although the lateral extent of PCE impacts in the deeper zone appears to be a significantly reduced footprint from the shallow zone, data indicates that the CVOC concentrations in the deeper zone have increased significantly in recent years. This increase appears to be a result of vertical migration of source material into the semi-confining layer and is causing the lateral and vertical extent of the deep dissolved-phase plume to expand.

3.1.3 Surface Water

Surface water on-site is present in a drainage swale along the northern margin of the property. Although the relationship between surface water and shallow groundwater is not firmly established, the perennially wet swale appears to be a surface expression of the water table and/or dayliighting of surface water in addition to a stormwater drainage feature. In the northwest corner of the Site, the swale is directed below grade to an off-site discharge location via a series of unsealed pipe segments. Data collected prior to operation of the treatment system indicates that surface water is unimpacted at its origin, is somewhat impacted prior to underground discharge, and is significantly impacted at the off-site discharge outlet after passing through shallow source material (prior to collection and treatment via Interim Remedial Measure [IRM]).

3.1.4 Sediment

Sediment samples collected from the swale and the forested wetlands did not exhibit impacts above SCGs for sediments (the swale and forested wetlands sample results would exceed protection of SCOs for CVOCs).

3.1.5 Soil Vapor

Soil vapor and/or indoor air have been impacted by the shallow PCE groundwater plume at more than one location within the OU2 Study Area. No assessment of soil vapor or indoor air was performed at the on-site building; however, soil vapor impacts are presumed to be significant. For the purpose of this FS, soil vapor will not be discussed further since the remedies addressing the contaminant mass in soil and groundwater will provide effective treatment of the soil vapor.

3.2 Contaminant Fate and Transport

Once the release(s) occurred, source material infiltrated into Site soil where it leached into shallow groundwater and migrated laterally and vertically. Depending on the location of the release, the unsealed surface water discharge pipe may have acted as a conduit for further release into the subsurface. Field observations (e.g., PID, MIP) indicate that shallow soil in the unsaturated zone is impacted above SCGs on-site; therefore, this material is acting as a continuous source of contamination to shallow Site groundwater during precipitation events and high water table conditions.

In groundwater, dissolved-phase contaminants have migrated within the shallow water-bearing zone a significant distance from the source via the processes of advection, diffusion, and dispersion. The presence of various subsurface features (e.g., septic tanks, buried utility piping, drainage disturbances, etc.) may have accelerated plume advancement at the top of the seasonally-high water table. In subsurface soil, the contaminant distribution indicates that the gravelly coarse sand is the preferential flow path for impacted groundwater. The underlying silty clay acts as an aquitard that has prevented the migration of significant contamination into the deeper portion of the overburden in off-site locations beyond OU2. However, the nature and presence of dense non-aqueous phase liquid (DNAPL) on-site has allowed source material and dissolved-phase contaminants to penetrate the aquitard and reach the deep water-bearing zone on-site in recent years.

Contaminants are adsorbed or desorbed onto soil as groundwater travels through the matrix, which can create a sustained residual source of soil contamination distinct from impacts within the unsaturated zone. Based on the contaminant distribution, this appears to be the case for off-site soils in the shallow water-bearing zone.

Contaminated saturated and unsaturated subsurface soil and associated DNAPL (collectively referred to as source material) present a sustained source of contamination for groundwater within the shallow and deep water-bearing zones on-site and off-site.

Shallow groundwater is estimated to migrate at approximately 2.5 ft/day (900 ft/year). The current known extent of the shallow groundwater plume is approximately 0.6-mile downgradient from the Site. The nature and extent of these impacts will be addressed in the OU1 RI Report.

Groundwater in the deep water-bearing zone (silty fine sand) flows to the southeast across OU2 under a hydraulic gradient of approximately 0.035 ft/ft. RI data confirmed the presence of a downward component of groundwater flow (seepage) that occurs from the shallow water-bearing zone, through the semi-confining silty clay layer, discharging to the deep water-bearing zone. The seepage rate has been estimated to be 9.7×10^{-4} ft/day (0.35 ft/year). At this seepage rate, the travel time for groundwater to seep vertically through the 10-foot thick silty clay unit at MW-102S/D is between 25 and 30 years.

4.0 Remedial Goals And Remedial Action Objectives

4.1 Remedial Goals

Under the State Superfund Program, 6 New York Codes, Rules and Regulations (NYCRR) Part 375-2.8 states, “The goal of the remedial program for a specific site is to restore that site to pre-disposal conditions, to the extent feasible. At a minimum, the remedy selected shall eliminate or mitigate all significant threats to the public health and to the environment presented by contaminants disposed at the Site through the proper application of scientific and engineering principles.”

Per Environmental Conservation Law (ECL) Article 27 Title 13, “The goal of any such remedial program shall be a complete cleanup of the Site through the elimination of the significant threat to the environment posed by the disposal of hazardous wastes at the Site and of the imminent danger of irreversible or irreparable damage to the environment caused by such disposal.”

4.2 Standards, Criteria, and Guidelines (SCGs)

Three categories of Standards, Criteria, and Guidelines (SCGs) exist: Chemical, Action, and Location-specific SCGs. The applicable SCGs for each of these categories are listed in Tables 4-1 through 4-3. SCG selection is based on the following:

Chemical-specific SCGs: These SCGs are typically technology- or health-risk-based numerical limitations on the contaminant concentrations in the ambient environment. They are used to assess the extent of the remedial action required and to establish cleanup goals for a site. Chemical-specific SCGs may be directly used as actual cleanup goals, or as a basis for establishing appropriate cleanup goals for the contaminants of concern at a site. Chemical-specific SCGs for soils, groundwater, and surface water are identified and listed in Table 4-1.

Action-specific SCGs: These SCGs are typically administrative or activity-based limitations that guide how remedial actions are conducted. These may include record-keeping and reporting requirements; permitting requirements; design and performance standards for remedial actions; and treatment, storage and disposal practices. Action-specific SCGs for the Site are provided in Table 4-2 and generally apply to the following:

- Implementation of remedial actions
- Transportation and disposal of contaminated soils
- Air emissions associated with remediation
- Siting of temporary hazardous waste facilities
- Injection of in-situ chemicals
- Treatment and discharge of groundwater

Location-specific SCGs: These SCGs apply to sites that contain features such as wetlands, floodplains, sensitive ecosystems, or historic buildings that are located on or in close proximity to the Site. Location-specific SCGs are listed in Table 4-3 and apply to the following:

- City and County Regulations and Ordinances
- Wetlands
- Historic preservation

4.3 Contaminants of Concern

Each environmental medium for OU2, including soil, groundwater, surface water, and sediment were evaluated for contaminants of concern; no soil vapor samples were collected from the on-site building due to access issues. As identified in the RI, the primary contaminants of concern are CVOCs. Of these compounds, the primary compound of concern is PCE, and its breakdown products trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride (VC). The maximum concentration detected in each medium was evaluated against the applicable SCGs (Table 4-4). Contaminants exceeding SCGs were retained and include the following:

- Soil – PCE, TCE, DCE
- Groundwater – PCE, TCE, DCE, VC
- Surface Water – PCE, TCE, DCE, VC
- Sediment – None
- Soil Vapor – PCE, TCE

4.4 Exposure Pathways

The contaminants of concern at this Site are CVOCs. These contaminants have impacted soil, soil vapor, groundwater, and surface water. Each impacted media has different potential exposure pathways as described in the following sections. Table 4-5 provides a summary of the applicable exposure pathways.

Table 4-5 – Summary of Exposure Pathways

Contaminated Media	Current Exposure Pathway	Future Exposure Pathway
Groundwater	None for OU2 (off-site exposure pathways addressed under OU1)	Construction/Utility workers - direct contact and inhalation of vapors
Surface Soil (0-0.2 feet)	None	None
Subsurface Soil (>0.2 feet)	None	Construction/Utility workers - direct contact and inhalation of vapors Future on-site residents
Surface Water	Direct contact, ingestion, and inhalation by on-site occupants and ecological exposure to impacted surface water	Direct contact, ingestion, and inhalation by on-site occupants/workers and ecological exposure to impacted surface water
Soil Vapor	Exposure to indoor air (assumed)	Exposure to indoor air

4.4.1 Soil

Future construction and utility workers within the study area may be exposed to soil and shallow groundwater through direct contact and/or inhalation of vapors while working in excavations.

Current on-site occupants and Site passers-by may be exposed through incidental ingestion and dermal contact to surface soils at the Site. This pathway also applies to future residents, construction and utility workers.

4.4.2 Groundwater

Groundwater within OU2 has no current exposure pathways. Potential future exposure pathways exist for construction and utility workers working within the Site. If groundwater continues to migrate off the Site, exposure pathways may exist through private water supplies and dermal contact. Off-site groundwater is addressed as part of OU1.

Residents located within 0.6 miles downgradient of the Site currently use water from the contaminated aquifer for drinking water. Contamination migrating off the Site has the potential to further contaminate these private drinking water wells. Groundwater contamination in the vicinity of these residents will be addressed in the OU1 FS.

Although groundwater contamination at the Site is within the recharge area for the drinking water aquifer for five municipalities, groundwater flow direction makes it very unlikely that on-site contamination will affect the public drinking water supply. All of the municipal well fields tapping the Schenectady Aquifer are located two or more miles from OU2 and not immediately downgradient; therefore, they are not directly threatened by groundwater impacts from the Site.

4.4.3 Surface Water and Sediment

Surface water on-site is present in a drainage swale along the northern margin of the property. Although the surface water elevation in the drainage swale was not determined, the perennially wet swale appears to be a surface expression of the water table and/or daylighting of the creek. Data collected prior to operation of the surface water collection and treatment system indicates that surface water was not impacted at its origin (eastern end of the drainage swale), was somewhat impacted prior to entering the underground discharge pipe, and was significantly impacted at the off-site drainage outlet, after passing through shallow source material. Sediment samples collected from the swale and the forested wetlands did not exhibit impacts above SCGs.

The FWRIA of the Site found a potential hazard to ecological receptors could exist where contaminated groundwater emerges to the surface and ecological receptors may contact contaminated sediment. However, since the IRM treatment system was installed, there are no current exceedances of site-related SCGs in OU2 media accessible to fish and wildlife, therefore the risk to on-site ecological receptors is considered acceptable.

4.4.4 Soil Vapor

Inhabitants of the building within OU2 have the potential to be exposed to elevated contaminant concentrations by the inhalation of contaminated indoor air. Sub slab depressurization systems were installed at properties which were determined to have an exposure risk. These systems mitigate the risk associated with soil vapor. Presently, the on-site building has no inhabitants.

4.5 Remedial Action Objectives (RAOs)

The RAOs for OU1 were developed to be protective of human health and the environment. The following criteria were used in their development:

- Contaminants exceeding applicable SCGs (PCE, TCE, cis-1,2-DCE, VC)
- The environmental media impacted by the contaminants exceeding the SCGs
- The extent of the impact to the environmental media
- All actual or potential human exposures and/or environmental impacts resulting from the contaminants in environmental media
- The current, intended, and reasonably anticipated future use of the Site and its surroundings (mixed residential and non-residential)

The RAOs for this Site are listed below by media.

4.5.1 Soil

1. Prevent ingestion/direct contact with contaminated soil.
2. Prevent inhalation of or exposure from contaminants volatilizing from soil contamination.
3. Prevent migration of contaminants that would result in groundwater or surface water contamination.

4.5.2 Groundwater

1. Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.
2. Prevent contact with, or inhalation of volatiles, from contaminated groundwater.
3. Restore groundwater aquifer to pre-disposal/pre-release conditions to the extent practicable.
4. Prevent the discharge of contaminants to surface water.
5. Remove the source of groundwater or surface water contamination.

4.5.3 Surface Water

1. Prevent ingestion of water impacted by contaminants.
2. Prevent contact or inhalation of contaminants from impacted water bodies.
3. Restore surface water to ambient water quality criteria for the contaminants of concern.

4.5.4 Soil Vapor

1. Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at a Site.

5.0 General Response Actions

General response actions were developed based on the RAOs for OU2. General response actions, as described in detail in the following sections, were developed for the source property (i.e., soils and groundwater), on-site surface water, and deep groundwater, with the following considerations:

- An estimate of the areas and volumes for the contaminated media, where applicable
- Are specific to the impacted medium, contaminants, and geologic characterization of the Site
- Eliminate technologies not appropriate for the Site due to site-specific factors or constraints
- Include non-technology specific categories
- Consider the use of innovative technologies, where available and applicable
- Identify technologies which are clearly not appropriate for the Site

Tables 5-1 through 5-3 provide a summary of the general response actions and technology screening for each medium. Appendix A includes the mass and volume calculations for each response action.

5.1 Soil

5.1.1 Impacted Area, Mass and Volume

In the RI Report, soils were divided into three general zones, 0-4, 4-15 and 15-25 feet bgs zones. Figure 5-1 shows the limits of contamination for each of these zones.

The 0-4 feet bgs zone is further divided here into a 0-2 and 2-4 feet bgs zone to allow for further evaluation of treatment alternatives within this zone.

The 4-15 feet bgs zone and 15-25 feet bgs zone were divided to provide a more accurate mass estimate. The conceptual site model (Section 3.3.1) assumes that highest PCE concentrations and likely DNAPL pools exist at the interface between the coarse sand/gravel and the underlying silty-clay. Although variable, for this FS, the interface was assumed to exist between 19 and 20 feet bgs and have an average concentration of 30,000 mg/kg.

As discussed in the RI Report, the off-site soils concentrations are substantially less than those observed on-Site and appear to have become contaminated by either migration through preferential pathways or through adsorption of dissolved phase contaminants through groundwater. This off-site area was calculated separate from the on-site area.

Two high concentration samples were collected on-site in the 4-15 feet bgs zone. This area appears to be isolated and the mass associated with it was calculated separately as a 4-5 feet bgs zone. A summary of the calculated mass from each zone is provided in Table 5-4. The supporting calculations are provided in Appendix A.

Table 5-4 - Soil Mass Summary

Area	Area (square feet)	Avg. PCE Conc. (mg/kg)	PCE Mass (pounds)	PCE Mass (gallons)
0-2' (unsaturated)	31,100	10	70	5
2-4' (unsaturated)	31,100	100	680	50
4-5' Hotspot	4,000	25,000	11,020	820
4-15'	31,500	100	3,810	280
15-19'	31,500	100	1,390	100
19-20'	31,500	30,000	104,170	7,730
20-25'	31,500	100	1,740	130
Total (On-site)			**122,880**	**9,115**
4-15' Off-Site	60,000	25	1,830	140
Total (Off-site)			**1,830**	**140**
Total (Off-Site and On-site)			**124,710**	**9,255**

5.1.2 Soil Remedial Units

The impacted soils at the Site have been broken into three units. The feasibility of applying different technologies to each of these units varies as the nature and extent of contamination in these units are different. Each general response action will be discussed with regards to each of these units.

1. *Unsaturated Soils (0-4 feet bgs zone)* – Low level contamination above the saturated zone (Figure 5-1). The footprint of these impacts was derived from analytical data as well as real-time soil screening.
2. *On-Site Contamination (4-25 feet bgs saturated zone)* – these soils are contaminated throughout the entire water column. This zone includes the entire 4-25 feet bgs footprint on-site which extends about 20 feet off-site to the South (Figure 5-1).
3. *Off-Site Contamination (4-15 feet bgs saturated zone)* – These soils exhibit moderate levels of contamination typically between 4-15 feet bgs. The aerial extent of these soils is defined by the 4-15 feet bgs zone that does not fall within the bounds of the On-site Contamination (i.e., 4-25 feet bgs zone) as shown in Figure 5-1.

5.1.3 Limited Action

The limited action response action could vary from a No Action alternative to implementation of institutional controls and long-term monitoring programs. The limited action response provides no treatment or reduction in mobility to contaminants. Limited action alternatives were retained for alternative development. These alternatives are often used as a baseline to compare alternatives or may be implemented in combination with other response actions.

RAOs Addressed:

- Depending on the limited action alternative different RAOs may be achieved, a No Action alternative would not achieve any of the RAOs while the use of institutional controls can prevent human exposure to contamination.

Area and Mass of Media Addressed:

- The limited action response action leaves all contamination remaining in OU2 and provides source for migration of contamination and expansion of impacts.

5.1.4 Removal

Removal technologies physically remove the contaminated media from the ground and either treat the contamination ex-situ or properly dispose of it at an off-site disposal facility. Removal technologies reduce mobility and mass of contaminants for the Site. If media is treated ex-situ, the contaminant mass and toxicity are also reduced. Excavation is the only applicable removal technology for OU2. Once soil is removed, it would either be landfilled or treated using technologies (e.g., thermal treatment or soil-vapor extraction). Vapors from soil treatment process would need to be collected and treated prior to discharge to the atmosphere.

Unsaturated Soils (0-4 feet bgs zone) – The volume of contaminated unsaturated soils to be removed is 3,600 cubic yards. As discussed below, other response actions have been determined impractical for these soils. Therefore removal of unsaturated soils will be a common element in all remedies.

On-Site Contamination (4-25 feet bgs saturated zone) – The removal footprint would include the entire on-site contamination footprint which includes the most highly impacted soils. Soil would need to be excavated down to clean clay (approximately 25 feet bgs zone). The excavated area would require side-slope support, due to the size of the Site and depth of the excavation; sheet pilling is the only applicable technology. Removal operations would require dewatering. Removal response action will be retained for technology screening and alternative development. Note some of the on-site contiguous soils exists off-site, but for ease of description, these soils will be referred to as on-site for the purpose of the FS.

Off-Site Contamination (4-15 feet bgs saturated zone) – Removal of non-contiguous off-site contamination is not practical at this Site. Large amounts of clean soil would need to be removed to access the contaminated soils and dewatering would be necessary adding large costs to the removal. As discussed below, in-situ treatment technologies are the most appropriate response action for these soils. For the purpose of this FS, the non-contiguous contamination will be referred to as off-site contamination.

RAOs Addressed

All soil RAOs for OU2 would be addressed assuming the off-site contamination is remediated separately.

Area and Mass of Media Addressed

The volumes and areas discussed below are associated with the unsaturated zone and on-site contamination addressed through the removal general response action. Off-site contamination mass and areas are discussed under the in-situ response action.

Unsaturated Soil Contamination (Common Element):

- 31,100 ft^2 of area removed to an average depth of 2 feet
- 2,300 cubic yards of contaminated soil removed
- 100 pounds of PCE mass removed (0.08% of soil mass)

On-Site Contamination:

- 38,000 ft^2 excavation footprint removed to an average depth of 25 feet approximately 6,000 ft^2 of non-impacted footprint removed due to shoring configuration)
- 35,330 cubic yards of contaminated soil removed
- 122,810 pounds of PCE mass removed (99% of soil mass)

5.1.5 In-Situ Treatment

In-situ treatment technologies reduce the mass volume and toxicity of the contamination. This response action has several major categories of technologies including biological, chemical, physical and thermal treatment.

Biological treatments utilize/enhance natural biological activities that degrade the contaminants to non-toxic compounds. These technologies include phytoremediation, and aerobic or anaerobic bacteria reduce contamination. Biological treatment technologies are not suited for the very high concentrations present in both the groundwater and soil at the Site and will not be retained for further development.

Physical treatment either stabilizes the contaminant in place or physically removes it from the ground using several different technologies such as solidification, surfactant enhanced recovery, electrokinetic separation, and soil vapor extraction. The shallow groundwater and possibility of mobilizing contaminants to the groundwater make these technologies inapplicable for this Site.

In-situ chemical treatment mixes chemicals such as an oxidant or reducing agent into the ground to react with the contaminant, physically changing the contaminant to non-hazardous compounds. Specific chemical technologies include chemical oxidation through injection, or soil mixing, as well as, chemical reduction. Common chemicals used for these technologies include permanganate (MnO_4), hydrogen peroxide, ozone, sodium persulfate, and zero valent iron.

Thermal treatment technologies heat the soil and groundwater to either volatilize or destroy the contaminant. For technologies which volatilize the contaminants, vapor extraction systems are installed to capture and treat the vapors. Specific thermal technologies include electrical resistive heating (ERH), electromagnetic heating, radio frequency heating, and thermal conductive heating (TCH).

Unsaturated Soils – The unsaturated soils at the Site are located within 4 feet of the ground surface. The application of these technologies at such low depths is much more difficult and does not guarantee SCGs can be met. The removal response action is the most appropriate response for these soils and in-situ chemical treatment will not be considered further.

Off-Site Contamination – The potential discontinuity and lower contamination levels in these soils makes thermal treatment technology not applicable to these soils. Chemical treatment allows for flexibility in both distribution and magnitude of contamination. As discussed throughout this section, other response actions have been determined not appropriate for these soils. Therefore, chemical in-situ treatment will be a common element in all soil alternatives.

On-Ste Contamination – Thermal and chemical treatment are potentially applicable for treating the contamination zone (4-25 feet bgs). The in-situ treatment footprint would include the entire on-site contamination footprint and includes the most highly impacted soils.

<u>RAOs Addressed</u>

In-situ treatment of soils at the Site using chemical injections and/or thermal treatment would meet the soil RAOs for the Site assuming the unsaturated soil contamination is removed or treated if thermal or chemical treatment is selected for the on-site contamination remedy.

<u>Area and Mass of Media Addressed</u>

The volumes and areas discussed below are associated with the on-site and off-site contamination addressed through the in-situ general response action. Unsaturated contamination mass and areas are discussed under the removal response action.

<u>Off-Site Contamination (Common Element):</u>

- 60,000 ft^2 of area treated to an average depth of 15 feet
- 24,440 cubic yards of contaminated soil would be treated
- 1,830 pounds of PCE mass removed (0.6% of soil mass)

<u>On-site Contamination:</u>

- 38,000 ft^2 of area treated to an average depth of 25 feet
- 32,230 cubic yards of contaminated soil would be treated
- 122,810 pounds of PCE mass treated (99% of soil mass)

5.1.6 Containment

Containment technologies generally reduce the mobility of the containments by creating a physical barrier around the contaminated soil and groundwater. Although containment reduces mobility and is protective of human health and the environment, there is no reduction in toxicity or mass. Containment technologies at this Site would need to reduce the mobility of contaminants to groundwater and prevent ecological and human receptors from exposure to the contaminated soils.

Containment technologies are typically physical barriers which include both a vertical barrier and a cap. A low permeability cap would need to be installed over the surface of the contaminated area to prevent infiltration of surface water and exposure to human and ecological receptors. Specific technologies for capping include asphalt, high-density polyethylene (HDPE) liner, and clay. Capping materials that do not limit infiltration such as soil, are not acceptable at this Site where vertical containment is necessary. The cap would be tied into the vertical barrier which provides a low permeability wall around the contaminants. Common technologies include slurry walls, cement/bentonite walls, grouted barriers, and sheet piling. The vertical barrier would be tied into the underlying clay layer at the Site to prevent further groundwater contamination.

The downward gradient of groundwater at the Site requires that groundwater within the containment cell be depressed to prevent further downward migration of contamination. This would be achieved with pumping wells and a groundwater treatment system.

Containment technologies require institutional controls and deed restrictions to make sure that the containment technologies remain unaltered and continue to be protective of human health and the environment. The implementation of the containment response action would require periodic monitoring to confirm the continued success of the containment system.

Unsaturated Soils – Unsaturated soils at this Site are within 4 feet of the ground surface. The containment response action is not appropriate for this contamination as the contamination is very shallow compared to the depth of the confining layer and the majority of these soils would be excavated to install the cap.

Off-Site Contamination – Containment response actions are most appropriate for areas which are contained to the Site's property boundaries. The soils in this zone are located off the Site and cross multiple property boundaries. The containment response action is not applicable to these soils and will not be retained.

On-Site Contamination – The containment response action is applicable to this zone and will be retained for technology screening and alternative development.

<u>RAOs Addressed:</u>

The containment response action leaves contamination on-site therefore, the RAO 5 for removing the source of groundwater contamination would not be achieved. The other RAOs for the Site would be met.

<u>Area and Mass of Media Addressed:</u>

The volumes and areas discussed below are associated with only the on-site contamination addressed in this containment general response action. Unsaturated soils and off-site contamination mass and areas are discussed under the removal and in-situ response actions respectively.

<u>On-site Contamination:</u>

- 38,000 ft^2 of area would be contained to an average depth of 25 feet
- 32,230 cubic yards of material would be contained
- 122,810 pounds of PCE mass would be contained (99% of soil mass)

5.2 Surface Water

5.2.1 Impacted Area

On-site surface water currently collects in a drainage swale, and is then piped to a sump where it is collected, treated and then discharged. The surface water becomes contaminated as it flows from the drainage swale to the sump. Concentrations in the surface water range from non-detect to 440 µg/L. On-site surface water concentrations are shown on Figure 5-2.

5.2.2 Limited Action

The limited action response action could vary from a No Action alternative to implementation of institutional controls and long-term monitoring programs. The limited action response provides no treatment or reduction in mobility to contaminants. Institutional controls may be required as part of the prevention presumptive remedy for surface water.

5.2.3 Prevention (Surface Water Rerouting)

Prevention technologies prevent surface water from becoming contaminated. Prevention technologies include physical barriers, rerouting and source removal. Physical technologies are implemented to prevent surface water from coming in contact with contaminated soils or to prevent groundwater from discharging and becoming surface water. Diversion of surface water reroutes water away from contaminated soils preventing the water from becoming contaminated and source removal removes or treats contaminated soils and groundwater that can impact surface waters.

Prevention is the presumptive remedy for the Site and may include a combination of different technologies to implement. Although treatment is applicable for the Site and currently being conducted as an IRM, containment is a more effective cost efficient response for on-site surface water. The prevention response for surface water can be implemented as part of the removal for unsaturated soils contaminated between 0 and 2 feet bgs.

The rerouted surface water will be restored to its open ditch flow westwardly along the railroad property after the remedial action is completed.

<u>RAOs Addressed</u>

- The prevention response action would address all surface water RAOs for the Site.

<u>Area and Mass of Media Addressed</u>

- No mass would be removed but approximately 170 linear feet of the currently contaminated drainage swale would rerouted; however, mass removal could be part of the soil removal remedy.

5.2.4 Treatment

Treatment reduces the mobility, toxicity and mass of the contaminant of concern. Treatment can be conducted inline or after collection. Specific treatment technologies vary depending on the exact composition of the water and include both physical and chemical means.

Treatment is currently being implemented as an IRM at the Site. Surface water is collected in a sump and then treated using physical and chemical means. The implementation of this IRM has shown that treatment of on-site surface water is not practical for the long-term remedy. The temporary treatment system requires significant maintenance and costs. Although this response action limits the mobility of contamination, it does not meet the RAOs for the Site as surface water would remain contaminated prior to treatment. Treatment of on-site surface water is not retained for further development.

RAOs Addressed:

- Mass and toxicity of treated water would be reduced but surface water would remain contaminated and potential human and ecological exposures would remain. As on-site contamination is removed the RAOs are more likely to be achieved.
- Mass removed would change over time as concentrations in surface water change.

5.3 Groundwater

5.3.1 Impacted Area, Mass and Volume

Groundwater at the Site is located at about 5 feet bgs. Groundwater impacts are present both above and below the silty-clay aquitard located at about 25 feet bgs. Impacts located in the upper water-bearing zone extend about 0.6 mile downgradient of the Site. The OU2 soil/groundwater remedies only address a small portion of the upper water-bearing zone associated with the source area and the deep groundwater. The majority of the off-site groundwater contamination in the upper water-bearing zone will be addressed as a part of OU1. Figure 5-3 shows the upper water-bearing zone groundwater concentrations within OU2. The limits of contamination in the deep water-bearing zone are shown in Figure 5-4.

Groundwater mass was calculated using plume maps developed in the RI Report and taking an average concentration for each area. An average groundwater thickness of 17 feet was assumed for groundwater impacts in the upper water-bearing zone and 15 feet was assumed for lower water-bearing zone impacts. Appendix A presents the groundwater mass calculations, Table 5-5 provides a summary of mass related to the OU2 groundwater impacts.

Table 5-5 - Groundwater Mass Summary

Area	CVOC Mass (lbs)	Area (ft^2)
Deep Groundwater	42	171,000

The response actions below discuss only responses to the deep water-bearing zone impacts. The shallow water-bearing zone is assumed to be addressed by the soil remedies.

5.3.2 Limited Action

The limited action response action could vary from a No Action alternative to implementation of institutional controls and long-term monitoring programs. The limited action response provides no active treatment or reduction in mobility to contaminants. Limited action alternatives were retained for alternative development. These alternatives are often used as a baseline to compare alternatives and may be implemented in combination with other response actions.

RAOs Addressed

- If source material is removed, naturally-occurring physical, chemical, and biological processes can reduce groundwater concentrations and achieve the groundwater RAOs for the Site.

Area and Mass of Media Addressed

- Contamination would only be reduced by naturally-occurring processes.

5.3.3 In-Situ Treatment

In-situ treatment technologies treat groundwater contamination reducing the mass mobility and toxicity of the contamination. The three major categories of technologies are biological, chemical and physical treatment. Physical treatment technologies generally involve the installation of semi-permanent well systems to conduct the treatment and or capture vapors from the treatment process. Since the contaminated groundwater being addressed is located below an aquitard, the implementation of physical treatment technologies in these conditions is not practicable and, therefore, will not be considered further.

Permeable reactive barriers (PRBs) are constructed downgradient of the plume that is to be contained. A trench is mixed with a reactive material such as zero valent iron. As groundwater passes through the barrier, groundwater is reduced to non-toxic substances. The implementation of this technology is similar to physical barriers and limited at this Site. Permeable reactive barriers will not be further evaluated.

Chemical and biological treatment technologies involve the injection of media into the groundwater using either temporary or permanent wells. The injected media either enhances natural processes or creates a chemical reaction with the contamination to physically change the contaminant to non-toxic substances. Both chemical and biological treatment technologies will be retained for technology screening and alternative development.

RAOs Addressed:

- In-situ treatment technologies may be capable of achieving groundwater RAOs for the Site and may need to be combined with other technologies to achieve these RAOs.

Area and Mass of Media Addressed:

- In-situ treatment technologies would treat 175,000 ft^2 of contaminated groundwater containing 42 lbs of VOCs.

5.3.4 Ex-situ Treatment

Ex-situ treatment technologies reduce the mass mobility and toxicity of contamination by physically removing groundwater and treating by biological, physical or chemical means. Once treated, the groundwater is discharged to a local surface water body, publicly-owned treatment works (POTW) or re-injected into the ground. The remediation timeframe for ex-situ technologies is usually an extended period of time.

This response action can be implemented as a component of a containment response action in the form of hydraulic containment depending on the extraction well locations. The relatively low concentrations and limited contaminant mass located off-site makes the application of this response action very limited. This response action would only be considered as a component of a containment response and not considered on its own.

RAOs Addressed:

- Ex-situ treatment technologies may be capable of meeting the RAOs for the Site but would take an extended period of time and would likely need to be combined with other technologies.

Area and Mass of Media Addressed:

- Properly placed wells and pumping rates could capture the entire groundwater plume. Due to Site conditions this response action is not being considered further.

5.3.5 Containment

Containment technologies prevent groundwater from further migration thus limiting the mobility of the contaminant. Groundwater containment technologies include physical barriers (e.g., PRBs, slurry walls), and hydraulic containment.

Physical barriers are constructed around the contaminated groundwater plume and prevent the migration of groundwater both in and out of the containment area. The barrier is constructed of a low permeability material (e.g., bentonite, cement, sheet piles) and keyed into a confining layer. The implementation of this technology would be limited at this Site as groundwater contamination is between 25 and 40 feet bgs and present beneath an aquitard. This technology will not be further developed.

Hydraulic containment physically removes groundwater within a “capture zone” preventing contaminated groundwater from migrating past the wells. Removed groundwater is then treated by biological, physical or chemical means. Once treated the groundwater is discharged to a local surface water body, POTW or re-injected into the ground.

The implementation of hydraulic containment for the entire groundwater plume at this Site is not practicable. Groundwater concentrations drop quickly once the property boundary is reached. To contain the entire plume would require significant groundwater extraction and treatment in addition to access to multiple private properties. Hydraulic containment will be considered only as a way to prevent migration of the highly contaminated groundwater from migrating off the Site. Groundwater beyond the Site would be addressed by the limited action response action (i.e., monitored natural attenuation [MNA]).

RAOs Addressed:

- In conjunction with the limited response general response action, all RAOs for the Site could be achieved.

<u>Area and Mass of Media Addressed:</u>

- An estimated 47,000 ft^2 of contaminated groundwater would be contained and eventually treated. This area contains the majority of the VOC mass (35 pounds or approximately 83%) the remaining would be contained and eventually treated under this response action. Lower level contamination downgradient of the extraction wells would be left to naturally attenuate.

5.4 Soil Vapor

5.4.1 Impacted Area, Mass and Volume

Impacts to indoor air and/or elevated sub-slab concentrations associated with Site COCs were identified at two buildings within the OU2 study area. These impacts are associated with the volatilization of contaminated groundwater and soils under or near these buildings (an IRM have been implemented to install, operate and monitor sub-slab depressurization system at the impacted commercial building as part of OU1). These impacts will be addressed as part of the OU2 alternatives and OU1 IRM (as needed).

6.0 Screening of Technologies

This section discusses the initial screening of specific technologies (processes) associated with each of the retained general technologies being evaluated for OU2 response actions. Specific technology processes are screened on a media specific basis similar to the general response actions and evaluated for implementability. Specific technologies retained will be evaluated as part of the developed remedial alternatives. Tables 6-1 and 6-2 provide a summary of this screening process.

6.1 Soil

6.1.1 Limited Action

6.1.1.1 No Action

Description: This limited action process involves no active remediation or monitoring. Any reduction in toxicity or mobility would be through natural attenuation.

Initial Screening: The No Action process will be retained as a process option and used as a comparison to active remedial alternatives.

6.1.1.2 Institutional Controls – Environmental Easement

Description: As required by NYSDEC “Environmental Easements are required for remedial projects which rely upon one or more institutional and/or engineering controls.” Environmental easements may include restrictions to the development of the land, or activities such as excavations or require the management of engineering controls (e.g., fences and caps). These restrictions are determined based on remaining contamination and site engineering controls. Environmental easements can also provide access to the property for long-term monitoring.

Initial Screening: An environmental easement or deed restriction may be required after the final remedy is completed and therefore will be retained as a process option.

6.1.1.3 Institutional Controls – Zoning/Ordinance

Description: This process would involve changes to local ordinances and/or zoning to limit potential exposure to Site contamination.

Initial Screening: Changes in zoning or local ordinances would not reduce toxicity or mobility of contamination at the Site. Contamination would continue to migrate off-site through groundwater and exposure at the Site would not be reduced. This process option will not be retained.

6.1.1.4 Institutional Controls – Site Management Plan

Description: A site management plan (SMP) is required for any site which has not been remediated to unrestricted use. The SMP provides a description of remaining contamination at the Site and any engineering or institutional controls that are in place. The SMP includes all pertinent information regarding the operation and maintenance of any remediation systems (e.g., treatment plants) and a monitoring and sampling plan for the Site.

Initial Screening: AN SMP may be required after the completion of the selected remedy and therefore will be retained as a process option.

6.1.2 Removal

6.1.2.1 Excavation On-Site Treatment – Biological

Description: Biological treatment of excavated soils includes techniques such as land farming and bio piles. Biological treatment methods promote naturally-occurring physical, chemical and biological processes to degrade and immobilize the contamination. To promote these processes soil amendments such as bulking agents and nutrients are often added to the soil. Depending on the contamination and biological process desired soils may be aerated to promote aerobic conditions or covered to promote anaerobic conditions. Once the soil has been tested and concentrations are below the Soil Cleanup Objectives (SCOs), the soil may be used as backfill.

Initial Screening: Biological processes require that the excavated soil be removed and placed on adjacent land for an extended period of time for contamination levels to reach the SCOs. Leaving the excavation open for an extended period of time at this Site is not feasible due to the depth of contamination and shallow groundwater. In addition, treatment of PCE using biological processes is not readily used as a treatment technology as it is more difficult to treat chlorinated solvent contamination, such as PCE. Biological treatment will not be retained as a process option.

6.1.2.2 Excavation On-Site Treatment – Soil Vapor Extraction

Description: Excavated soils would be treated by extracting volatile contamination (e.g., PCE, TCE) from stockpiled soil. Soil vapor extraction (SVE) systems are implemented by installing perforated piping in the zone of contamination and applying a vacuum to induce the movement of soil gases. SVE systems typically include knockout drums to remove moisture from the soil gases, followed by vapor-phase treatment prior to discharge to the atmosphere.

Initial Screening: SVE systems typically take between 6 and 48 months to treat the contaminated soils. The depth of excavation and dewatering requirements make keeping the entire excavation open for this period of time impracticable. SVE emissions would likely need to be captured and treated. The quantity of vapor phase contamination to be treated may also be a limiting factor in implementing this process option. SVE will not be retained as a process option.

6.1.2.3 Excavation On-Site – Thermal Desorption

Description: Excavated soils can be treated using thermal desorption at an on-site treatment plant. Thermal desorption is a contained ex-situ thermal treatment method that heats contaminated material to a temperature at which contaminants would volatilize. The volatilized contaminant is then collected, treated and discharged to the atmosphere. The treated soil can then be used backfilled. Direct and indirect thermal desorption treatment plants can be used. High concentrations of PCE at the Site would require special consideration of air handling. Thermal desorption treats soils relatively quickly such that the rate of treatment is approximately the same as the rate of excavation, preventing excavations from remaining open longer than would be necessary if imported backfill is used.

Initial Screening: Thermal desorption of excavated soil is an applicable treatment technology for excavated soils. Thermal desorption will be retained as a process option.

6.1.2.4 Excavation Off-Site Disposal – Landfill

Description: Landfilling involves transporting excavated soil to a landfill facility permitted for the waste material being disposed of. Landfilling material only shifts contaminant mass from one area to another. Contaminated soils disposed of at landfills must meet the requirements of the Land Disposal Restriction (LDR) program.

Initial Screening: Concentrations of PCE in soils at this Site exceed 10 times the Universal Treatment Standard (UTS) for PCE of 6 mg/kg (i.e., 60 mg/kg). Therefore, any soils at the Site that exceed this value would require treatment prior to disposal. Although a potentially significant portion of the soils at the Site may not require treatment, segregating these soils for different disposal methods may not be practical given Site limitations. Therefore, landfilling as a stand-alone process option for soils at depths greater than 4 feet will not be retained. If landfilling is to be used for soils at depths greater than 4 feet, it must be combined with a treatment process option such as thermal desorption.

Soils less than 2 feet deep at the Site likely contain soils that could be disposed of without treatment as either hazardous or non-hazardous waste. Landfilling will be retained as a process option for these soils.

6.1.2.5 Excavation Off-Site – Thermal Desorption/Incineration

Description: Excavated soils would be transported off-site to a thermal treatment facility. Thermal desorption is a contained ex-situ thermal treatment method that heats contaminated material to a temperature at which contaminants would volatilize. The volatilized vapors are then collected, treated, and discharged to the atmosphere. The treated soil can then be reused or disposed of depending on final soil concentrations.

Initial Screening: Thermal desorption of excavated soil is an applicable treatment technology for excavated soils. No local facilities within New York State have been identified as being capable of handling the concentrations present at the Site. Excavated soils would need to be transported out of state for treatment. Thermal desorption/incineration will be retained as a process option.

6.1.3 In-Situ Treatment

6.1.3.1 Chemical Treatment – Chemical Oxidation/Reduction (Injection)

Description: For this process option, a chemical would be injected into the subsurface reacting with contaminated soils, thereby either reducing or oxidizing the contamination to benign compounds. The injections could be conducted by several methods including temporary wells, permanent wells, or injection galleries. The injection locations can be screened such that specific zones of contamination are targeted and different concentrations of chemicals can be applied to different zones. The effectiveness of chemical oxidation/reduction through injection is limited by the ability for the chemical to interact with the contamination and thus soil heterogeneity and density of injection wells must be considered. Typical oxidants/reductive agents used in remediation include hydrogen peroxide, permanganate, sodium persulfate, ozone, and zero valent iron. Post-remediation monitoring is required to confirm that concentrations of contaminants do not rebound to unacceptable levels. Multiple rounds of injections are often necessary to fully treat the effected media.

Initial Screening: Chemical oxidation/reduction is an effective way of destroying CVOCs at the Site. Although soils at the Site are heterogeneous, methods to alleviate this challenge can be evaluated during the design. Chemical oxidation/reduction through injection will be retained as a process option.

6.1.3.2 Chemical Treatment – Chemical Oxidation/Reduction (Soil Mixing)

Description: For this process option, a chemical would be mixed into the subsurface using large augers or buckets to either reduce or oxidize the contamination to benign compounds. Soil mixing is more advantageous to injections in that there is more certainty that all contamination has contacted the reducing/oxidizing agent. Soil mixing may also provide the opportunity to mix chemicals in particulate form (not aqueous), which can provide lengthened treatment times and reduce likelihood of contamination rebound.

Initial Screening: Chemical oxidation/reduction is an effective way of destroying CVOCs at the Site. Chemical oxidation/reduction through soil mixing will be retained as a process option.

6.1.3.3 Thermal Treatment – Electrical Resistive Heating (ERH)

Description: Electrical resistive heating involves the installation of electrodes into the subsurface to heat groundwater to boiling temperature. The electrical resistance of the soils cause heating as electrical current is passed between the electrodes. Contaminants are removed primarily by hydrolysis, volatilization and steam stripping. A vapor extraction system is required to capture and treat the volatilized contamination. ERH works for treating both the vadose and saturated zones.

Initial Screening: ERH could be an effective means of treating on-site contamination. ERH would treat both groundwater and soil contamination to concentrations less than the SCGs. ERH will be retained as a process option.

6.1.3.4 Thermal Treatment – Radio Frequency (RFH)

Description: This process uses electromagnetic energy to heat soil and volatilize the COCs. Rows of electrodes are installed in the ground and soil/water is heated vertically downward and laterally outward. A vapor extraction system is required to capture and treat the volatilized contamination prior to discharge to the atmosphere.

Initial Screening: RFH could be an effective means of treating on-site contamination. RFH would treat both groundwater and soil contamination to concentrations less than the SCGs. RFH will be retained as a process option.

6.1.3.5 Thermal Treatment – Steam Injection and Extraction

Description: Steam is injected into the subsurface below the contaminated soil through injection wells. The steam heats the surrounding soil and water, volatilizing and increasing mobility of the contamination. Steam injections are coupled with water and/or vapor extraction wells to extract and treat contamination.

Initial Screening: This approach is used for highly permeable and homogeneous lithologies, which is not the case at this site. In additiona a steam generation facility would be required at the Site. Steam injections are not retained as a process option.

6.1.3.6 Thermal Treatment – Thermal Conductive Heating (TCH)

Description: Soil is heated through steel wells equipped with an insulated conductive heating element. The heating element typically runs at a temperature between 400 and 500 degrees Celsius (°C). The surrounding soils are then heated and contaminants volatilized. A vapor extraction system is required to capture and treat the volatilized contamination.

Initial Screening: This is a well understood method and has been used at many CVOC sites. Thermal conductive heating will be retained as a process option.

6.1.4 Containment

6.1.4.1 Capping – Asphalt/HDPE/Clay Cap

Description: For this process option, a layer of impermeable material (i.e., asphalt, HDPE, or clay cap) would be placed over impacted soil, providing a physical barrier that would prevent future exposure to impacted soil and prevent subsequent rainfall infiltration. HDPE and clay caps, can be installed with a vegetative soil layer to reduce surface water runoff. An asphalt cap would require the proper management of surface water runoff. Regular inspections would be required to evaluate any damage to the cap.

Initial Screening: Caps can mitigate the exposure risks at this Site; however, off-site migration of contamination is not controlled. This process option will be retained to be evaluated in conjunction with a vertical containment process option (e.g., slurry wall, sheet piling).

6.1.4.2 Vertical Containment – Slurry Wall

Description: A slurry wall is a vertical barrier designed to physically isolate contamination and reduce groundwater flow through the contained area, thus reducing migration of contamination. Slurry walls are constructed by installing a trench typically 2 to 5 feet wide and filling it with a soil/cement/bentonite mixture. The slurry wall must be keyed into a non-permeable confining layer below. Slurry walls are typically constructed with a cap system to prevent infiltration of groundwater. Slurry walls are often installed in conjunction with pump and treat systems to further prevent any possible migration of groundwater.

Initial Screening: A slurry wall may be an effective way to mitigate migration of groundwater off-site. This process option would need to be installed in conjunction with an impermeable cap (i.e., HDPE, asphalt, or clay cap) and a pump and treat system. Vertical containment will be retained as a process option.

6.1.4.3 Vertical Containment – Cement/Bentonite Walls

Description: The construction of a cement/bentonite wall is similar to that of a slurry wall except that soil is replaced with cement. These walls are typically installed where there is insufficient room to mix the soil and bentonite. These walls are also generally more permeable than the soil/bentonite walls.

Initial Screening: The construction of a traditional slurry wall is implementable at this Site and more effective; therefore, cement/bentonite walls will not be retained as a process option.

6.1.4.4 Vertical Containment – Grouted Barrier

Description: Grout would be injected into the ground to provide a lower permeability barrier to isolate contamination. Either particulate or chemical grout can be used and would either be injected into the subsurface by pressure grouting or jet grouting.

Initial Screening: Grouted barriers are typically installed where excavation and installation of a slurry wall is not practicable or in areas where a suitable key is not available such as in rock. These are not limitations at this Site and therefore the grouted barrier process option will be retained.

6.1.4.5 Vertical Containment – Sheet Piles

Description: Sheet piles can be driven into the soil to contain contamination similar to other vertical barriers. The sheet piles would be keyed into an aquitard or confining unit. The sheets are installed with interlocking seams that are designed to be leak free using grout and or gaskets.

Initial Screening: During the design of a sheet pile containment system, the expected lifespan of the sheeting needs to be evaluated for the Site conditions. Sheet piles may be an effective way to mitigate migration of groundwater off-site. This process option would need to be installed in conjunction with an impermeable cap (i.e., HDPE, asphalt, or clay) and a pump and treat system. Installation of sheet piles is technically feasible at the Site and will be retained as a process option.

6.2 Surface Water

The remedy for surface water is rerouting, thereby preventing the surface water from contacting contaminated groundwater or surface water on-site. The following process options are applicable to this general response action.

6.2.1.1 Institutional Controls – Environmental Easement

Description: As required by NYSDEC “Environmental Easements are required for remedial projects which rely upon one or more institutional and/or engineering controls.” Environmental easements may include restrictions to the development of the land, or activities such as excavations or require the management of engineering controls (e.g., fences and caps). These restrictions are determined based on remaining contamination and site engineering controls. Environmental easements can also provide access to the property for long-term monitoring.

Initial Screening: An environmental easement may be necessary depending on the selected remedy.

6.2.1.2 Institutional Controls – Site Management Plan

Description: AN SMP is required for any site which has not been remediated to unrestricted use. The SMP provides a description of remaining contamination at the Site and any engineering or institutional controls that are in place. The SMP includes all pertinent information regarding the operation and maintenance of any remediation systems (e.g., treatment plants, caps) and a monitoring and sampling plan for the Site.

Initial Screening: AN SMP may be required after the completion of the selected remedy.

6.2.1.3 Physical Barrier – Clay/HDPE Liner

Description: A low permeability liner such as clay or HDPE would be installed along the existing path of the on-site surface water. The liner would prevent any contact with contaminated soils and would be installed such that it would prevent any contaminated groundwater from surfacing.

Initial Screening: The physical barrier at the Site would prevent contact with contaminated surface soils and prevent any potentially contaminated groundwater from surfacing and impacting surface water. This process option will be retained as a potential remedy.

6.2.1.4 Source Removal – Excavation

Description: Contaminated surface soil contacting surface water would be excavated and either treated or disposed of off-site. Excavation would be filled with clean backfill, thus preventing surface water from becoming contaminated.

Initial Screening: Surface water at the Site is primarily contaminated through contact with contaminated surface soils. Removal of contaminated soils would prevent water from becoming contaminated. This process option would need to be combined with a physical barrier to prevent contaminated groundwater from surfacing. This process option will be retained as potential remedy.

6.2.1.5 Diversion – Upgradient Drainage Diversion

Description: The current path of the surface water at the Site would be moved to an alignment that avoids contaminated soils thus preventing the surface water from becoming contaminated.

Initial Screening: Surface water at the Site is primarily contaminated through contact with contaminated surface soils. If contaminated groundwater is surfacing and impacts surface water, this process option would need to be combined with a physical barrier. This process option will be retained as a potential remedy.

6.3 Groundwater

6.3.1 Limited Action

6.3.1.1 No Action

Description: This limited action process involves no active remediation or monitoring. Any reduction in toxicity or mobility would be through natural attenuation.

Initial Screening: The No Action process will be retained as an alternative as a comparison to active remedial alternatives.

6.3.1.2 Institutional Controls – Environmental Easement

Description: As required by NYSDEC “Environmental Easements are required for remedial projects which rely upon one or more institutional and/or engineering controls.” Environmental easements may include restrictions to the development of the land, or activities such excavating. These restrictions are determined based on remaining contamination and site engineering controls. Environmental easements can also provide access to the property for long-term monitoring.

Initial Screening: An environmental easement may be required after the final remedy is completed and, therefore, will be retained as a process option.

6.3.1.3 Institutional Controls – Zoning/Ordinance

Description: This process would involve changes to local ordinances and/or zoning to limit potential exposure to Site contamination.

Initial Screening: Changes in zoning or local ordinances would not reduce toxicity or mobility of contamination at the Site. Contamination would continue to migrate off-site through groundwater, and exposure at the Site would not be reduced. This process option will not be retained.

6.3.1.4 Institutional Controls – Site Management Plan

Description: An SMP is required for any site which has not been remediated to unrestricted use. The SMP provides a description of remaining contamination at the Site and any engineering or institutional controls that are in place. The SMP includes all pertinent information regarding the operation and maintenance of any remediation systems (e.g., treatment plants) and a monitoring and sampling plan for the Site.

Initial Screening: An SMP may be required after the completion of the selected remedy and, therefore, will be retained as a process option.

6.3.1.5 Monitored Natural Attenuation (MNA)

Description: A network of groundwater monitoring wells located both on- and off-site are used to monitor groundwater concentrations over time. MNA relies on naturally-occurring processes to reduce groundwater contamination once source material is removed.

Initial Screening: There are no current risks to human health or the environment associated with impacts to deep groundwater at the Site. MNA can reduce Site contaminants to acceptable levels over time and will be retained as a process option in conjunction with a source removal technology.

6.3.2 In-Situ Treatment

6.3.2.1 Biological Treatment: Aerobic

Description: In-situ aerobic treatment is an enhanced bioremediation method in which oxygen and/or nutrients are introduced into a contaminated area to support aerobic biological degradation of organic contaminants. Aerobic microbes can directly contribute to degradation where oxygen is used as a terminal electron acceptor and chlorinated ethenes are used as electron donors. Aerobic co-metabolism is another type of aerobic biodegradation, where biochemical reactions from bacterial enzymes catalyze aerobic oxidation of certain CVOCs while not providing any benefit to the bacteria.

Initial Screening: Research literature has documented that direct oxidation and aerobic co-metabolic biodegradation has not been observed to occur on PCE, but has been documented to degrade TCE, DCE and VC. PCE is the target groundwater contaminant; therefore, this option will not be retained as a process option.

6.3.2.2 Biological Treatment: Anaerobic

Description: In anaerobic biodegradation, microbial organisms can use CVOCs as terminal electron acceptors under anaerobic conditions. Also known as direct anaerobic reductive dechlorination, this degradation pathway can be enhanced by adding electron donors (e.g., carbon substrate and/or other nutrients) to stimulate the microbial activity of dechlorinating bacteria.

Co-metabolic anaerobic reductive dechlorination is another anaerobic degradation pathway in which CVOCs are stripped of their chlorine atoms by non-specific enzymes or co-factor generated during microbial metabolism of another compound in an anaerobic environment, rather than the microorganisms themselves. This pathway could be enhanced with the introduction of additional materials/compounds to be metabolized.

Bioaugmentation is a biological treatment method that introduces microorganisms engineered to degrade a specific contaminant at an accelerated rate and can be used in conjunction with either aerobic or anaerobic treatment. These microorganisms introduce previously unavailable or modified enzymes to the subsurface, which have beneficial enzymatic activity that allow for the biochemical transformation of a formerly persistent compound. Use of bioaugmentation to enhance PCE and other chlorinated ethenes has been documented with varying success in research.

Initial Screening: Direct anaerobic reductive and anaerobic co-metabolic biodegradation has been observed to occur on the target groundwater contaminants. Additional groundwater parameters would need to be gathered to determine the applicability of enhanced anaerobic biodegradation and the potential use of bioaugmentation. Biological treatment will be retained as a process option.

6.3.2.3 Chemical Treatment – Chemical Oxidation/Reduction (Injection)

Description: For this process option, a chemical would be injected into the subsurface to mix with contaminated soils and either reduce or oxidize the contamination to benign compounds. The injections could be conducted by several methods including temporary wells or permanent wells. The effectiveness of chemical oxidation/reduction through injection is limited by the ability for the chemical to interact with the contamination; thus soil heterogeneity and density of injection wells must be considered. Typical oxidants/reductive agents used in remediation include hydrogen peroxide, permanganate, sodium persulfate, ozone and zero valent iron. Post remediation monitoring is required to confirm that concentrations of contaminants do not rebound to unacceptable concentrations. Multiple rounds of injections are often necessary to fully treat the effected media.

Initial Screening: Chemical oxidation/reduction is an effective way of destroying CVOCs at the Site. Although soils at the Site are heterogeneous, methods to alleviate this challenge can be evaluated during the design. Chemical oxidation/reduction through injection will be retained as a process option.

6.3.2.4 Chemical Treatment – Chemical Oxidation/Reduction (Soil Mixing)

Description: For this process option, a chemical would be mixed into the subsurface using large augers or buckets to either reduce or oxidize the contamination to benign compounds. Soil mixing is more advantageous to injections in that there is more certainty that all contamination has contacted the reducing/oxidizing agent. Soil mixing may also provide the opportunity to mix chemicals in particulate form (not aqueous) which can provide lengthened treatment times and reduce the likelihood of contamination rebound.

Initial Screening: Groundwater contamination is located below an aquitard between 25 and 40 feet bgs. The application of soil mixing is limited in the depth it can achieve. Soil mixing at this Site will not be retained as a process option.

6.3.2.5 Thermal Treatment

In-situ thermal remediation generates heat in-situ or applies heat directly to the subsurface, raising the temperature to above the boiling point of the target VOC contaminants, and evaporating VOCs from the soil. Vapors are collected from the subsurface through soil vapor extraction wells for subsequent aboveground treatment.

Initial Screening: In-situ Thermal treatment of impacted deep groundwater at the site is technically feasible and the Site. The cost associated with installing thermal system for the low mass area would not be practicable. However, if a thermal system is already being installed for the treatment of the on-site soils, extending the treatment zone into the deep groundwater may be able to treat the groundwater for a reasonable cost.

6.3.3 Ex-situ Treatment

6.3.3.1 Oxidation-Permanganate

Description: Oxidation with permanganate has been proven as an efficient oxidant of CVOCs. This chemical treatment technology introduces permanganate to the contaminated water.

Initial Screening: The application of this chemical needs to be very accurate to avoid discharging residual chemicals. Other process options (e.g., air stripping and activated carbon) are readily available; therefore oxidation with permanganate will not be retained as a process option.

6.3.3.2 Oxidation-UV

Description: This treatment technology oxidizes contamination by introducing an oxidant such as ozone or hydrogen peroxide to the water and exposing it to ultra-violet light. Treatment can be conducted in both batch or continuous flow modes.

Initial Screening: This process option is an effective way of treating VOCs and unlike carbon adsorption or air stripping destroys the contaminant of concern. Oxidation with ultra-violet light will be retained as a process option.

6.3.3.3 Gravity Separation

Description: Gravity separation is a set of unit processes in which gravity removes settable solids and associated pollutants, floatables, and dispersed petroleum products. Removal occurs downward for solids denser than water such as sediment, and upward for solids lighter than water such as dispersed droplets of petroleum, oil, and paper.

Initial Screening: This treatment system would not be effective at treating dissolved VOCs therefore; gravity separation will be not retained as a process option.

6.3.3.4 Sedimentation with Coagulation

Description: This process enhances sedimentation with the use of a coagulant (e.g., aluminum or iron salts) to neutralize the negative charge on the surfaces of suspended solids present in the water, thereby eliminating the repulsive forces between the particles and enabling them to aggregate and settle out.

Initial Screening: This treatment system would not be effective at treating dissolved CVOCs; therefore, sedimentation with coagulation will not be retained as a process option.

6.3.3.5 Dissolved Air Floatation

Description: Dissolved air floatation (DAF) is a process for the removal of fine suspended material from an aqueous suspension. DAF provides the energy for effective floatation in the form of extremely fine air bubbles, which become attached to the suspended material to be removed. This attachment of bubbles to the particle reduces the density of the particle resulting in increased buoyancy, thus effecting floatation. Particles are then removed by a float skimming belt that skims particles from the surface of the DAF tank. Chemical conditioning is often used to increase the effectiveness of the DAF process.

Initial Screening: This treatment system would not be effective at treating dissolved VOCs; therefore, DAF will not be retained as a process option.

6.3.3.6 Filtration: Granular/Multi-granular

Description: The process of filtration involves the flow of water through a granular bed of sand or another suitable media. The media retains most solid matter while permitting the water to pass. The process of filtration is usually repeated to ensure adequate removal of unwanted particles in the water. The use of carbon as the filtration media adds a chemical process causing CVOCs to adsorb to the carbon.

Initial Screening: Granular and multi-granular filters with carbon have been proven efficient in removing PCE, TCE and DCE and less efficient at removing VC. This process will be retained as an option.

6.3.3.7 Filtration: Cartridge/Bag

Description: Cartridge/bag filters are fabric or polymer-based filters designed primarily to remove particulate material from fluids. They are usually rigid or semi-rigid and manufactured by affixing the fabric or polymer to a central core. These types of filters are disposal and easily replaceable. This process option is typically used for giardia cyst, cryptosporidium oocust, and turbidity control.

Initial Screening: Little research has documented use of this process option in treated water contaminated with CVOCs dissolved in groundwater; however, this process will be retained as an option for particulate removal associated with any groundwater treatment system remedy.

6.3.3.8 Air Stripping

Description: Air strippers are treatment systems designed to encourage the volatilization of contaminates dissolved in water. Tanks or towers consist of packed media (e.g., plastic, steel, or ceramic) which water is gravity fed through. Counter current air is forced against the flow of water passing through the packed media to enhance volatilization. Volatilized contaminants are collected at the top of the tank and released to the atmosphere (with air treatment systems depending on discharge standards).

Initial Screening: Air stripping has been proven effective in remediating chlorinated ethenes and is currently being used to treat CVOCs in groundwater at the Site. Depending on treatment system sizing, off-gas treatment of volatilized CVOCs may be needed (e.g., activated carbon). This process will be retained as an option.

6.3.3.9 POTW Treatment

Description: POTW treatment is use of a publically owned wastewater treatment plant to treat contaminated water. Groundwater would be piped to a nearby POTW for treatment and discharged to the surface, the ground, or the POTW's designated discharge point.

Initial Screening: Any contaminated water originating from the Site may require pretreatment prior to discharging to the POTW collection system. Discharging to the POTW would put additional load on the plant and not decrease on-Site treatment cost. POTW treatment will be retained as a processes option in conjunction with a groundwater removal option and in the instance where discharge for treated groundwater to a surface water body is unavailable.

6.3.4 Containment

6.3.4.1 Induced Drawdown-Pump & Treat

Description: Groundwater extraction wells are positioned to intercept groundwater preventing migration of contaminated groundwater past the extraction wells. Extracted groundwater is then treated using ex-situ treatment systems (e.g., activated carbon, cartridge/bag filters, air stripping) to meet discharge criteria.

Initial Screening: Currently, a pump and treat system is running efficiently at the Site as part of the surface water/groundwater IRM system. Therefore, this process option will be retained.

7.0 Development and Analysis of Alternatives

Based on the technology review and screening, remedial alternatives have been developed for contaminated soil, groundwater, and surface water. These alternatives include readily available technologies, which have been proven to be effective at similar sites with VOC contamination in soil, groundwater, surface water and soil vapor.

The selected alternatives that will undergo detailed analysis in this section include:

- Alternative 1 – No Action
- Alternative 2 – Excavation with Off-Site Disposal (2-25') with In-Situ Chemical Treatment (25-40')
- Alternative 3 – Excavation with On-Site Treatment (2-25') with In-Situ Chemical Treatment (25-40')
- Alternative 4 – Thermal Treatment (2-40')
- Alternative 5 – In-Situ Chemical Treatment (2-40')
- Alternative 6 – Containment (2-40')

Each alternative was evaluated against the following remedy selection evaluation criteria. Of these criteria, the first two are threshold criteria that must be satisfied in order for an alternative to be considered for selection. The remaining seven criteria are balancing criteria used to compare the positive and negative aspects of the alternatives. Community acceptance is evaluated after completion of the proposed remedial action plan by NYSDEC. Section 8 compares the alternatives against these criteria.

1. <u>Overall Protection of Human Health and the Environment:</u> This criterion is an evaluation of the ability of the alternative to protect public health and the environment: the ability of the alternative to eliminate, reduce or control any existing or potential human exposures or environmental impacts identified in the RI Report, and to achieve the RAOs identified in Section 4. This assessment considers other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with SCGs.
2. <u>SCGs:</u> This criterion is used to evaluate the extent to which each alternative conforms to the SCGs identified in Section 4.
3. <u>Long-Term Effectiveness and Permanence:</u> This criterion addresses the long-term effectiveness and permanence of the alternative after implementation. If contamination remains after implementation, this criterion requires evaluation of human exposures, ecological receptors, or impacts to the environment. In addition, long-term impacts to the community may occur through the consumption of materials, resources, energy and gas emissions (including carbon dioxide, nitrogen oxides, and sulfur oxides) associated with the operation and maintenance following construction of a remedy.
4. <u>Reduction of Toxicity, Mobility, and Volume:</u> This criterion is an evaluation of the ability of the alternatives to reduce the toxicity, mobility and volume of site contamination. Alternatives that

permanently or significantly reduce the toxicity, mobility or volume of the contamination at the Site are preferred.

5. Short-Term Impacts and Effectiveness: This criterion is an evaluation of potential short-term adverse environmental impacts and human exposures during construction or implementation of the alternative. Short-term impacts are conditions which may cause human exposures, adverse environmental impacts and nuisance conditions. Means of controlling short-term impacts are identified. The effectiveness of these controls is evaluated. Examples of short-term impacts include increased truck traffic, odors, vapors, dust, habitat disturbance, run off, consumption of materials, resources, energy, gas emissions, and noise. In general, the longer the construction schedule at a site the greater the short-term impacts. An analysis of the sustainability of each option was performed using an SRT© framework (AFCEE 2011) platform (the tool) utilizing metrics associated with gas emissions (carbon dioxide, nitrogen oxides, sulfur oxides; and particulate matter emissions). Energy consumption presented as (mega gules; and kilowatt hours).
6. Implementability: This criterion evaluates the technical and administrative feasibility of implementing an alternative. Technical feasibility includes difficulties associated with construction and the ability to monitor the effectiveness of the alternative. Administrative feasibility includes the availability of the necessary personnel and material and potential difficulties in obtaining approvals, access, etc.
7. Cost Effectiveness: An evaluation of the overall cost effectiveness of an alternative. An assessment is made as to whether the cost is proportional to the overall effectiveness of the alternative.
8. Land Use: This criterion is an evaluation of the current, intended, and reasonably anticipated future use of the Site and its surroundings as it relates to the alternative when unrestricted levels are not achieved.
9. Community Acceptance: This criterion is evaluated after the public review of the remedy selection process as part of the final Division of Environmental Remediation (DER) election/approval of the remedy for the Site.

7.1 Common Elements

Common elements are included in each of the alternatives (excluding No Action) for the rerouting of surface water; excavation of the top 2 feet of soil; targeted in-situ chemical treatment of the off-site deep soil (2-15'); and demolition of the on-site building. Each of these is discussed in the sections below.

7.1.1 Surface Water – Rerouting

The presumptive remedy is to prevent surface water from encountering impacted soil and groundwater. This remedy would be implemented during the 0-2 feet excavation of contaminated soils. The remedy includes the following elements:

1. Removal of all contaminated soil/sediment that surface water may contact.
2. Connecting the current drainage swale to existing drainage that eventually discharges to Warner Creek.
3. Lining the drainage swale to mitigate surface discharge of contaminated groundwater.

4. Removal of existing drainage piping.

The remedy would remove any contaminated soils or sediment which may be contaminating surface water. Removed soils would either be disposed of off-site or treated on-site as determined by the 0-2 feet removal design. After excavation is complete, the Site would be backfilled and graded such that any surface water runoff would drain into the drainage ditch located parallel to the railroad tracks (Figure 7-1).

The current drainage swale along the railroad right-of-way would be connected to existing off-site drainage eventually discharging to Warner Creek. This extension would be constructed such that surface water can no longer be directed to the south. The drainage swale connection may be completed by extending the drainage swale or installing a drainage pipe.

A clay liner would be placed during backfill operations and/or drainage swale construction to prevent any contaminated groundwater from surfacing. An environmental easement would be needed to ensure that the clay liner remains undisturbed until groundwater at the Site is fully remediated.

The estimated capital cost for the surface water presumptive remedy is $0.13 million. This alternative has no other Operations and Maintenance (O&M) costs once implemented. The detailed cost evaluation for this alternative is provided in Appendix B.

7.1.2 In-Situ Chemical Treatment of Soils (4-15')

This common element addresses the off-site contamination through in-situ chemical treatment. The off-site contamination consists of soils located between approximately 4 and 15 feet bgs.

The treatment surface area as shown in Figure 7-1 is 60,000 ft^2. Although contamination may not be on-site throughout the entire treatment zone, for the purpose of this FS, treatment is assumed to be conducted throughout the entire aerial footprint and includes the saturated soils between 4 to 15 feet bgs. The estimated contaminant mass is 830 pounds in this area based on an average concentration of 25 mg/kg. The footprint and treatment depth would be refined during the pre-design investigation and only portions of the treatment area may actually be treated. Although contamination may exist under the building at 99 FBR, the mass of contamination is likely low. The application of chemicals under the building is not easily implementable and not considered under this remedy.

The treatment of these soils would consist of chemical oxidation or reduction of the contamination in the soil. The selected chemical(s) would oxidize contaminants into benign by-products. The primary COC at the Site is PCE, which, when complete pathways are present, degrades to carbon dioxide, water and chlorine. Many different oxidants/reductants can be used for the remediation of chlorinated VOCs (e.g., PCE, TCE, VC) and include permanganate, peroxide, persulfate, ozone and zero valent iron. During the design investigation, a bench scale treatment study would be conducted to determine the optimum chemical and dosage for treatment at this Site. Permanganate is a commonly used oxidizer that is readily available. For the purpose of this FS, permanganate is assumed to be the selected chemical.

The two primary methods of getting the oxidant in contact with the contaminant is (1) through direct injection of the oxidant into the subsurface either through temporary or permanent wells (depending on the number of applications required) or (2) direct mixing of the oxidant in the soil with an excavator or auger. The use of direct injections may be less costly per application; however more applications may be required and getting the oxidant completely distributed throughout the treatment area would be difficult given the heterogeneity of the soil. Physical mixing of the oxidant in the contaminated media would require more chemical to be applied, more site disruption, and cost more to do the mixing than direct injections; however, the physical mixing would provide better distribution of the oxidant throughout the treatment zone.

For the purpose of this FS, permanganate would be injected using temporary injection wells. The use of temporary injection wells allows the flexibility to target different areas and depths depending on concentrations. Two rounds of injections, and a third with half the wells has been assumed for the FS in order to meet the soil SCOs. The shallow depth to groundwater in this area will require special consideration during the design and implementation of the injection to minimize any risk that oxidant would daylight.

After each round of injections, soil samples would be collected at different depths throughout the treatment zone to document that the soil SCOs have been achieved. In addition to soil samples, several groundwater wells located both within the treatment zone and immediately downgradient of the treatment zone would be sampled. These wells would be sampled annually for 5 years after the injections are complete.

The estimated capital cost for the in-situ chemical treatment presumptive remedy is $6.3 million, and including 5 years of post-treatment monitoring brings the total cost to $6.5 million. This alternative has no other O&M costs once implemented. The detailed cost evaluation for this alternative is provided in Appendix B.

7.1.3 Excavation Soil (0-2')

This common element addresses the excavation of contaminated materials located in the upper 2 feet of soil on-site. The footprint of the excavation area as shown in Figures 7-1 is 31,500 ft^2. The total mass of PCE in this area is 70 pounds based on a soil concentration of 10 mg/kg.

Soil would be excavated using traditional construction equipment. If an excavation alternative for the on-site contamination is selected (Alternatives 2 and 3), then the 0-2 feet zone would be incorporated into the shoring design. Otherwise, this excavation would be completed with appropriate side slopes to provide a stable excavation. Elements of other remedies may be completed while the excavation is open (e.g., soil mixing of oxidation/reduction chemicals).

Excavated soil would be disposed of at a permitted landfill unless the final selected alternative includes on-site treatment of soil. Assuming soil would be landfilled, the pre-design investigation would include waste characterization sampling sufficient to allow for direct unloading of excavated material to trucks for transportation and disposal. For the purpose of this FS, all soils within the unsaturated zone have been assumed non-hazardous. Soils would be transported to the disposal facility over-road using trucks. Truck traffic would be evenly distributed across the duration of the project and equal about three trucks per hour and not have a noticeable impact on local traffic. The Site would have an access road for trucks to enter and leave.

The estimated capital cost for the excavation presumptive remedy is $0.50 million. This alternative has no other O&M costs once implemented. The detailed cost evaluation for this alternative is provided in Appendix B.

7.1.4 Building Demolition

This common element requires the removal of the approximately 5,135-square foot, one story dilapidated metal/block building and adjacent shed to better access contaminated source material. No evaluation of the inside of the building or shed has been completed, so a survey would be required to identify any hazardous materials or asbestos. Any hazardous material identified during the survey would have to be removed and properly disposed prior to razing the building. Razing of the building would be performed using traditional construction equipment. For the purpose of the FS, all building material would be disposed at a nearby landfill capable of accepting construction debris.

The estimated capital cost for the building demolition remedy is $0.25 million. This alternative has no other O&M costs once implemented. The cost evaluation for this alternative is provided in Appendix B.

7.2 Alternative 1 – No Action

This alternative is developed as a baseline for comparison to other alternatives. In this alternative, No Action would be completed to address soil contamination, and no measures would be implemented to prevent exposure or migration of the contamination.

<u>Overall Protection of Human Health and the Environment:</u>

The No Action alternative (Alternative 1) does not eliminate, reduce, or control human or ecological exposure to contamination at the Site, and none of the Site RAOs for soil would be addressed. Contamination would only be reduced through naturally-occurring processes and, therefore, contamination would likely continue to impact groundwater and migrate off-site.

<u>SCGs:</u>

- *Chemical-Specific SCGs*: The chemical-specific SCG for soil is NYSDEC Part 375. This SCG would not be met under this alternative.
- *Action-Specific SCGs:* No Action is being implemented under this remedy and therefore no action-specific SCGs need to be complied with.
- *Location-Specific SCGs:* No Action is being implemented under this remedy and, therefore, no action location-specific SCGs need to be complied with.

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

The No Action alternative leaves all contamination on-site unaddressed and does not include any institutional controls. The RAOs for soil at the Site would not be achieved and human and ecological receptors would still be exposed to contaminated soil. Groundwater in contact with soils would continue to be impacted and migrate off-site.

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

The No Action alternative does not reduce toxicity, mobility, or volume of contamination at the Site.

Short-Term Impacts and Effectiveness:

Although the No Action alternative does not have any short-term impacts, the current environmental impacts at the Site are not addressed.

Implementability:

This remedy requires that No Action be performed; therefore, there are no technical or administrative concerns to implement this remedy.

Cost Effectiveness:

There are no capital or operation and maintenance costs associated with this alternative.

Land Use:

The No Action alternative leaves impacted soils un-remediated at the Site, and does not include any deed restrictions or environmental easements. From a legal standpoint, the property could continue to be used for both current and future uses within the zoning requirements, but these activities would be subject to exposure to contamination.

7.3 Alternative 2 – Excavation With Off-Site Disposal (2-25’) with In-Situ Chemical Treatment (25-40’)

This alternative involves the excavation of the on-site contamination down to a depth of 25 feet bgs, targeted in situ chemical treatment from 25 to 40 feet bgs, and the common elements discussed in Section 7.2.

Excavation with Off-Site Disposal (2-25’)

The footprint of the excavation area as shown in Figure 7-2 is 38,000 ft^2. The excavation would be completed from the ground surface to a depth where clean soil is reached, assumed to be at 25 feet bgs. A total of 32,230 CY of material containing 122,810 lbs PCE mass is anticipated to be excavated and disposed off-site. The mass and volume of material only includes soils from 2 to 25 feet bgs and not from the 0-2 feet interval.

Given the depth of excavation, a shoring system would be required. A preliminary analysis indicates that sheet piles with a minimum section modulus of 47 cubic inch (in^3)/feet (e.g., AZ26) and a length of 50 feet would be required. Internal bracing would be used to allow the excavation depth to reach 25 feet. A cell size of approximately 50 feet by 35 feet would be used. A preliminary layout of the shoring cells is shown in Figure 7-2. Vapors associated with the excavation may be significant and a temporary structure will likely be necessary over the excavation to contain vapors.

Groundwater at the Site is at approximately 5 feet bgs; therefore, dewatering would be required to complete the excavation. A temporary groundwater extraction and treatment system would be used. Although the only COCs at the Site are VOCs, operation of the existing temporary treatment plant on-site has shown that metals treatment would be required to meet the discharge requirements. The groundwater treatment system would likely consist of frac tanks, bag filters, air stripper, activated carbon vessels, and a metal treatment system. Treated water would be discharged to the constructed surface water swale under a SPDES-equivalent permit or to the local POTW as a backup to the surface water discharge.

A pre-design investigation would be conducted and include waste characterization sampling sufficient to allow for direct loading of excavated material to trucks for transportation and disposal. Contamination levels vary from levels that could likely be characterized as non-hazardous waste (i.e., < 14 mg/kg), to levels that significantly exceed 10 times the UTS for PCE of 6 mg/kg (i.e., 60 mg/kg). For the purpose of this FS, segregating excavated soils from the 4 to 25 foot zone is considered impractical. Therefore, as the average concentration of these soils is assumed to be greater than the 60 mg/kg limit, all soils would need to be treated prior to disposal to meet the LDR requirements. Soils within the unsaturated zone of contamination are still assumed to be disposed of as non-hazardous waste as discussed in Section 7.1. The excavated area would be backfilled with clean fill imported to the Site.

Contaminated soils would be transported to a permitted disposal facility over-road using trucks. Trucks would be evenly distributed over the duration of the project, equaling about 3 trucks per hour and will not have a notable impact to local traffic. The Site would have an access road for trucks to enter and exit. A decontamination pad would be constructed at the Site exit to allow each truck to be decontaminated prior to leaving the Site.

Targeted In-Situ Chemical Treatment (25-40’)

Targeted in situ chemical treatment would treat the contaminated groundwater in the deep water-bearing zone using chemical oxidants or reductive agents. The treatment area as shown in Figure 7-2 is 31,500 ft^2, and would treat the entire groundwater mass of approximately 40.7 lbs of the 42 lbs of the total mass in the deep groundwater, or 97%. The remaining 3% of the plume mass would be left to naturally attenuate. Removing the majority of the upgradient plume mass would minimize the potential for contamination to migrate further downgradient and allow for groundwater SCGs to be achieved more quickly.

The treatment would consist of injecting an oxidant or reductive agent with the impacted groundwater. The selected chemical would degrade contaminants into benign by-products. The primary COC at the Site is PCE, which degrades to carbon dioxide, water and chlorine atoms. Many different chemicals can be used for the remediation of CVOCs including permanganate, peroxide, persulfate, ozone and zero valent iron. During the design investigation, a bench scale treatment study would be conducted to determine the optimum chemical and dosage for treatment at this Site. The bench scale study will also evaluate the use of biological treatment. Permanganate is commonly used oxidizer that is readily available. For the purpose of this FS, permanganate is assumed to be the selected chemical.

Groundwater injection wells would be installed to inject the selected chemical into the groundwater. Wells would be installed on a 20 foot grid assuming each well has a 10 foot radius of influence. The exact depth of this water-bearing zone is unknown, but a 15 foot thickness was assumed. The injection wells would be used to monitor groundwater concentrations after the injections are complete. Groundwater concentrations would likely rebound after the first round of injections. Therefore, two rounds of injections have been assumed to complete the treatment of the contaminated groundwater. Additional monitoring wells would be installed downgradient to confirm that contamination is not migrating downgradient. Wells would continue to be monitored for at least five years to confirm contamination is fully treated.

<u>Overall Protection of Human Health and the Environment:</u>

The implementation of this remedy would meet the RAOs for the Site and be protective of human health and the environment. This remedy permanently removes (through excavation) or destroys (through in situ chemical treatment) contamination eliminating any exposure to human or ecological receptors. The remedy prevents further off-site migration of contamination through containment of surface water.

<u>SCGs:</u>

Chemical-Specific SCGs: This remedy would remove the majority of impacted soils greater than the NYSDEC Part 375 SCOs for unrestricted use and treat the impacted groundwater to levels below the NYSDEC Division of Water TOGS 1.1.1 within 30 years.

Action-Specific SCGs: The implementation of this remedy would be accomplished using a NYSDEC approved work plan and design that follows NYSDEC DER-10 technical guidance for site investigation and remediation. Workers and work activities that occur during implementation of this alternative would comply with Occupational Safety and Health Administration (OSHA) requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904.

Off-site disposal of excavated soils would comply with applicable United States Department of Transportation (USDOT) regulations. Resource Conservation and Recovery Act (RCRA), UTS/LDR, and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials would be adhered to. Compliance with these requirements would be achieved by utilizing a licensed waste transporter and properly permitted disposal facilities

The excavation requires dewatering and discharge to a surface water receiving body; therefore, SCGs applicable to the treatment and discharge of water would be followed. Applicable SCGs include 6 NYCRR 703, 6 NYCRR 750 and NYSDEC Division of Water Technical & Operational Guidance Series (TOGS) 1.2.2.

As part of the common element for all soil alternatives, the requirements for the underground injection control (UIC) program would be followed for the injection of a chemical oxidant or reducing agent to treat the deeper groundwater and off-site contamination.

Although no removal is planned for within the railroad right-of-way, it is likely that some construction will occur in this area. Proper permits and flagman from the railroad company will be obtained for any work conducted within the railroad right-of-way.

Location-specific SCGs: Remedial activities would be conducted in accordance with local codes and ordinances. Any impacts to the delineated on-site wetlands will be mitigated.

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

Alternative 2 includes the removal/treatment of the most highly contaminated soils and groundwater at the Site. The implementation of this remedy would remove any exposure to ecological or human receptors from soils and remove impacts to the environment from contamination. The implementation of this remedy would be permanent as most contamination would be either removed from the Site or destroyed. The implementation of this remedy would require institutional controls or environmental easements until all SCGs are met.

Reduction of Toxicity, Mobility, and Volume:

This remedy removes contaminated soils from the Site with off-site disposal, thus reducing the volume and toxicity of contamination at the Site. The final fate of the contaminant and its toxicity depends on the treatment/disposal method. When treatment is required there must be a minimum of 90% reduction before landfilling is acceptable. Therefore, a portion of contamination may only be relocated where toxicity of the soil would remain the same. A properly permitted landfill would minimize any potential future impacts to the environment and exposure to human or ecological receptors.

The in-situ treatment of the off-site contamination using oxidative or reductive chemicals would physically transform the contamination into non-toxic compounds reducing the overall volume of contamination at the Site.

The removal and treatment of contaminated soils would eliminate soil as a source of groundwater contamination. The removal of this source material would prevent future migration of contamination off-site through groundwater.

Short-Term Impacts and Effectiveness:

Implementation of this remedy includes excavation and in-situ chemical treatment of contaminated soils. Workers conducting these activities may be exposed to contamination through dermal contact, ingestion and/or inhalation. In addition to exposure to COCs at the Site, workers may also be exposed to the oxidative or reductive chemicals being used for remediation.

These potential exposures to workers would be minimized using appropriate PPE that would be specified in the Site-specific Health and Safety Plan (HASP).

In addition to worker exposure, residents in the immediate vicinity of the Site have the potential to be exposed to contaminated dust leaving the Site. Engineering controls and Best Management Practices (BMPs) would be in place to minimize any dust generation. In addition, a Community Air Monitoring Plan (CAMP) would be in place to monitor dust and VOC levels and ensure appropriate controls are in place to reduce this exposure such as wetting of the excavated area and covering of stockpiled material.

Excavated material and clean fill would be transported to and from the Site using trucks. Truck traffic from this alternative would not cause a noticeable impact to local traffic. A construction entrance and exit would be established at the Site. Prior to leaving the Site, trucks would be decontaminated. The construction exit and decontamination pad would be built to minimize and water or uncontaminated dirt from leaving the Site. Trucks would enter and exit the Site making right hand turns to minimize any potential impacts to traffic.

Implementability:

This remedy could be performed by many contractors with OSHA 40-hour training. There are no major technical barriers that would impact the implementation of this remedy.

The PCE concentrations at the Site would likely require that the soil be treated prior to disposal. The local treatment facilities are unable to handle the concentrations present at the Site; thus, soil would need to be shipped to non-local facilities increasing costs and complicating logistics of implementation.

Work would be required adjacent to and perhaps within the railroad right-of-way, which would require additional administrative and engineering controls (e.g., insurance, access agreements, flagpersons).

Cost Effectiveness:

The estimated capital cost for this alternative is $22.9 million, and including 30 years of post-treatment monitoring brings the total cost to $23.5 million. The detailed cost evaluation for this alternative is provided in Appendix B, and evaluated against the costs of other alternatives in Section 8.

Land Use:

No limitations or restrictions on land use at the Site are anticipated after the remedy is completed.

7.4 Alternative 3 – Excavation With On-Site Treatment (2-25’) with In-Situ Chemical Treatment (25-40’)

This alternative would be implemented in the same way as Alternative 2 with the exception that excavated material would be treated on-site and backfilled rather than being disposed of off-site and having clean fill material brought back in.

The excavated soils would be treated using a portable direct-fired thermal desorption system. Several companies supply these types of units ranging in size and capacity. For the purpose of this FS, a trailer type unit would be used (e.g., Model 431D supplied by Midwest Soil Remediation, Inc.). This type of unit was selected for its ability to treat the highly contaminated soils at a high loading rate (15 tons/hour).

Soil from the excavation would be stockpiled adjacent to the treatment unit to allow for continuous operation of the unit. A temporary structure with an off-gas treatment unit may be required to house the excavated untreated soils to control and treat vapor emissions. After treatment clean soil would be stockpiled and tested to confirm that soil concentrations are below the SCOs prior to backfilling the clean material. The design of this alternative option would not require the in-situ waste characterization sampling.

Overall Protection of Human Health and the Environment:

Same as Alternative 2, excavation with off-site disposal.

SCGs:

The SCGs for this alternative remain the same as Alternative 2 with the exception that the USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials would not be required as soils are not being disposed of off-site.

The operation of the thermal desorption unit would comply with action-specific SCGs related to air emissions including DAR-1, guidelines for the control of toxic ambient air contaminants and 6 NYCRR 212, general process emission sources.

Long-Term Effectiveness and Permanence:

Long-term effectiveness and permanence is the same as Alternative 2.

Reduction of Toxicity, Mobility, and Volume:

The reduction of toxicity mobility and volume remain the same as Alternative 2.

Short-Term Impacts and Effectiveness:

Short-term impacts and effectiveness would be similar to Alternative 2 except that impacts related to trucks would not be an issue as soils would be treated on-site.

Implementability:

Implementability of this alternative is similar to Alternative 2 except instead of not having a local disposal facility; this alternative is limited by the availability of the thermal treatment system and also permitting the use of the thermal treatment system, which may cause delays to initiating work.

Work would be required adjacent to and perhaps within the railroad right-of-way, which would require additional administrative and engineering controls (e.g., insurance, access agreements, flagpersons).

Cost Effectiveness:

The estimated capital cost for this alternative is $13.2 million, and including 5 years of post-treatment monitoring brings the total cost to $13.9 million. The detailed cost evaluation for this alternative is provided in Appendix B, and evaluated against the costs of other alternatives in Section 8.

Land Use:

Land use is the same as Alternative 2.

7.5 Alternative 4 – Thermal Treatment (2-40')

This alternative involves the remediation of the on-site contamination zone through in-situ thermal treatment, and the common elements discussed in Sections 7.1. Several thermal treatment technologies could be applicable to this Site including electrical resistive heating, radio frequency heating, and thermal conductive heating. In general each of these technologies require the same design elements and include, medium to high voltage power or propane/natural gas supplies, an array of heating wells, condensate treatment, vapor collection wells, vapor treatment system, and monitoring wells. The footprint of the treatment area as shown in Figure 7-3 is 38,000 ft^2. The PCE mass to be thermally treated would be 122,810 lbs. The design phase would include an evaluation of vapor treatment options and their costs.

For the purpose of this FS, electrical restive heating would be the technology used to evaluate the overall applicability of the treatment technology. ERH is an appropriate treatment technology as the contamination being treated is below the water table, and CVOCs at the Site do not require temperatures above the boiling point of water to be extracted.

The implementation of this remedy would include the installation of an array of electrodes powered with an alternating electric current supplied from a local high energy line. As the current runs from electrode to electrode, the soil and groundwater are heated to a temperature greater than the boiling points of the contaminants, thereby t volatilizing the contamination. The heating wells (e.g., electrodes) are typically spaced at a density between 15 and 20 feet apart. An array of vapor collection wells is required to capture the volatilized contamination from the heating system. These wells can be either integrated into the heating wells or standalone, either vertical or horizontal, depending on the needs of the site-specifics. The extraction wells would be connected to a vapor/water treatment system. For this alternative, the onsite building would remain in place and the thermal treatment system could also be installed in the building.

Monitoring wells would be installed within the thermal treatment area to monitor treatment progress. Performance monitoring would include the use of temperature probes placed throughout the treatment zone to ensure the proper temperature is achieved, vapor and pressure monitoring points, and possibly soil sampling during and after treatment.

From AECOM and vendor case studies, in-situ thermal remediation systems generally heat the subsurface at a rate of 2° to 2.5°C per day following start up to temperatures of 80° to 85°C. Based on a baseline temperature of approximately 10°C, this initial heating would occur over four to five weeks after start-up, depending on-site-specifics. Heating the subsurface to approximately 100°C from the 80° to 85°C mark is generally then observed to occur at a rate of 1 to 1.5°C per day, which would occur over an additional two to three weeks (six to eight weeks total after start-up). Peak temperatures are generally maintained for a minimum of at least 60 days at most in-situ thermal remediation implementations for vapor extraction. The minimum total time of heating is estimated at approximately 120 days. This estimate, which is based on assumed average rates of soil heating, corresponds to observations of a review of a number of in-situ thermal projects, including several performed by AECOM, where the typical treatment duration for similar projects is approximately 120 to 180 days of heating, plus additional cool-down and monitoring periods.

Confirmation soil sampling would be conducted prior to the completion of thermal treatment to confirm that soil and groundwater SCGs have been achieved.

<u>Overall Protection of Human Health and the Environment:</u>

The implementation of this remedy would likely achieve the RAOs for the Site and is protective of human health and the environment. The remedy permanently removes the most elevated concentrations of contaminants from the Site preventing any potential exposure to human and ecological receptors. The removal of contamination also prevents the migration of contamination from the Site through groundwater.

<u>SCGs:</u>

Chemical-Specific SCGs: This remedy would remove the majority of impacted soils greater than the NYSDEC Part 375 SCOs for unrestricted use and treat the impacted groundwater to levels below the NYSDEC Division of Water TOGS 1.1.1 within 10 years.

Action-specific SCGs: The implementation of this remedy would be accomplished using a NYSDEC approved work plan and design that follows NYSDEC DER-10 technical guidance for site investigation and remediation. Workers and work activities that occur during implementation of this alternative would comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904.

Local permits would be required for the power requirements and the siting of the treatment system. The treatment system would comply with both water and air treatment and discharge SCGs including surface water and groundwater quality standards, groundwater effluent limitations (6 NYCRR 703), obtaining and operating in accordance with a temporary SPDES permit (6 NYCRR 750), guidelines for the control of toxic ambient air contaminants (DAR-1), and general process emission sources (6 NYCRR 212).

The injection of oxidative chemicals requires the submission of a UIC notification to the USEPA Region 2.

Off-site disposal of the unsaturated zone soils would comply with applicable USDOT regulations. If any of the materials are characterized as a hazardous waste, then the RCRA, UTS/LDR, and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials would be adhered to. Compliance with these requirements would be achieved by utilizing a licensed waste transporter and properly permitted disposal facilities.

Work would be required adjacent to and perhaps within the railroad right-of-way, which would require additional administrative and engineering controls (e.g., insurance, access agreements, flagpersons). In addition, depending on the thermal treatment method employed as the Site, special restrictions may be required to prevent interference with the railroad operations (e.g., stray voltage from ERH).

Location-specific SCGs: Remedial activities would be conducted in accordance with local codes and ordinances. Any impacts to the delineated on-site wetlands will be mitigated.

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

This alternative includes the removal/treatment of the most highly contaminated media at the Site. The implementation of this remedy would remove any exposure to ecological or human receptors from soils and groundwater and remove impacts to the environment from contamination. The implementation of this remedy would be permanent as all contamination, once successfully treated, would be either removed from the Site or destroyed. The implementation of this remedy would require no institutional control or environmental easements as long as the SCGs are met.

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

This remedy removes contamination from the Site through thermal treatment. Thermal treatment destroyes or removes the overall mass and volume of contamination present at the Site and prevents further migration of contamination off-site through groundwater, assuming remediation of all source material does not re-contaminate the treatment zone.

<u>Short-Term Impacts and Effectiveness:</u>

Implementation of this remedy includes in-situ thermal treatment of contaminated soils. The implementation of the thermal treatment system either thermally destroys or volatizes contamination and collects it through extraction wells. This process creates an increased risk that workers and residents/workers in close proximity to the Site could be exposed to the volatilized contamination. A properly designed vapor extraction system would mitigate this risk. To confirm the system is working correctly an air monitoring program would be implemented both on the Site and the Site perimeter.

The common elements of excavation and in-situ chemical treatment have additional short-term impacts for workers and local residents/workers and include; increased truck traffic, exposure to treatment chemicals, and dust generation. These impacts are described in more detail in the excavation and in-situ chemical treatment alternatives above, and would be mitigated using a site-specific HASP, BMPs, and a CAMP.

Implementability:

There are no major technical barriers that would impact the implementation of this alternative. The thermal treatment of soils is only conducted by a limited number of contractors although this is not anticipated to cause any significant delays or problems with the implementation. The common elements of this remedy (in-situ chemical treatment, and excavation) can be performed by many readily available contractors with OSHA 40-hour training.

There are no administrative concerns related to this alternative and no institutional controls would be necessary after the completion of the remedy as long as the site SCGs were met.

Cost Effectiveness:

The estimated capital cost for this alternative is $13.8 million, and including 5 years of post-treatment monitoring brings the total cost to $14.0 million. The detailed cost evaluation for this alternative is provided in Appendix B, and evaluated against the costs of other alternatives in Section 8.

Land Use:

No limitations or restrictions on future use at the Site are anticipated after the remedy is competed.

7.6 Alternative 5 – In-Situ Chemical Treatment (2-40')

Alternative 5 involves the chemical treatment of the on-site zone of contamination with in situ chemical treatment and the common elements discussed in Sections 7.1. The treatment surface area as shown in Figure 7-4 is 38,000 ft^2. The estimated mass of PCE is 122,810 pounds. The treatment of these soils would consist of mixing an oxidant or reductive agent with the soil. The selected chemical would transform contaminates into less harmful chemical species. The primary COC at the Site is PCE, which oxidizes to carbon dioxide, water and chlorine atoms. Many different chemicals can be used for the remediation of chlorinated VOCs (e.g., PCE, TCE, VC) and include permanganate, peroxide, persulfate, ozone and zero valent iron. During the design investigation, a bench scale treatment study would be conducted to determine the optimum chemical and dosage for treatment at this Site. Permanganate is commonly used oxidizer that is readily available. For the purpose of this FS, permanganate is the selected oxidant.

The two primary methods of getting the oxidant in contact with the contaminant are (1) through direct injection of the chemical into the subsurface either through temporary or permanent wells (depending on the number of applications required) or (2) direct mixing of the chemical in the soil with an excavator or auger. The use of direct injections may be less costly per application; however, multiple applications would be anticipated.

Physical mixing of the oxidant in the contaminated media cost more to do the mixing than direct injections; however, the physical mixing would provide better distribution of the oxidant throughout the treatment zone. For the purpose of this FS, mixing of the permanganate with an auger was assumed down to the confining layer (assumed 25 feet bgs) and then injection for the deep groundwater interval (25-40 feet bgs). Mixing would be performed while the excavation of the unsaturated zone (0-2 feet interval) is open. A temporary fabric structure may be installed over the auger to capture any CVOCs volatilized during mixing. The augering process will loosen up the soil, so 20% of the soil mixed has been assumed to be spoils that would require off-site disposal.

Soil samples would be collected at different depths throughout the treatment zone after the oxidant is assumed to be spent (e.g. one year after mixing is complete). The samples would be used, to document soil concentrations reaming after treatment. In addition to soil samples, groundwater wells would be installed immediately downgradient of the treatment zone and on-site building after soil mixing is completed. These monitoring wells would be used to confirm that the treatment was successful in reducing soil contamination that can cause groundwater impacts. Groundwater wells would continue to be monitored for at least 5 years.

Injections to the deeper groundwater interval (25-40 feet bgs) would be the same as that for Alternatives 2 and 3 as discussed in Section 7.3.

Overall Protection of Human Health and the Environment:

The implementation of this remedy may achieve the soil RAOs for the Site and is protective of human health and the environment. The remedy permanently destroys the most impacted media at the Site preventing any potential exposure to human and ecological receptors. The destruction of contamination also prevents the migration of contamination off-site through groundwater.

SCGs:

Chemical-Specific SCGs: This remedy would remove the majority of impacted soils greater than the NYSDEC Part 375 SCOs for unrestricted use and treat the impacted groundwater to levels below the NYSDEC Division of Water TOGS 1.1.1 within 30 years.

Action-specific SCGs: The implementation of this remedy would be conducted using a NYSDEC approved work plan and design that follows NYSDEC DER-10 technical guidance for site investigation and remediation. Workers and work activities that occur during implementation of this alternative would comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904.

The injections associated with the in situ chemical treatment common element would require the submission of an UIC notification to the USEPA Region 2.

Off-site disposal of the unsaturated zone soils associated with the excavation common element would comply with applicable USDOT regulations. If any of the materials are characterized as a hazardous waste, then the RCRA, UTS/LDR, and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials would be adhered to. Compliance with these requirements would be achieved by utilizing a licensed waste transporter and properly permitted disposal facilities.

Proper permits and flagman from the railroad company will be obtained for any work conducted within the railroad right-of-way.

Location-specific SCGs: Remedial activities would be conducted in accordance with local codes and ordinances. Any impacts to the delineated on-site wetlands will be mitigated

Long-Term Effectiveness and Permanence:

The implementation of this remedy includes the chemical treatment contamination. This technology permanently removes the contamination from the Site by transforming it into non-toxic substances.

Any potential exposure to ecological or human receptors from soils at the Siteor impacts to the environment would be removed. The implementation of this remedy would require an institutional control in the form of an environmental easement until SCGs are met.

Reduction of Toxicity, Mobility, and Volume:

The in-situ chemical treatment of the contamination oxidizes the contamination into benign by-products, thus reducing/eliminating the mass/volume, toxicity, and mobility of the contamination within the treatment zone.

Short-Term Impacts and Effectiveness:

The use of chemical oxidants adds increased risk to the Site such as dermal exposure to chemical, gas and heat generation and potential uncontrolled reactions due to improper storage of treatment chemicals. These risks would be controlled with a site-specific HASP. The delivery of chemicals to the Site would be conducted to reduce the total amount of chemical on-site at any given time. Chemicals would be stored on-site in a secure location to further reduce any tampering, accidental discharge or contact with the chemicals.

Implementability:

Due to the use of strong chemical oxidants, this remedy would be implemented by OSHA 40-hour trained subcontractor with experience implementing in situ chemical treatment. There are multiple contractors qualified to perform the work, and there are no major technical barriers that would impact the implementation of this remedy.

Cost Effectiveness:

The estimated capital cost for this alternative is $10.2 million, and including 30 years of post-treatment monitoring brings the total cost to $10.9 million. The detailed cost evaluation for this alternative is provided in Appendix B, and evaluated against the costs of other alternatives in Section 8.

Land Use:

No limitations or restrictions on future use after the remedy is completed are anticipated; however, the use of soil mixing will alter the geotechnical attributes of the Site. These changes may limit future development.

7.7 Alternative 6 – Containment (2-40’)

Alternative 6 involves installing a physical barrier around the on-site contamination using a vertical barrier (e.g., slurry wall) and impermeable cap (e.g., HDPE, clay or asphalt), groundwater extraction and the common elements discussed in Sections 7.1. The vertical barrier and impermeable cap would prevent any off-site migration of contamination from the Site. The limits of the vertical barrier and cap are shown in Figure 7-5 and cover 38,000 ft^2. The PCE mass is estimated to be 122,810 pounds.

The slurry wall would be constructed 3 feet wide and extend at least 2 feet into the confining clay layer. The clay layer was assumed to be at 20 ft bgs and therefore the slurry wall would be installed to a depth of 22 feet. The slurry wall would be constructed using standard construction techniques such as a long-arm excavator or a deep trencher. The slurry wall would be constructed using a bentonite and/or cement mixture with the existing native soils. During the pre-design a bench study would be completed to determine the optimal mixture of bentonite and or cement required to achieve the desired permeability.

The construction of the slurry wall would generate spoils. For this FS, 25% of the slurry wall volume would become spoils and be disposed off-site. Three of the four sides of the slurry wall would be constructed within the uncontaminated soils at the Site. These spoils are assumed non-hazardous. The southeast side of the slurry wall would remain within the contaminated soils of the Site. These spoils are assumed to be less contaminated than the soil contained within the slurry wall and would be also non-hazardous. Spoils generated from the construction of the slurry wall would be stockpiled on-site for waste characterization sampling prior to disposal.

The impermeable cap could be constructed from several materials including HDPE, clay or asphalt. For the purpose of this FS, the cap would be constructed of a 2 foot thick clay layer with 6 inches of top soil and a vegetated top. The installation of the cap would be done in conjunction with the removal of the unsaturated zone of contamination. The footprint of the unsaturated zone removal would be extended to include the entire cap footprint. The additional soils requiring removal would also have waste characterization done in place to allow for direct loading. These soils are assumed non-hazardous. The cap would be graded such that all surface water is properly diverted to the drainage ditch along the railroad right-of-way to the north of the Site. The on-site building is to remain in place for this alternative; the cap would be tied into the building to the extent practicable.

A downward hydraulic gradient exists at the Site which may be the cause of the downward migration of contamination to the lower water-bearing unit. To prevent further downward migration of contamination, a groundwater extraction system would be required to reduce the downward gradient within the containment cell. The vertical head difference between the shallow and deep aquifers at the Site is approximately 10 feet downward. For the purpose of this FS, the groundwater table would need to be depressed 12 feet to reverse the vertical gradient upwards into the cell.

Pumping wells would also be required to control future migration of impacted groundwater in the deep water-bearing unit off-site. Three pumping wells would be located at the downgradient portion of the Site boundary. Groundwater located downgradient of the pumping system would be left to naturally attenuate. The location of the wells would treat the highest concentration groundwater on-site. During the pre-design investigation, modeling, and aquifer testing would be conducted to determine the placement and pumping rates of the extraction wells. Extracted groundwater would be treated for both CVOCs and metals. The soil in this water-bearing unit is generally silty sand. Three pumping wells located along the property boundary, each pumping 5 gpm, were assumed to create sufficient influence to prevent any further off-site migration of contamination. Treated water would be discharged to the constructed drainage swale running along the railroad right-of-way.

To maintain this groundwater depression, a treatment system capable of treating 30 gpm would be needed, though modeling during the design would be required to appropriately size the treatment plant. Based on experience running the temporary treatment system at the Site, both CVOCs and metals would need to be treated. Treated water would be discharged to the constructed drainage swale along the railroad right-of-way.

Monitoring wells would be installed along the perimeter of the slurry wall to confirm that contamination is not migrating through the slurry wall. Wells would be monitored on an annual basis for the required 30-year period.

The implementation of this remedy would require a deed restriction/environmental easement be placed on the property. The Site could not be redeveloped with any buildings but could be used as open space or as a parking lot. In addition, the Site would require access for inspections of the cap and sampling of groundwater wells.

Overall Protection of Human Health and the Environment:

The implementation of this remedy meets the soil RAOs for the Site. Contamination remaining on-site would be contained and capped in place. These physical barriers would prevent exposure to human and ecological receptors and prevent groundwater contamination from migrating off-site. The effectiveness of the remedy requires that groundwater be treated from within the containment area to prevent downward migration of contamination.

SCGs:

Chemical-Specific SCGs: This remedy would leave the impacted soils contained in-place and not meet the NYSDEC Part 375 SCOs for unrestricted use, the chemical-specific SCG for soil. This remedy would remove the majority of impacted groundwater in the deep water bearing zone above the NYSDEC Division of Water TOGS 1.1.1 within 30 years; however the groundwater in the shallow water bearing zone will remain impacted for over 30 years.

Action-specific SCGs: The implementation of this remedy would be accomplished using a NYSDEC approved work plan and design that follows NYSDEC DER-10 technical guidance for site investigation and remediation. Workers and work activities that occur during implementation of this alternative would comply with OSHA requirements for training, safety equipment and procedures, monitoring, recordkeeping, and reporting as identified in 29 CFR 1910, 29 CFR 1926, and 29 CFR 1904.

Off-site disposal of the unsaturated zone soils would comply with applicable USDOT regulations. If any of the materials are characterized as a hazardous waste, then the RCRA, UTS/LDR, and USDOT requirements for the packaging, labeling, transportation, and disposal of hazardous or regulated materials would be adhered to. Compliance with these requirements would be achieved by utilizing a licensed waste transporter and properly permitted disposal facilities.

Proper permits and flagman from the railroad company will be obtained for any work conducted within the railroad right-of-way.

Location-specific SCGs: Remedial activities would be conducted in accordance with local codes and ordinances. Any impacts to the delineated on-site wetlands will be mitigated

Long-Term Effectiveness and Permanence:

The majority of contamination at the Site would remain contained in place.

Reduction of Toxicity, Mobility, and Volume:

The common elements of this alternative remove the contamination from the Site but the majority of the mass would remain contained on-site. As long as the factors discussed in long-term effectiveness and permanence remain true the mobility of the contamination would be mitigated.

Short-Term Impacts and Effectiveness:

Implementation of this remedy includes excavation, in-situ chemical treatment, and installation of a slurry wall and cap. Workers conducting these activities may be exposed to contamination through dermal contact, ingestion and/or inhalation. In addition to exposure to COCs at the Site, workers may also be exposed to the oxidative or reductive chemicals being used for remediation.

These potential exposures to workers would be minimized using appropriate PPE that would be specified in the Site-specific HASP.

Residents in the immediate vicinity of the Site have the potential to be exposed to contaminated dust leaving the Site. Engineering controls and BMPs would be in place to minimize any dust generation. In addition, a CAMP would be in place to determine if unacceptable levels of dust are leaving the Site. If this condition is found, additional measures would immediately be put in place and may include wetting of excavated area and covering of stockpiled material.

Implementability:

This remedy could be performed by many contractors with OSHA 40-hour training. There are no major technical barriers that would impact the implementation of this remedy. The containment design as proposed in this FS encompasses the most highly contaminated soils. To achieve this, the slurry wall and cap extend beyond the Site property boundary. Implementation of this remedy would require access and an environmental easement for this adjacent property. If an agreement cannot be achieved, the containment cell would need to be shifted to remain within the Site property boundary reducing the mass of contamination contained within the cell. The common chemical oxidation/reduction element for the off-site soils could be extended to potentially address this area.

Cost Effectiveness:

The estimated capital cost for this alternative is $3.0 million. The remedy also requires an estimated annual O&M cost of $166,000, which, using a 30 year operation period, brings the total present worth to $5.5 million. The detailed cost evaluation for this alternative is provided in Appendix B, and evaluated against the costs of other alternatives in Section 8.

Land Use:

Land use of the Site would be restricted after the implementation of this remedy depending on the exact type of cap selected; the Site could be used for open space or a parking lot. No buildings could be constructed over the cap. An environmental easement would be necessary to continue operation of the treatment plant, inspect the cap/slurry wall, and conduct groundwater monitoring.

8.0 Comparative Analysis of Remedial Alternatives

This section provides a discussion on how the developed alternatives compare to the nine selection criteria:

1. Overall protection of human health and the environment
2. Compliance with SCGs
3. Long-term effectiveness and permanence
4. Reduction of toxicity mobility and volume
5. Short-term impacts and effectiveness
6. Implementability
7. Cost effectiveness
8. Land use
9. Community acceptance

Each of the nine criteria is discussed comparing key differences between the alternatives. Key advantages and disadvantages are identified so that tradeoffs between alternatives can be identified. This section does not provide a discussion on community acceptance as this criterion is evaluated after regulatory review and public comment.

Each of the eight criteria listed above (excluding community acceptance) is discussed below for each of the six alternatives and summarized in Table 8-1:

- Alternative 1 – No Action
- Alternative 2 – Excavation with Off-Site Disposal (2-25') with In-situ Chemical Treatment (25-40')
- Alternative 3 – Excavation with On-site Treatment (2-25') with In-situ Chemical Treatment (25-40')
- Alternative 4 – Thermal Treatment (2-40')
- Alternative 5 – In-situ Chemical Treatment (2-40')
- Alternative 6 – Containment (2-40')

8.1 Overall Protection of Human Health and the Environment

Alternative 1 (No Action) does not provide any protection to public health and the environment and will not be evaluated further. Alternatives 2 and 3, by removing all soil contaminated above the Unrestricted soil cleanup objectives, meet the threshold criteria. Alternatives 4 and 5 also comply with this criterion but to a lesser degree or with lower certainty. Alternatives 2, 3, 5 and 6 rely on a restriction of groundwater use at the site to protect human health. Alternative 4 may require a short-term restriction on groundwater use. The potential for soil vapor intrusion will be significantly reduced by Alternatives 2, 3, 4 and 5, and to a somewhat lesser extent, Alternative 6.

8.2 Standards, Criteria, and Guidance

Each of the alternatives would be implemented in compliance with any applicable action of location-specific SCGs. The chemical-specific SCGs of achieving the Part 375 unrestricted use SCO for soils and TOGS 1.1.1 for groundwater would likely be achieved by Alternatives 2, 3, and 4 since the contamination is either removed or treated. Alternative 5 may meet the SCGs; however, the efficacy is dependent on contact of the chemicals with the contamination. Alternative 1 and 6 would leave the contamination on-site; therefore, would not meet the chemical-specific SCG for the Site within 30 years.

8.3 Long-Term Effectiveness and Permanence

Alternatives 2, 3, 4, 5 and 6 would all be an effective long term solution to the soil contamination. Alternative 2, 3, 4, and 5 physically remove or treat the contamination from the Site, thus reducing the volume, mobility and toxicity at the site. Alternative 2 would result in no reduction in contamination, only relocation of contamination to a secure landfill. Alternative 3 would require treatment of soil on-site and the contamination would be transferred to the vapor phase where it would either be destroyed through oxidation or adsorbed to carbon and treated off-site. Alternative 4 would destroy most of the contamination through oxidation or transfer it to the vapor phase where it would be either be destroyed through oxidation or adsorbed to carbon and treated off-site. Alternative 5 would chemically oxidize the contamination, though the effectiveness would be directly linked to the ability to get the chemical oxidant in contact with the contamination. Alternative 6 leaves the main source area of contamination in place and relies on a low permeability slurry wall and pumping system to contain the contamination on-site. In the event the pumping system is no longer operational or a breach in the slurry wall occurs, contamination could migrate beyond the treatment zone.

8.4 Reduction of Toxicity, Mobility, and Volume

Alternatives 2, 3, 4, 5 and 6 would all be an effective long term solution to the soil contamination. Alternative 2, 3, 4, and 5 physically remove or treat the contamination from the Site, thus reducing the volume, mobility and toxicity at the site. Alternative 2 would result in no reduction in contamination, only relocation of contamination to a secure landfill. Alternative 3 would require treatment of soil on-site and the contamination would be transferred to the vapor phase where it would either be destroyed through oxidation or adsorbed to carbon and treated off-site. Alternative 4 would destroy most of the contamination through oxidation or transfer it to the vapor phase where it would be either be destroyed through oxidation or adsorbed to carbon and treated off-site. Alternative 5 would chemically oxidize the contamination, though the effectiveness would be directly linked to the ability to get the chemical oxidant in contact with the contamination. Alternative 6 leaves the main source area of contamination in place and relies on a low permeability slurry wall and pumping system to contain the contamination on-site. In the event the pumping system is no longer operational or a breach in the slurry wall occurs, contamination could migrate beyond the treatment zone.

8.5 Short-Term Impacts and Effectiveness

Each alternative would be implemented to minimize any worker or resident exposure to contamination and prevent any nuisance conditions from remedial activities. Alternatives 2 and 3 would require the construction of a temporary structure with an air handling unit to prevent volatilization impacts to the community during excavation. Alternative 2 would have increased truck traffic on local roads and an increased risk of contaminated dust leaving the Site as work is being conducted. Alternative 3 would have a temporary fabric structure and thermal treatment system constructed, which would have visual impacts. Alternative 4 involves the in-situ volatilization of the contamination; if extraction wells are not installed properly, there could be a potential increased exposure to contaminated vapors at the surface during vapor recovery. Alternative 5 involves a specialty auger mixer on-site and handling large quantity of oxidation/reduction chemicals both on-site and trucked through the community. Alternative 6 has the least additional impacts as a minimal amount of contaminated soil would be disturbed.

An analysis of the sustainability of each option was performed using an SRT© framework (AFCEE 2011) platform (the tool) utilizing metrics associated with the factors provided below.

- Gas emissions:
  - Carbon dioxide (CO2) emissions;
  - Nitrogen oxides (NOx) emissions;
  - Sulfur oxides (SOx) emissions; and
  - Particulate matter emissions with a diameter of 10 μm or less (PM10).
- Energy Consumption presented as:
  - Mega gules; and
  - Kilowatt hours.

This analysis is provided in Appendix C. The result of this analysis identifies in-situ chemical treatment (Alternative 5) as the lowest treatment contributor to gas emissions and energy use. The largest contributor to gas emissions and energy usage is the on-site excavation and thermal treatment remedy (Alternative 3).

8.6 Implementability

Alternatives 2, 3, 4, 5, and 6 are favorable in that they are implementable, though each will have administrative or technical requirements. Alternative 2 will require the handling, transporting and disposing of hazardous waste to permitted facilities likely located in another state or Canada. Alternative 3 will require the construction of a temporary structure to handle the vapors emitted during the treatment of the excavated soils; workers would also require more stringent personal protective equipment for working in the structure. Alternatives 4 and 5 have limited number of contractors who can do thermal treatment and in situ chemical treatment auger mixing, which could affect the bidding process. Alternative 6 requires that the remedy will require contamination to be left in place, which may require more difficulty in getting an environmental easement in place.

8.7 Cost Effectiveness

Alternatives 2, 3, 4 and 5 each permanently remove contamination from the Site; Alternative 6 leaves the contamination on-site with minimal treatment. The preliminary costs for these alternatives have the present worth of costs for these alternatives at (ranked least to most costly): Alternative 6 ($5.5 million); Alternative 5 ($10.9 million); Alternative 3 ($13.9 million); Alternative 4 ($14.0 million) and Alternative 2 ($23.5 million). These costs include the common elements of surface water rerouting, soil excavation (0-2') and building demolition. The common element of off-site in-situ chemical treatment is not included.

8.8 Land Use

Alternatives 2, 3, 4, and 5 will not likely inhibit current or intended future use of the site. Alternative 6 may limit future use of the site with maintaining a soil cap and also having a treatment system located on the property. Alternatives 2, 3 and 4, and possibly 5 will provide the most likely chance of meeting the unrestricted soil cleanup objectives and thus limit any soil restrictions. Alternative 4 will have the most likely success of meeting the ambient groundwater standards, with Alternatives 2, 3, and 5, providing slightly less treatment efficacy. Alternative 6 will likely not meet soil or groundwater standards within 30 years.

9.0 Recommended Remedy

To be completed after public comment period.

10.0 References

AECOM, 2015. Draft Final Remedial Investigation Report, Former Chemical Company, OU2 Source Area. February 27.

Air Force Center for Engineering and the Environment (AFCEE). 2011. Sustainable Remediation Tool User Guide, Version 2.2. September.

New York State Department of Environmental Conservation (NYSDEC), 2007. Presumptive/Proven Remedial Technologies. February.

NYSDEC, 2010. Technical Guidance for Site Investigation and Remediation. DER-10. Division of Environmental Remediation. May.

NYSDEC, 2010. Green Remediation. DER-31. Division of Environmental Remediation. August.

United States Geological Survey (USGS), 1995. Groundwater Atlas of the United States, Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, Vermont, HA 730-M. by Perry G. Olcott

Tables

AECOM

Table 4-1
Chemical-Specific Standards, Criteria and Guidance
Former Kenco Chemical Company

Media	Requirement	Name	Description	Comment
Soil	6 NYCRR Part 375-6 and NYSDEC CP-51	NYSDEC Soil Cleanup Objectives (SCOs)	SCO based on site-specific cleanup objectives (i.e., unrestricted, residential, commercial, industrial, protection of groundwater, ecological).	Used to develop soil cleanup objectives.
Groundwater	NYSDEC, Division of Water, TOGS (1.1.1)	Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations	Provides a compilation of ambient water quality guidance values and groundwater effluent limitations.	Used to develop groundwater cleanup objectives.
Soil Vapor	Guidance for Evaluation Soil Vapor Intrusion in the State of New York	Guidance for Evaluation of Soil Vapor Intrusion in the State of New York	General guidance for parties evaluating soil vapor intrusion in the State of New York.	Used to evaluate soil vapor concentration and cleanup objectives.
Surface Water	NYSDEC, Division of Water, TOGS (1.1.1)	Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations	Provides a compilation of ambient water quality guidance values and groundwater effluent limitations.	Used to develop groundwater cleanup objectives.
	40 CFR Part 131 USEPA 440/5-86/001	Clean Water Act (CWA)-Ambient Water Quality Criteria-"Quality Criteria For Water-1986"	Criteria for protection of aquatic life and/or human health depending on designated water use.	Criteria may be applicable for assessing surface water quality.
Sediment	NYSDEC Technical Guidance for Screening and Assessment of Contaminated Sediments	Screening and Assessment of Contaminated Sediments (NYSDEC, 2014)	Provides screening criteria for sediment contamination.	Used to screen sediment contamination in water bodies and wetlands.

Table 4-2
Action-Specific Standards, Criteria and Guidance
Former Kenco Chemical Company

	Requirements	Name	Description	Comment
General	DER-10	NYSDEC Technical Guidance for Site Investigation and Remediation	Provides overall remedial action requirements including implementation, compliance, institutional controls, and progress reporting.	Applicable to any selected remedy.
	29 CFR Part 1910	OSHA General Industry Standards	Specifies the 8-hour time-weighted average concentration for worker exposure to various compounds, and training requirements for workers at hazardous waste operations.	Applicable to the implementation of remedies.
	29 CFR Part 1926	OSHA Safety and Health Standards	Specifies the type of safety equipment and procedures to be followed during construction.	Applicable to the implementation of remedies.
	29 CFR Part 1904	OSHA Recordkeeping, Reporting and Related Regulations	Outlines recordkeeping and reporting requirements for an employer under OSHA.	Applicable to the implementation of remedies.
Transportation and Disposal of Soils	6 NYCRR Part 364	Waste Transporter Permits	Governs the collection, transport, and delivery of regulated waste.	Applicable if any hazardous and non-hazardous waste soils or liquids are transported from the site.
	6 NYCRR Part 370	Hazardous Waste Management System-General	Provides definitions of terms and general standards applicable to Parts 370 through 374, and 376.	Applicable if any hazardous waste soils or liquids are managed at or transported from the site.
	6 NYCRR Part 371	Identification and Listing Of Hazardous Wastes	Establishes the procedures for identifying those solid wastes which are subject to regulation as hazardous wastes.	Applicable if soils or liquids are being managed or disposed.
	6 NYCRR Part 372	Hazardous Waste Manifest System	Establishes standards for generators, transporters, and treatment, storage or disposal facilities relating to the use of the manifest system and its record keeping requirements.	Applicable if any hazardous waste soils or liquids are transported from the site.
	6 NYCRR Part 373-2	Final Status Standards For Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities	Establishes minimum State standards which define the acceptable management of hazardous waste.	Applicable if hazardous waste soils or liquids are treated as part of the remedial action.
	6 NYCRR Part 360	Solid Waste Management Facilities	Regulates solid waste management facilities, other than hazardous waste management facilities.	Applicable if soils or liquids can be disposed of as non-hazardous waste.
	40 CFR Part 262, Subpart B	Resource Conservation and Recovery Act (RCRA) Subtitle C-Manifesting	Generators must prepare a Hazardous Waste Manifest (USEPA form 8700-22) for all off-site shipments of hazardous waste to disposal or treatment facilities.	Applicable if any hazardous waste soils or liquids are transported from the site.

Table 4-2
Action-Specific Standards, Criteria and Guidance
Former Kenco Chemical Company

	49 CFR Parts 107, 171.1-172.558	USDOT Rules for Transportation of Hazardous Materials	Outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous materials.	Applicable if any hazardous waste soils or liquids are transported from the site.
Treatment and Discharge of Groundwater	6 NYCRR Part 703	Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations	Establishes surface water and groundwater effluent limitations.	Applicable if treating groundwater and discharging to either surface water or groundwater.
	6 NYCRR Part 750	Obtaining and Operating in Accordance with a SPDES Permit	Describes the procedures and substantive rules concerning the SPDES program.	Applicable if treating groundwater and discharging to either surface water or groundwater.
	NYSDEC, Division of Water, TOGS (1.2.2)	Administrative Procedures and the Environmental Benefit Permit Strategy for Individual SPDES Permits	New York State Implementation of the National Pollutant Discharge Elimination System (NPDES), including discharge to groundwater.	Applicable if treating groundwater and discharging to either surface water or groundwater.
Air Pollution	Substantive Compliance with Air Requirements	Substantive Compliance with Air Requirements	Prescribes that any air emissions greater than 0.5 lb/hr of total volatile organic compounds must have air pollution control equipment.	Applicable for treating soil vapors, volatilization of surface water contaminants, treatment of groundwater, thermal treatment of soils, and ex-situ treatment of soils.
	NYSDEC Air Discharge DAR-1	Guidelines for the Control of Toxic Ambient Air Contaminants	Provides guidance for the control of toxic ambient air contaminants.	Applicable if air emission rates are greater than 0.5 lb/hr.
	6 NYCRR Part 212	General Process Emission Sources	Provides air cleaning requirements based on characteristics of contaminant established in permit.	Applicable if air emission rates are greater than 0.5 lb/hr.
Facility Siting	6 NYCRR Part 360	Siting Of Industrial Hazardous Waste Facilities	Regulates the siting of new industrial hazardous waste facilities.	Applicable if soils are treated as part of the remedial action.
Chemical Injection	40 CFR Part 144	Underground Injection Control Program	Requirements for the Underground Injection Control (UIC) program.	Applicable if any in-situ injection (e.g., chemical, heat) remediation is conducted.

Table 4-3
Location-Specific Standards, Criteria and Guidance
Former Kenco Chemical Company

	Requirements	Name	Description	Comment
General	County and City Regulations and Ordinances	County and City Regulations and Ordinances	Typical city and county regulations and ordinances include noise, transportation, building permits, etc.	Specific county and city regulation and ordinances will need to be followed.
	40 CFR Part 6.302 Executive Orders 11988 and 11990	National Environmental Policy Act	Requires federal agencies, where possible, to avoid or minimize adverse impact of federal actions upon wetlands and enhance natural values.	Executive orders will be considered if work will be conducted in wetlands.
Wetlands	CWA Section 404	Clean Water Act	Regulates the disturbance and mitigation of wetlands.	Applicable if any wetlands are disturbed during the remediation.
	33 CFR Parts 320-330	USACE Wetland Permits	Permit(s) may be required for structures or activities that affect wetlands.	Applicable if any wetlands are disturbed during the remediation.
	40 CFR Part 230	Compensatory Mitigation for Losses of Aquatic Resources Final Rule	Establishes performance standards and criteria for wetland mitigation.	Applicable if any wetlands are disturbed during the remediation.
	40 CFR Part 6 Appendix A	Statement of Procedures for Floodplain Management and Wetlands Protection	Procedures on floodplain management and wetlands protection. Activities taking place within wetlands must be done to avoid adverse impacts and preserve beneficial values in wetlands.	Applicable if any wetlands are disturbed during the remediation.
Historic Sites	16 USC 470, 36 CFR Part 65, 36 CFR Part 800	National Historic Preservation Act	Establishes that effects or impacts on eligible or listed properties are considered and avoided or mitigated during the project planning process.	Applicable to any remedy that involves disturbance of soils.
	New York State Historic Preservation Act	New York State Historic Preservation Act	Establishes that effects or impacts on eligible or listed properties are considered and avoided or mitigated during the project planning process.	Applicable to any remedy that involves disturbance of soils.

Table 4-4
Contaminants of Concern and SCGs
Former Kenco Chemical Company

Media	Contaminants	Screening Criteria	Maximum Observed Concentration	Retained as Contaminant of Concern	Applicable SCG
Groundwater	PCE	5 ug/L	67,000 ug/L	Yes	TOGS 1.1.1 - Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations
	TCE	5 ug/L	6,700 ug/L	Yes	
	cis-1,2-DCE	5 ug/L	7,600 ug/L	Yes	
	Vinyl Chloride	2 ug/L	240 ug/L	Yes	
Soil[1]	PCE	1.3 mg/kg	72,000 mg/kg	Yes	Part 375-6 Remedial Program Soil Cleanup Objectives
	TCE	0.47 mg/kg	45 mg/kg	Yes	
	cis-1,2-DCE	0.25 mg/kg	25 mg/kg	Yes	
	Vinyl Chloride	0.02 mg/kg	0.0095 mg/kg	No	
Surface Water[2]	PCE	0.7 ug/L	440 ug/L	Yes	TOGS 1.1.1 - Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations
	TCE	5 ug/L	80 ug/L	Yes	
	cis-1,2-DCE	5 ug/L	120 ug/L	Yes	
	Vinyl Chloride	0.3 ug/L	6.8 ug/L	Yes	
Sediment[3a/3b]	PCE	16 mg/kg[3a]	0.038 mg/kg	No	Screening and Assessment of Contaminated Sediment (2014)
	TCE	1.8 mg/kg[3a]	ND	No	
	cis-1,2-DCE	0.8 mg/kg[3b]	0.35 mg/kg	No	
	Vinyl Chloride	0.56 mg/kg[3b]	0.22 mg/kg	No	
Soil Vapor[4]	PCE	100 µg/m^3	7,100 µg/m^3	Yes	Guidance for Evaluation of Soil Vapor Intrusion in the State of New York
	TCE	5 µg/m^3	260 µg/m^3	Yes	
	cis-1,2-DCE	100 µg/m^3	ND	No	
	Vinyl Chloride	5 µg/m^3	0.59 µg/m3	No	

Notes:
ug/L - microgram per liter
mg/kg - milligram per kilogram
µg/m^3 - micrograms per cubic meter
ND - Not Detect
[1] = Screening criteria for soil assumed to be Unrestricted Use Soil Cleanup Objectives (6NYCRR Part 375)
[2] = Screening criteria for surface water is assumed to be protective for a source of drinking water (TOGS 1.1.1).
[3a] = Screening criteria are Freshwater Sediment Guidance Value - Class A (NYSDEC, 2014).
[3b] = Screening criteria based on NYSDEC Equilibrium partitioning model (2014) using parameters from USEPA Region III BTAG Sediment Screening Criteria (Updated 2006) calculated based on 2% Total Organic Carbon or 20,000 mg/kg
[4] = Screening criteria for least possible sub-slab concentration that could result in an action (NYSDOH, 2006).

Table 5-1
Preliminary Screening of Technologies and Process Options - Soil
Former Kenco Chemical Company

General Response Actions	Technology	Process Option	Description	Screening Comments
Limited Action	No Action	No Action	Leave site in current condition with no treatment or institutional controls.	**Applicable - Retained as a baseline to compare against other remedial alternatives.**
	Institutional Controls	Environmental Easement	Non-physical means of enforcing a restriction on the site that limits exposure to impacted materials and prevents actions that would interfere with the remedial program.	**Potentially Applicable - May be required in combination with other remedial alternatives.**
		Zoning/Ordinance		
		Current Site Use		
		Deed Restrictions		
		Site Management Plan		
Removal	Excavation (Sheet Piling) with On-site Treatment and Backfill	Biological Treatment (e.g., Land farm, bio pile)	Excavated soils treated on site by one of the treatment options listed (ex-situ treatment).	**Applicable - Excavation and treatment will effectively remove VOC contaminant mass from the source area; shoring protection will be required to meet excavation depths. Treatment facility will need to be located at or nearby the site.**
		Soil vapor extraction		
		Thermal desorption		
	Excavation (Sheet Piling) with Off-site Treatment/Disposal	Thermal desorption	Excavate soils from impacted areas; requires off-site treatment and/or disposal.	**Applicable - Excavation and disposal will effectively remove VOC contaminant mass from the source area; shoring protection will be required to meet excavation depths.**
		Landfill		
In-Situ Treatment	Biological Treatment	Aerobic	Biological processes are used to treat contamination. Different methods, such as nutrient addition, can be used to enhance these naturally-occurring processes.	Not Applicable - Due to high concentrations in both the groundwater and soils.
		Anaerobic		
		Phytoremediation/Constructed Wetlands		
	Physical Treatment	Solidification/Stabilization	Various treatment technologies that either extract contamination from soil or stabilize contamination in place.	Not Applicable - Due to the soil heterogeneity, shallow groundwater, and potential to release additional contamination into the groundwater.
		Soil flushing		
		Surfactant enhanced recovery		
		Electro kinetic separation		
		Heat enhanced recovery		
		Soil vapor extraction		
	Chemical Treatment	Chemical Oxidation/Reduction (Injection)	Apply chemical oxidant or reducing agent into subsurface for oxidation/destruction of contaminants in soil. Strong oxidants require careful handling procedures.	**Applicable - Soil heterogeneity and large contaminant mass requiring treatment may limit this technology's capability to effectively treat source area soils.**
		Chemical Oxidization/Reduction (Soil Mixing)		
	Thermal Treatment	Electrical Resistive Heating (ERH)	in-situ thermal remediation generates heat or heat is applied directly to the subsurface, raising the temperature to either destroy or volatilize contaminants in soil. Vapors are collected from the subsurface through soil vapor extraction wells for subsequent aboveground treatment.	**Applicable - Thermal treatment can remove a majority of VOC contaminant mass from the source area.**
		Electromagnetic heating		
		Radio frequency heating		
		Steam injection and extraction		
		Thermal Conductive Heating (TCH)		
		Vitrification		
Containment	On-Site Capping	Asphalt cap	Capping provides a physical barrier capable of limiting exposure to impacted soil. Capping may also provide a barrier which prevents infiltration of precipitation and subsequent leaching issues.	**Applicable - Capping will prevent future leaching into groundwater.**
		HDPE cap		
		Clay cap		
	Vertical Containment	Slurry Wall	Vertical containment provides a physical barrier preventing the migration of contaminated groundwater downgradient of the site.	**Applicable - Vertical Containment will prevent further migration of contaminated groundwater.**
		Cement/bentonite walls		
		Grouted Barriers		
		Sheet Piling		

Table 5-2
Preliminary Screening of Technologies and Process Options - Groundwater
Former Kenco Chemical Company

General Response Actions	Technology	Process Option	Description	Screening Comments
Limited Action	No Action	No Action	Leave site in current condition with no treatment or institutional controls.	**Applicable - Retained as a baseline to compare against other remedial alternatives.**
	Institutional Controls	Environmental Easement	Non-physical means of enforcing a restriction on the site that limits exposure and use of impacted groundwater and prevents actions that would interfere with the remedial program.	**Applicable - May be required, in addition, to remediation, depending on future site use and selected remedy.**
		Zoning/Ordinance		
		Site Management Plan		
	Environmental Monitoring	Groundwater Monitoring	Monitoring natural attenuation mechanisms, and plume mobility. Assumes plume is stable.	**Applicable - May be required, in addition, to remediation, depending on future site use and selected remedy.**
		Monitored Natural Attenuation		
In-situ Treatment	Biological Treatment	Aerobic	Aerobic bioremediation enhances biodegradation with the addition of oxygen and/or deficient nutrients to subsurface.	**Potentially Applicable - Aerobic/anaerobic bioremediation with bioaugmentation may treat site contaminants.**
		Anaerobic	Anaerobic bioremediation enhances anaerobic reductive degradation by adding electron donor (carbon substrate and/or nutrients) to stimulate the microbial activity of dechlorinating bacteria.	
		Bioaugmentation	Bioaugmentation comprises adding a known contaminant-degrading microbial culture to accelerate the bioremediation process.	
	Chemical Treatment	in-situ Chemical Oxidation/Reduction (Injection)	Apply chemical oxidant into subsurface for oxidation/destruction of contaminants in groundwater. Strong oxidants require careful handling procedures. Oxidant types and loadings will vary based on contamination type (i.e., DNAPL, sorbed, or dissolved).	**Applicable - Chemical oxidation has been demonstrated to directly treat site contaminants.**
		in-situ Chemical Oxidation/Reduction (Soil Mixing)		
		Permeable Reactive Barrier Wall (Zero Valent Iron)	Construction of a reactive iron wall, biobarrier, or carbon wall to treat groundwater as it flows through the wall.	Not Applicable - The use of a reactive wall installed below the confining layer to treat the deep groundwater is not practical.
	Physical Treatment	Air Sparging	Strips VOCs from groundwater through addition of air below treatment zone, transferring VOCs to vapor phase for extraction, and can enhance aerobic biodegradation by injecting air and providing oxygen source.	Not Applicable - Contamination in a confined aquifer makes this technology not implementable.
		In Well Air Stripping	Injection of air into water column within a well to volatilize constituents. Groundwater circulation is performed in-situ with groundwater entering the well at one interval and being discharged at another interval. Captured air will require treatment.	
		High Vacuum Multi-phase Extraction (MPE)	Utilize high vacuums to extract groundwater and expose impacted upper saturated zone soil for vapor extraction.	Not Applicable - Contamination in a confined aquifer makes this technology not implementable.
	Thermal Treatment	Electrical Resistive Heating (ERH)/Thermal Conductive Heating (TCH)	in-situ thermal remediation generates heat in-situ or applies heat directly to the subsurface, raising the temperature to above the boiling point of the target VOC contaminants (typically 100oC or greater), and evaporating VOCs from the soil. Vapors are collected from the subsurface through soil vapor extraction wells for subsequent aboveground treatment.	**Potentially Applicable - Contamination below a confining layer would require vapor recovery system to capture volatiles in the off-gas.**
Ex-Situ Treatment	Hydraulic Pumping - Biological Treatment	Activated Sludge	Impacted groundwater is pumped from the subsurface and treated ex-situ using a biological unit process to meet discharge criteria (e.g., surface water, reinjection into groundwater or discharge to POTW).	Not Applicable - Biological processes to treat chlorinated solvents, while feasible, are not typically used, as there are quicker and more cost-effective physical means of removing compounds from water that are more readily applied.
		Fluidized Bed Reactor		
		Attached Growth Methanogens		
		Constructed Wetland		
	Hydraulic Pumping - Physical / Chemical Treatment	Oxidation - KMnO4	Impacted groundwater is pumped from the subsurface and treated ex-situ using a biological unit process to meet discharge criteria (e.g., surface water, reinjection into groundwater or discharge to POTW). Current IRM surface water/groundwater treatment system consists of filtration, air stripping, and activated carbon prior to discharge to the surface water.	**Potentially Applicable - May be used as hydraulic containment and treat highest groundwater concentrations. Not applicable to entire plume.**
		Oxidation - UV		
		Gravity Separation		
		Sedimentation with Coagulation		
		Dissolved Air Floatation		
		Filtration - Granular/Multi-granular		
		Filtration - Cartridge/Bag		
		Air Stripping		
		Adsorption (Activated Carbon)		
Containment	Physical Containment	Slurry Wall, Solidification, and Sheet Pile	Geotechnical methods for the isolation of source areas, thus preventing the ongoing migration of contaminants. Methods include sheet pile walls, diaphragm walls, and bentonite slurry walls. Barrier will likely alter natural groundwater flow paths.	Not Applicable - Contamination in a confined aquifer makes this technology not implementable.
	Hydraulic Containment	Induced Drawdown - Pump and Treat	Proven method for containment of dissolved-phase contaminants. Extraction wells intercept groundwater and groundwater is treated ex-situ using a biological unit process(es) to meet discharge criteria (e.g., surface water, reinjection into groundwater or discharge to POTW). May also recirculate back to upgradient injection locations until contaminants have attenuated.	**Applicable - Requires installation of extraction wells; relies on attenuation or ex-situ treatment for remediation. Requires long-term infrastructure and operation.**

Table 5-3
Preliminary Screening of Technologies and Process Options - Surface Water
Former Kenco Chemical Company

General Response Actions	Technology	Process Option	Description	Screening Comments
Limited Action	No Action	No Action	Leave site in current condition with no treatment or institutional controls.	Not Applicable - Presumptive there is a presumptive remedy for surface soils and therefore no need to evaluate against a no action alternative.
	Institutional Controls	Environmental Easement	Non-physical means of enforcing a restriction on the site that limits exposure to impacted materials and prevents actions that would interfere with the remedial program.	**Potentially Applicable - May be required in combination with final remedial alternative.**
		Site Management Plan		
Prevention	Physical Barrier	Clay Liner	Low permeability layer such as clay is constructed along existing surface water paths. Prevents contact with contaminated sediment and soils; prevents impacted groundwater from discharging as surface water.	**Applicable - Part of the remedy to prevent surface water impacts. Will be used to prevent contaminated groundwater from entering surface water.**
		HDPE		
	Diversion	Upgradient Drainage Diversion	Surface water is diverted around the source of contamination. Only applicable to surface water contaminated by contact with shallow source material and/or impacted groundwater.	**Applicable - Part of the remedy to prevent surface water impacts. Surface water will be diverted around the most contaminated portion of the site.**
	Source Removal	Thermal Treatment	Removal of impacted soils that can impact surface water.	**Applicable - Part of the remedy to prevent surface water impacts. Soils causing surface water impacts will be removed.**
		Chemical Oxidation		
		Excavation		
Treatment	Pumping	Pump and Treat	Impacted surface water is captured and treated through an ex situ treatment system consisting of physical and/or chemical processes. Treated water is discharge to a near by surface water body, ground water or POTW.	Not Applicable - Requires capturing water and treatment of water in a facility with maintenance requirements. The IRM as currently operating has shown treatment is cost prohibitive as a full scale remedy for this site.
	Volatilization	Aeration	Impacted surface water is captured and aerated through pumps or fountains.	Not Applicable - requires collection of water for treatment. The IRM as currently operating has shown treatment is cost prohibitive as a full scale remedy for this site.

Table 6-1
Preliminary Screening Process Options - Soil
Former Kenco Chemical Company

General Response Actions	Technology	Process Option	Effectiveness	Implementability	Relative Costs	Initial Screening
Limited Action	No Action	No Action	Not effective at reducing exposure	Implementable	None	Retained
	Institutional Controls	Environmental Easement	Effective means of legally restricting site use and monitoring requirements.	Implementable	Low	Retained
		Zoning/Ordinance	Not effective at reducing exposure	Not Implementable	Low	Not Retained
		Site Management Plan	Effective means to document long term monitoring and maintenance requirements for the site	Implementable	Low	Retained
Removal	Excavation and On-site Treatment and Backfill (Sheet Piling)	Biological Treatment	Not effective at reducing high concentrations of soil quickly.	Not Implementable Requires large space and long treatment times	Low	Not Retained
		Soil Vapor Extraction	Not effective at reducing high concentrations of soil quickly.	Not Implementable Requires large space and long treatment times	Low	Not Retained
		On-Site Thermal esorption	Effective at treating all concentrations of VOCs	Implementable	High	Retained
	Excavation and Off-site Treatment/ Disposal (Sheet Piling)	Landfill	Effective at removing contamination from site	Only implementable if concentrations are below 10 times the UTS (i.e., 60 mg/kg)	High	Retained
		Off-Site Thermal Desorption	Effective at treating all concentrations of VOCs	Not all facilities are capable of treating concentrations present at site	High	Retained
In-Situ Treatment	Chemical Treatment	Chemical Oxidation/Reduction (Injection)	Effective at treating VOCs the high concentrations and heterogeneity of the site may impact effectiveness	Implementable	Medium	Retained
		Chemical Oxidization/Reduction (Soil Mixing)	Effective at treating VOCs the high concentrations at the site may impact effectiveness	Implementable	Medium	Retained
	Thermal Treatment	Electrical Resistive Heating (ERH)	Effective at treating all concentrations of VOCs	Implementable	Medium	Retained
		Electromagnetic Heating	Effective at treating all concentrations of VOCs	Implementable	Medium	Retained
		Radio Frequency Heating	Effective at treating all concentrations of VOCs	Implementable	Medium	Retained
		Steam Injection and Extraction	Effective at treating all concentrations of VOCs	Implementable Other thermal technologies are equally effective and less expensive for CVOCs	Medium	Not Retained
		Thermal Conductive Heating (TCH)	Effective at treating all concentrations of VOCs	Implementable	Medium	Retained
Containment	On-Site Capping	Asphalt/HPDE/Clay Cap	Effective at reducing exposure to contamination and infiltration of groundwater. Contamination remains on-site and can continue to migrate.	Implementable	Low	Retained
	Vertical Containment	Slurry Wall	Effective at reducing migration of contamination off-site.	Implementable	Medium	Retained
		Cement/Bentonite walls	Not as cost-effective as slurry wall.	Implementable	Medium/High	Not Retained
		Grouted Barriers	Used more often in rock	Implementable	Medium	Not Retained
		Sheet Piling	Effective at reducing migration of contamination off-site	Implementable	Medium	Retained

Table 6-2
Preliminary Screening of Technologies and Process Options - Groundwater
Former Kenco Chemical Company

General Response Actions	Technology	Process Option	Effectiveness	Implementability	Relative Costs	Initial Screening
Limited Action	No Action	No Action	Not effective at reducing exposure.	Implementable	None	Retained
	Institutional Controls	Environmental Easement	Effective means of legally restricting site use and monitoring requirements.	Implementable	Low	Retained
		Zoning/Ordinance	Not effective at reducing exposure.	Not Implementable	Low	Not Retained
		Site Management Plan	Effective means to document long-term monitoring and maintenance requirements for the site.	Implementable	Low	Retained
	Monitored Natural Attenuation	Monitored Natural Attenuation	Contamination can be naturally reduced, but can take a very long time.	Implementable	Low	Retained
In-Situ Treatment	Biological Treatment	Aerobic	Not effective at treating VOCs.	Implementable	Medium	Not Retained
		Anaerobic	May be effective at treating VOCs. Additional parameters required to evaluated effectiveness.	Implementable	Medium	Retained
		Bioaugmentation	May be effective at treating VOCs. Additional parameters required to evaluated effectiveness	Implementable	Medium	Retained
	Chemical Treatment	In-situ Chemical Oxidation/Reduction (Injection)	Effective at treating VOCs.	Implementable	Medium	Retained
		In-situ Chemical Oxidation/Reduction (Soil Mixing)	Effective at treating VOCs.	Implementable	High	Not Retained
	Thermal Treatment	Electrical Resistive Heating (ERH)/Thermal Conductive Heating (TCH)	Effective at treating VOCs.	Implementable	Medium/High	Retained if used in conjunction with soil treatment
Ex-Situ Treatment	Hydraulic Pumping - Physical / Chemical Treatment	Oxidation - KMnO4	Effective at treating VOCs.	Implementable	Medium	Retained
		Oxidation - UV	Effective at treating VOCs.	Implementable	Medium/High	Retained
		Gravity Separation	Not effective at treating VOCs.	Implementable	Low	Not Retained
		Sedimentation with Coagulation	Not effective at treating VOCs.	Implementable	Medium	Not Retained
		Dissolved Air Floatation	Not effective at treating VOCs.	Implementable	Low	Not Retained
		Filtration - Granular/Multi-granular	Filtration with carbon is effective at treating VOCs.	Implementable	Low	Retained
		Filtration - Cartridge/Bag	Not effective at treating VOCs.	Implementable	Low	Retained for particulate removal
		Air Stripping	Effective at removing VOCs.	Implementable	Low	Retained
		POTW Treatment	May require pre-treatment from one of the methods discussed above prior to discharge to POTW.	Implementable	Low/Medium	Retained
Containment	Hydraulic Containment	Induced Drawdown - Pump and Treat	Effective at preventing migration of groundwater.	Implementable	High	Retained

Table 8-1
Evaluation of Alternatives
Former Kenco Chemical Company

	Overall Protection of Human Health and the Environment	Compliance with SCGs	Long-term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume	Short-Term Impacts and Effectiveness	Implementability	Cost Effectiveness	Land Use	Preliminary Cost Estimate[1,2]	Score[3]
Alternative 1: No Action	**Low** No improvement to the protection of human health and the environment.	**Low** Does not meet any of the SCGs.	**Low** Contamination is not being addressed. Contamination likely to be present long term.	**Low** No reduction in toxicity or mobility to contaminants.	**High** No short-term impacts.	**High** Requires no action to implement.	**Medium** No costs but no reduction in contamination.	**Low** Site would remain contaminated and future use would be prohibited.	**$0**	**16**
Rank	1	1	1	1	3	3	2	1	3	
Alternative 2: Excavation with Off-Site Disposal (2-25') and In Situ Chemical Treatment (25-40')	**High** Highest concentrations of contamination would be removed from the site from 2-25' or destroyed from 25-40'.	**High** Majority of soil contamination above SCOs removed; some discrete areas of higher concentration may remain; majority of groundwater will be treated in deeper unit.	**High** Highest levels of contamination removed or treated from the site.	**High** Highest levels of contamination removed or treated from the site.	**Low** Construction period would be short term. Increased truck traffic due to soil removal from site. Large area of soil exposed increasing potential airborne exposure risk. Chemical transport/storage on site	**High** Technology is readily available; need to find off-site disposal/treatment facility.	**High** High cost with removal/treatment of contamination.	**High** Contamination would be removed and site could be redeveloped.	**$23.5 Million**	**23**
Rank	3	3	3	3	1	3	3	3	1	
Alternative 3: Excavation with On-Site Treatment (2-25') and In Situ Chemical Treatment (25-40')	**High** Highest concentrations of contamination would be treated on the site from 2-25' or destroyed from 25-40'.	**High** Majority of soil contamination above SCOs treated; some discrete areas of higher concentration may remain; majority of groundwater will be treated in deeper unit.	**High** Highest levels of contamination removed or treated from the site.	**High** Highest levels of contamination removed or treated from the site.	**Low** Construction period would be moderate term. Increased truck traffic and on-site material handling due to soil exavation and treatment. Large area of soil exposed increasing potential airborne exposure risk. Chemical transport/storage on site.	**Low** Technology is available; though only a few companies have capabilities to treat CVOC soils on-site. Given small size of site, additional land would have to be leased to contain the treatment system.	**High** High cost with treatment of contamination.	**High** Contamination would be treated and site could be redeveloped.	**$13.9 Million**	**22**
Rank	3	3	3	3	1	1	3	3	2	
Alternative 4: In Situ Thermal Treatment (2-40')	**High** Highest concentrations of contamination would be treated and removed from the site.	**High** Majority of soil contamination above SCOs removed and groundwater mass removed; some discrete areas of higher concentration will remain.	**High** Highest levels of contamination removed from the site.	**High** Highest levels of contamination removed from the site.	**Medium** Construction period would be short term. Some increased risk of exposure, as contamination, is volatized, collected, and treated onsite.	**Medium** Technology is readily available, contracting issues may arise due to propietary technologies.	**High** Medium cost, high likelihood of reducing most contamination.	**High** Contamination would be removed and site could be redeveloped.	**$14.0 Million**	**24**
Rank	3	3	3	3	2	2	3	3	2	
Alternative 5: In Situ Chemical Treatment (2-40')	**High** Highest concentrations of contamination would be treated and removed from the site.	**Medium** Majority of soil contamination above SCOs removed and groundwater mass removed; some discrete areas of higher concentration will remain.	**High** Highest levels of contamination treated from the site though treatment effeciency based on contact of chemicals with contaminants.	**Medium** Highest levels of contamination treated from the site though treatment efficiency based on contact of chemicals with contaminants.	**Medium** Construction period would be moderate term. Increased risk of exposure due to augering of soil; temporary fabric structure required. Chemicals would be stored on-site.	**Medium** Technology is available; though speciality eqiupment would be required for auger mixing.	**Medium** Low cost, but risk is that oxidation may not work or may miss some contamination.	**Medium** Contamination would be removed and site could be redeveloped though the structural integrity would need evaluation given the auger mixing.	**$10.9 Million**	**20**
Rank	3	2	3	2	2	2	2	2	2	
Alternative 6: Containment (2-40')	**Medium** Alternative prevents contact and mobility of contaminants, but leaves contamination in place.	**Low** Does not meet any of the SCGs.	**Medium** Contained soils would be capped, but contamination would be left in place, and long term monitoring would be required to confirm effectiveness of slurry wall and groundwater extraction system.	**Medium** Contamination left in place; therefore, toxicity and volume are not reduced, but mobility would be reduced by slurry wall and hydraulic containment.	**High** Minimal short-term impacts; implementation period would be short. Activities would be located primarily on-site with minimal risk of increased exposure to the public.	**High** Technology is readily available; no major roadblocks anticipated.	**Medium** Cost does not reduce contaminant mass.	**Low** Site would remain contaminated and future use would be prohibited.	**$5.5 Million**	**18**
Rank	2	1	2	2	3	3	2	1	2	

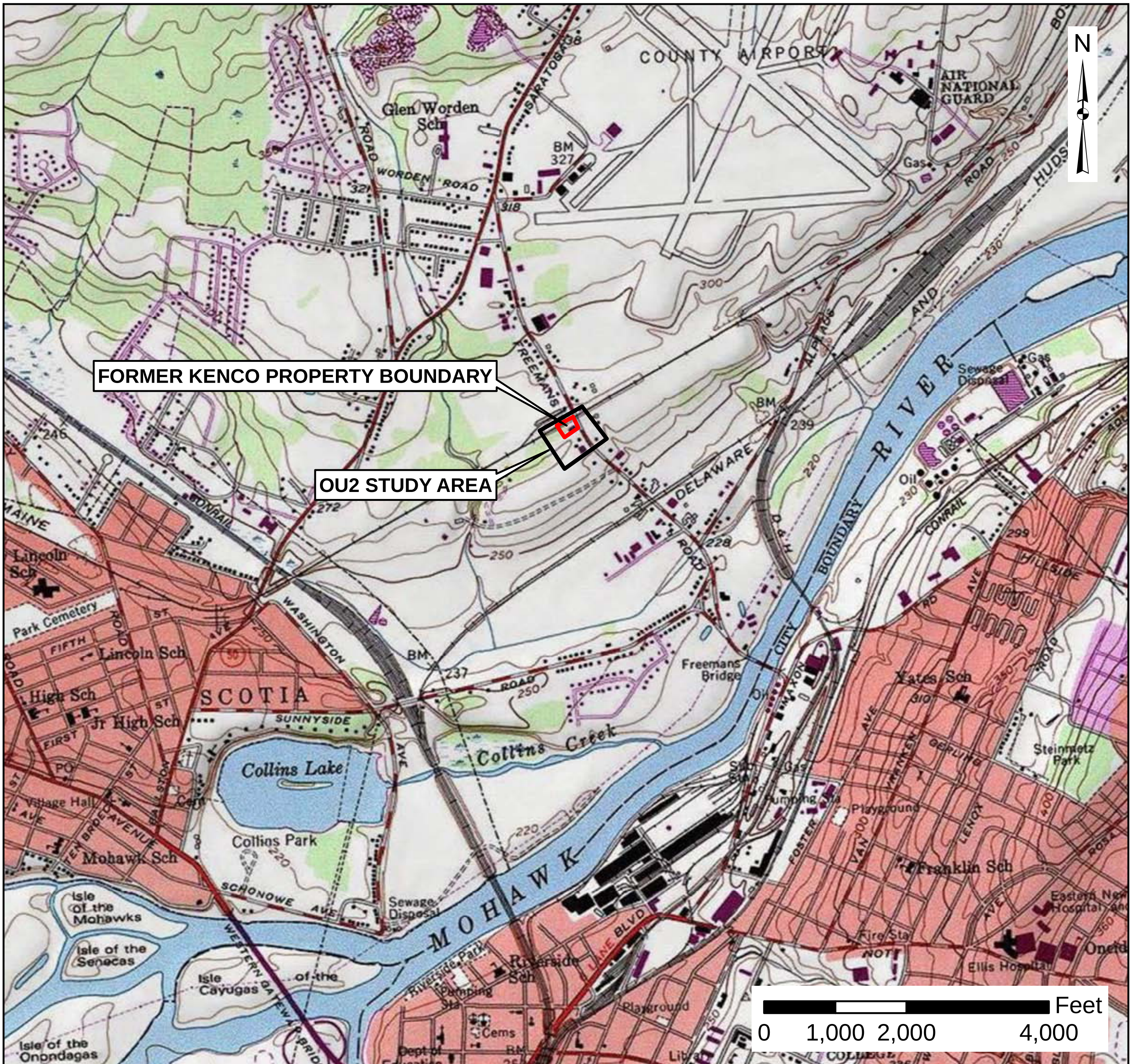
[1] Common Element Costs included in cost estimates for Alternatives 2 through 6. These costs are:
- $0.13 Million for Surface Water Rerouting
- $0.50 Million for Excavation (0-2')
- $0.25 Million for Building Demolition

[2] Common Element Costs NOT included in cost estimates for Alternatives 2 through 6. These costs are:
- $6.5 Million for Off-Site In Situ Chemical Treatment (4-15')

[3] Score is the sum of the ranks of the eight criteria (the higher the score, the better the alternative in meeting the RAOs)

[4] Rank based on the following (higher rank is better): 1 (Low); 2 (Medium); 3 (High)

Figures



Source: ArcGIS Topographic Map

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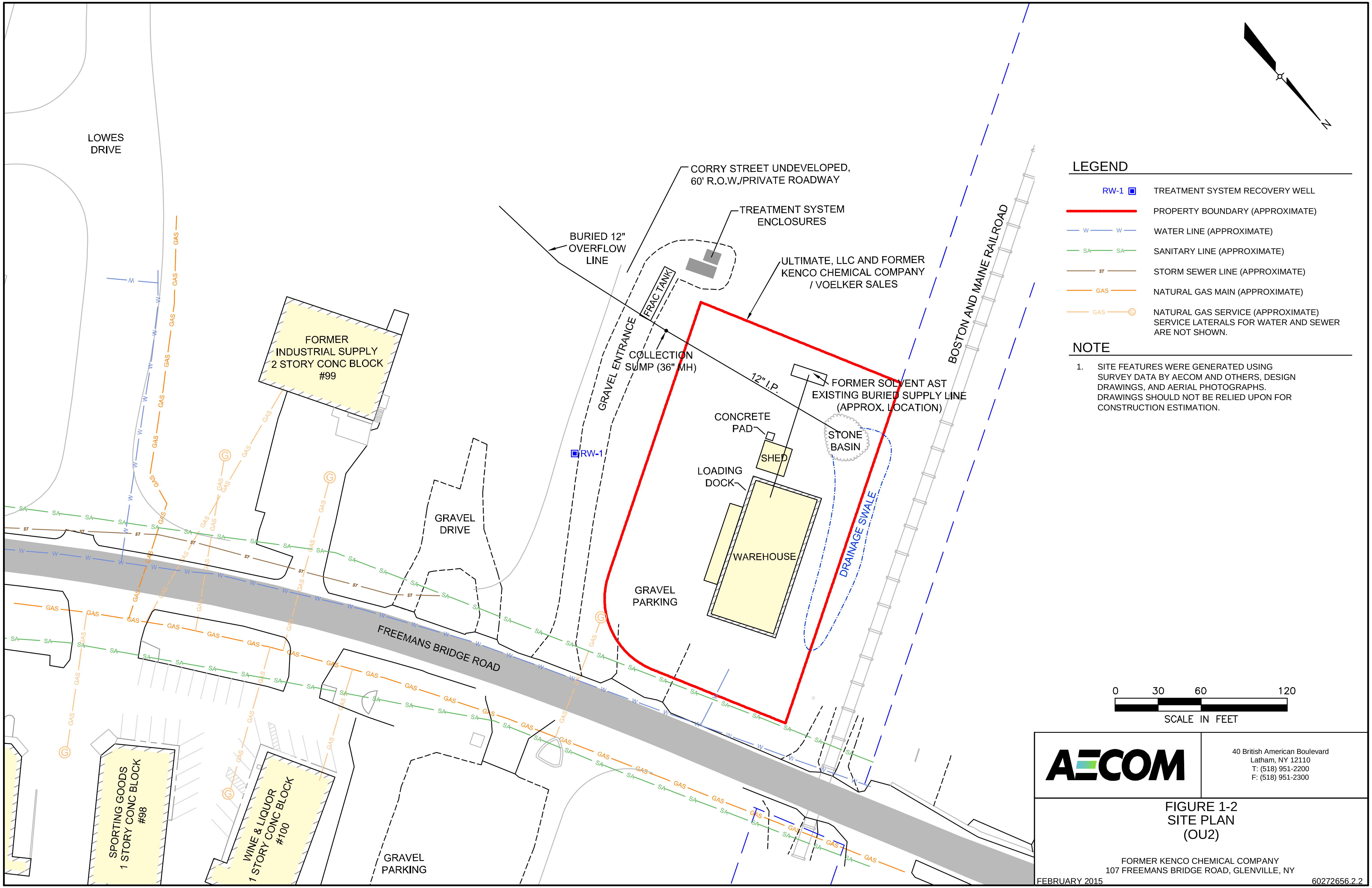
FIGURE 1-1

SITE LOCATION MAP

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

FEBRUARY 2015

60272656



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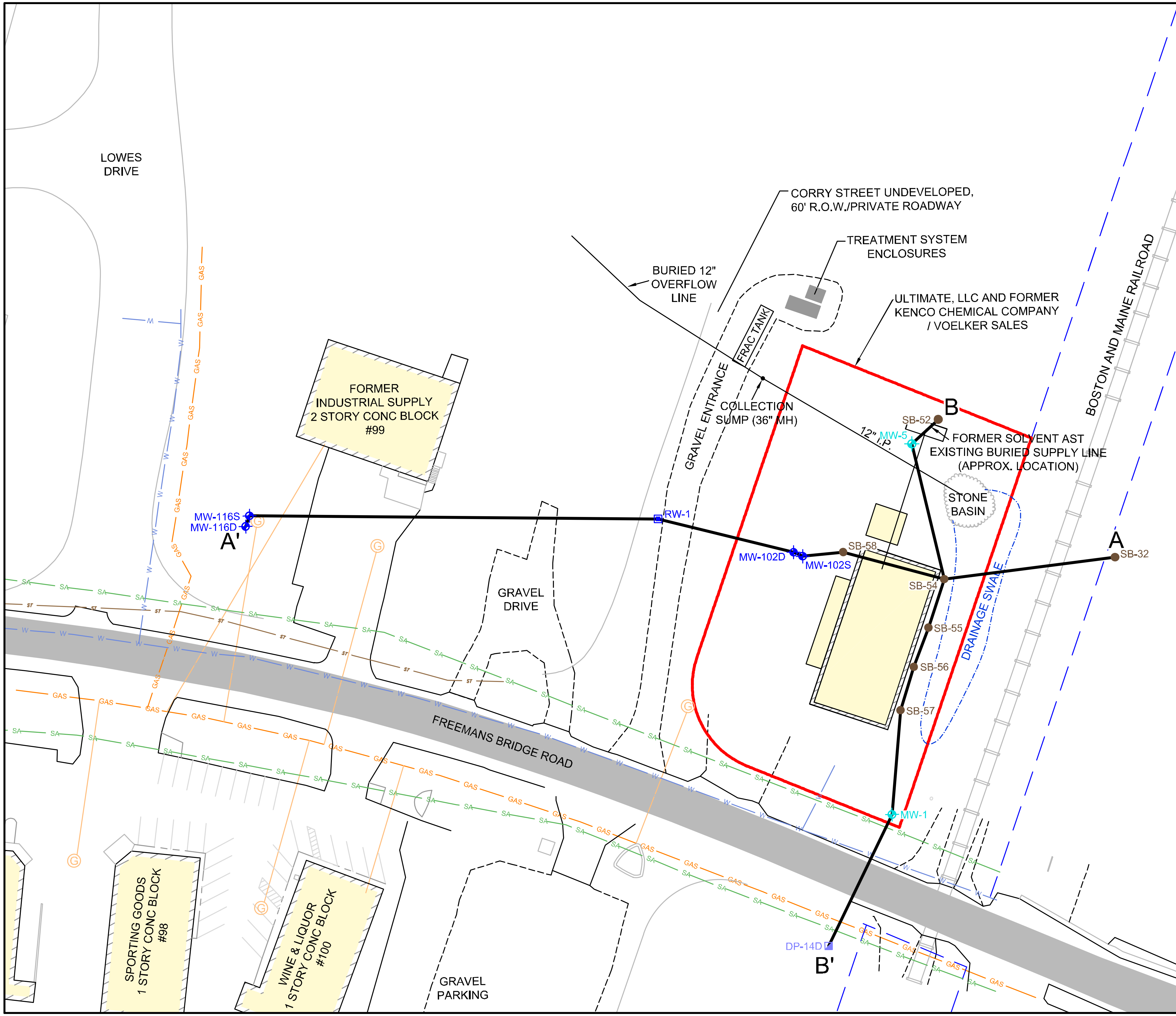

LEGEND

- A—A' CROSS-SECTION LOCATION CUT
- MONITORING WELL LOCATION (SURVEYED 2013)
- DIRECT PUSH LOCATION (SURVEYED 2013)
- SOIL BORING LOCATION (SURVEYED 2013) USEPA SOIL BORING (NOT SURVEYED)
- PROPERTY BOUNDARY (APPROXIMATE)
- WATER LINE (APPROXIMATE)
- SANITARY LINE (APPROXIMATE)
- STORM SEWER LINE (APPROXIMATE)
- NATURAL GAS MAIN (APPROXIMATE)
- NATURAL GAS SERVICE (APPROXIMATE) SERVICE LATERALS FOR WATER AND SEWER ARE NOT SHOWN.

NOTES

1. HISTORICAL LOCATIONS ARE APPROXIMATE EXCEPT MW-1, MW-3, MW-4, MW-5, DP-3, DP-4S/D, DP-14S/D, AND DP-16S/D.
2. SITE FEATURES WERE GENERATED USING SURVEY DATA BY AECOM AND OTHERS, DESIGN DRAWINGS, AND AERIAL PHOTOGRAPHS. DRAWINGS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION ESTIMATION.

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FIGURE 3-1
CROSS-SECTION LOCATION MAP (OU2)

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

FEBRUARY 2015 60272656.2.2

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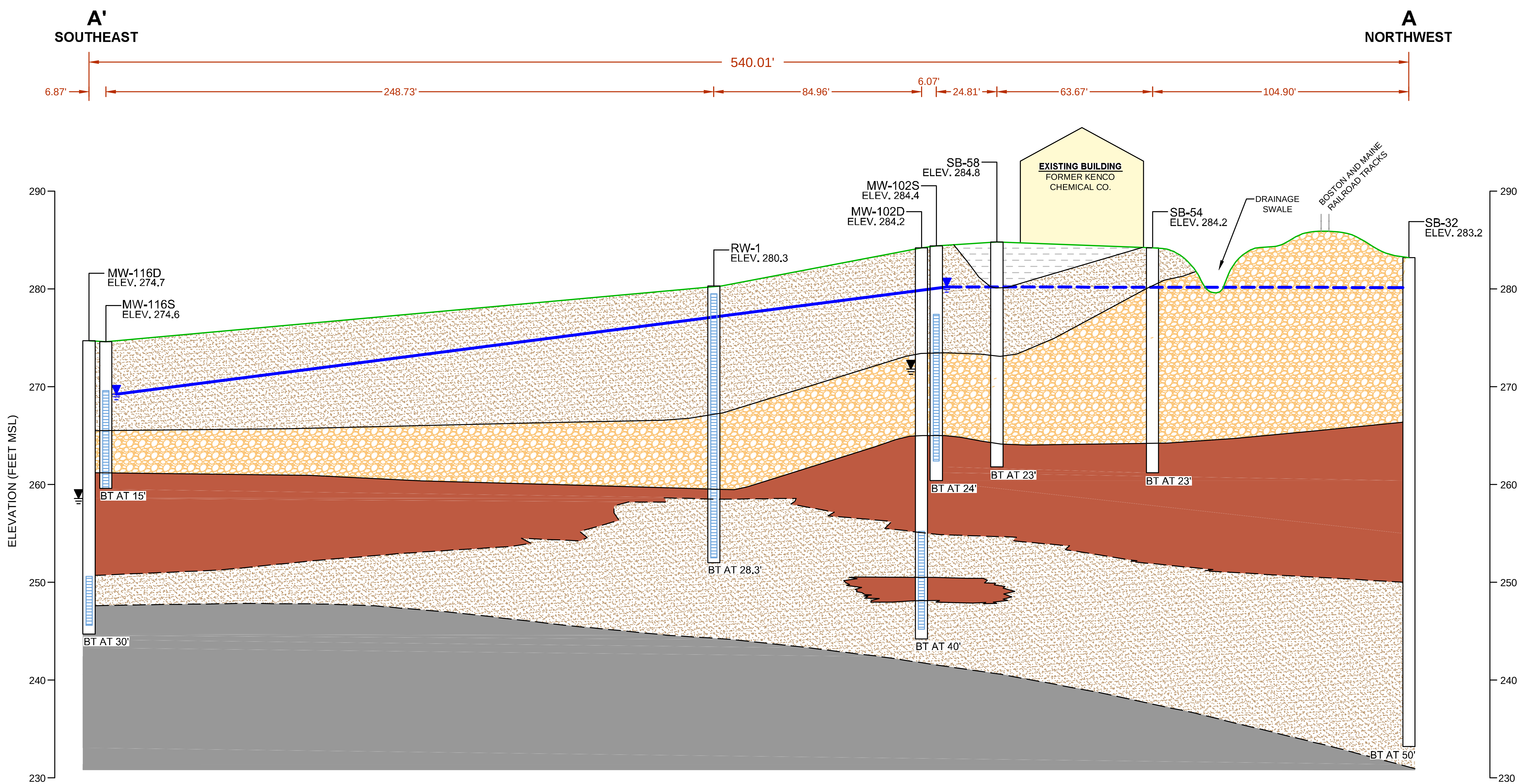

LEGEND

MW-116D	WELL I.D.
ELEV. 274.7	GROUND SURFACE ELEVATION (FEET, MSL)
BT	BORING TERMINATED
	SCREENED INTERVAL
	SHALLOW GROUNDWATER ELEVATION (DASHED WHERE INFERRED)
	DEEP GROUNDWATER ELEVATION
	WELL/BORE HOLE
	SILTY FINE SAND
	GRAVELLY COARSE SAND
	SILTY CLAY
	GLACIAL TILL
	FILL

NOTES

1. STRATIGRAPHIC UNITS CONTACTS (DASHED WHERE INFERRED)
2. RW-1 IS A GROUNDWATER EXTRACTION WELL INSTALLED BY PRECISION ENVIRONMENTAL SERVICES, INC. (PES) FOR NYSDEC. STRATIGRAPHY SHOWN AT RW-1 IS AECOM's INTERPRETATION OF PES's BOREHOLE LOG.

0 20 40 80
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET
VERTICAL EXAGGERATION = 4x

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FIGURE 3-2
CROSS-SECTION A-A'
(OU2)

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

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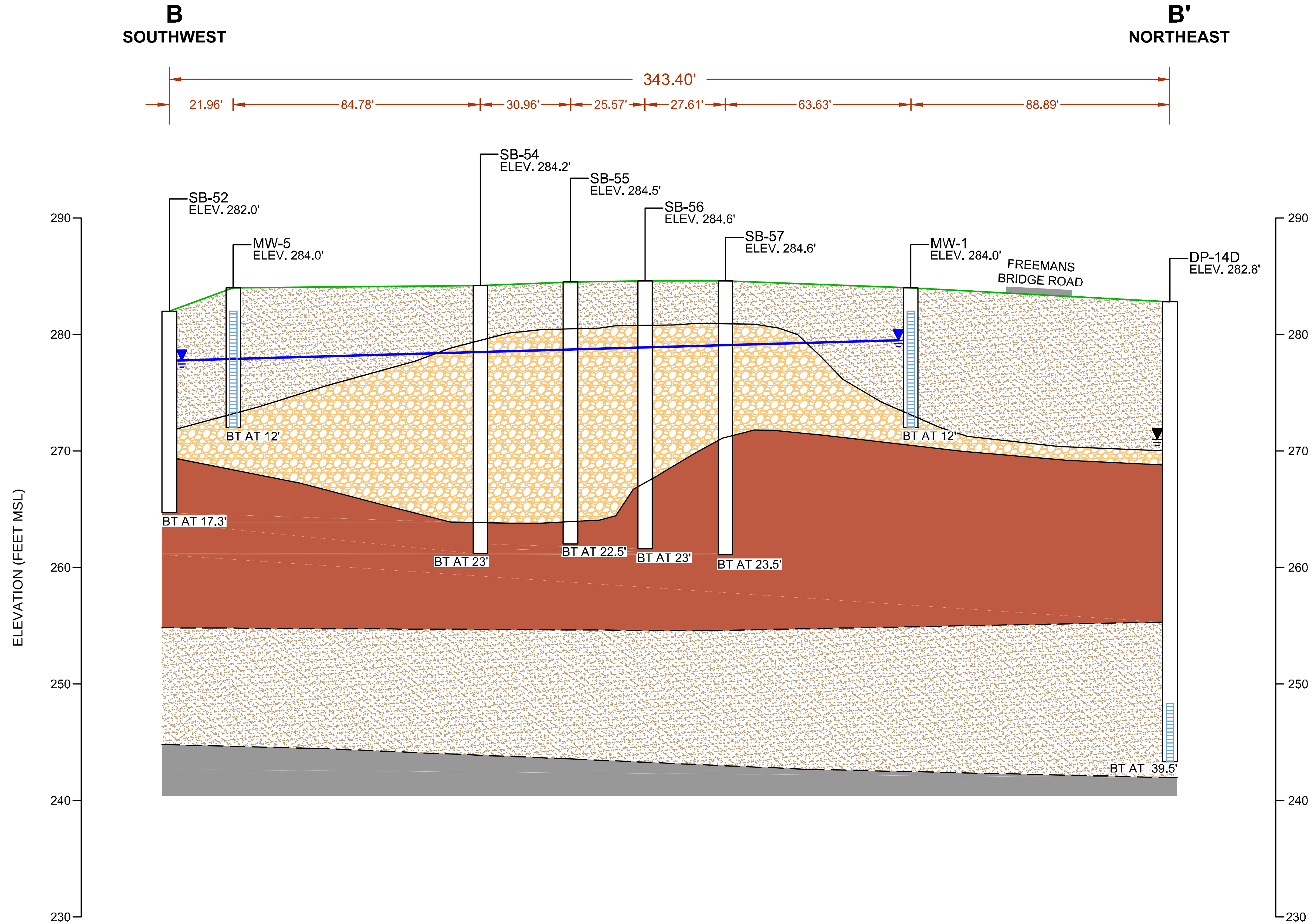

LEGEND

SB-52	WELL I.D.
ELEV. 282.0'	GROUND SURFACE ELEVATION (FEET, MSL)
BT	BORING TERMINATED
	SCREENED INTERVAL
	SHALLOW GROUNDWATER ELEVATION (DASHED WHERE INFERRED)
	DEEP GROUNDWATER ELEVATION
	WELL/BORE HOLE
	SILTY FINE SAND
	GRAVELLY COARSE SAND
	SILTY CLAY
	GLACIAL TILL
	FILL

NOTES

1. STRATIGRAPHIC UNITS CONTACTS (DASHED WHERE INFERRED)
2. MW-1 AND MW-5 ARE MONITORING WELLS INSTALLED BY NORTHEASTERN ENVIRONMENTAL TECHNOLOGIES, CORP. (NETC) FOR NYSDEC. STRATIGRAPHY SHOWN AT THESE BOREHOLES ARE AECOM's INTERPRETATION OF NETC's BOREHOLE LOG.

0 20 40 80
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET
VERTICAL EXAGGERATION = 4x

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FIGURE 3-3
CROSS-SECTION B-B'
(OU2)

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

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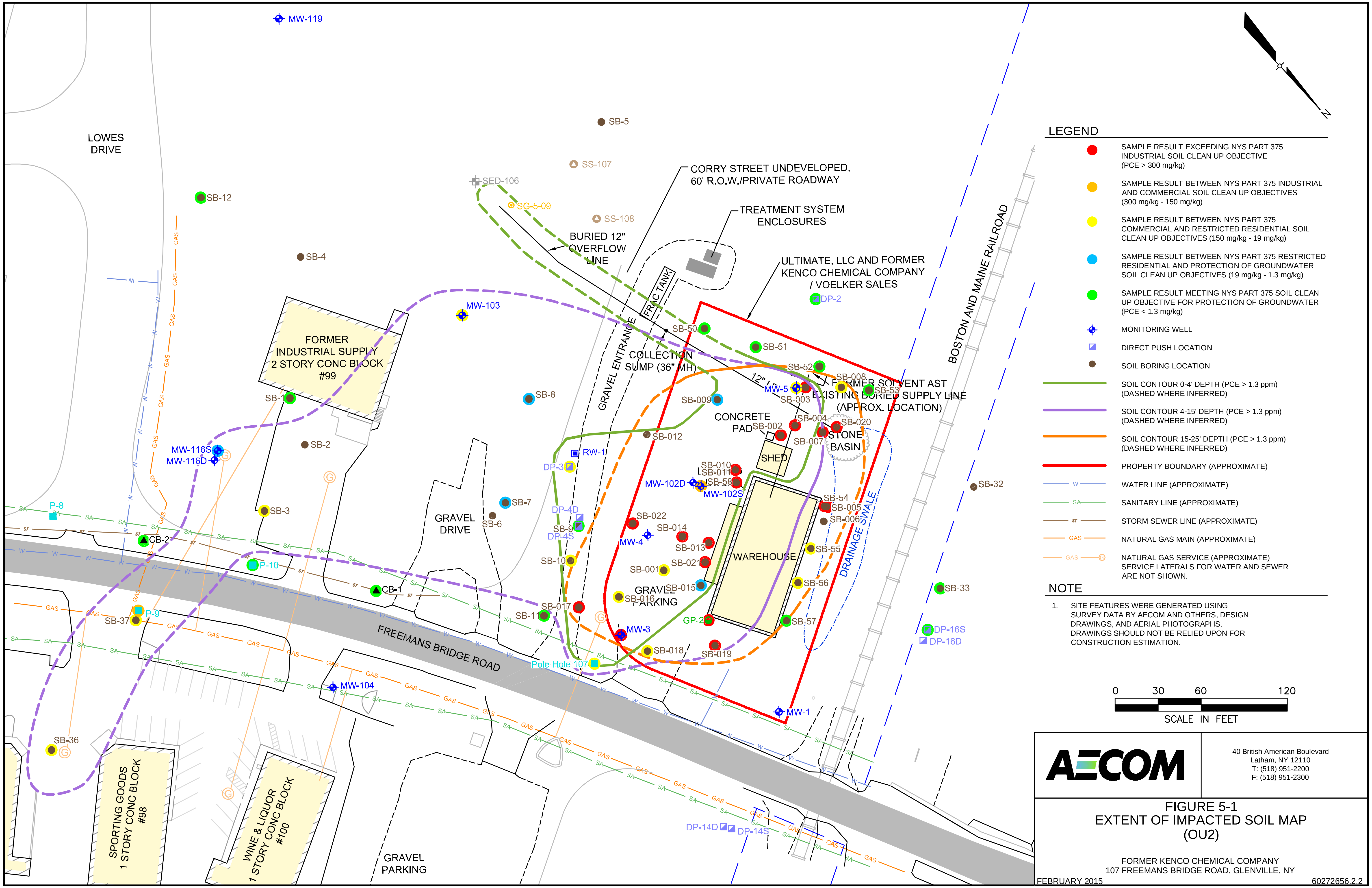

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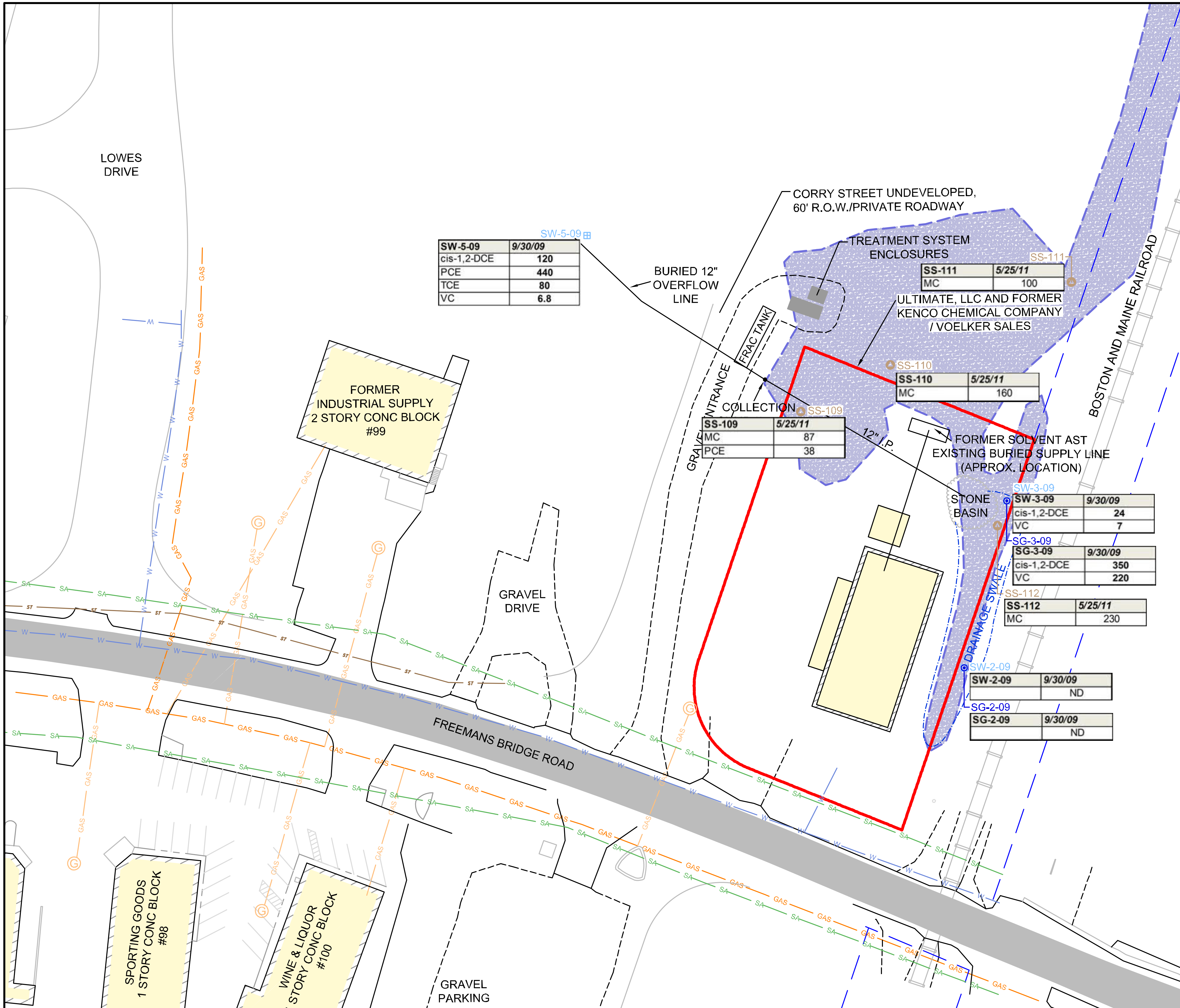

SW-5-09	9/30/09
cis-1,2-DCE	**120**
PCE	**440**
TCE	**80**
VC	**6.8**

SS-111	5/25/11
MC	100

SS-110	5/25/11
MC	160

SS-109	5/25/11
MC	87
PCE	38

SW-3-09	9/30/09
cis-1,2-DCE	**24**
VC	**7**

SG-3-09	9/30/09
cis-1,2-DCE	**350**
VC	**220**

SS-112	5/25/11
MC	230

SW-2-09	9/30/09
	ND

SG-2-09	9/30/09
	ND

LEGEND

- SURFACE WATER SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION
- SURFACE WATER / SEDIMENT SAMPLE LOCATION
- "WF-2" WETLAND BOUNDARY (APPROXIMATE)
- SITE BOUNDARY/PROPERTY BOUNDARY (APPROXIMATE)
- W — WATER LINE (APPROXIMATE)
- SA — SANITARY LINE (APPROXIMATE)
- ST — STORM SEWER LINE (APPROXIMATE)
- GAS — NATURAL GAS MAIN (APPROXIMATE)
- GAS — NATURAL GAS SERVICE (APPROXIMATE)

SERVICE LATERALS FOR WATER AND SEWER ARE NOT SHOWN.

NOTES

1. SITE FEATURES WERE GENERATED USING SURVEY DATA BY AECOM AND OTHERS, DESIGN DRAWINGS, AND AERIAL PHOTOGRAPHS. DRAWINGS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION ESTIMATION.
2. SURFACE WATER ANALYTICAL STANDARDS
   EXCEEDANCES SHOWN IN BOLD

	NYSAWQS Surface Water (µg/L)
cis-1,2-Dichloroethene	5
Tetrachloroethene	0.7
Trichloroethene	5
Vinyl Chloride	0.3

3. SEDIMENT ANALYTICAL STANDARDS
   EXCEEDANCES SHOWN IN BOLD

	Sediment Criteria	
	TOC-Normalized SGV (µg/g OC)	Freshwater SGV Class A (µg/Kg dw)
cis-1,2-Dichloroethene (DCE)	39.8	800.00
Methylene Chloride (MC)	NL	NL
Tetrachloroethene (PCE)	814.1	16,000
Vinyl Chloride (VC)	27.75	560.00

0 30 60 120
SCALE IN FEET

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FIGURE 5-2
SURFACE WATER AND SEDIMENT ANALYTICAL RESULTS (OU2)

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

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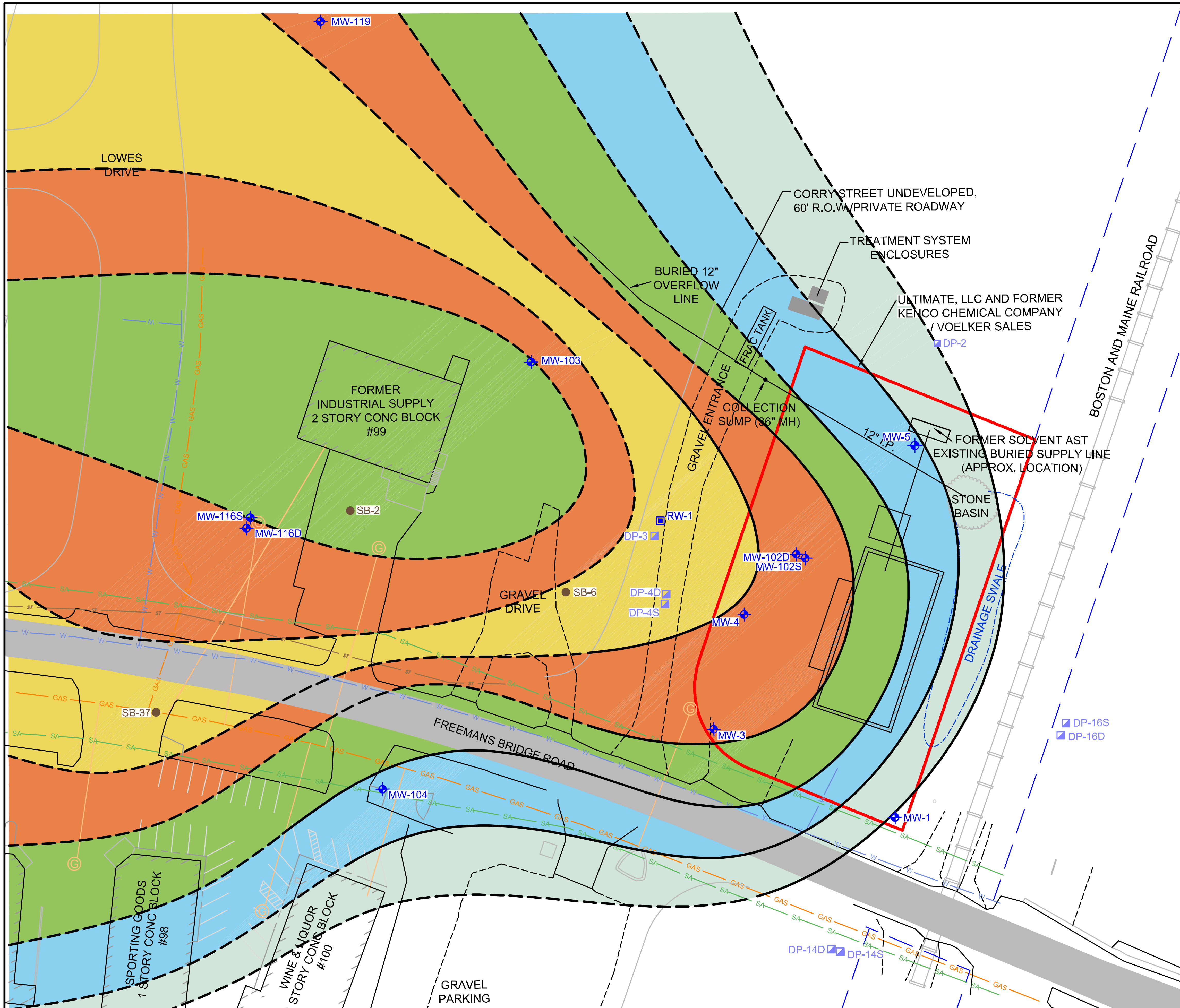

N

LEGEND

- MONITORING WELL LOCATION (SURVEYED 2013)
- DIRECT PUSH LOCATION (SURVEYED 2013)
- SOIL BORING LOCATION (SURVEYED 2013)
- TOTAL CVOC ISOCONCENTRATION CONTOUR (DASHED WHERE INFERRED)
- TOTAL CVOC CONCENTRATION 5 µg\L TO 10 µg\L
- TOTAL CVOC CONCENTRATION 10 µg\L TO 100 µg\L
- TOTAL CVOC CONCENTRATION 100 µg\L TO 1,000 µg\L
- TOTAL CVOC CONCENTRATION 1,000 µg\L TO 10,000 µg\L
- TOTAL CVOC CONCENTRATION >10,000 µg\L
- PROPERTY BOUNDARY (APPROXIMATE)
- W — WATER LINE (APPROXIMATE)
- SA — SANITARY LINE (APPROXIMATE)
- ST — STORM SEWER LINE (APPROXIMATE)
- GAS — NATURAL GAS MAIN (APPROXIMATE)
- GAS — NATURAL GAS SERVICE (APPROXIMATE)

SERVICE LATERALS FOR WATER AND SEWER ARE NOT SHOWN.

NOTES

1. THE ISOCONCENTRATION CONTOURS ARE BASED ON DATA COLLECTED DURING THE RI, ALONG WITH HISTORICAL DATA COLLECTED BY OTHERS. SOIL BORINGS SB-6 AND SB-37 DEPICT LOCATIONS WHERE 'GRAB' GROUNDWATER SAMPLES WERE USED IN CONTOURING.
2. ALL HISTORICAL LOCATIONS ARE APPROXIMATE.
3. SITE FEATURES WERE GENERATED USING SURVEY DATA BY AECOM AND OTHERS, DESIGN DRAWINGS, AND AERIAL PHOTOGRAPHS. DRAWINGS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION ESTIMATION.

0 30 60 120

SCALE IN FEET

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FIGURE 5-3
TOTAL CVOC ISOCONCENTRATION CONTOUR MAP
SHALLOW WATER BEARING ZONE
(OU2)

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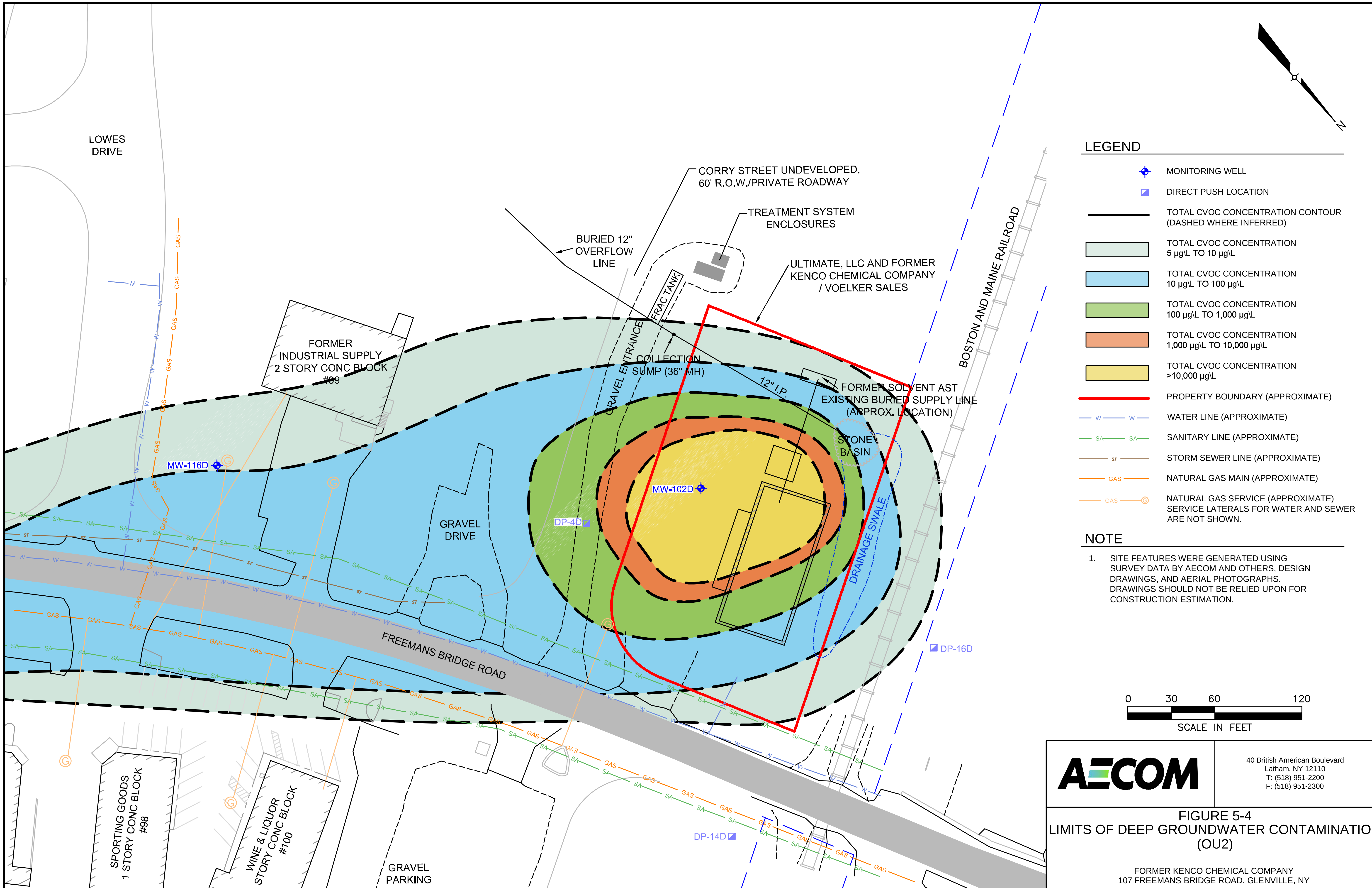

NOTE

1. SITE FEATURES WERE GENERATED USING SURVEY DATA BY AECOM AND OTHERS, DESIGN DRAWINGS, AND AERIAL PHOTOGRAPHS. DRAWINGS SHOULD NOT BE RELIED UPON FOR CONSTRUCTION ESTIMATION.

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FIGURE 5-4
LIMITS OF DEEP GROUNDWATER CONTAMINATION (OU2)

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

FEBRUARY 2015

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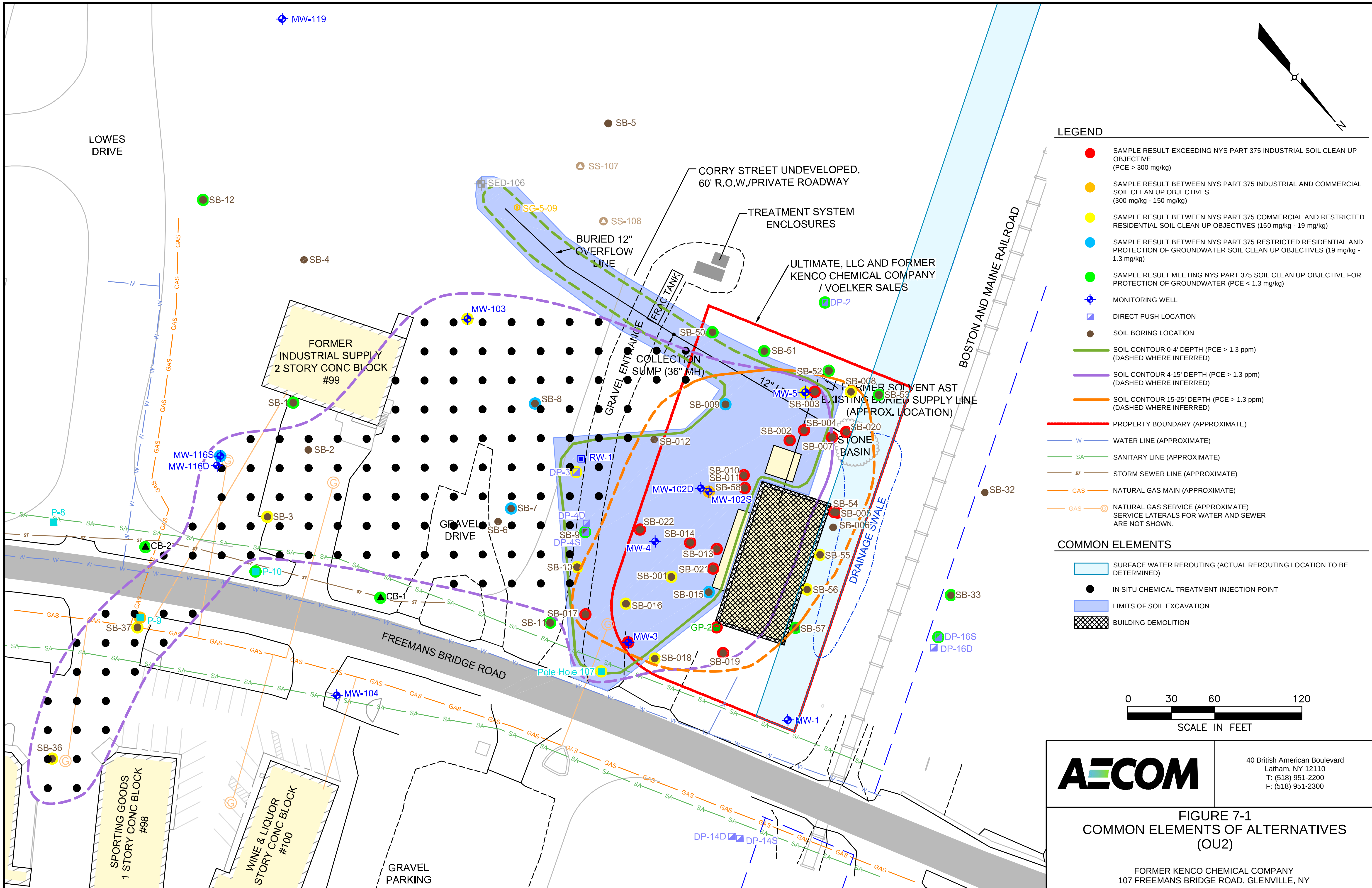

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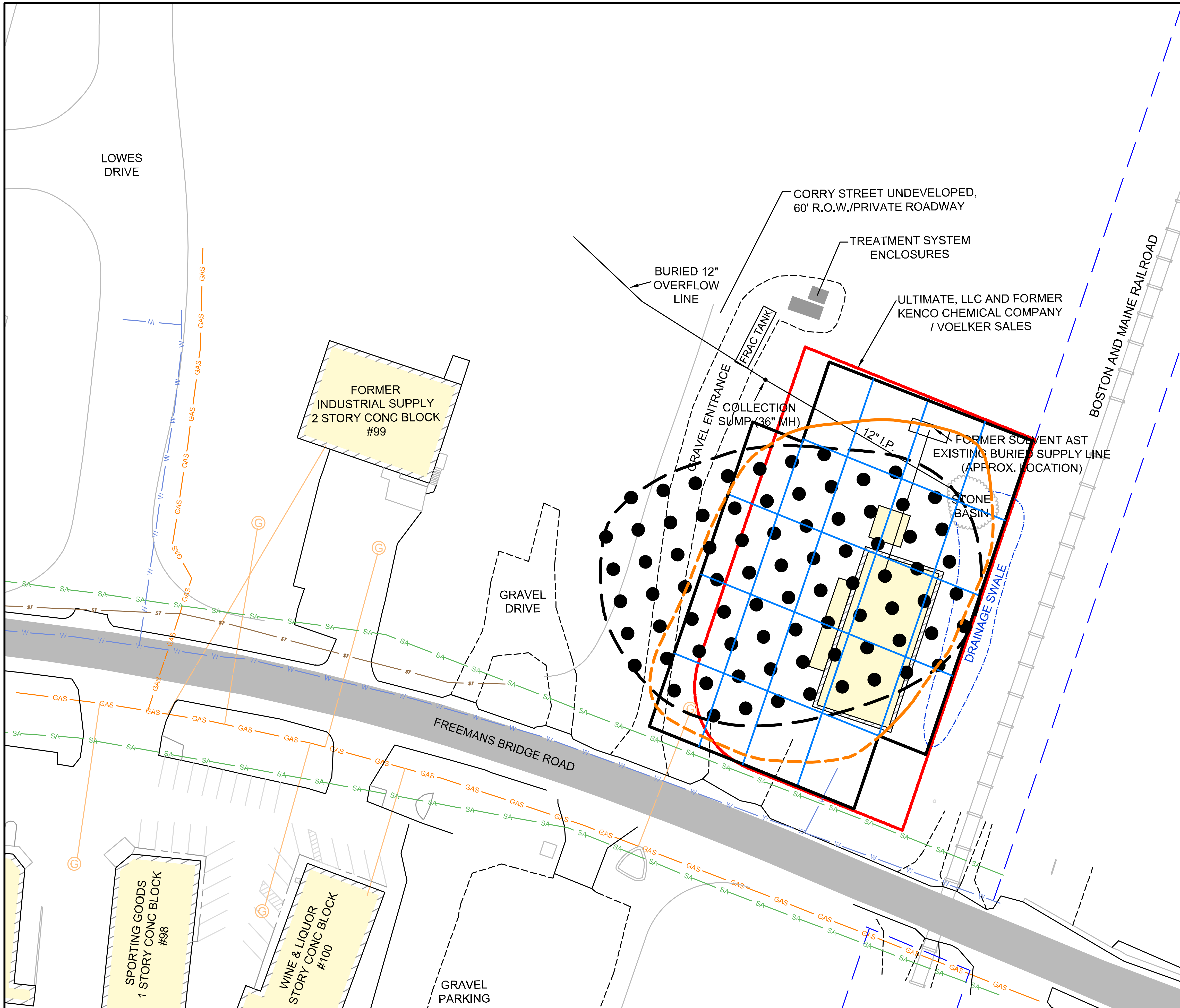

LEGEND

- LIMITS OF EXCAVATION
- TOTAL CVOC CONCENTRATION > 100 µg/L
- SHORING
- SOIL CONTOUR 15-25' DEPTH (PCE > 1.3 ppm) (DASHED WHERE INFERRED)
- PROPERTY BOUNDARY (APPROXIMATE)
- W — WATER LINE (APPROXIMATE)
- SA — SANITARY LINE (APPROXIMATE)
- ST — STORM SEWER LINE (APPROXIMATE)
- GAS — NATURAL GAS MAIN (APPROXIMATE)
- GAS — NATURAL GAS SERVICE (APPROXIMATE) SERVICE LATERALS FOR WATER AND SEWER ARE NOT SHOWN.
- IN SITU CHEMICAL TREATMENT INJECTION POINT (25-40')

0 30 60 120

SCALE IN FEET

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FIGURE 7-2
ALTERNATIVES 2 AND 3 - EXCAVATION (2-25') AND ISCO (25-40') (OU2)

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

FEBRUARY 2015

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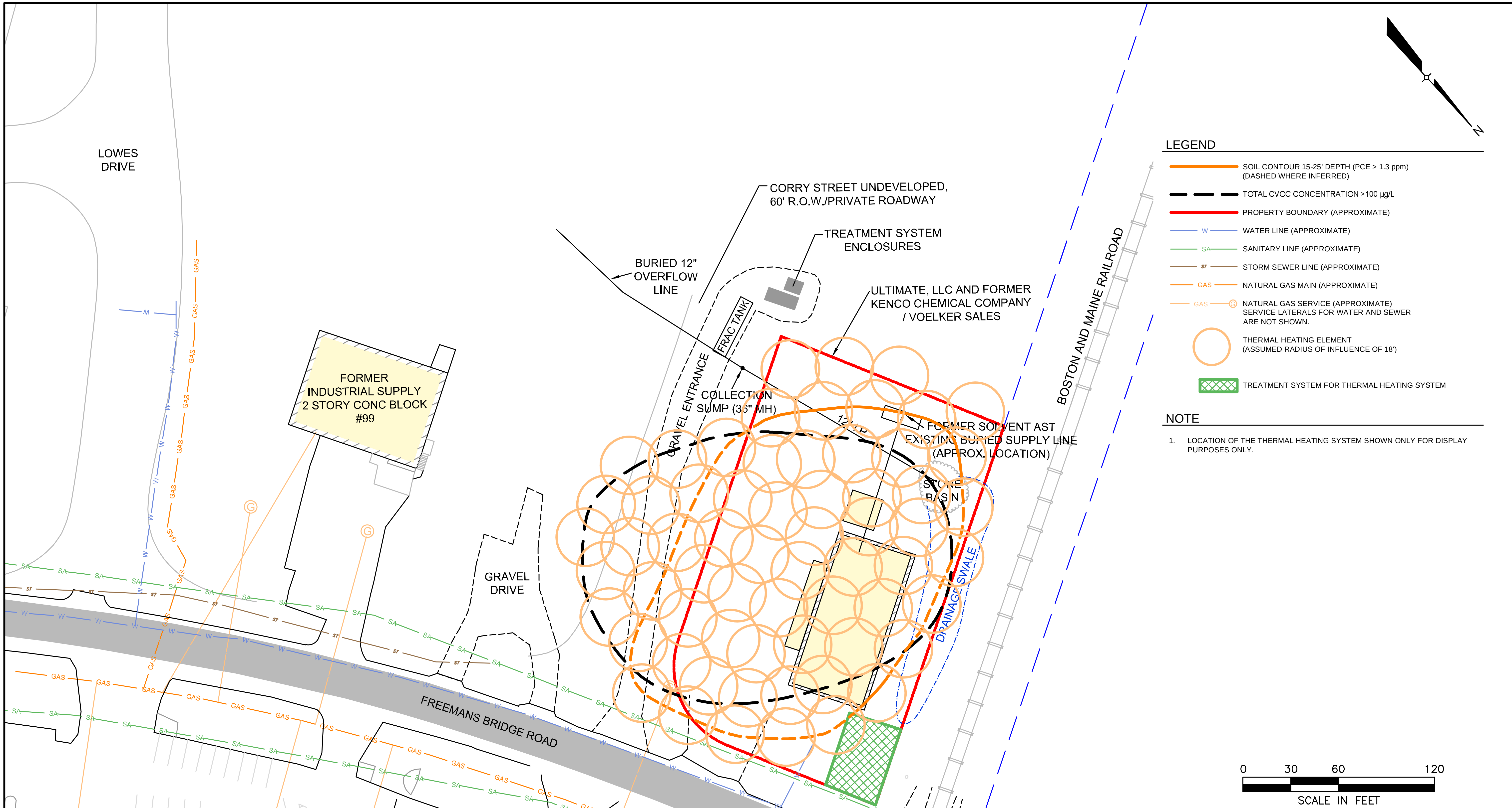

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FIGURE 7-3
ALTERNATIVE 4 - THERMAL TREATMENT (2-40')
(OU2)

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

FEBRUARY 2015 60272656.2.2

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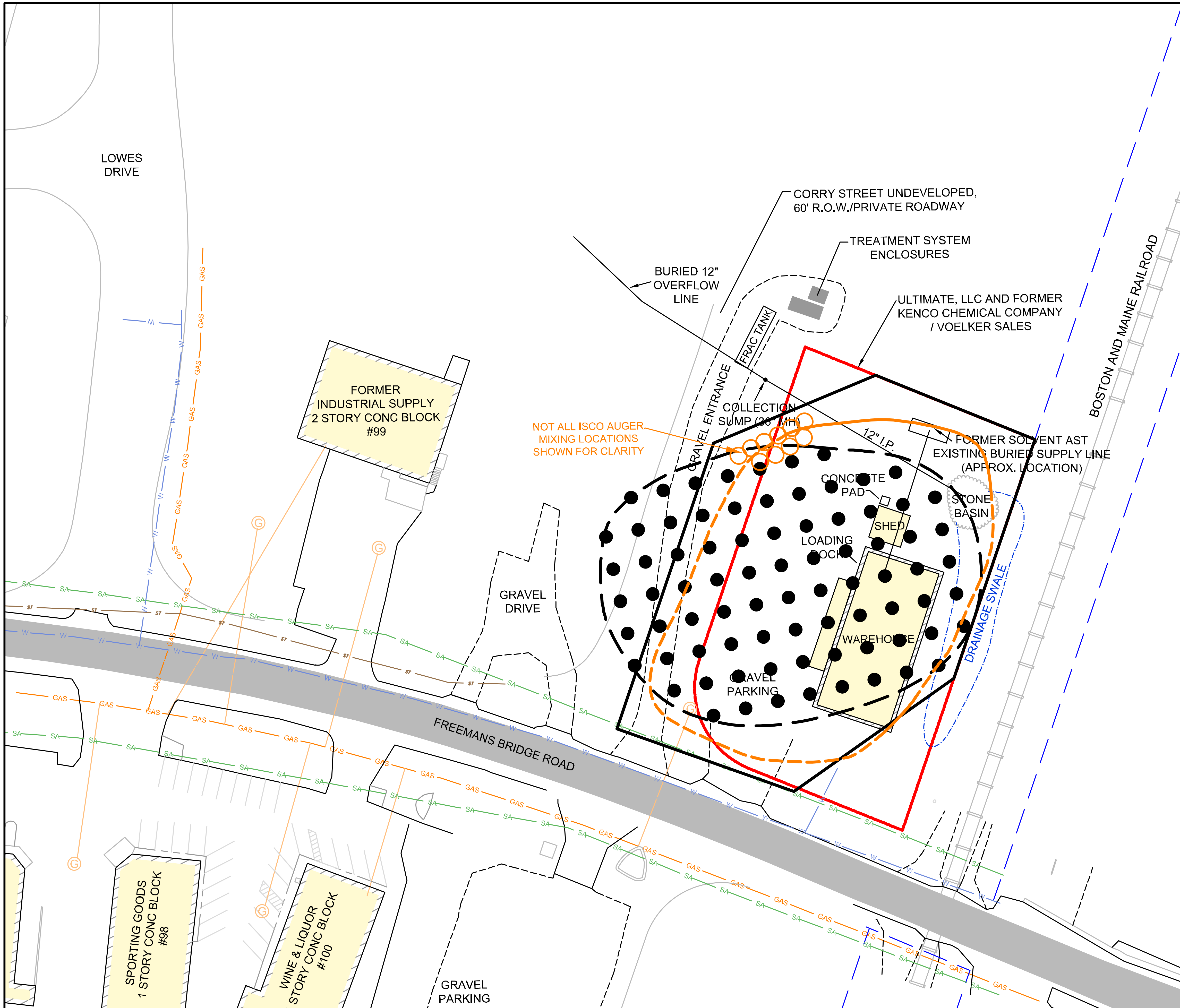

LEGEND

- SOIL CONTOUR 15-25' DEPTH (PCE > 1.3 ppm) (DASHED WHERE INFERRED)
- DEEP GROUNDWATER TOTAL CVOC CONCENTRATION >100 µg/L
- PROPERTY BOUNDARY (APPROXIMATE)
- WATER LINE (APPROXIMATE)
- SANITARY LINE (APPROXIMATE)
- STORM SEWER LINE (APPROXIMATE)
- NATURAL GAS MAIN (APPROXIMATE)
- NATURAL GAS SERVICE (APPROXIMATE) SERVICE LATERALS FOR WATER AND SEWER ARE NOT SHOWN.
- IN SITU CHEMICAL TREATMENT MIXING POINT (ASSUMED 10' AUGER)
- IN SITU CHEMICAL TREATMENT INJECTION POINT (25-40')

NOTES

1. IN SITU CHEMICAL TREATMENT AUGERING WILL BE FROM 2-25' (TOP OF CONFINING LAYER)
2. IN SITU CHEMICAL TREATMENT INJECTION WILL BE FROM 25-40'
3. NOT ALL IN SITU CHEMICAL TREATMENT AUGERING INJECTION POINTS NOT SHOWN FOR CLARITY

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FIGURE 7-4
ALTERNATIVE 5 - IN SITU CHEMICAL OXIDATION/REDUCTION (2-40') (OU2)
FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

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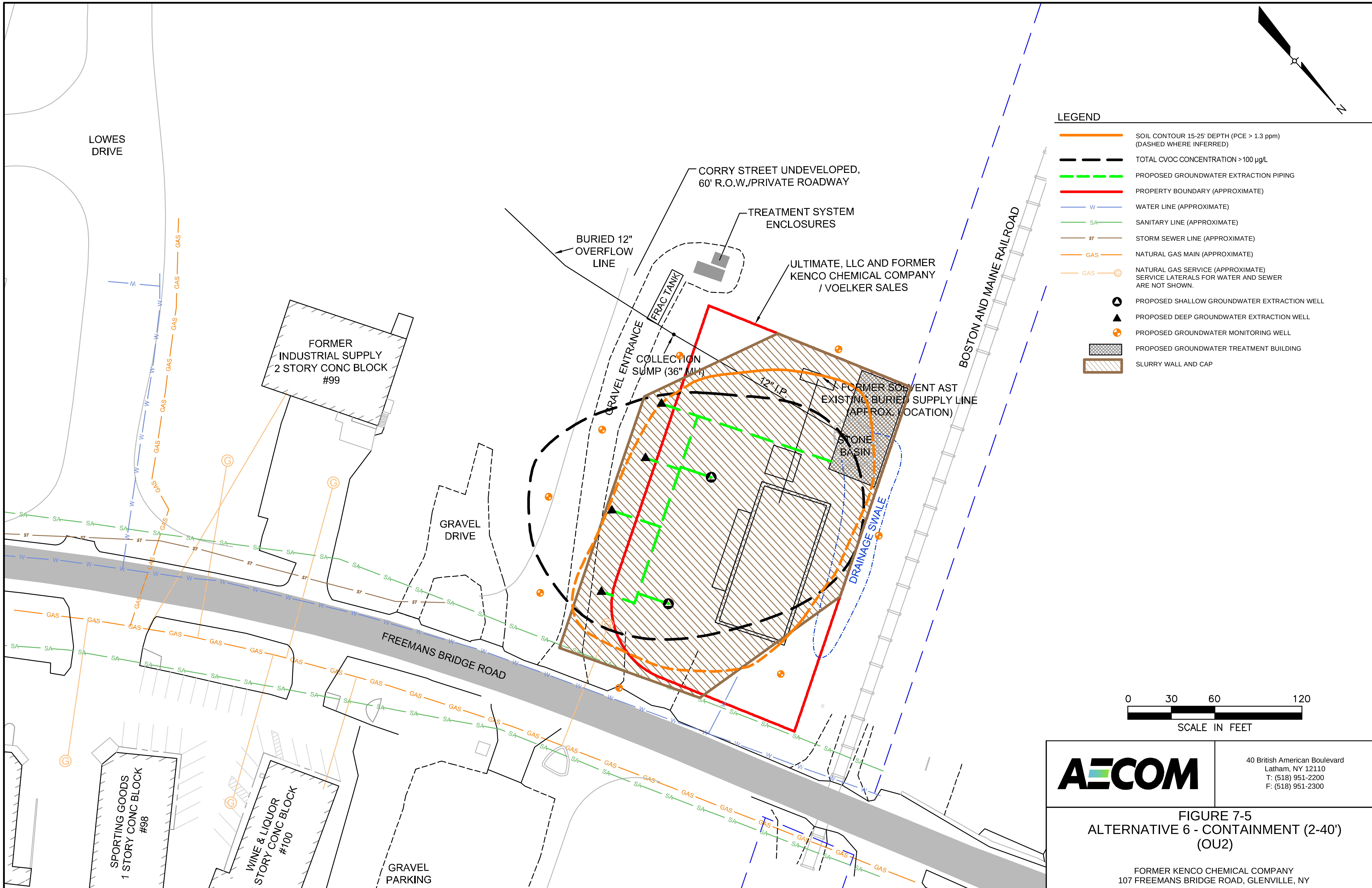

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FIGURE 7-5
ALTERNATIVE 6 - CONTAINMENT (2-40')
(OU2)

FORMER KENCO CHEMICAL COMPANY
107 FREEMANS BRIDGE ROAD, GLENVILLE, NY

FEBRUARY 2015 60272656.2.2

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Appendix A

Mass and Volume Estimates

Table A-1
Soil Mass and Volume Estimate (0-25')
Former Kenco Chemical Company

Zone	Area (sq ft)[1]	Avg PCE Concentration (mg/kg)	Soil Thickness (ft)	Soil Volume (CY)	PCE Mass[2] (kg)	PCE Mass (lbs)	PCE Volume (Gallons)[3]
0-2'	31,100	10	2	2,300	30	70	5
2-4'	31,100	100	2	2,300	310	680	50
4-5' Hot Spot	4,000	25,000	1	150	5,000	11,020	820
4-15'	31,500	100	11	12,830	1,730	3,810	280
15-19'	31,500	100	4	4,670	630	1,390	100
19-20'	31,500	30,000	1	1,170	47,250	104,170	7,730
20-25'	31,500	100	5	5,830	790	1,740	130
On-Site Subtotal				**29,250**	**55,740**	**122,880**	**9,115**
4-15' Off-Site	60,000	25	11	24,440	830	1,830	140
Off-Site Subtotal				**24,440**	**830**	**1,830**	**140**
Total				**53,690**	**56,570**	**124,710**	**9,255**

Notes:

[1] Areas based on PCE concentration exceeding NYSDEC Unrestricted Soil Cleanup Objective 1.3 mg/kg (Figures 5-1 through 5-3)

[2] Assumes density of soil is 110 lbs/ft^3 (50 kg/ft^3)

[3] Assumes density of PCE is 1.62 g/cm^3

Table A-2
Removal Mass and Volume Calculations (0-25')
Former Kenco Chemical Company

Zone	Area (sq ft)[1]	Avg Conc (mg/kg)	Soil Depth (ft)	Volume (CY)[1]	PCE Mass[2] (kg)	PCE Mass (lbs)	PCE Volume (Gallons)[3]
On-Site Contamination							
2-4'	38,000	100	2	2,810	310	680	50
4-5' Hot Spot	4,000	25,000	1	150	5,000	11,020	820
4-15'	38,000	100	11	15,480	1,730	3,810	280
15-19'	38,000	100	4	5,630	630	1,390	100
19-20'	38,000	30,000	1	1,410	47,250	104,170	7,730
20-25'	38,000	100	5	7,040	790	1,740	130
On-Site Subtotal				**32,520**	**55,710**	**122,810**	**9,110**
Total				**32,520**	**55,710**	**122,810**	**9,110**

Notes and Assumptions:

[1] Area and volume based on preliminary excavation shoring design

[2] PCE mass based on Table A-1

[3] Assumes density of PCE is 1.62 g/cm^3

Table A-3
In-Situ Treatment (Thermal and Chemical) Mass and Volume Calculation (2-25')
Former Kenco Chemical Company

Zone	Area (sq ft)[1]	Avg Conc (mg/kg)	Soil Thickness (ft)	Volume (CY)[1]	PCE Mass[2] (kg)	PCE Mass (lbs)	PCE Volume (Gallons)[3]
On-Site Contamination							
2-4'	38,000	100	2	2,810	310	680	50
4-5' Hot Spot	4,000	25,000	1	150	5,000	11,020	820
4-15'	38,000	100	11	15,480	1,730	3,810	280
15-19'	38,000	100	4	5,630	630	1,390	100
19-20'	38,000	30,000	1	1,410	47,250	104,170	7,730
20-25'	38,000	25	5	7,040	790	1,740	130
On-Site Subtotal				**32,520**	**55,710**	**122,810**	**9,110**
Total				**32,520**	**55,710**	**122,810**	**9,110**

Notes and Assumptions:

[1] Volume of contaminated soil treated, the use of soil mixing to implement remedy would require non-impacted soils to be treated increasing total treatment volume

Table A-4
Containment Mass and Volume Calculations (2-25')
Former Kenco Chemical Company

Zone	Area (sq ft)[1]	Avg Conc (mg/kg)	Soil Thickness (ft)	Volume (CY)[3]	PCE Mass[2] (kg)	PCE Mass (lbs)	PCE Volume (Gallons)[4]
On-Site Contamination							
2-4'	34,000	100	2	2,520	310	680	50
4-5' Hot Spot	4,000	25,000	1	150	5,000	11,020	820
4-15'	38,000	100	11	15,480	1,730	3,810	280
15-19'	38,000	100	4	5,630	630	1,390	100
19-20'	38,000	30,000	1	1,410	47,250	104,170	7,730
20-25'	38,000	100	5	7,040	790	1,740	130
On-Site Subtotal				**32,230**	**55,710**	**122,810**	**9,110**
Total				**32,230**	**55,710**	**122,810**	9,110

Notes and Assumptions:

[1] Area and volume based on conceptual containment layout

[2] PCE mass based on Table A-1

[3] Volume of contaminated soil treated, the use of soil mixing to implement remedy would require non-impacted soils to be treated increasing total treatment volume

[4] Assumes density of PCE is 1.62 g/cm^3

Table A-5
Deep Groundwater Mass Estimate Calculations (25-40')
Former Kenco Chemical Company

	Area (sq ft)	Avg Conc (µg/L)	GW Depth (ft)	Porosity	PCE Mass (kg)	PCE Mass (lbs)	PCE Volume (Gallons)[1]
>5ug/L Total CVOCs	54,000	8	15	0.3	0.1	0.1	0.01
>10ug/L Total CVOCs	85,500	50	15	0.3	0.5	1.2	0.1
>100ug/L Total CVOCs	15,000	500	15	0.3	1.0	2.1	0.2
>1,000ug/L Total CVOCs	5,500	5,000	15	0.3	3.5	7.7	0.6
>10,000ug/L Total CVOCs	11,000	10,000	15	0.3	14	31	2.3
Total	**171,000**				**19.1**	**42.0**	**3.1**

Notes and Assumptions:

[1] Assumes density of PCE is 1.62 g/cm^3

Table A-6
Deep Groundwater Containment Mass Estimate Calculations (25-40')
Former Kenco Chemical Company

	Area (sq ft)	Avg Conc (µg/L)	GW Depth (ft)	Porosity	PCE Mass (kg)	PCE Mass (lbs)	PCE Volume (Gallons)[1]
>5ug/L Total CVOCs	14,000	8	15	0.3	0.01	0.03	0.002
>10ug/L Total CVOCs	12,000	50	15	0.3	0.1	0.2	0.0
>100ug/L Total CVOCs	7,000	500	15	0.3	0.4	1.0	0.1
>1,000ug/L Total CVOCs	4,000	5,000	15	0.3	2.5	5.6	0.4
>10,000ug/L Total CVOCs	10,000	10,000	15	0.3	13	28	2.1
Total	**47,000**				**15.8**	**34.9**	**2.6**

Notes and Assumptions:

[1] Assumes density of PCE is 1.62 g/cm^3

Table A-7
Deep Groundwater Targeted ISCO Mass Estimate (25-40')
Former Kenco Chemical Company

	Area (sq ft)	Avg Conc (µg/L)	GW Depth (ft)	Porosity	PCE Mass (kg)	PCE Mass (lbs)	PCE Volume (Gallons)[1]
>5ug/L Total CVOCs	0	8	15	0.3	0	0.0	0.000
>10ug/L Total CVOCs	0	50	15	0.3	0.0	0.0	0.0
>100ug/L Total CVOCs	15,000	500	15	0.3	1.0	2.1	0.2
>1,000ug/L Total CVOCs	5,500	5,000	15	0.3	3.5	7.7	0.6
>10,000ug/L Total CVOCs	11,000	10,000	15	0.3	14	31	2.3
Total	**31,500**				**18.5**	**40.7**	**3.0**

Notes and Assumptions:
[1] Assumes density of PCE is 1.62 g/cm^3

Appendix B

Remedial Alternative Cost Estimates

Kenco Feasibility Study Cost Estimate
Remedial Alternatives Cost Estimate Summary

	Alternative	Capital	Annual OM&M	Total Years OM&M	O&M Present Worth	Total Present Worth
1	Alt 1 - No Action	$0	$0	30	$0	$0
2	Alt 2 - Excavation Off-Site Disposal (2-25'); In Situ Chemical Treatment (25-40')	$22,884,000	$61,000	30	$640,000	$23,524,000
3	Alt 3 - Excavation On-Site Treatment (2-25'); In Situ Chemical Treatment (25-40')	$13,246,000	$61,000	30	$640,000	$13,886,000
4	Alt 4 - Thermal Treatment (2-40')	$13,826,000	$41,000	5	$178,000	$14,004,000
5	Alt 5 - In Situ Chemical Treatment (2-40')	$10,215,000	$61,000	30	$640,000	$10,855,000
6	Alt 6 - Containment (2-40')	$2,952,400	$166,000	30	$2,553,000	$5,505,400

Note: 1) Cost estimates shown above (excluding No Action) include the following common elements costs: Surface Water Rerouting; Building Demolition; Excavation 0-2'.

2) Cost estimates shown above DO NOT include the In Situ Chemical Oxidation common element.

CE1	Common Element In Situ Chemical Treatment	$6,267,000	$48,000	5	$208,000	$6,475,000
CE2	Common Element Surface Water Rerouting	$128,000	$0	0	$0	$128,000
CE3	Common Element Building Demolition	$250,000	$0	0	$0	$250,000
CE4	Common Element Excavation (0-2')	$496,000	$0	0	$0	$496,000

Kenco Feasibility Study Cost Estimate
Common Element In-Situ Chemical Treatment

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Injection Well Installation				$300,000
Project Manager	75	HR	$150.00	$11,250
Project Scientist	150	HR	$100.00	$15,000
Mobilize/Demobilize Drilling Rig	1	LS	$2,985.00	$2,985
Organic Vapor Analyzer Rental	75	DAY	$42.71	$3,203
Field Technician	750	HR	$60.00	$45,000
4.25" HSA <50 feet	2,250	LF	$25.00	$56,250
2" PVC, Schedule 40, Well Materials	2,250	LF	$15.00	$33,750
2" PVC, Schedule 40, Well Screen	1,500	LF	$15.00	$22,500
DOT steel drums, 55 gal.	40	EA	$60.00	$2,400
2" Screen, Filter Pack	1,500	LF	$10.00	$15,000
Surface Pad, Concrete, 2' x 2' x 4"	150	EA	$325.00	$48,750
2" Well, Portland Cement Grout	750	LF	$50.00	$37,500
2" Well, Bentonite Seal	150	EA	$10.00	$1,500
Soil Disposal (per drum)	40	EA	$100.00	$4,000
Chemical Injections				$3,640,000
Project Engineer	375	HR	$110.00	$41,250
Field Technician	7,500	HR	$60.00	$450,000
Chemical Storage Tank	300	DAY	$100.00	$30,000
40% Sodium Permanganate	1,238,294	LBS	$2.50	$3,095,734
Truck Rental	188	DAY	$100.00	$18,750
Chemical Injection Pumps	2	EA	$2,000.00	$4,000
Security Fence	1	LS	$2,500.00	$2,500
Soil Sampling				$348,000
Project Manager	43	HR	$150.00	$6,375
Project Scientist	425	HR	$100.00	$42,500
Project Engineer	160	HR	$110.00	$17,600
Disposable Materials per Sample	1,675	EA	$10.33	$17,303
Analytical (VOCs)	1,675	EA	$80.00	$134,000
4.25" HSA <50 feet	3,350	LF	$25.00	$83,750
Split Spoon Samples	1,675	EA	$25.00	$41,875
55 Gallon Drums	24	EA	$60.00	$1,440
Soil Disposal (per drum)	24	EA	$100.00	$2,400
Groundwater Sampling (Yearly Cost)				$48,000
Project Manager	20	HR	$150.00	$3,000
Project Scientist	200	HR	$100.00	$20,000
Project Engineer	100	HR	$110.00	$11,000
Disposable Materials per Sample	30	EA	$10.33	$310
Analytical (VOCs)	30	EA	$80.00	$2,400
Contingency (30%)	1	LS	$11,012.97	$11,013
Design (15% Capital)				$644,000
Contingency (30% Capital)				$1,287,000
Total Capital				$6,267,000
Present Value OM&M Costs (assume 5 years of GW Sampling and a 5% discount rate)				$208,000
Total Capital and Present Value Costs for In Situ Chemical Oxidation/Reduction common elemer				$6,475,000

Kenco Feasibility Study Cost Estimate
Common Element Surface Water Rerouting

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Clearing & Grubbing				$3,000
Selective clearing	0.23	ACR	$251.27	$58
Site clearing trees	20	EA	$12.70	$254
Grub stumps	20	EA	$9.02	$180
Dump Charges	4	EA	$15.00	$60
910, 1.25 CY, Wheel Loader	8	HR	$105.13	$841
8 CY, Dump Truck	8	HR	$113.81	$910
Excavation & Backfilling				$84,000
12 CY Dump Truck Haul/Hour	20	HR	$166.93	$3,339
Excavate and load	741	BCY	$2.76	$2,044
Unclassified Fill, 6" Lifts	370	CY	$44.24	$16,385
Seeding, Vegetative Cover	0.23	ACR	$6,010.00	$1,380
Project Manager	12	HR	$150.00	$1,800
Project Scientist	50	HR	$100.00	$5,000
Project Engineer	20	HR	$110.00	$2,200
Word Processing/Clerical	10	HR	$50.00	$500
Draftsman/CADD	10	HR	$80.00	$800
Disposable Materials per Sample	1	EA	$10.33	$10
Disposal Sampling Analytical	1	EA	$550.00	$550
Waste Disposal	1,100	TON	$30.00	$33,000
Waste Disposal Transport (Truck)	1,100	TON	$15.00	$16,500
Disposable Materials per Sample	12	EA	$10.33	$124
Confirmatory Sampling (VOCs)	12	EA	$80.00	$960
Design (15% Capital)				$14,000
Contingency (30% Capital)				$27,000
Total Capital				$128,000
Present Value OM&M Costs				$0
Total Capital and Present Value Costs for Excavation common element				$128,000

Kenco Feasibility Study Cost Estimate
Common Element Building Demolition

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Building Demolition and Reconstruction				$172,000
Remove Asbestos - Ceilings	7,400	SF	$2.75	$20,350
Remove Asbestos - Beams/Columns	7,400	SF	$3.50	$25,900
Construct Abatement Work Area	7,400	SF	$4.00	$29,600
Asbestos Abatement Equipment	100	EA	$40.00	$4,000
Asbestos Waste Disposal	100	CY	$150.00	$15,000
Building Demolition	63,000	CF	$0.30	$18,900
Dump Charges	2,136	EA	$25.00	$53,400
988, 7.0 CY, Wheel Loader	7	HR	$200.00	$1,400
35 Ton, 769, Off-highway Truck	14	HR	$200.00	$2,800
Design (15% Capital)				$26,000
Contingency (30% Capital)				$52,000
Total Capital for Building Demolition				$250,000
Present Value OM&M Costs (no O&M costs)				$0
Total Capital and Present Value Costs for Building Demolition common element				$250,000

Kenco Feasibility Study Cost Estimate
Common Element Excavation (0-2')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Clearing & Grubbing				$11,000
Selective clearing	0.73	ACR	$251.27	$185
Site clearing trees	100	EA	$12.70	$1,270
Grub stumps	100	EA	$9.02	$902
Dump Charges	295	EA	$15.00	$4,425
910, 1.25 CY, Wheel Loader	7	HR	$105.13	$736
8 CY, Dump Truck	22	HR	$113.81	$2,504
Excavation & Backfilling				$330,000
12 CY Dump Truck Haul/Hour	40	HR	$166.93	$6,677
Excavate and load	2,370	BCY	$2.76	$6,542
Unclassified Fill, 6" Lifts	2,963	CY	$44.24	$131,081
Seeding, Vegetative Cover	1	ACR	$6,010.00	$4,415
Project Manager	60	HR	$150.00	$9,000
Project Scientist	60	HR	$100.00	$6,000
Project Engineer	30	HR	$110.00	$3,300
Word Processing/Clerical	20	HR	$50.00	$1,000
Draftsman/CADD	20	HR	$80.00	$1,600
Disposable Materials per Sample	2	EA	$10.33	$21
Disposal Sampling Analytical	2	EA	$550.00	$1,100
Waste Disposal	3,520	TON	$30.00	$105,600
Waste Disposal Transport (Truck)	3,520	TON	$15.00	$52,800
Disposable Materials per Sample	36	EA	$10.33	$372
Confirmatory Sampling (VOCs)	36	EA	$80.00	$2,880
Design (15% Capital)				$52,000
Contingency (30% Capital)				$103,000
Total Capital				$496,000
Present Value OM&M Costs				$0
Total Capital and Present Value Costs for Excavation common element				$496,000

Kenco Feasibility Study Cost Estimate
Alternatives 2, 3, 5 – Targeted In Situ Chemical Treatment (25-40')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Monitoring Well Installation				$81,000
Project Manager	16	HR	$150.00	$2,400
Project Scientist	32	HR	$100.00	$3,200
Mobilize/Demobilize Drilling Rig	1	LS	$2,985.00	$2,985
Organic Vapor Analyzer Rental	16	DAY	$42.71	$683
Field Technician	160	HR	$60.00	$9,600
4.25" HSA <50 feet	640	LF	$25.00	$16,000
2" PVC, Schedule 40, Well Materials	640	LF	$15.00	$9,600
2" PVC, Schedule 40, Well Screen	240	LF	$15.00	$3,600
DOT steel drums, 55 gal.	12	EA	$60.00	$720
2" Screen, Filter Pack	240	LF	$10.00	$2,400
Surface Pad, Concrete, 2' x 2' x 4"	16	EA	$325.00	$5,200
2" Well, Portland Cement Grout	400	LF	$50.00	$20,000
2" Well, Bentonite Seal	16	EA	$10.00	$160
Soil Disposal (per drum)	12	EA	$100.00	$1,200
Survey Well Locations	1	LS	$2,500.00	$2,500
Chemical Injections				$709,000
Project Engineer	40	HR	$110.00	$4,345
Field Technician	790	HR	$60.00	$47,400
Direct Push Rig Mob	1	LS	$2,000.00	$2,000
Direct Push Rig	20	DAY	$2,000.00	$39,500
Chemical Storage Tank	300	DAY	$100.00	$30,000
40% Sodium Permanganate	231,836	LBS	$2.50	$579,591
Truck Rental	20	DAY	$100.00	$1,975
Chemical Injection Pumps	2	EA	$2,000.00	$4,000
Security Fence	1	LS	$2,500.00	$2,500
Groundwater Sampling (Yearly Cost)				$34,000
Project Manager	10	HR	$150.00	$1,500
Project Scientist	120	HR	$100.00	$12,000
Project Engineer	100	HR	$110.00	$11,000
Disposable Materials per Sample	16	EA	$10.33	$165
Analytical (VOCs)	16	EA	$80.00	$1,280
Contingency (30%)	1	LS	$7,783.58	$7,784
Design (15% Capital)				$119,000
Contingency (30% Capital)				$237,000
Total Capital/Year 1 Costs				$1,180,000
Present Value OM&M Costs (assume 30 years of GW Sampling with a 5% discount rate)				$523,000
Total Capital and Present Value Costs for Targeted In Situ Chemical Treatment 25-40'				$1,703,000

Kenco Feasibility Study Cost Estimate
Alternative 2 – Excavation With Off-site Disposal (2-25')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Excavation and Backfilling				$13,983,000
12 CY Dump Truck Haul/Hour	1,180	HR	$166.93	$196,977
Excavate and load	32,370	CY	$2.76	$89,342
Backfill (delivery and placement)	40,463	CY	$44.24	$1,790,081
Steel Sheeting	110,000	SF	$13.92	$1,531,200
Trash Pump, 75 GPM	118	DAY	$46.81	$5,524
Seeding, Vegetative Cover	1	ACR	$6,010.00	$5,243
Project Manager	100	HR	$150.00	$15,000
Project Scientist	150	HR	$100.00	$15,000
Project Engineer	1,180	HR	$110.00	$129,800
Word Processing/Clerical	20	HR	$50.00	$1,000
Draftsman/CADD	20	HR	$80.00	$1,600
Disposable Materials per Sample	25	EA	$10.33	$258
Disposal Sampling (Analytical)	25	EA	$550.00	$13,750
Disposable Materials per Sample	43	EA	$10.33	$444
Confirmatory Sampling (VOCs)	43	EA	$80.00	$3,440
Temporary Fabric Structure Rental	1	LS	$450,000.00	$450,000
Soil Treatment/Disposal Facility NonHaz	26,439	Ton	$30.00	$793,155
Waste Disposal Transport (Truck) NonHaz	26,439	Ton	$15.00	$396,578
Soil Treatment/Disposal Facility Haz	21,632	Ton	$250.00	$5,407,875
Waste Disposal Transport (Truck) Haz	21,632	Ton	$145.00	$3,136,568
15 GPM Treatment System				$382,000
Project Manager	20	HR	$150.00	$3,000
Staff Engineer	100	HR	$110.00	$11,000
Metals Precipitation	1	LS	$290,063.19	$290,063
Media Filtration	1	LS	$26,593.28	$26,593
Carbon Adsorption (gas)	1	LS	$5,318.54	$5,319
Air Stripper	1	LS	$45,638.60	$45,639
Groundwater Sampling (Yearly Cost)				$27,000
Project Manager	20	HR	$150.00	$3,000
Project Scientist	60	HR	$100.00	$6,000
Project Engineer	100	HR	$110.00	$11,000
Disposable Materials per Sample	8	EA	$10.33	$83
Analytical (VOCs)	8	EA	$80.00	$640
Contingency (30%)	1	LS	$6,216.79	$6,217
Design (15% Capital)				$2,155,000
Contingency (30% Capital)				$4,310,000
Total Capital for Excavation with Off-site Disposal				$20,830,000
Present Value OM&M Costs (assume 5 years of GW Sampling with a 5% discount rate)				$117,000
Total Capital and Present Value Costs for Excavation (2-25') with Off-site Disposal				$20,947,000

Kenco Feasibility Study Cost Estimate
Alternative 3 – Excavation With On-site Treatment (2-25')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Excavation and Backfilling				$7,336,000
Steel Sheeting	110,000	SF	$13.92	$1,531,200
Trash Pump, 75 GPM	337	DAY	$46.81	$15,775
Seeding, Vegetative Cover	1	ACR	$6,010.00	$5,243
Project Manager	100	HR	$150.00	$15,000
Project Scientist	150	HR	$100.00	$15,000
Project Engineer	3,370	HR	$110.00	$370,700
Word Processing/Clerical	20	HR	$50.00	$1,000
Draftsman/CADD	20	HR	$80.00	$1,600
Disposable Materials per Sample	25	EA	$10.33	$258
Post Treatment Sampling (VOCs)	25	EA	$80.00	$2,000
Disposable Materials per Sample	1	EA	$10.33	$10
Confirmatory Sampling (VOCs)	900	EA	$80.00	$72,000
Temporary Fabric Structure Rental	1	LS	$450,000.00	$450,000
On-Site Soil Treatment	32,370	CY	$150.00	$4,855,556
15 GPM Treatment System				$382,000
Project Manager	20	HR	$150.00	$3,000
Staff Engineer	100	HR	$110.00	$11,000
Metals Precipitation	1	LS	$290,063.19	$290,063
Media Filtration	1	LS	$26,593.28	$26,593
Carbon Adsorption (gas)	1	LS	$5,318.54	$5,319
Air Stripper	1	LS	$45,638.60	$45,639
Groundwater Sampling (Yearly Cost)				$27,000
Project Manager	20	HR	$150.00	$3,000
Project Scientist	60	HR	$100.00	$6,000
Project Engineer	100	HR	$110.00	$11,000
Disposable Materials per Sample	8	EA	$10.33	$83
Analytical (VOCs)	8	EA	$80.00	$640
Contingency (30%)	1	LS	$6,216.79	$6,217
Design (15% Capital)				$1,158,000
Contingency (30% Capital)				$2,316,000
Total Capital for Excavation with On-site Treatment				$11,192,000
Present Value OM&M Costs (assume 5 years of GW Sampling with a 5% discount rate)				$117,000
Total Capital and Present Value Costs for Excavation (2-25') with On-site Treatment				$11,309,000

Kenco Feasibility Study Cost Estimate
Alternative 4 – Thermal Treatment (2-25')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Thermal Treatment System				$6,973,000
Treatment Unit Vendor Estimate	1	LS	$5,500,000.00	$5,500,000
Utilities	1	LS	$1,400,000.00	$1,400,000
Project Manager	100	HR	$150.00	$15,000
Project Scientist	100	HR	$100.00	$10,000
Field Technician	800	HR	$60.00	$48,000
Soil Sampling				$103,000
Project Manager	11	HR	$150.00	$1,650
Project Scientist	110	HR	$100.00	$11,000
Project Engineer	160	HR	$110.00	$17,600
Disposable Materials per Sample	420	EA	$10.33	$4,339
Analytical (VOCs)	420	EA	$80.00	$33,600
4.25" HSA <50 feet	840	LF	$25.00	$21,000
Split Spoon Samples	420	EA	$25.00	$10,500
55 Gallon Drums	15	EA	$60.00	$900
Soil Disposal (per drum)	15	EA	$100.00	$1,500
Groundwater Sampling (Yearly Cost)				$27,000
Project Manager	20	HR	$150.00	$3,000
Project Scientist	60	HR	$100.00	$6,000
Project Engineer	100	HR	$110.00	$11,000
Disposable Materials per Sample	8	EA	$10.33	$83
Analytical (VOCs)	8	EA	$80.00	$640
Contingency (30%)	1	LS	$6,216.79	$6,217
Design (15% Capital)				$1,062,000
Contingency (30% Capital)				$2,123,000
Capital Costs Thermal Treatment				$10,261,000
Present Value OM&M Costs (assume 5 years of GW Sampling with a 5% discount rate)				$117,000
Total Capital and Present Value Costs for Thermal Treatment 2-25'				$10,378,000

Kenco Feasibility Study Cost Estimate
Alternative 4 – Thermal Treatment (25-40')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Thermal Treatment System				$1,855,000
Treatment Unit Vendor Estimate	1	LS	$4,000,000.00	$1,240,000
Utilities	1	LS	$1,500,000.00	$590,000
Project Manager	100	HR	$150.00	$15,000
Project Scientist	100	HR	$100.00	$10,000
Field Technician	0	HR	$60.00	$0
Groundwater Sampling (Yearly Cost)				$14,000
Project Manager	10	HR	$150.00	$1,500
Project Scientist	30	HR	$100.00	$3,000
Project Engineer	50	HR	$110.00	$5,500
Disposable Materials per Sample	4	EA	$10.33	$41
Analytical (VOCs)	4	EA	$80.00	$320
Contingency (30%)	1	LS	$3,108.40	$3,108
Design (15% Capital)				$279,000
Contingency (30% Capital)				$557,000
Capital Costs Thermal Treatment				$2,691,000
Present Value OM&M Costs (assume 5 years of GW Sampling with a 5% discount rate)				$61,000
Total Capital and Present Value Costs for Thermal Treatment 25-40'				$2,752,000

Kenco Feasibility Study Cost Estimate
Alternative 5 – In Situ Chemical Treatment (2-25')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Chemical Soil Mixing				$5,524,000
Project Engineer	129	HR	$110.00	$14,243
Field Technician	2,590	HR	$60.00	$155,378
Temporary Fabric Structure Rental	1	LS	$450,000.00	$450,000
Soil Mixing with Auger	32,370	ton	$45.00	$1,456,667
Potassium Permanganate	1,261,281	lbs.	$2.50	$3,153,201
Soil Treatment/Disposal Facility NonHaz	6,474	Ton	$30.00	$194,222
Waste Disposal Transport (Truck) NonHaz	6,474	Ton	$15.00	$97,111
Security Fence	1	LS	$2,500.00	$2,500
Soil Sampling				$103,000
Project Manager	11	HR	$150.00	$1,650
Project Scientist	110	HR	$100.00	$11,000
Project Engineer	160	HR	$110.00	$17,600
Disposable Materials per Sample	420	EA	$10.33	$4,339
Analytical (VOCs)	420	EA	$80.00	$33,600
4.25" HSA <50 feet	840	LF	$25.00	$21,000
Split Spoon Samples	420	EA	$25.00	$10,500
55 Gallon Drums	15	EA	$60.00	$900
Soil Disposal (per drum)	15	EA	$100.00	$1,500
Groundwater Sampling (Yearly Cost)				$27,000
Project Manager	20	HR	$150.00	$3,000
Project Scientist	60	HR	$100.00	$6,000
Project Engineer	100	HR	$110.00	$11,000
Disposable Materials per Sample	8	EA	$10.33	$83
Analytical (VOCs)	8	EA	$80.00	$640
Contingency (30%)	1	LS	$6,216.79	$6,217
Design (15% Capital)				$845,000
Contingency (30% Capital)				$1,689,000
Total Capital Cost				$8,161,000
Present Value OM&M Costs (assume 5 years of GW Sampling with a 5% discount rate)				$117,000
Total Capital and Present Value Costs for In Situ Chemical Treatment 2-25'				$8,278,000

Kenco Feasibility Study Cost Estimate
Alternative 6 – Slurry Wall Containment (2-25')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Environmental Easement				$21,000
Overnight Delivery, 8 oz Letter	8	EA	$19.05	$152
Project Manager	40	HR	$150.00	$6,000
Staff Engineer	10	HR	$110.00	$1,100
Word Processing/Clerical	15	HR	$17.98	$270
Draftsman/CADD	8	HR	$80.00	$640
Attorney, Senior Associate	12	HR	$220.60	$2,647
Paralegal, Real Estate	12	HR	$52.16	$626
ALTA Survey	1	LS	$9,000.00	$9,000
Local Fees	2	LS	$200.00	$400
Slurry Wall Installation				$261,000
Project Manager	19	HR	$150.00	$2,850
Staff Engineer	190	HR	$110.00	$20,900
Backfill Trench, Borrow Material	866	CY	$30.30	$26,247
Slurry wall installation	4,416	CY	$8.12	$35,858
Bentonite	563	TON	$157.50	$88,657
Slurry mixing and placement	297,487	GAL	$0.11	$32,724
Bentonite backfill mixing	2,475	CY	$3.82	$9,455
Slurry wall cleanup and re-grade	56,250	SF	$0.11	$6,188
Waste Disposal	835	Ton	$30.00	$25,059
Waste Disposal Transport (Truck)	835	Ton	$15.00	$12,530
Cap Installation Subtotal				$258,000
Project Manager	8	HR	$150.00	$1,200
Staff Engineer	80	HR	$110.00	$8,800
Fill	1,714	CY	$29.52	$50,585
Imported topsoil	857	LCY	$34.42	$29,498
Seeding, Vegetative Cover	0.85	ACR	$4,010.00	$3,409
Clay	3,428	CY	$47.84	$163,996
Groundwater Monitoring Well Installation				$25,000
Project Manager	5	HR	$150.00	$750
Project Scientist	10	HR	$100.00	$1,000
Mobilize/Demobilize Drilling Rig	1	LS	$2,985.00	$2,985
Organic Vapor Analyzer Rental	5	DAY	$42.71	$214
Field Technician	50	HR	$60.00	$3,000
4.25" HAS <50 feet	150	LF	$25.00	$3,750
2" PVC, Schedule 40, Well Materials	150	LF	$15.00	$2,250
2" PVC, Schedule 40, Well Screen	50	LF	$15.00	$750
DOT steel drums, 55 gal.	3	EA	$60.00	$180
2" Screen, Filter Pack	50	LF	$10.00	$500
Surface Pad, Concrete, 2' x 2' x 4"	10	EA	$325.00	$3,250
2" Well, Portland Cement Grout	100	LF	$50.00	$5,000
2" Well, Bentonite Seal	10	EA	$10.00	$100
Soil Disposal (per drum)	3	EA	$100.00	$300
Groundwater Extraction Wells/Piping				$29,000
Project Manager	2	HR	$150.00	$300
Project Scientist	4	HR	$100.00	$400
Mobilize/Demobilize Drilling Rig	1	LS	$2,985.00	$2,985
Organic Vapor Analyzer Rental	5	DAY	$42.71	$214
5,000 Gallon Aboveground Tank	1	EA	$10,000.00	$10,000
6" PVC, Schedule 40, Well Casing	8	LF	$33.14	$265
2" Pitless Adapter	2	EA	$882.44	$1,765
6" PVC, Schedule 40, Well Screen	10	LF	$42.67	$427
6" PVC, Well Plug	2	EA	$92.67	$185
4" Submersible Pump, 0.3-7 GPM	2	EA	$920.63	$1,841
Air Rotary, 8" Dia Borehole	30	LF	$96.42	$2,893
DOT steel drums, 55 gal.	2	EA	$60.00	$120
Well Development Equipment	1	WK	$556.50	$557
6" Screen, Filter Pack	10	LF	$34.95	$350

Kenco Feasibility Study Cost Estimate
Alternative 6 – Slurry Wall Containment (2-25')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
6" Well, Bentonite Seal	2	EA	$152.02	$304
Well Vault	2	EA	$500.00	$1,000
2" PVC buried piping	190	LF	$25.50	$4,845
30 GPM Treatment System				$750,000
Project Manager	20	HR	$150.00	$3,000
Staff Engineer	100	HR	$110.00	$11,000
Treatment System Construction	1	LS	$580,126.38	$580,126
Media Filtration	1	LS	$53,186.56	$53,187
Carbon Adsorption (gas)	1	LS	$10,637.08	$10,637
Air Stripper	1	LS	$91,277.20	$91,277
Treatment System O&M				$50,000
Project Manager	25	HR	$150.00	$3,750
Staff Engineer	50	HR	$110.00	$5,500
Field Technician	260	HR	$60.00	$15,600
Disposable Materials per Sample	12	EA	$10.33	$124
Analytical (VOCs, Metals)	12	EA	$165.00	$1,980
LGAC Drums, Disposable	5	EA	$643.16	$3,216
Transport Bulk Liquid	800	MI	$2.73	$2,184
Transportation Hazardous Waste	800	MI	$2.83	$2,264
Truck washout	1	EA	$194.60	$195
DOT steel drums, 55 gal.	2	EA	$63.85	$128
Liquid Bulk Waste Stabilization	420	GAL	$1.84	$774
Sulfuric Acid, 750 Lb Drum	1	EA	$300.20	$300
Hydrated Lime, Powdered, Bulk	1	TON	$149.36	$149
Electrical	13,956	KWH	$0.12	$1,675
Contingency (30%)	1	LS	$11,351.41	$11,351
Groundwater Sampling (Yearly Cost)				$30,000
Project Manager	20	HR	$150.00	$3,000
Project Scientist	80	HR	$100.00	$8,000
Project Engineer	100	HR	$110.00	$11,000
Disposable Materials per Sample	10	EA	$10.33	$103
Analytical (VOCs)	10	EA	$80.00	$800
Contingency (30%)	1	LS	$6,870.99	$6,871
Design (15% Capital)				$202,000
Contingency (30% Capital)				$404,000
Total Capital Costs				$1,950,000
Present Value OM&M Costs (assume 30 years of GW Sampling with a 5% discount rate)				$1,230,000
Total Capital and Present Value Costs for Slurry Wall Containment (2-25')				$3,180,000

Kenco Feasibility Study Cost Estimate
Alternative 6 - Hydraulic Containment (25-40')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Environmental Easement				$21,000
Overnight Delivery, 8 oz Letter	8	EA	$19.05	$152
Project Manager	40	HR	$150.00	$6,000
Staff Engineer	10	HR	$110.00	$1,100
Word Processing/Clerical	15	HR	$17.98	$270
Draftsman/CADD	8	HR	$80.00	$640
Attorney, Senior Associate	12	HR	$220.60	$2,647
Paralegal, Real Estate	12	HR	$52.16	$626
ALTA Survey	1	LS	$9,000.00	$9,000
Local Fees	2	LS	$200.00	$400
Groundwater Monitoring Well Installation				$37,000
Project Manager	8	HR	$150.00	$1,200
Project Scientist	16	HR	$100.00	$1,600
Mobilize/Demobilize Drilling Rig	1	LS	$2,985.00	$2,985
Organic Vapor Analyzer Rental	8	DAY	$42.71	$342
Field Technician	80	HR	$60.00	$4,800
4.25" HAS <50 feet	240	LF	$25.00	$6,000
2" PVC, Schedule 40, Well Materials	240	LF	$15.00	$3,600
2" PVC, Schedule 40, Well Screen	80	LF	$15.00	$1,200
DOT steel drums, 55 gal.	5	EA	$60.00	$300
2" Screen, Filter Pack	80	LF	$10.00	$800
Surface Pad, Concrete, 2' x 2' x 4"	16	EA	$325.00	$5,200
2" Well, Portland Cement Grout	160	LF	$50.00	$8,000
2" Well, Bentonite Seal	16	EA	$10.00	$160
Soil Disposal (per drum)	5	EA	$100.00	$500
Groundwater Extraction Wells/Piping				$30,000
Project Manager	4	HR	$150.00	$525
Project Scientist	7	HR	$100.00	$700
Mobilize/Demobilize Drilling Rig	1	LS	$2,985.00	$2,985
Organic Vapor Analyzer Rental	5	DAY	$42.71	$214
5,000 Gallon Aboveground Tank	1	EA	$10,000.00	$10,000
6" PVC, Schedule 40, Well Casing	8	LF	$33.14	$265
2" Pitless Adapter	2	EA	$882.44	$1,765
6" PVC, Schedule 40, Well Screen	10	LF	$42.67	$427
6" PVC, Well Plug	2	EA	$92.67	$185
4" Submersible Pump, 0.3-7 GPM	2	EA	$920.63	$1,841
Air Rotary, 8" Dia Borehole	30	LF	$96.42	$2,893
DOT steel drums, 55 gal.	5	EA	$60.00	$300
Well Development Equipment	1	WK	$556.50	$557
6" Screen, Filter Pack	10	LF	$34.95	$350
6" Well, Bentonite Seal	2	EA	$152.02	$304
Well Vault	2	EA	$500.00	$1,000
2" PVC buried piping	190	LF	$25.50	$4,845
30 GPM Treatment System - covered under 2-25' Containment Costs				$0
Treatment System O&M (Annual Cost)				$50,000
Project Manager	25	HR	$150.00	$3,750
Staff Engineer	50	HR	$110.00	$5,500
Field Technician	260	HR	$60.00	$15,600
Disposable Materials per Sample	12	EA	$10.33	$124
Analytical (VOCs, Metals)	12	EA	$165.00	$1,980
LGAC Drums, Disposable	5	EA	$643.16	$3,216
Transport Bulk Liquid	800	MI	$2.73	$2,184
Transportation Hazardous Waste	800	MI	$2.83	$2,264
Truck washout	1	EA	$194.60	$195
DOT steel drums, 55 gal.	2	EA	$63.85	$128
Liquid Bulk Waste Stabilization	420	GAL	$1.84	$774
Sulfuric Acid, 750 Lb Drum	1	EA	$300.20	$300
Hydrated Lime, Powdered, Bulk	1	TON	$149.36	$149

Kenco Feasibility Study Cost Estimate
Alternative 6 - Hydraulic Containment (25-40')

Description	Quantity	Unit of Measure	Unit Cost	Extended Cost
Electrical	13,956	KWH	$0.12	$1,675
Contingency (30%)	1	LS	$11,351.41	$11,351
Groundwater Sampling (Annual Cost)				$36,000
Project Manager	20	HR	$150.00	$3,000
Project Scientist	120	HR	$100.00	$12,000
Project Engineer	100	HR	$110.00	$11,000
Disposable Materials per Sample	16	EA	$10.33	$165
Analytical (VOCs)	16	EA	$80.00	$1,280
Contingency (30%)	1	LS	$8,233.58	$8,234
Design (15% Capital)				$14,000
Contingency (30% Capital)				$26,400
Total Capital Costs				$128,400
Present Value OM&M Costs (assume 30 years with a 5% discount rate)				$1,323,000
Total Capital and Present Value Costs for Hydraulic Containment (25-40')				$1,451,400

Appendix C

Green and Sustainable Metrics Memorandum

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Memorandum

Introduction

This memorandum presents the methods used for estimating green and sustainability metrics relevant to the remediation activities associated with the Former Kenco Chemical Company OU2 Source Area (the Site) Feasibility Study Report. The scope of this study is to evaluate the potential impacts of the potential remedies identified for the Site. This analysis was performed on an SRT© framework (AFCEE 2010) platform (the tool) utilizing metrics associated with the factors provided below.

- Gas emissions:
  - Carbon dioxide (CO_2) emissions;
  - Nitrogen oxides (NO_x) emissions;
  - Sulfur oxides (SO_x) emissions; and
  - Particulate matter emissions with a diameter of 10 µm or less (PM_{10}).
- Energy Consumption presented as:
  - Mega gules; and
  - Kilowatt hours.

Input Data Requirements

The Feasibility Study Report identifies six soil and groundwater remediation alternatives for the Site, as shown below.

- Alternative 1 – No Action
- Alternative 2 – Excavation with Off-Site Disposal (2-25') with In Situ Chemical Treatment (25-40')
- Alternative 3 – Excavation with On-Site Treatment (2-25') with In Situ Chemical Treatment (25-40')
- Alternative 4 – Thermal Treatment (2-40')
- Alternative 5 – In Situ Chemical Treatment (2-40')
- Alternative 6 – Containment (2-40')

SRT© provides an excel macro based tool for calculating the metrics discussed in this memorandum. This tool includes a series of project specific inputs resulting in a series of project specific outputs. Two alternative assessment options are provided within the tool. The first is a broad assessment that allows simple inputs (e.g., cubic yards to be removed). The second allows more specific inputs that may have a significant impact to the project results (e.g., the volume of soil a disposal truck can carry). The first, or less complex, approach has been taken for this assessment.

Results

Table C1 summarizes the tool's outputs associated with each remedial option (see tables C2 through C12). The tool identifies In Situ Chemical Treatment (Alternative 5) as the lowest treatment contributor to gas emissions and energy use. The largest contributor to gas emissions and energy usage is Excavation with On-Site Treatment (Alternative 3).

Table C1 - Sustainable Evaluation Outputs
Former Kenco Chemical Company

Sustainability Results		Common Elements		Alternatives				
				2	3	4	5	6
		Excavation (0-2 FT BGS)	ISCO (4-15 FT BGS)	Excavation With Off-Site Disposal (2-25') with Targeted In Situ Chemical Oxidation/ Reduction (25-40')	Excavation With On-Site Treatment (2-25') with Targeted In Situ Chemical Oxidation/Reduction (25-40')	Thermal Treatment (2-40')	In Situ Chemical Oxidation/ Reduction (2-40')	Containment (2-40')
Emissions								
CO^2	tons	5.7	110	982	10,246	10,000	380	2,104
CO^2 per contaminant	lbs./lbs.	220	6.7	8,010	2,143	140	8,000	NA
NOx	tons	0.043	0.095	4.838	59	58	0.048	12.37
SOx	tons	0	0.025	0.02207	110	110	0.018	35.68
PM10	tons	0.0021	0.0061	0.236	20	20	0.003	4.13
Energy								
Consumption	Megajoules	76,000	850,000	8,000,000	160,000,000	130,000,000	360,000	43,000,000
Consumption	kWh	21,000	240,000	2,230,000	44,000,000	36,000,000	100,000	11,900,000

Notes:

Lowest Value Option

Highest Value Option

Results obtained through the use of SRT©AFCEE 2010

Table C2 - Common Excavation/T&D Contaminated 0-2 feet Zone SRT Outputs

Former Kenco Chemical Company

Emissions		
CO^2	tons	6
CO^2 per contaminant	lbs./lbs.	220
NOx	tons	0.04
SOx	tons	0
PM10	tons	0.0021
Energy		
Consumption	Megajoules	76,000
Consumption	kWh	21,000

Table C3 - Common ISCO Contaminated 4-15 feet Zone SRT Outputs

Former Kenco Chemical Company

Emissions		
CO^2	tons	110
CO^2 per contaminant	lbs./lbs.	6.7
NOx	tons	0.095
SOx	tons	0.0250
PM10	tons	0.0061
Energy		
Consumption	Megajoules	850,000
Consumption	kWh	240,000

Table C4 - Alternative 2 - Excavation/T&D 2-25 feet Zone Non-Hazardous Portion SRT Outputs

Former Kenco Chemical Company

Emissions		
CO^2	tons	92
CO^2 per contaminant	lbs./lbs.	1.5
NOx	tons	0.69
SOx	tons	0.00007
PM10	tons	0.033
Energy		
Consumption	Megajoules	1,200,000
Consumption	kWh	330,000

Table C5 - Alternative 3 - Excavation/T&D 2-25 feet Zone Hazardous Portion SRT Outputs

Former Kenco Chemical Company

Emissions		
CO^2	tons	510
CO^2 per contaminant	lbs./lbs.	8.5
NOx	tons	4.1
SOx	tons	0.004
PM10	tons	0.2
Energy		
Consumption	Megajoules	6,800,000
Consumption	kWh	1,900,000

Table C6 - Alternative 3 - Excavation / On-Site Thermal Contaminated 2-25 feet Zone SRT Outputs

Former Kenco Chemical Company

Emissions		
CO^2	tons	9,600
CO^2 per contaminant	lbs./lbs.	170
NOx	tons	46
SOx	tons	84
PM10	tons	16
Energy		
Consumption	Megajoules	130,000,000
Consumption	kWh	36,000,000

Table C7 - Alternative 4 - Thermal Treatment
Contaminated 2-40 feet Zone SRT Outputs
Former Kenco Chemical Company

Emissions		
CO^2	tons	10,000
CO^2 per contaminant	lbs./lbs.	140
NOx	tons	58
SOx	tons	110
PM10	tons	20
Energy		
Consumption	Megajoules	160,000,000
Consumption	kWh	44,000,000

Table C8 -Alternatives 2&3 - Onsite ISCO 25-40 feet Zone SRT Outputs

Former Kenco Chemical Company

Emissions		
CO^2	tons	380
CO^2 per contaminant	lbs./lbs.	8,000
NOx	tons	0.048
SOx	tons	0.018
PM10	tons	0.003
Energy		
Consumption	Megajoules	360,000
Consumption	kWh	100,000

Table C9 - Alternative 5 - Onsite ISCO 2-40 feet Zone SRT Outputs

Former Kenco Chemical Company

Emissions		
CO^2	tons	380
CO^2 per contaminant	lbs./lbs.	8,000
NOx	tons	0.048
SOx	tons	0.018
PM10	tons	0.003
Energy		
Consumption	Megajoules	360,000
Consumption	kWh	100,000

Table C10 - Alternative 6 - Containment 2-25 feet Zone[1]

Former Kenco Chemical Company

Emissions		
CO^2	tons	804
CO^2 per contaminant	lbs./lbs.	NA
NOx	tons	4.67
SOx	tons	21.68
PM10	tons	1.43
Energy		
Consumption	Megajoules	21,000,000
Consumption	kWh	5,800,000

1) SRT does not provide input/output associated with a slurry wall. Estimated values have been used.

INPUTS:	**Unit**	**Value**
Area of Slurry Wall:		
	SF	1472
Other:		
Installation Rate	SF/HR	200
Rig Power Rating	HP/HR	95
Constants:		
CO2 Emission Factor	LBS./HP	1.15
CO Emission Factor	LBS./HP	0.00668
NOX Emission Factor	LBS./HP	0.031
SOX Emission Factor	LBS./HP	0.00205

Outputs:

Metric	Units	Alt 2
CO2 Emissions	LBS.	804
CO Emissions	LBS.	5
NOX Emissions	LBS.	22
SOX Emissions	LBS.	1

Table C11 - Alternative 6 - Onsite P&T 4-40 feet Zone SRT Outputs

Former Kenco Chemical Company

Emissions		
CO^2	tons	1,300
CO^2 per contaminant	lbs./lbs.	27,000
NOx	tons	7.7
SOx	tons	14
PM10	tons	2.7
Energy		
Consumption	Megajoules	22,000,000
Consumption	kWh	6,100,000