A BETTER TOMORROW made possible

FEASIBILITY STUDY REPORT

Gastown Former MGP Site
Site No. 9-15-171
Tonawanda, Erie County, NY
Work Assignment No. D003821-21

Prepared for:

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January 2005

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1.0 INTRODUCTION

This Feasibility Study (FS) Report for the Gastown Former MGP Site, Site No. 9-15-171("site" or "the site"), located on East Niagara Street in the City of Tonawanda, Erie County, New York (Figure 1-1), was prepared in conjunction with the Remedial Investigation (RI) performed under Work Assignment No. D003821-21 of the State Superfund Standby Contract between New York State Department of Environmental Conservation (NYSDEC) and Earth Tech Northeast, Inc. (Earth Tech).

This document provides the basis for developing a comprehensive, site-wide remedy protective of human health and the environment using applicable Federal and State guidelines.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of the document is to identify and analyze remedial alternatives that: are protective of human health and the environment; attain, to the maximum extent practicable, Federal and State standards, criteria and guidelines (SCGs); and, are cost effective. Accordingly, the Gastown Former MGP site FS is based on the objectives, methodologies, and evaluation criteria as generally set forth in the following Federal and State regulations and guidelines:

- Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) and the Superfund Reauthorization Act of 1986 (SARA);
- National Oil and Hazardous Substances Contingency Plan (NCP);
- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, October 1988);
- Resource Guide for MGP Site Characterization and Remediation; Expedited Site Characterization and Source Remediation at Former Manufactured Gas Plant Sites (USEPA, 2000 - EPA 542-R-00-005).
- New York Rules for Inactive Hazardous Waste Disposal sites, 6 NYCRR Part 375 (May 1992);
- CERCLA Compliance with Other Laws Manual, 1988, OSWER Directive No. 9234.1-01 and -02;
- NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #HWR-89-4025 "Guidelines for RI/FS's";
- NYSDEC TAGM #HWR-90-4030 "Selection of Remedial Actions at Inactive Hazardous Waste sites"; and,
- NYSDEC TAGM #HWR-89-4022 "Records of Decision for Remediation of Class 2 Inactive Hazardous Waste Disposal sites".

The remainder of Section 1.0 contains background information about the site and surrounding area, and a brief summary of the scope of the RI and pertinent findings including the physical setting and the nature and extent of contamination. Section 2.0 identifies the remedial action objectives, general response actions and remedial technologies, and presents the screening of the remedial technologies to identify those effective for the wastes and media at the site. In Section 3.0, the technologies are grouped into remedial alternatives, which are then screened to eliminate those that are not suitable. In Section 4.0, a detailed analysis of the retained alternatives is presented, and the recommended remedial alternative is identified and described.

The FS is intended for use by the NYSDEC in preparing a Proposed Remedial Action Plan (PRAP) for the site that will be distributed for public comment. The PRAP and subsequent Responsiveness Summary addressing public comments will be used to develop a Record of Decision (ROD) formally outlining the NYSDEC's plan for site remediation.

1.2 SITE DESCRIPTION AND HISTORY

The site was the location of a manufactured gas plant (MGP), which operated between about 1884 and 1957. The MGP operations resulted in the release of various types of MGP wastes at the site. The NYSDEC listed the site on the Registry of Inactive Hazardous Waste Sites as a Class 2 site (Site No. 9-15-171), indicating that the site presents a significant threat to human health and/or the environment.

The total area of the site is approximately 3.5 acres in size (Figure 1-2). It is currently utilized as a rental property for several light industrial businesses. Adjacent property to the east of the site is owned by the Niagara Frontier Transportation Authority (NFTA), which leases a portion of its property to the Gastown Sportsman's Club. An active CSX rail line forms the southern and western border of the site. East Niagara Street is located north of the site. Tonawanda Creek, an active segment of the New York State Barge Canal System, is located just north of East Niagara Street. A small strip of land used as a recreational path is located between East Niagara Street and Tonawanda Creek. Much of the property to the east of the Sportsman's Club property and west of the CSX rail line is residential. The entire site and vicinity has a gentle downward slope to the north towards Tonawanda Creek.

Underground utilities at the site include sanitary and storm sewer lines, natural gas and water. Overhead lines provide electrical service to the site. An AT&T fiber optic underground cable runs north-south within the parking lot of the Sportsman's Club property, approximately 25 feet west of the clubhouse.

Historic Sanborn Fire Insurance Maps, aerial photographs, and records kept by the Tonawanda Historical Society and the Erie County Clerk's office were searched. The historic site layout is shown in Figure 1-3. The Gastown MGP site was formerly operated under the ownership of the Tonawanda Gas Light Company; the Niagara Light, Heat & Power Company; the Republic Light, Heat & Power Company; and the Iroquois Gas Corporation. The Tonawanda Gas Light Company was incorporated in 1884. The MGP appears in telephone directories between 1889 and 1957.

Public Service Commission (PSC) reports for this plant were reviewed, including reports from the Niagara Light, Heat & Power Company (1906-1919) and the Republic Light, Heat & Power Company (1919-1956). The plant opened in 1884 as a coal carbonization plant. The coal carbonization facilities expanded over time with new retorts added in 1904 (12 retorts), 1913 (12 retorts), 1914 (6 retorts) and 1916 (6 retorts). The maximum capacity of the coal carbonization plant was 290 million cubic feet (MCF)/24 hours. The coal carbonization facility included a 400 barrel tar tank, and the plant appears to have collected and sold the majority of coal carbonization tar. A carbureted water gas (CWG) set was added in 1910, and the plant produced gas using both processes until 1921. There was no indication in the PSC records of any attempt to capture the water gas tar. No gas was produced in 1922, and in 1923 the production facilities were dismantled. The plant site continued to be used as a booster and storage facility. A summary of PSC production figures is provided in Appendix B.

A number of holders were constructed at the plant. The original plant included only a 40,000 cubic feet (CF) brick relief holder. A 100,000 CF holder was constructed in 1895. A new 500,000 CF holder was added in 1926 or 1927. Records show the 100,000 CF holder was dismantled in 1953.

As manufactured gas cooled, a number of less-volatile chemical compounds would condense to form a complex oily liquid mixture commonly called coal tar. In some cases, this tar could be burned as a fuel at the MGP itself. Some tar was sold as a roofing and road-building material. Other uses for tar developed over the years, as chemists discovered processes for making dyes and a variety of other chemicals, using coal tar as a starting point.

However, for a variety of reasons, the tar could be considered a waste. In many cases, some or all of the tars produced by the plant formed an emulsion with water, and could not be easily reused or sold. Many MGPs simply produced more tar than could be reused or sold. In addition, many of these plants operated for decades and significant quantities of coal tar were likely released due to spills or leaks.

Although it is common to use the phrase "coal tar" to describe this material, it is important to note that this name is somewhat misleading. Most people think of tar as a sticky, viscous material, commonly used for road building or roofing repair. MGP tars, particularly those produced by the CWG process, are far less viscous. Many of the tars found at CWG MGP sites are quite fluid, with roughly the same viscosity as vegetable oil. Consequently, CWG tars are more likely to migrate through soil and appear at distant locations from where they originally leaked or were disposed. The tars are often referred to as non-aqueous phase liquid (NAPL) because it occurs in an undissolved state in the subsurface. Also, these NAPLs tend to be denser than water so the term dense non-aqueous liquid (DNAPL) is also applicable.

The plant probably did not operate after the 1950's, as was typical for MGPs in New York State. In 1964, the property was purchased from Iroquois Gas Corporation by Mr. Wilbert Holler and in 1968, incorporated into the Holler and Schenk Building Company. The property was transferred to Mr. Jack Holler in 1986 under corporate dissolution. The property is currently utilized by Mr. Holler for rental income from several local industries.

1.3 PREVIOUS SUBSURFACE INVESTIGATIONS

1.3.1 NYSDEC Spill Response Investigation

In March 1993, the NYSDEC Spill Response Unit responded to a spill complaint at the Gastown Sportsman's Club where an unknown petroleum product was entering basement sumps of the clubhouse. Preliminary sampling revealed that the material found in the sumps was composed of constituents associated with coal tars related to the coal gas manufacturing process. The Spill Response Unit subsequently conducted an investigation which entailed

- Records search revealing the former site use and owners/operators;
- Sampling of NAPL and water from the basement sumps of the Gastown Sportsmen's Club for chemical analysis;
- Completion of test pits/trenches;

- Completion of a push probe investigation and groundwater sampling to determine groundwater flow direction, the magnitude of groundwater contamination, and the areal extent of NAPL in the subsurface environment;
- Construction of five monitoring wells within the NAPL plume;
- Removal and disposal of contaminated soils where coal tars had surfaced in the club's parking lot.
- Replacement of the sump discharge line following the removal action.
- Construction of a temporary shroud around the club's basement sump and installation of a fan to vent potentially hazardous organic vapors.

A sample of NAPL from the club's basement sumps reportedly revealed that the substance was a characteristic hazardous waste for benzene. Based upon this finding, the site was referred to the NYSDEC Hazardous Waste Remediation Unit for additional action.

1.3.2 1998 NAPL Extraction / Groundwater Treatment System

The Hazardous Waste Remediation Unit conducted an initial inspection of the site following the spill response unit investigation. NYSDOH was then contacted in regard to potential human health impacts from contamination within the Gastown Sportsman's Club. NYSDOH conducted an indoor air evaluation of the clubhouse on April 13, 1998. The analysis found levels of certain volatile organics in the basement at levels of concern relative to the public health. As a result, additional monitoring wells were installed and a groundwater/NAPL extraction and treatment system was designed to capture NAPL and contaminated groundwater reaching the clubhouse sumps. This NAPL extraction system, in operation since September 2, 1998 consists of a single 10-inch diameter extraction well and a treatment system for contaminated NAPL and groundwater. Treated water is discharged directly to Tonawanda Creek.

1.3.3 1998 - 2001 Site Investigation Report

Upon completion of the groundwater/NAPL extraction and treatment system, the NYSDEC Hazardous Waste Remediation Unit deemed that a more thorough investigation was necessary to determine the extent of off-site contamination along East Niagara and Carney Streets. As a result, the NYSDEC initiated a subsequent site investigation with the following objectives:

- Evaluate the effectiveness of the groundwater/NAPL extraction and treatment system;
- Determine the extent to which NAPL had migrated under the Gastown Sportsman's Club toward nearby properties; and
- Determine the extent to which contaminated groundwater had migrated from the Site.

Activities completed to meet these objectives included the drilling and sampling of 13 soil borings and 5 monitoring wells and measurement of water levels. Water level measurements for Tonawanda Creek were also taken. This information was used to evaluate groundwater flow patterns across the site and to evaluate the effectiveness of the extraction system at removing/containing impacted groundwater.

A Site Investigation Report, dated January 2001, was prepared by the NYSDEC, Region 9, which summarized all the investigation activities at the site. The site investigation revealed that NAPL extends under the NFTA and Gastown Sportsman's Club properties. However, the investigation did not fully delineate the downgradient extent of NAPL or the contaminated groundwater plume and the report recommended that a Remedial Investigation/Feasibility Study (RI/FS) be completed to fully delineate the nature and extent of contamination associated with the site for the purpose of selecting a long-term remedy. Particular areas of concern included the site as well as delineating the contamination found west of the site and to the east, near Carney Street. Information from the January 2001 Site Investigation Report is incorporated into the RI report.

1.4 SUMMARY OF REMEDIAL INVESTIGATION

Earth Tech performed this RI at the site to evaluate the nature and extent of impacts related to historic site operations and subsequent activities. The potential presence of off-site sources of constituents and any potential risk to the environment and human health were assessed. The data necessary to evaluate appropriate remedial alternatives was assessed and developed.

1.4.1 Physical Setting

The stratigraphy of the Gastown Former MGP site has been evaluated by examining the stratigraphic logs obtained from soil borings completed during the two previous investigations and the remedial investigation. The locations of these borings are shown on Figure 1-3.

The stratigraphy at the site generally comprises unconsolidated sediments of glacial and post-glacial origin overlying the Late Silurian age Camillus Shale formation. Geologic cross-sections were prepared and are available in the RI report. Descriptions of the stratigraphic units at the Gastown Former MGP Site, in order of increasing depth, are provided below.

1.4.1.1 Fill

Typical urban fill material overlies the native deposits throughout most of the Gastown Former MGP site. Such fill is generally used to grade and level areas for construction of structures and infrastructure. The fill material consists predominately of loose, coarse-grained crushed stone, cinders, various colored ash, coal, coke, slag and brick, mixed with sand. The Fill unit also consists of native soil that appeared to have been re-worked (excavated and backfilled) at some time in the past. Fill materials were encountered in many of the soil borings installed during the investigation and, where encountered, ranged in thickness from several inches to several feet. The greatest thickness of fill identified during the RI was 22 feet, at soil boring DP-11 and monitoring well MW-43, both of which were advanced within the footprint of an underground gas holder. Re-worked native soil and brick fragments were penetrated in these borings, followed by probe and auger refusal at a depth of 22 feet. The refusal is presumed to reflect the base of the former gas holder. In boring DP-15, located on top of the berm of the former railroad right-of-way at the southeastern corner of the site. The fill thickness in this boring was observed to a depth between 10.4’ and 12.0’ (inferred depth of 11.2’) below grade, which equals the approximate height of the berm.

1.4.1.2 Recent Alluvium Deposit

A relatively thick recent alluvium deposit underlies the entire Gastown Former MGP site (except where reworked within the former gas holder at DP-11 and MW-43), and is the primary water-bearing zone encountered during the investigation. The recent alluvium consists of post-glacial reworked glaciolacustrine and glaciofluvial deposits eroded from upstream areas and redeposited as overbank deposits during periodic flooding of Tonawanda Creek and its tributaries. The overall thickness of the recent alluvium was found to be variable, ranging from 3.5 feet to 20 feet. The unit was observed to be comprised of two primary deposits, including an upper silty clay deposit and underlying (lower) fine-grained silty-sand deposit.

Upper Silty Clay Deposit

The upper silty clay deposit exists throughout much of the site, beneath the fill material or is present as the uppermost layer where fill is absent. The thickness of this deposit ranges from approximately 2 to 15 feet. The upper silty clay deposit is generally gray in color, but is extensively mottled yellow, brown, orange and black. In many locations, nearer to Tonawanda Creek and the northern portion of the site, the base of this unit grades downward to an overbank swamp or muck deposit, consisting of black, highly organic silty clay with abundant shell fragments, roots and decayed wood. The unit was generally observed to not contain NAPL, except in the immediate vicinity of probable release areas on site.

Lower Fine-Grained Silty-Sand Deposit

This lower portion of the recent alluvium directly underlies the upper silty clay deposit, and consists predominately of gray, fine-grained sand and silt interbedded with thin layers of relatively less permeable gray clayey silt and silty clay. This interbedded layering is common in alluvial deposits representing differing flood stages and associated depositional energy. Much of the NAPL underlying the site observed during the RI was found within this deposit.

1.4.1.3 Sand and Gravel Deposit

A relatively thin sand and gravel deposit directly underlies the recent alluvium deposit. It was encountered in the majority of the deep borings completed at the site. The thickness of this deposit across most of the site is on the order of one to two feet. It is somewhat more variable in some areas of the investigation, apparently in relation to the elevation of the surface of the underlying glaciolacustrine silty clay deposit. The sand and gravel deposit was found to be thin to absent in areas where the surface of the underlying glaciolacustrine deposit is at relatively higher elevations (i.e., boring DP-39). It was observed to be as much as 5 to 8 feet thick to the western side of the site where the underlying silty clay is at a lower elevation (DP-24, DP-35 and DP-38). The sand and gravel deposit may be glaciofluvial in origin, emplaced during late stages of Glacial Lake Tonawanda, as water levels receded, or may represent the retracting beach facies of Former Glacial Lake Tonawanda as it drained. The surface elevation of this deposit ranges from 562 ft AMSL to 544 ft AMSL and changes erratically with no discernable directional trend suggesting a glaciofluvial origin. The unit is locally discontinuous probably through erosion and or reworking of the unit after deposition. NAPL was encountered only sporadically within this deposit at the interface between this deposit and the underlying silty clay unit.

1.4.1.4 Glaciolacustrine Silty Clay Deposit

A silty clay deposit underlies the sand and gravel deposit, or recent alluvium in the limited areas where the sand and gravel deposit is absent. This glaciolacustrine deposit is encountered throughout the Tonawanda area and consists predominately of reddish brown to brown, soft to very soft, saturated, highly plastic, silty clay. Laminations (varves) are common throughout the glaciolacustrine deposit, indicating that it was deposited in a glacial lake environment with the varves representing seasonal and/or periodic changes in the depth and energy of the depositional environment. Silt lenses, fine sand lenses, and infrequent occurrences of subangular to subrounded gravel and pebbles (possibly ice-rafted material) are also observed within this deposit. The glaciolacustrine silty clay was observed to be free of NAPL at all locations tested.

This glaciolacustrine silty clay deposit effectively acts as a confining layer preventing the downward migration of contaminated groundwater and NAPL. The thickness of the glaciolacustrine deposit was found to range between about 5 feet at the northern edge of the site (MW-46B and MW-50B) and 16.5 feet at location MW-49B at the southeast corner of the site.

1.4.1.5 Glacial Till Deposit

Glacial till was penetrated at the three bedrock well locations, and the surface of this deposit was encountered at soil boring DP-54. The till is generally comprised of compact reddish brown coarse to fine grained sand and clayey silt with a little gravel. The till was about 11 feet thick at locations MW-46B and MW-50B and 21 feet thick at location MW-49B. There was no visible or olfactory evidence of NAPL in the till.

1.4.1.6 Bedrock

The Camillus Shale bedrock underlying the site was encountered at three locations during the RI, for the installation of bedrock monitoring wells MW-46B, MW-49B and MW-50B. At these locations, the upper 16 to 19 feet of bedrock was drilled with HQ wireline coring methods. The bedrock surface was encountered at a depth of about 35 feet below grade at the northern edge of the site (MW-46B and MW-50B) and at a depth of 52 feet below grade at the southeastern corner of the site (MW-49B). Based on this and surface topography, the surface of the bedrock slopes downward in elevation by about 14 feet from north to south across the site. The rock core revealed the bedrock to be generally comprised of moderately weathered and fractured gray to gray-brown shale. NAPL was not observed in any of the recovered bedrock core samples. The rock quality designations (RQDs) of recovered core ranged from 13% to 73%.

1.4.2 Site Hydrogeology

From the results of the RI and previous NYSDEC investigations, in conjunction with published literature related to regional hydrogeology, three hydrogeologic units were identified at the site. These units are summarized in order of increasing depth as follows:

- ***Unconfined Water Table Water-Bearing Zone-*** This hydrogeologic unit is comprised by the saturated portion of the fill material (where present below water table), the recent alluvium deposit, and the underlying glacial sand and gravel deposit. Water level data indicate that all portions of the alluvium and underlying sand and gravel in this zone act as a single water-bearing unit. This is the primary water-bearing zone of interest because it is highly contaminated with coal tar NAPL in areas, and it provides the greatest potential for subsurface contaminant migration away from the site. The horizontal hydraulic conductivity of this zone was estimated from previous K-testing to be approximately 0.34 ft/day. Groundwater flow in this zone in the vicinity of the site is generally to the north, with discharge to Tonawanda Creek. However, a ridge or mound in the water table exists near the north central portion of the site, causing flow to be divergent from this area to the eastern and western sides of the site. Horizontal groundwater flow velocity in this zone is estimated to range between 3 and 30 ft/year.

- ***Glaciolacustrine/Glacial Till Aquitard-*** The shallow water-bearing zone is underlain by relatively less permeable glaciolacustrine silty clay and glacial till. These two units are expected to exhibit similar hydraulic properties, and together serve as an aquitard to restrict downward movement of contaminated groundwater and NAPL, and to serve as a confining layer to the deeper water bearing zones (i.e., the Camillus Shale bedrock).

Upper Bedrock Water-Bearing Zone- This hydrogeologic unit is comprised of the upper approximate 15 foot section of the Camillus Shale Formation, where the bedrock is moderately to highly fractured and weathered. Based on a single round of water level measurements, the groundwater elevation in this zone drops by about 1 foot from the southeastern corner of the site to the northern side of the site near

Tonawanda Creek, indicating horizontal groundwater flow is to the north. Water level monitoring data indicates that there is little or no vertical hydraulic gradient between the alluvium and bedrock water bearing zones at the northern downgradient edge of the site, and a slight downward gradient between the zones at the southeast corner of the site.

Tonawanda Creek is a small river in Western New York. Tonawanda Creek rises in Wyoming County and enters the Niagara River between Niagara County and Erie County, forming the boundary between them. Tonawanda Creek passes through the Village of Attica, the City of Batavia, and flows past the City of Tonawanda and the City of North Tonawanda before entering the Niagara River.

1.4.3 Utilities and Other Man-Made Structures

In-ground utilities (sewers, water mains, electrical conduits, etc.) and man-made structures represent potential preferred migration flow paths for contaminants due to the relatively higher permeability of the surrounding backfill. Due to the urbanized setting of the site and surrounding area, underground storm water and sanitary sewers are present on site. As described in Section 1.4.1.1, subsurface portions of a 65 foot diameter gas holder appear to be present near the center of the site. Based on drilling refusal in soil borings MW-43 and DP-11, the base of this holder is at a depth of 22 feet below grade. Also, an approximate 10,000 gallon UST was exposed near the center of the site. The UST was measured to be about 13 feet in diameter and 10 tall, and the top of the tank is located about one foot below grade. The contents of the UST were not investigated during the RI, however some coal tar was observed to be leaking from the tank. The locations of the gas holder and UST are shown in Figure 1-2.

Other significant sub-surface features on or near the site are described below.

1.4.3.1 Retaining Wall along Tonawanda Creek

The south bank of Tonawanda Creek has been reinforced with a concrete retaining wall that extends from the northwest corner of the site (at the railroad bridge) several hundred feet westward. The navigation channel for the creek is just north of this wall. The height of the top of the retaining wall above water surface in Tonawanda Creek is approximately 8 feet and the depth of water in the creek is approximately 14 feet. It is not known how deep the retaining wall penetrates below the ground surface, but it likely extends below the water table.

In addition to the concrete retaining wall, an apparent former loading dock is located immediately east of the railroad bridge. The walls (sheet piling) of the structure are still largely intact. Historic photos indicate that the dock may have been used at the time of the gas plant operation, but there is no record of MGP related activity at this location.

1.4.3.2 Fiber Optic Cable Line

An AT&T fiber optic underground cable is located approximately 25 feet west of the clubhouse of the Gastown Sportsman's Club. This cable runs north-south through the club's parking lot. The depth of the trench for this cable is not known.

1.4.4 Nature of Contamination

1.4.4.1 NAPL Contamination

Laboratory analyses of NAPL samples collected from the extraction system during the IRM indicates the coal tar NAPL at the site contains concentrations of BTEX up to 139,600 mg/kg and total PAH compounds as high as 364,380 mg/kg.

One objective of the RI was to determine the vertical and areal extent to which NAPL has migrated away from apparent source areas the former MGP site. To accomplish this objective, subsurface soil samples collected from the RI soil borings were examined for the presence of NAPL. This examination was performed based on visual observation combined with volatile screening using a photoionization detector (PID). The information obtained from this field examination, in conjunction with subsurface soil laboratory analytical results where available, were used to identify the depth and thickness of the NAPL at each soil boring location. Figure 1-4 depicts the mapped thickness of NAPL identified during the RI.

It is important to note that for presentation purposes, the NAPL delineation is based on mapped thickness (Figure 1-4), which is quite generalized on a site-wide basis. The thickness values mapped in this figure comprise the upper and lower vertical limit of soil that was observed to contain any NAPL, including blebs and stringers as well as relatively permeable seams where there was full NAPL saturation. Due to the extremely heterogeneous characteristics of the subsurface soils where the NAPL is present (i.e., sandy seams in lower portion of alluvium), the actual extent of NAPL in any specific location may vary to some degree from that indicated in Figure 1-4. This is especially the case nearer the mapped downgradient limits of the plume (eastern and western limits) where the NAPL was observed to be isolated to thin seams of sand at the very bottom of the alluvium. In addition, as a result of sample heterogeneity and limited volume of NAPL-containing soil in relatively large sample aliquots, laboratory analytical results may not fully corroborate or accurately portray actual NAPL presence in all areas.

Based on the review of historical information, field observations, and chemical analyses of soil and groundwater samples, the sixty-five foot diameter relief holder (Gasometer No.1), shown in Figure 1-2, appears to be the major release point of the observed NAPL and a continuing source of contamination from the MGP site. Other MGP structures north and west of this holder also may be continuing sources, as well as the steel tank located to the north and west. Subsurface soils saturated with NAPL exist in the vicinity of these structures with thicknesses between five and fifteen feet.

The observed NAPL is thickest in the north central portion of the site, and decreases to thinner layers at greater depth moving away from the apparent source area(s). The depth to the top of the NAPL is shallowest near the former source area(s), on the order of 4 to 5 feet below grade, and ranges from about 13 to 17 feet below grade at off-site locations.

To the east of the site, beyond the Sportsmen's Club property, NAPL appeared to be limited to a single thin seam of sand at approximately 17 ft below grade. NAPL was observed in borings located as far eastward as Carney Street. To the west, NAPL contamination appears to move under the railroad tracks in a series of sand seams from 8.5 to 21 feet below grade. Further west, at East Avenue, the NAPL is limited to thin seams from 17 to 22 feet below grade. NAPL does not appear to extend west beyond East Ave. No significant migration of NAPL was observed South of the source area(s). Northward migration of NAPL towards Tonawanda Creek was observed to have occurred only on the western side of the site, near the railroad bridge.

1.4.4.2 Soil Contamination

Surface soils in general did not indicate visual, olfactory or field PID screening evidence of coal tar contamination. Consequently, no surface soil samples were collected for laboratory analysis except at one location where a waste material (blue green granular material) was encountered at 2.2 feet. This sample contained concentrations of several polynuclear aromatic hydrocarbons (PAHs), as well as Arsenic, Cadmium, Copper, Mercury, Iron and Zinc, that exceeded the RSCOs. This condition appears to be an isolated occurrence and is not believed to be associated with the coal tar waste.

A total of 43 subsurface soil samples and 3 duplicate samples were collected from 34 soil borings and 4 test pits and submitted for laboratory analysis. Significant site related contamination was identified in subsurface soils. The magnitude and extent (both lateral and vertical) of the contamination was found to closely mimic the coal tar NAPL plume. Total VOCs and SVOCs of up to 72,000,000 µg/kg and 280,000,000 µg/kg were reported.

PCBs were detected in one subsurface soil sample collected during the RI. Aroclor-1260 was detected at a concentration of 1,200 mg/kg, which slightly exceeded the RSCO of 1,000 mg/kg. Due to its low frequency of detection, the relatively low concentration detected and the fact that the source of contamination at the Site is coal tar, PCBs are not considered a contaminant of concern for the site.

1.4.4.3 Groundwater Contamination

A total of 45 groundwater samples were collected from 31 groundwater monitoring wells and submitted for laboratory analysis. Based on these analyses, groundwater in the shallow alluvium water-bearing zone has been impacted with dissolved phase MGP-related contaminants. As would be expected, the groundwater is most significantly contaminated at locations more directly downgradient of and nearer to the edge of the NAPL plume. Downgradient groundwater impact appears to be most significant near the railroad bridge beyond the northwestern edge of the NAPL plume, and relatively high concentrations of dissolved phase MGP contaminants are likely discharging to the Tonawanda Creek in this area. To the east of the site, the analytical results indicate that low concentrations (2-4 µg/l) of Benzene have migrated as far as 300 to 400 feet downgradient of the NAPL plume.

Groundwater samples collected from the 3 bedrock monitoring wells in July 2004 were reported to contain Acetone, Carbon Disulfide, and Chloroform in one or more of these wells at concentrations in excess of NYSDEC AWQS. These compounds were not detected in the shallow overburden wells associated with these deep wells and were not to be significant in samples otherwise impacted with coal tar VOCs, and therefore are not considered to be related to the coal tar NAPL or the overburden dissolved phase groundwater contamination at the site. No SVOCs were reported in any of the samples at concentrations in excess of the method detection limits of 10 µg/l.

1.4.4.4 Soil Gas and Indoor Air

A total of 20 sub-slab and 6 perimeter soil gas samples, 9 indoor air samples, and 6 ambient/background air samples were collected and analyzed to evaluate the potential for vapor intrusion of site-related VOCs into structures on or near the site. Soil gas appears to be impacted by volatile organic chemicals entering the vadose zone from contaminated groundwater. Buildings located above or near the groundwater contamination west of the site had elevated levels of MGP related chemicals in the sub-slab samples collected. While there does not appear to be an immediate health concern associated with this contamination, there is a potential for indoor air to be impacted by the VOCs in the soil gas if conditions change in the future.

1.4.4.5 Tonawanda Creek Sediment and Surface Water

A total of 3 surface water and 19 sediment samples were collected and submitted for laboratory analysis in order to evaluate the potential for impacts from the site. Based on this sampling, Tonawanda Creek sediment contamination related to the site appears to be restricted to a relatively limited area near the shoreline between the railroad bridge and the loading dock. There is no evidence of any site related contaminants of concern impacting the surface water quality in the Tonawanda Creek.

1.4.5 Fate and Transport

The environmental fate and transport of the contaminants at the site, VOCs and SVOCs are dependent upon their physical and chemical properties. For simplicity, the environmental fate and transport of these contaminants of concern will be discussed as groups of compounds rather than on an individual basis.

1.4.5.1 Lighter Petroleum Hydrocarbons/VOC Contamination

The specific gravity of the coal tar beneath the Site is greater than water and can be present as a NAPL in separate phase form. In general, the lighter petroleum fractions (aliphatic hydrocarbons up to C12 and up to C9 aromatic hydrocarbons) are relatively soluble in water, are moderately to highly volatile, will readily desorb from soils, and are readily degraded by microorganisms. Thus, these lighter petroleum fractions are moderately mobile in the subsurface.

The primary VOC analytes detected in the environmental media samples collected at the Site were benzene, toluene, ethylbenzene, and xylenes (collectively referred to as BTEX), methyl substituted benzenes (1,3,5-trimethylbenzne and 1,2,4-trimethylbenzene) and naphthalene. All of the petroleum-related VOCs detected at the Site, with the exception of naphthalene, contain a benzene ring as the base molecular structure with, depending upon the compound, various alkane chains attached. The molecular structure of naphthalene consists of two benzene rings with one common side. All of these VOCs have low to moderate molecular weights, high water solubilities, high vapor pressures, moderate to high Henry’s Law constants, low water-carbon partition coefficients, and low to moderate octanol-water partition coefficients. These properties result in only slight adsorption to soils and rapid volatilization into soil vapor and the atmosphere.

1.4.5.2 Heavier Petroleum Hydrocarbons/PAH Contamination

Compounds typical of three to six-ringed PAHs generally have low solubility values. Accordingly, PAHs tend to be retained in the soil matrix, and exhibit little mobility. Such compounds are characterized by low Henry's law values and are not considered highly volatile and thus stable. These compounds biodegrade more slowly than lighter compounds, and tend to persist in the environment.

The fate and transport of the heavier molecular weight petroleum fractions (>C12 aliphatic hydrocarbons and >C10 aromatic hydrocarbons) are dependent on the petrochemical composition of the source, weathering, natural biodegradation, etc. In general, these heavier weight petroleum fractions generally behave as PAHs, with the exception of the lighter PAH compounds such as naphthalene and 2-methylnaphthalene, which are more soluble and biodegradable than most PAH compounds.

1.4.5.3 Migration Pathways, and Potential Indoor Air Impacts

Potential migration pathways have been identified based on data obtained during the RI and previous investigations. Elements necessary for a migration pathway to exist include a source of contamination, a release mechanism, and a medium allowing movement of the contaminants.

The potential migration pathways include migrations of contaminants via:

- Groundwater
- Soil Gas
- Indoor air
- Ambient air
- Movement of contaminated soil particles via ambient air or erosion
- Underground utilities
- Surface water and sediments

Groundwater is the most significant migration pathway at the Site. The groundwater contamination plume at the site developed primarily due to the migration of contaminants dissolved in groundwater. As the groundwater moves naturally within the subsurface, the dissolved contaminants are transported with the water. Additionally, contaminants adsorbed to fine soil particles carried by the groundwater can serve as a potential migration pathway. However, because the quantity of soil that actually moves through the subsurface is small, it is unlikely that this mode of transport has ever been or will ever be a significant migration pathway.

Volatilization of contaminants from soil or groundwater can result in contamination of soil gas, and ultimately indoor or ambient air. To evaluate the potential for migration of vapors to indoor air, soil gas, indoor air and ambient air samples were collected during the RI investigations between December 2002 and April 2003. These samples indicated the presence of VOCs in the soil gases of the vadose zone from impacted groundwater (and soil). The indoor samples from buildings located near the groundwater contamination east and west of the Site also indicated detectable levels of VOCs. Therefore, soil gas is considered to be a current migration pathway.

Ambient air does not appear to be a significant migration pathway because the concentrations of VOCs in the soil, groundwater and soil gas generally do not appear to be high enough to result in VOC concentrations that will be detected in ambient air above background conditions. In addition, air monitoring conducted during the RI field investigation did not detect concentrations of VOCs in ambient air above typical background levels.

Air does not appear to be an existing or potential migration pathway due to fugitive dust because the Site is generally covered with vegetation, paved and/or covered by buildings. These site features, and the depth to contaminated soil and NAPL (>2 feet), make it unlikely that fugitive dust emissions will provide a significant migration pathway. In addition, the large atmospheric dilution factor would likely reduce concentrations below background levels. These site features also make erosion and transport of soil particles an unlikely pathway.

Surface water and sediment sampling in the nearby Tonawanda Creek indicated the presence of coal tar-related contamination in sediments. No coal tar-related contaminants were present in Tonawanda Creek surface water. Therefore, sediments are considered a likely migration pathway at the Site.

1.5 SUMMARY OF QUALITATIVE HUMAN HEALTH EXPOSURE ASSESSMENT

The environmental data collected at the site were evaluated to identify substances that were to be the focus of the Human Health Exposure Assessment (HHEA). In the development of the list of contaminants of potential concern (COPC) for use in the HHEA, the environmental samples collected during the RI were grouped into five media:

- Groundwater
- Surface soil
- Subsurface soil
- Indoor air
- Surface water
- Sediment

The following list of chemicals were selected as COPCs for determining potential human health risks related to site groundwater:

VOCs

Benzene
Toluene
Ethylbenzene
Xylenes
1,3,5-Trimethylbenzene
1,2,4-Trimethylbenzene
Naphthalene

SVOCs

Acenaphthene
Acenaphthylene
Anthracene
Carbazole
Dibenzofuran
Fluoranthene
Fluorene
2-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene

No COPCs were identified for surface soil. The following list of chemicals were selected as COPCs for determining potential human health risks related to site subsurface soil:

VOCs

Benzene
Toluene
Ethylbenzene
Xylenes
1,3,5-Trimethylbenzene
1,2,4-Trimethylbenzene
Naphthalene

SVOCs

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene

Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Carbazole
Chrysene
Dibenzo(a,h)anthracene
Dibenzofuran
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
2-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene

The following list of chemicals were selected as COPCs for determining potential human health risks related to site indoor air:

VOCs

Benzene
Toluene
Ethylbenzene
Xylenes
1,3,5-Trimethylbenzene
1,2,4-Trimethylbenzene

No COPCs were selected for surface water. The following parameters were selected as COPCs for evaluating Tonawanda Creek sediments in this Qualitative Human Health Exposure Assessment:

VOCs

Benzene
Toluene
Ethylbenzene
Xylenes
1,3,5-Trimethylbenzene
1,2,4-Trimethylbenzene
Naphthalene

SVOCs

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Carbazole
Chrysene
Dibenzo(a,h)anthracene
Dibenzofuran

Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
2-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene

The HHEA was intended to evaluate current known site conditions and available environmental analytical results in an effort to identify COPCs and potential human exposure pathways at the site. This was accomplished in accordance with state and federal guidelines.

1.5.1 Exposure Assessment

1.5.1.1 Characterization of the Exposure Setting

The purpose of an exposure assessment is to identify potential current and future human exposure pathways. The exposure assessment utilizes the current environmental conditions at the Former Gastown MGP site in determining potential exposure scenarios. The analysis assumes that the concentrations of chemicals in environmental media has stabilized and will not change significantly over time.

The Former Gastown MGP site is located on East Niagara Street in the City of Tonawanda, Erie County, New York. Manufactured gas was produced at the approximately 3.4 acre site from 1884 through the 1950s. The site is currently under private ownership and is used as a rental property for several local industries including Acme Grinding Services, Inc., Advanced Electrical Services, D.L. Moore, Inc. (fluid handling and equipment), The Cutting Edge (landscaping), and Great Lakes Gear. The Site is bordered to the north by East Niagara Street. Further to the north, is a recreational walking/biking path and then Tonawanda Creek (an active segment of the New York Barge Canal System). The abutting property to the east is owned by NFTA, which leases a portion of the property to the Gastown Sportsman's Club. The parcel of land to the east of the NFTA property is owned by the Gastown Sportsman's Club and residential properties are located along the eastern boundary of the club property. An active railroad line forms the southern and western boundaries of the former Gastown MGP property, and residential properties are located further to the west of the railroad lines. An AT&T fiber optic underground cable is located within the parking lot of the Sportsman's Club, approximately 25 feet west of the clubhouse.

The topography of the Site and general vicinity slopes gently to the north towards Tonawanda Creek; an active segment of the New York State Barge Canal System. A railroad bridge over Tonawanda Creek is present to the northwest of the Site. A concrete retaining wall begins at the railroad bridge and continues westward. The height of the wall is approximately 8 feet above the water level and the depth of water in this area is approximately 14 feet. An apparent former loading dock is located to the east of the railroad bridge (the walls of the structure are intact).

The total population of Tonawanda, according to the US Census 2000 data, is 16, 136. The closest school to the Site is the Baptist School, located approximately 600 feet west of the Site in the Open Bible Baptist Church property on East Niagara Street. The East Niagara Street Playground containing a playground and soccer, baseball, softball and football fields is located approximately 0.2 miles east of the Site. The walking/biking path and public parks located along Tonawanda Creek are used extensively for recreational purposes during the warmer (summer) months. Private docks are located along the banks of Tonawanda Creek to the east of the Site.

1.5.2 Potential Exposure Pathways/Human Receptors

The purpose of this exposure assessment is to identify pathways through which people can be exposed to contaminants in environmental media. As outlined in the U.S. Environmental Protection Agency's *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)* (USEPA/540/1-89/002, December 1989), an exposure pathway generally consists of four elements:

- A source and mechanism of chemical release;
- A retention and transport medium (media);
- A point of potential human contact with the impacted media; and
- An exposure route at the contact point.

In order for an exposure pathway to be complete, all four of the above elements must be met. The source itself (e.g., soil containing chemicals) may be an exposure point, or an impacted media may be a contaminant source for other media (e.g., impacted soil could be a source for groundwater contamination). Considering the chemical/physical properties of the chemicals detected on the Former Gastown MGP site, the adjoining property uses/characteristics, the environmental media providing potential human exposure pathways include:

- Subsurface Soils
- Surface Soils
- Groundwater
- Ambient Air
- Indoor Air
- Surface Water and Sediment

Based on the characteristics of the Former Gastown MGP site and surrounding areas, potential human receptors/exposure pathways were identified. A complete discussion of these evaluations follows.

These include the following potential exposure pathways that are discussed in detail below:

- Direct contact with subsurface soils by future on-site residents, future on-site workers, future site visitors, and future construction/utility worker.
- Ingestion/household use of impacted groundwater by future site residents, future on-site workers, future on-site visitors and future nearby residents (if a private well is installed in the future), and direct contact with shallow (overburden) groundwater by future construction/utility workers.
- Inhalation of impacted indoor air by future on-site workers/visitors, future on-site residents, and future nearby residents/Sportsman's Club visitors.
- Direct contact with stream sediments by nearby residents and area visitors during recreational activities.
- Ingestion of fish from the Tonawanda Creek by nearby residents/visitors during recreational fishing activities.
- Direct contact with free phase product (NAPL) by future on-site residents, future on-site workers, future on-site visitors, future nearby residents and future construction/utility workers.

1.6 SUMMARY OF THE FISH AND WILDLIFE ASSESSMENT

The criteria-specific analysis indicates that contaminants are present in sediments from Tonawanda Creek, near the Gastown Site, at concentrations that may adversely affect aquatic organisms. The toxic effects analysis suggests that concentrations of PAHs currently found in creek sediments may adversely affect wildlife feeding in the vicinity of the creek through ingestion of contaminated fish and/or invertebrates. Many of the metals and PAHs detected in creek sediments are widespread contaminants and their presence in Tonawanda Creek may or may not be associated with previous site activities. Site conditions do not appear to be impacting the surface water quality of the Tonawanda Creek.

1.7 IDENTIFICATION OF SCGS

Remedial actions at the Gastown Former MGP site must, at a minimum, achieve overall protection of human health and the environment and comply with New York State Standards, Criteria, and Guidelines (SCGs) as defined by NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4030. In New York State, a remedial program is governed by the Environmental Conservation Law (ECL) and the regulations in 6 NYCRR Part 375. These regulations are analogous to the Federal National Contingency Plan (40 CFR 300) which requires that the selection of remedial actions meet applicable or relevant and appropriate requirements (ARARs) of state and federal environmental laws and regulations.

SCGs are defined in 6 NYCRR Part 375 as follows: “A site's program must be designed so as to conform to standards and criteria that are generally applicable, consistently applied, and officially promulgated, that are either directly applicable, or that are not directly applicable but are relevant and appropriate, unless good cause exists why conformity should be dispensed with. Such good cause exists if any of the following are present:

a) “The proposed action is only part of a complete program that will conform to such standard or criterion [of guidance] upon completion; or

b) Conformity to such standard or criterion will result in greater risk to the public health or to the environment than alternatives; or

c) Conformity to such standard or criterion is technically impracticable from an engineering perspective; or

d) The program will attain a level of performance that is equivalent to that required by the standard or criterion through the use of another method or approach.”

SCGs are used to assist in determining the appropriate extent of site cleanup, to scope and formulate remedial action alternatives, and to govern the implementation of a selected response action. Laws and regulations identified as SCGs are either applicable or, alternatively, relevant and appropriate. In accordance with TAGM #4030, an alternative which does not meet the SCGs should not be considered unless a waiver to the SCG(s) is appropriate or justifiable.

This section of the FS identifies potential SCGs for the Gastown Former MGP site. These SCGs are identified as chemical-specific, location-specific, or action-specific. SCGs are used to create a framework for determining health- and risk-based limits for remedial action and developing remedial action alternatives, as outlined in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

Initially, potential SCGs are compiled. After review of the potential SCGs, media-specific preliminary remediation goals are defined. Remedial action objectives are then developed which specify the contaminants of concern (COCs), exposure routes and receptors, and acceptable contaminant levels for each exposure route (preliminary remediation goals). Ultimately, it is necessary to demonstrate that the final remedy addresses all pathways and COCs, not just those that trigger the need for remedial action.

The remedial action alternatives evaluated as part of this Feasibility Study must attain New York State environmental standards and federal environmental laws and regulations, standards, goals, guidelines or other criteria applicable to specific site concerns resulting from the groundwater and soil contamination. In determining chemical-specific, location-specific, and action-specific SCGs for treatment of the contaminated groundwater and soil, the state, local, and federal regulatory requirements listed below were considered.

1.7.1 Potentially Applicable Guidelines, Regulations, and Other Criteria

Potential SCGs are broken down into three groups:

- Location-specific SCGs;
- Chemical-specific SCGs; and
- Action-specific SCGs;

Each of these groups of SCGs is described below. In addition, other criteria to be considered (TBC), which are not enforceable standards but may be technically or otherwise appropriate for consideration in the development of remedial alternatives, are described below.

1.7.2 Location-Specific SCGs

These are restrictions based on the conduct of activities in specific types of locations. Examples of natural site features include wetlands, scenic rivers, and floodplains. Examples of man-made features include historic districts and archaeological sites. Remedial action alternatives may be restricted or precluded depending on the location or characteristics of the site and the requirements that apply to it. Potential location-specific SCGs and their applicability to the Gastown Former MGP site and remedial alternatives are identified and detailed in Table 1-1.

1.7.3 Chemical-Specific SCGs

These are health- or risk-based numerical values or methodologies that establish concentration or discharge limits, or a basis for calculating such limits, for particular contaminants. Examples of chemical-specific SCGs are drinking water maximum contaminant levels (MCLs), ambient air quality standards, or ambient water quality criteria for PCBs. If more than one such requirement applies to a contaminant, compliance with the more stringent applicable SCG is required. Potentially applicable guidelines and regulations include those promulgated by the State of New York and those of the U.S. Government. Potential chemical-specific SCGs and their applicability to the Gastown Former MGP site and remedial alternatives are identified and detailed in Table 1-2.

1.7.4 Action-Specific SCGs

Action-specific requirements set controls or restrictions on particular kinds of activities related to the management of hazardous substances, pollutants, or contaminants, and are primarily used to assess the feasibility of remedial technologies and alternatives. Action-specific SCGs are applicable to particular remedial actions, technologies, or process options. As such, these do not define site cleanup levels or remedial action objectives, but affect the implementation of specific types of remediation. For example, although ambient air has not been identified in the RI as a contaminated medium of concern, air quality SCGs are listed below, since some potential remedial actions may result in air emissions of toxic or hazardous substances. As such, these SCGs are not considered in the development of the remedial action objectives; these action-specific SCGs are considered in the screening and evaluation of remedial alternatives in subsequent chapters of this report.

Certain action-specific SCGs include permit requirements; however, under the NYSDEC Inactive Hazardous Waste Disposal site Remedial Program, state and local permits and other administrative requirements are not required for remedial actions conducted entirely on sites being remediated by the NYSDEC under Superfund or pursuant to an Order on Consent with New York State. Exemptions from permit requirements include approval of or consultation with administrative bodies, documentation, reporting, record-keeping and enforcement. However, the substantive requirements of other SCGs, such as health-based, technology-based, or site-specific requirements still must be satisfied. Potential action-specific SCGs and their applicability to the Gastown Former MGP site and remedial alternatives are identified and detailed in Table 1-3.

1.7.5 Other Criteria to be Considered (TBC)

TBC criteria are not enforceable standards but may be technically or otherwise appropriate to consider in developing site- or media-specific remedial action objectives or cleanup goals. Federal secondary drinking water standards are considered as TBC criteria in the development of remedial alternatives. Federal secondary drinking water standards are based on aesthetic considerations rather than human-health considerations. As such, many of the secondary criteria relate to qualities of finished (treated) potable water (e.g., taste, color, turbidity) and are not applicable to groundwater or water sources.

Criteria established by publicly-owned treatment works (POTWs), such as pretreatment requirements or other acceptance criteria, for discharge of wastewater into public sewer systems are also considered TBCs.

Figure 1-1 Site Location Map

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 INTRODUCTION

This section identifies the remedial action objectives, general response actions, and potentially applicable remedial technologies for the Gastown Former MGP site. This site presents some of the most challenging conditions that a remedial engineer faces when designing a site remedy. These conditions include:

- A significant quantity of free phase product (coal tar) within the site and beyond its borders,
- Contaminants (PAHs) that are not readily volatilized or degraded,
- Contamination in both the vadose and saturated zones,
- Impacted zones have relatively low hydraulic conductivity (fine sand stratified with silty clay), which can reduces the effectiveness of in-situ treatment, and
- Active businesses, railroad lines and residences occupying the space above contamination subsoils including free product.

No one remedial technology can effectively be implemented to remediate the site under these conditions, so a wide range of remedial technologies have been identified as potentially capable of meeting one or more of the remedial action objectives. Each remedial technology has been evaluated with respect to applicable guidance criteria, and appropriate technologies were retained for use in developing the remedial action alternatives for the site.

2.2 REMEDIAL ACTION OBJECTIVES

The remedial action objectives (RAOs) are goals intended to minimize or reduce to target levels, the potential for human exposure to or environmental damage from the presence and/or migration of contaminants of concern associated with the improper on-site disposal of hazardous waste materials. Definition of the RAOs requires identification and assessment of the contaminants of concern, effected media, potential migration pathways, exposure routes, and potential receptors. The RAOs are typically established based on the SCGs to protect human health and the environment. Based on the SCGs specified in Section 1, the results of the RI, the Human Heath Risk Assessment (HHRA), and the Fish and Wildlife Impact Analysis (FWIA) the primary RAOs developed for the site are the following:

To eliminate or reduce to the extent practicable:

- the presence of NAPL and MGP-related contaminants as the sources of soil, groundwater, soil gas and sediment contamination;
- migration of NAPL and MGP-related contaminants that would result in soil, groundwater, soil gas and sediment contamination;
- the release of contaminants from NAPL in on-site soil into groundwater that result in exceedances of groundwater quality standards;
- the potential for ingestion of groundwater with contaminant levels exceeding drinking water standards;
- the potential for ingestion/direct contact with contaminated soil or sediment;
- impacts to biota from ingestion/direct contact with soil or sediment; and
- the release of contaminants from subsurface soil under buildings into indoor air through soil gas migration and intrusion.

Further, the remediation goals for the site include attaining, to the extent practicable:

- recommended soil cleanup objectives in TAGM 4046;
- ambient groundwater quality standards;
- sediment screening criteria, and
- USEPA target indoor air criteria.

2.2.1 Compounds of Concern

The analytes of interest for the site as discussed in Section 1.4 are VOCs and SVOCs. Soil containing free phase NAPL is the primary target of the remediation and VOCs and SVOCs migrating from this source to soil, groundwater, indoor air and sediment are also of interest.

2.2.2 Numeric Objectives for COCs

Once compounds of concern (COCs) are identified, cleanup levels are developed to further define the remedial goals for the site. A cleanup level is a numeric objective used to determine what areas are targeted for remediation and when remediation is complete. Numeric objectives can be derived in three ways. A quantitative site-specific fish and wildlife assessment and human health risk assessment can be performed to develop site-specific risk-based objectives using actual soil, groundwater, air and sediment characteristics (e.g., organics content, analytical results). Second, site background data can be used as a remedial goal. The third method for obtaining numeric objectives for a site is to review State or Federal guidelines for chemical specific criteria. Standard cleanup criteria are developed based on assumed rates of transport of the contaminants from soil/sediment into groundwater or surface water.

Site-specific risks to human health have not been quantified for the Gastown Former MGP site, nor are there sufficient background data to develop cleanup goals. Groundwater standards from the NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 and recommended soil cleanup objectives (RSCOs) from NYSDEC Technical Administrative Guidance Memorandum (TAGM) 4046 were considered for use as numeric remediation goals.

The numeric objectives for a site are used to determine the area and volume of material to be remediated. To evaluate contaminated site soil, Geographic Information System (GIS) software was used to prepare soil concentration maps for each of the groups of COCs to assess the lateral extent of soil and groundwater exceeding the selected numeric remediation goals.

Non-Aqueous Phase Liquids (NAPL)

The free-phase product (NAPL) present in the subsurface is depicted in Figure 2-1. Although no current human exposures are occurring (the material is below the ground surface at a depth of approximately 5 feet below grade), the presence of NAPL may be a point of direct contact, and inhalation of vapors, by future construction and utility workers in excavations. Additionally, this material may affect the indoor air quality of an on-site and nearby buildings building due to potential migration of vapors. As the occurrence of visually observable NAPL correlates with the soil that exceeds remediation goals, NAPL is anticipated to be remediated as part of the overall site remediation plan.

Volatile Organic Compounds

The numeric remediation goals for VOCs (primarily BTEX and naphthalene) in soil are the standards in NYSDEC's TAGM 4046 and in groundwater are the standards in the NYSDEC Division of Water, TOGS 1.1.1. The extent of VOC contamination in soil is not defined by available data but correlates to the geometry of the NAPL plume. Contamination in soil samples may be associated with dissolved VOCs in groundwater, which extend beyond the leading edge of the NAPL plume. The groundwater VOC plume is not defined by available data.

Semi-volatile Organic Compounds

The numeric remediation goals for SVOCs in soil are the standards in the NYSDEC's TAGM 4046 groundwater are the standards in the NYSDEC Division of Water, TOGS 1.1.1. The extent of SVOC contamination in soil is not defined by available data but correlates to the geometry of the NAPL plume. Contamination in soil samples may be associated with dissolved SVOCs in groundwater, which extend slightly beyond the leading edge of the NAPL plume. The numeric remediation goals for SVOCs in sediment correspond to the NYSDEC Technical Guidance for Screening Contaminated Sediment (January 1999). The sediment samples collected from the surface of the Tonawanda Creek bottom and the subsurface sediments contained many SVOCs in excess of the screening criteria. There is not sufficient evidence to attribute these contaminants to the site NAPL.

2.2.3 Areas and Volumes to be Remediated

The lateral limits of contamination for all COCs are combined in Figure 2-1. This figure shows the zones with similar conditions that may be considered separately when evaluating remedial technologies. These zones are delineated as follows:

Zone 1: Areas where the NAPL was observed in soil borings in the form of seams, pools or masses of NAPL saturated soil. NAPL in these areas ranges from small blebs and tiny seams to several feet of contiguous NAPL saturation. These areas would include contaminated groundwater.

Zone 2: Areas where the NAPL was observed in soil borings in the form of tiny seams or small blebs. Contaminated groundwater is also present in these areas.

Zone 3: These areas constitute the groundwater VOC plume (which encompasses the SVOC plume), which extents well beyond the NAPL plume.

Zone 4: This area constitutes the zone of impacted sediments in the Tonawanda Creek bed. A slight trend of increased levels of NAPL-related contaminants (total PAHs and naphthalene) were observed in the area designated as Zone 4. Additional sediment sampling would be required to confirm the extent of impacted sediments.

A detailed discussion of how volumes of soil to be remediated are estimated is provided in future sections where treatment and disposal options are evaluated.

2.3 GENERAL RESPONSE ACTIONS

General response actions are actions that may satisfy the remedial action objectives. They may include no action, institutional controls, containment, in-situ treatment, source removal/excavation with ex-situ treatment and/or disposal, and/or long-term monitoring. These actions may be utilized individually or in combination. The general response actions selected for the Gastown Former MGP site are identified below:

- No action,
- Institutional controls,
- Engineering controls,

- In-situ treatment, and,
- Removal with ex-situ treatment, and on-site or off-site disposal.

2.4 IDENTIFICATION AND PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES

NYSDEC guidance recommends screening remedial technologies using the criteria of effectiveness and implementability. In this section, a broad range of remedial technologies is identified and screened to eliminate from further consideration those technologies and processes that may be of limited effectiveness, or may not be able to be rapidly and practically implemented at the site. The purpose of this screening is to better focus the FS on those technologies that offer the greatest promise of being effective and that can be implemented at the site within a reasonable time frame.

Potentially applicable remedial technologies are identified for the site to satisfy the general response actions specified in Section 2.3. The RAOs and general response actions are identified on Table 2-1. Remedial technologies, affected media, and process options potentially capable of achieving one or more of the RAOs are summarized in Table 2-2. These remedial technologies are evaluated based on site-specific information and are screened initially for technical applicability. Technologies are considered applicable if, individually or in combination, they would achieve the RAOs. Innovative technologies are not retained for further analysis unless they are proven and are readily available.

Table 2-3 provides the results of the preliminary screening of the potentially applicable remedial technologies, including the technical justification for eliminating technologies from further consideration. The following technologies/processes were eliminated from further consideration during the preliminary screening:

Phytoremediation	Bioreactor
Electrokinetic Separation	Soil Washing
Soil Flushing	Chemical Extraction
Air Sparging	Supercritical CO2 Fluid Extraction
In-well Air Stripping	Co-buring
Ion Exchange	Cold/Hot-mix Asphalt Batching
Sprinkler irrigation	High Energy Destruction
Landfarming	Membrane Separation
Biopiles	Scrubbers
	Deep Well Injection

Those technologies retained after the initial screening are further evaluated/screened based on effectiveness and implementability. The anticipated effectiveness of a technology refers to the ability of that technology to contribute to a remedial program that is protective of human health and the environment, and capable of meeting the stated remedial action objectives. In assessing the effectiveness of each technology, the demonstrated successful performance of each technology is considered. Implementability is the feasibility and the ease with which the technology can be applied at the site. Implementability takes technical and administrative factors into consideration, such as:

- Are the hazardous substances present at the site compatible with the technology?
- Is there sufficient room at the site to install and/or operate the technology?
- Will access difficulties prevent delivery of certain treatment equipment?
- Is the use of the technology compatible with surrounding land uses?

- Will application of the technology unacceptably interfere with other ongoing uses of the site?
- What permitting and other regulatory requirements apply to use of the technology?
- Does the technology require resources of a type or in a quantity that is not readily available at the site?
- Are there experienced contractors that can provide, install, and operate the technology?

During this secondary phase of the screening process, the relative costs of the alternative technologies are also considered.

2.5 EVALUATION OF REMEDIAL TECHNOLOGIES

The conditions at the Gastown Former MGP site present significant challenges for the remedial designer. The conditions that could limit the effectiveness or implementability of many of the available remedial technologies are:

- The presence of significant quantity of NAPL in the subsurface soils,
- The soils and groundwater containing contaminants are relatively low permeability and heterogeneous (fine sands stratified with silty clays) making many in-situ treatment technologies ineffective,
- Some of the contaminants (4, 5 and 6 ring PAHs) are relatively resistant to some forms of treatment,
- The buildings on site contain active businesses, and
- The contamination has migrated off-site and is underlying an active rail line, roads, utilities and residential houses.

No one technology is likely to be effective for addressing the five Zones of contamination at the Gastown Former MGP site, so the following evaluation of remedial technologies considers how these technologies might reasonably be combined to accommodate the various challenging conditions.

The remedial technologies retained for further consideration following the secondary phase of the screening process are listed below.

No action: Consideration of the "No Action Alternative" is required by NYSDEC guidance.

Access Restrictions: Access restrictions are used to prevent direct exposure to waste and impacted media, protect installed remedial technologies, and/or for site security during the construction/remediation phase.

> *Institutional Controls (deed restrictions)*: Land use restrictions by themselves do not result in a rapid or significant reduction or elimination of the potential for direct exposure and therefore do not meet the remedial action objectives. They are retained because they could be an effective and/or necessary means of reducing future exposure if certain remedial alternatives are selected. typically, the owner of the site will submit to the NYSDEC for review and approval a legal instrument, to run with the land, that will in perpetuity notify any potential purchasers of the property of the contamination present at the property and of the engineering and institutional controls necessary to protect public health and the environment. This instrument will be recorded and filed with the appropriate County Clerk, and proof of recording and filing will be submitted to NYSDEC.

Physical barriers (fencing): Use of barrier fencing and hazard warnings to restrict access to the site could be readily implemented and would be effective in rapidly reducing the potential for exposure. May be a component of certain remedial options, particularly those that result in significant residual wastes remaining on the property.

Business or Residence Relocation: Businesses and or residences are encouraged to relocated through property purchase or eminent domain procedures. Removal of site occupants would provide full access and prevent direct exposure during remedial construction. Relocating businesses would likely be easier to achieve than relocation of residential occupants. This mechanism may be used in conjunction with other remedial technologies.

Containment:

Capping: Installation of natural and/or synthetic cover materials, either with or without solidification/stabilization would be an effective means of preventing direct exposure to impacted soils. An impermeable barrier could be used to prevent the infiltration of precipitation through the impacted soil reducing the dissolution of contaminants into the groundwater. A cap alone would not reduce the volume or toxicity of the contaminants or prevent the migration of impacted groundwater. Long-term maintenance of the cap would be required. Land use restrictions necessary to protect the cap would prohibit most beneficial uses of the property in the contained areas.

Grout/slurry/pile walls: Vertical barriers walls keyed into the lacustrine silty clay could be installed to prevent the lateral migration of NAPL and reduce or prevent the flow of groundwater from the impacted site. Barrier walls would not be effective alone but in combination with capping and hydraulic containment they could effectively isolate contaminants thereby preventing direct exposure and mitigating contaminant migration. Containment walls are generally easy to install with conventional construction equipment and the technology is proven, reliable, and readily available. However, utilities, roads, rail lines, buildings and residential features (pools, fences) present obstacles to installing barrier walls at ideal locations. Innovative methods such as jet grouting, may be necessary to complete walls in inaccessible areas. These methods are not as reliable or verifiable as other forms of containment walls.

Hydraulic containment: Hydraulic containment could be utilized to prevent the migration of impacted shallow groundwater. Hydraulic containment can be achieved through pumping from wells designed to capture contaminated groundwater by reversing flows, or by installing a collection trench downgradient of a source area, cutting off the flow of contaminated groundwater. Combined with capping and barrier walls, hydraulic containment could provide complete long-term isolation of waste mass from the surrounding environment. Treatment of groundwater prior to discharge would be necessary.

Note: Deed restrictions and physical barriers would be needed for any containment option(s) to restrict access and future use of the containment areas.

In-Situ Treatment:

The main advantage of in-situ treatment as compared to removal and treatment or disposal is the minimized disruption to the site and potential cost savings. However, in-situ treatment technologies general take more time to remediate contaminated media and verification that RAOs have been achieved can be difficult. If in-situ treatment is ineffective, an alternative remedial measure may be required.

All in-situ treatment technologies rely on establishing contact with the contaminants. Often a technology is most effective in a permeable and homogeneous formation and has limited effectiveness in lower permeability, heterogeneous soil. The relatively low permeability of the alluvium at the Gastown site (fine sand stratified with silty clay) would limit the efficiency of any in-situ treatment technology, but since other site conditions may eliminate the implementability of other technologies (removal and ex-situ treatment/disposal), a less than optimum in-situ treatment system may be warranted over MNA alone.

Another inherent problem with in-situ treatment at the Gastown site is the presence of NAPL. Biological and chemical treatment occurs on the surface of NAPL blebs or areas of soil saturated by NAPL (saturated areas). Considerable time would be needed for microbial degradation or chemical reaction to penetrate through thick layers or zones of NAPL, and with the continuous flushing of groundwater a continuing source of oxygen, nutrients or chemicals would be required to maintain the optimum levels at the NAPL boundaries. In-situ treatment will often appear successful because groundwater contaminant levels are reduced to remediation objectives, but if NAPL remains in the pore spaces, it eventually recontaminates the groundwater, causing what is called a "rebound" effect. Additionally, high concentrations of contaminants can be lethal to some microorganisms and naturally occurring organic material can lower the efficiency of chemical treatment..

The advantages and limitations specific to the Gastown MGP Site are listed below for each of the in-situ treatment technologies.

Biological Insitu Treatment

"Bioremediation techniques are destruction techniques directed toward stimulating the microorganisms to grow and use the contaminants as a food and energy source by creating a favorable environment for the microorganisms. Generally, this means providing some combination of oxygen, nutrients, and moisture, and controlling the temperature and pH. Sometimes, microorganisms adapted for degradation of the specific contaminants are applied to enhance the process." Federal Remediation Technology Roundtable (FRTR), Remediation Technologies Screening Matrix and Reference Guide Version 4.0 (FRTR web site www.frtr.gov). Bioremediation techniques have been successfully used to remediate soils and groundwater contaminated by BTEX and PAHs. These techniques can be more successful in degrading heavier molecular weight PAHs that are often resistant to other treatment methods, than other in situ remedial methods. Bioventing and enhanced bioremediation are two variations of bioremediation techniques.

> Bioventing: Oxygen is delivered to contaminated unsaturated soils by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation. Bioventing stimulates the natural in situ biodegradation of any aerobically degradable compounds in soil by providing oxygen to existing soil microorganisms. Bioventing techniques have been successfully used to remediate soils contaminated by petroleum hydrocarbons, nonchlorinated solvents, some pesticides, wood preservatives, and other organic chemicals.
>
> *Enhanced Bioremediation*: Enhanced bioremediation is a process in which indigenous or inoculated micro-organisms (e.g., fungi, bacteria, and other microbes) degrade (metabolize) organic contaminants found in soil and/or ground water, converting them to innocuous end products. Nutrients, oxygen, or other amendments may be used to enhance bioremediation and contaminant desorption from subsurface materials.

Advantages:

- Effective for site contaminants (BTEX and PAHs).
- Biological processes are typically implemented at low cost.
- Technology is readily available and proven effective.
- Technology can be implemented with a minimum of disturbance to site areas.
- Effective for both soil and groundwater.

Limitations:

- The low permeability, heterogeneous formation would limit efficient distribution of air or microorganisms, which would likely follow preferential flow paths. Residual contamination would result if bioremediation methods cannot be applied in all contaminated areas.
- This technology is inefficient or ineffective in the presence of free product. The high concentrations of contaminants adjacent to the NAPL can be lethal to the microorganisms. Also, if any microorganism could survive, the microbial degradation occurs only on the surface of NAPL blebs or saturated zones and would take a considerable amount of time to completely degrade the NAPL. It may be useful as a secondary "polishing" treatment after source removal or on the fringe of the NAPL plume (Zones 2 and 3).
- Low temperatures can slow remediation. Heating blankets can be placed at the surface during very cold outdoor temperatures. Since contamination is at depth, low temperatures are not likely to be a problem.
- Bioventing and enhanced bioremediation may require capture of vapors to prevent buildup in nearby basements.
- Bioremediation tends to be slow compared with other technologies and requires monitoring throughout the treatment period.

In-situ Chemical Treatment

Direct injection of oxidation agents chemically converts hazardous contaminants to innocuous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. The FRTR web site describes the three primary chemical oxidizing agents as follows:

> *Ozone Addition:* Ozone gas can oxidize contaminants directly or through the formation of hydroxyl radicals. Ozone reactions are most effective in systems with acidic pH. The oxidation reaction proceeds with extremely fast, pseudo first order kinetics. Due to ozone's high reactivity and instability, O_3 is produced on site, and it requires closely spaced delivery points (*e.g.*, air sparging wells). In-situ decomposition of the ozone can lead to beneficial oxygenation and biostimulation.
>
> *Peroxide:* Oxidation using liquid hydrogen peroxide (H_2O_2) in the presence of native or supplemental ferrous iron (Fe^{+2}) produces Fenton's Reagent which yields free hydroxyl radicals (OH^-). These strong, nonspecific oxidants can rapidly degrade a variety of organic compounds. Fenton's Reagent oxidation is most effective under very acidic pH (e.g., pH 2 to 4) and becomes ineffective under moderate to strongly alkaline conditions. The reactions are extremely rapid and follow second-order kinetics.
>
> *Permanganate:* The reaction stoichiometry of permanganate (typically provided as liquid or solid $KMnO_4$, but also available in Na, Ca, or Mg salts) in natural systems is complex. Due to its multiple valence states and mineral forms, Mn can participate in numerous reactions. The reactions proceed at a somewhat slower rate than the previous two reactions, according to second-

order kinetics. Depending on pH, the reaction can include destruction by direct electron transfer or free radical advanced oxidation—permanganate reactions are effective over a pH range of 3.5 to 12.

There are remediation companies such as ISOTEC, Inc. who purport to have developed a modified Fenton's reagent which is effective in neutral conditions and react more slowly, avoiding the extreme heat and potential for soil heaving.

Modified Fenton's Reagent Technology: ISOTEC's patented modified Fenton's reagent technology uses chelated iron catalysts and stabilized hydrogen peroxide that are injected into the contaminated subsurface at neutral pH to produce oxidizing and reducing free radicals that attack contaminants. The innocuous reaction byproducts including carbon dioxide, water and chloride if chlorinated contaminants are present.

Advantages:

- Effective for site contaminants, BTEX and PAHs, although heavier molecular weight PAHs may resist degradation.
- Technology is readily available.
- Technology can be implemented with a minimum of disturbance to site areas.
- Costs could be lower than excavation and treatment/disposal, but the presence of NAPL could require large quantities of costly chemicals to be injected or long-term application of ozone.
- Effective for both soil and groundwater.
- Short-term monitoring to evaluate effectiveness. May need to be followed by bioremediation or MNA.

Limitations:

- The low permeability, heterogeneous formation would limit efficient distribution of oxidants, which would likely follow preferential flow paths. Residual contamination would result if oxidants cannot be applied in all contaminated areas.
- This technology is inefficient in the presence of free product. As previously discussed, the chemical reactions occur on the surface of NAPL blebs or saturated zones. If the outer edge of the NAPL is neutralized by the oxidants, the reaction discontinues and the NAPL inside this outer zone is left untreated. Only when natural groundwater flushing eventually removes the degraded constituents from the surface of the NAPL does the untreated NAPL become exposed and available for further treatment. Many rounds of oxidant injection may be required to significantly reduce quantities of NAPL, which would be costly. It may be useful as secondary "polishing" treatment after source removal or on the fringe of the NAPL plume (Zones 3 and 4).
- May require pH adjustment of soil to be effective and naturally occurring organics in soils would consume oxidants. Naturally occurring organics have been observed in site soils so careful characterization of the extent of this material would be important prior to design.
- Some oxidants produce strong exothermic reactions where heat and soil heaving can create problems at the surface. The heat can also mobilize otherwise static NAPL and the migration would be difficult to predict or control.
- The heat associated with oxidization can mobilize the NAPL in ways that is difficult to predict. Containing the treatment areas with barrier walls or collection trenches would prevent uncontrolled migration.
- Requires handling of large quantities of hazardous oxidizing chemicals.
- Requires a pilot study to evaluate effectiveness.

In-situ Thermal Treatment

In-situ thermal treatment uses heat to release volatile contaminants to the vapor phase to be captured and treated, or to degrade (oxidize or pyrolize) contaminants. Sometimes called in-situ thermal desorption (ISTD), steam injection or enhanced soil vapor extraction (SVE). Heat, in the form of steam or hot gas is forced into the formation through injection wells to vaporize volatile and semivolatile contaminants. For ISTD, in-well heaters or electrodes heat the contaminated soils. Volatilized gasses are extracted from the injection wells and/or through a vapor recovery system and treated prior to discharge to the air. The heat transfer increases the potential of movement of volatilized contaminants to collection points and is therefore more efficient than technologies that simply inject liquids. However, the heat also can mobilize the NAPL in ways which can be difficult to predict and control.

Steam/Hot Air Injection: Steam or hot air is injected below the contaminants to drive contaminants into the vapor phase. A temporary cap and SVE points are installed to extract and capture the vapors. Groundwater extraction may be necessary to increase the size of the vadose zone. Effective for VOCs and SVOCs.

In-situ Thermal Desorption: To remediate VOCs and SVOCs, high heat is applied to rods or wells installed within the contaminated zones. The water in the formation is either dewatered prior to treatment or boiled away improving the soil vapor extraction capacity. Then the VOCs and SVOCs volatilize and are captured. Contaminants near the heating elements are destroyed.

Vitrification: Specialized physical process form of solidification. Electrical current used to melt soils at high temperatures, destroying organic contaminants by pyrolysis and immobilizing contaminants into a solidified crystalline mass (glass). Typically considered for use with inorganics as VOCs and SVOCs would be volatilized. No commercial portable vitrification systems are known to be currently available. Construction of an on-site processing plant would be very expensive for the quantities of soil to be processed.

Advantages:

- Effective for site contaminants, BTEX and PAHs, including NAPLs and could be used in source areas in conjunction with NAPL migration controls (barrier walls).
- Technology is readily available and proven effective.
- Technology can be implemented with a minimum of disturbance to site areas. Can be applied under buildings and roads with sufficient vapor phase controls.
- Effective for both soil and groundwater.
- Could be followed by bioremediation because pH would not be affected.
- Short-term monitoring to evaluate effectiveness.

Limitations:

- The low permeability, heterogeneous formation, particularly in the upper 10 feet of the alluvium, would limit efficient capture of vapors. The vadose zone is approximately 5 to 8 feet at the Gastown site and with the low permeability soil SVE would not likely be effective. Lowering of the groundwater table may be possible with an extraction system, or ISTD could be used to drive off the water in the formation (control of groundwater recharge may be required).
- While the heat can drive NAPLs to their vapor phase, it can also mobilize the NAPL in ways that is difficult to predict. Containing the treatment areas with barrier walls or collection trenches would prevent uncontrolled migration.
- High temperatures required to volatilize SVOCs can be costly because heating elements must be more closely spaced and significant energy is required to generate the heat.

- Soil that has a high organic content has a high sorption capacity of VOCs, which results in reduced removal rates or high energy costs to "burn-off" the organics.
- Air treatment and permitting may be required and residual liquids and spent activated carbon may require further treatment.

In-Situ Solidification/Stabilization:

Solidification/Stabilization: Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Solidification/stabilization agents are mixed with soils in-place through the use of a large diameter auger or conventional excavation equipment (in trenches). Surface access is required over the contaminated areas, which eliminates treatment under structures unless some form of horizontal augering could be performed or the buildings are removed. Use of stabilization agents is not effective with significant quantities of NAPL.

Pozzolan/Portland Cement: The Pozzolan/Portland cement process consists primarily of silicates from pozzolanic-based materials like fly ash, kiln dust, pumice, or blast furnace slag and cement-based materials like Portland cement. These materials chemically react with water to form a solid cementious matrix which improves the handling and physical characteristics of the waste. They also raise the pH of the water, which may help precipitate and immobilize some heavy metal contaminants. Resulting high pH may need to be buffered. Pozzolanic and cement-based binding agents are typically appropriate for inorganic contaminants. The effectiveness of this binding agent with organic contaminants varies.

Quicklime: Quicklime (CaO) is less expensive than cement. It is used to stabilize soil and the heat of hydration also can drive VOCs and SVOCs to their vapor phase which can be captured and treated within a containment building over the excavation or auger. Resulting high pH may need to be buffered. Has been successfully used with MGP waste.

Advantages:
- Effective for site contaminants, BTEX and PAHs with vapor containment and treatment.
- Technology is readily available and proven effective for areas with limited NAPL.
- Effective in saturated and unsaturated zones.
- May be more cost effective than other treatment or removal/disposal technologies.
- Short-term monitoring required to evaluate effectiveness.

Limitations:
- Not effective with significant quantities of NAPL. Could be considered at the fringe of the NAPL plume. Can be combined with chemical oxidation to reduce NAPL volumes.
- Requires full access to remediation zones. Not applicable under structures. Moderately disruptive to site areas, especially if vapor containment is required (sprung building).
- Volume increase could limit applicability.

Permeable Reactive Barrier Walls

Permeable Reactive Barrier (PRB) Wall: Passive in-situ remediation, which relies on the natural flow of groundwater through a permeable barrier, designed to bind or neutralize the dissolved or particulate contaminants. PRBs are typically used for chlorinated solvents (PCE/TCE) and are comprised of zero-valent iron. This type of wall is not effective for PAHs. Activated carbon could be used for BTEX and

PAHs, but intensive long-term O&M and maintenance of the wall would be required to replace spent carbon.

The following technologies would be applicable at the Gastown Former MGP Site in combination with other technologies.

Removal: Collection/extraction and/or excavation of the liquid coal tar waste material and associated contaminated soils, in combination with appropriate treatment or disposal technologies, would likely meet the remedial action objectives. NAPL extraction through pumping wells has already been accomplished for portions of the NAPL plume, complete removal of NAPL is not possible with this technology because the NAPL is not sufficiently mobile (a certain percentage gets caught in the interstitial spaces within the soil particles). Groundwater, vapor and NAPL extraction could be combined with numerous other technologies, but would not be effective alone.

Because of the presence of NAPL, excavation and disposal is a common technology used at MGP sites. There are areas in Zone 1 that would be accessible without removal of structures but the construction activities would require temporary shutdown of businesses. NAPL beneath buildings could be accessed in conjunction with building demolition, which would require relocation of businesses. Other Zone 1 areas cannot be excavated due to the presence of the railroad line. Residential housing could also be affected by certain Zone 1 removal. Areas in Zone 2 could also be targeted for removal but some areas are below the rail line and residential property.

Source removal technologies retained for evaluation include:

Groundwater Pumping
Vapor Extraction
Dual-Phase Extraction
Excavation
Interceptor Trench(es)

Ex-Situ Treatment (assumes removal and off-site disposal): Ex-situ treatment of groundwater or impacted soil may be required in association with certain on-site or off-site solid waste disposal options. Ex-situ treatment technologies retained for evaluation include:

GW Phase Treatments:
- Adsorption/Absorption
- Advanced Oxidation
- Air Stripping

Liquid Waste and Soil Treatments:
- Solidifaction/Stabilization
- Soil washing
- Chemical Extraction
- Thermal Treatment

Vapor Phase Treatments:
- Catalytic Thermal Oxidation
- Carbon Adsorption

One or more of these technologies may be combined in process trains in order to achieve the RAOs with respect to all site-specific COCs and affected media.

Disposal (assumes removal):

On-site Disposal: Similar to the containment options described above, an engineered Corrective Action Management Unit (CAMU) would be constructed. Waste would be excavated, consolidated and disposed of in the CAMU. Residual wastes from ex-situ treatment processes could also be placed in the CAMU. Site access restrictions, deed restrictions, and long term monitoring would be necessary. The site does not provide sufficient space for on-site disposal so this technology will be eliminated from further consideration.

Off-site Disposal (off-site facility): Off-site disposal of the waste material is a proven and readily implementable method for remediation. Permitted disposal facilities are available to receive the waste. Waste streams may be segregated for disposal. Off-site disposal will be retained for further evaluation.

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ACTION ALTERNATIVES

3.1 INTRODUCTION

This section presents a preliminary description of remedial action alternatives that have been developed for the Gastown Former MGP site. Alternatives were developed by combining one or more of the applicable remedial technologies that passed the preliminary screening. Table 3-1 summarizes the preliminary remedial action alternatives.

Some of the alternatives have components that could be implemented by using a variety of technologies. The advantages and disadvantages of the various technologies are evaluated for the purpose of selecting a representative technology to be used in this FS as described below.

3.2 DEVELOPMENT OF REPRESENTATIVE TECHNOLOGIES

General response actions are broad categories of remediation that may be applicable to a specific site. Certain general response actions (i.e., hydraulic containment, groundwater treatment, or vapor treatment) have a number of possible technologies that could be employed depending on site-specific conditions. Rather than evaluating each permutation of applicable technologies available to a specific alternative, one representative technology was selected for each alternative to represent the range of technologies that could be used. For example, vapor phase treatment can be accomplished by advanced oxidation, thermal catalytic destruction, or granular activated carbon (GAC) adsorption. For the purposes of this FS, each alternative with a vapor phase treatment component would be assumed to utilize GAC adsorption. The specific technology to be used for the final selected remedy would be determined based on the results of an engineering design study performed prior to implementation of the selected remedy.

In the following sections isolation and control technologies, groundwater extraction and treatment, in-situ soil/NAPL treatment, mitigation of potential air hazards, sediment remediation, ex-situ soil treatment, and waste disposal are evaluated and representative technologies selected.

3.2.1 Isolation and Control Technologies

The NAPL and contaminated groundwater at the site could be isolated and controlled to limit human and environmental exposure, and off-site migration. A variety of technologies exist to control exposure to and migration of NAPL and contaminated groundwater. These are described below.

Groundwater/NAPL Interceptor Trenches

Trenches filled with granular media and pumped to maintain a low water level can be used to intercept lateral flow of groundwater. In some cases, one wall of the trench can be lined with a geomembrane liner to reduce inflow (such as from a clean area not requiring remediation). Coarse sand, crushed stone or pea gravel is typically used as backfill for the interceptor trench. The backfill must meet both drainage and filtration requirements to function effectively over the long term. If surrounding soils are rich in fines and pea gravel is used, it may be necessary to lay filter geotextiles on the trench walls prior to backfilling to prevent the fines from migrating into and plugging the gravel backfill.

The conventional methods of excavating an interceptor trench in unconsolidated materials are to use either an open-cut excavation or shoring / trench boxes, if trench wall stability is an issue. An alternative technique involves excavating the trench using a biodegradable slurry to support the trench walls. After backfilling the trench with permeable material, a reagent is added to break down the slurry and the trench is flushed to remove the residual slurry and prevent biological growth. Liquids are withdrawn from the interceptor trench by pumping from sumps located in the trench. It may be necessary to install perforated piping along the base of the trench in order to transmit water to the sumps.

Gradient Control Wells

A system of extraction wells can be used to control hydraulic gradients and groundwater migration. Recovered water can be treated and discharged or otherwise disposed of as discussed herein. The principal concern with a recovery system is the adequacy of capture. Due to the relatively low permeability of the soils at the site, well spacing may need to be tightened to achieve sufficient capture zones. Dissolved salts, minerals and certain bacteria in the collected water can cause clogging and necessitate frequent reconditioning of wells and piping systems.

Grout Curtains

Fixed subsurface barriers can be formed by injecting a liquid slurry or emulsion of grout through grout holes arranged in a pattern of 2 or 3 adjacent rows. The injected fluid fills the pores and fissure and greatly reduces the permeability of the grouted zone. Grouts typically used are neat portland cement, cement-bentonite and chemical resins. Cement-based permeation grouts are not effective in silty soils. Therefore, chemical grouts will be required at this site. Chemical grouts are costly and construction of a barrier may be difficult to verify.

Sheet Piling

Cut-off walls can be constructed by driving interlocking sheet piles into the ground. Sheet piles can be made of steel or, where structural strength is not required, plastic, such as vinyl or high density polyethylene. Sheeting is frequently used as a temporary measure during construction to contain or divert groundwater and / or leachate. Depending on the degree to which subsurface conditions are corrosive, steel sheet piling may last many years. Pre-coating of the piles prior to driving is also an option to extend their useful life. Plastic sheet piles are inherently more resistant to corrosive groundwater conditions. A careful study of corrosion potential is warranted during design. The permeability of the sheet piling system is controlled by the interlocks of the sheets. The overall permeability of the sheet piling can be reduced by sealing the interlocks by grouting (i.e., Waterloo barrier) or applying polymers to the interlocks that swell in the presence of water.

The depth of sheeting is limited by the mechanical ability to drive the sheeting. Sheet piling is not suitable for sites with buried obstructions, such as rubble or boulders. Sheeting may be used at sites where shallow buried obstructions can be removed by pre-excavation.

Cut-off Walls

Low permeability walls can be installed in the subsurface to impede groundwater flow. These walls are typically used in conjunction with extraction wells or recovery trenches to dewater a zone or to divert or capture groundwater flow. Cut-off trenches can be installed either in a continuous operation of backhoe excavation followed closely by fill placement (see slurry trenches, below). Backhoe excavation is capable of installing trenches to depths of approximately 70 feet. In unconsolidated deposits, trenches are supported with a slurry. This slurry also acts to infiltrate the trench walls and seal permeable zones. The slurry may not be able to seal zones of open cobbles or loose rubble.

The trench is most often backfilled with the excavation spoils amended with expansive clays, such as bentonite, and the trenching slurry to achieve a permeability of 10^{-6} to 10^{-8} cm/sec. Trench spoils containing rubble, cobbles or chemistry incompatible with the expansive clay amendments may be unsuitable for use as backfill. In these situations, clean soil with an appropriate gradation can be imported for the soil component of the trench backfill.

The most commonly used type of cut-off wall is that constructed by the slurry trench method of excavation and backfilled with native soils amended with bentonite or other expansive clay. Slurry walls are typically excavated through unconsolidated deposits with a backhoe. The trench is maintained full of bentonite – water slurry of sufficient density to prevent collapse of the trench walls. In permeable deposits the slurry infiltrates surrounding soils and forms a filter cake of bentonite at the trench walls, which acts to further reduce the permeability of the wall. Excavation spoils from the trench, which have an appropriate gradation and are free of rocks, rubble and deleterious chemicals, are suitable for trench backfill. The suitability of soils for backfill and the required amounts of bentonite or other clays are determined by geotechnical tests and compatibility testing with dissolved and non-aqueous phase chemicals. Soil – bentonite cut-off walls have been widely applied in construction and waste site remediation (D'Appolonia, 1980; Geo-Con, 1985).

In cases where the cut-off wall is very shallow (generally less than 10 feet), the trench can be dug without support (slurry or shoring) and backfilled with compacted clay or other techniques.

Capping

Capping consists of placement of one or more layers of natural or synthetic materials to limit infiltration and / or cover and isolate contamination from people and the environment. Layers incorporated into a cap may be designed to support vegetation and limit erosion (topsoil layer), support a working surface such as a parking lot (asphalt layer), provide physical separation (barrier protection layer), drain infiltration (drainage layer), limit infiltration (barrier layer) or vent gases (gas vent layer) originating from the covered materials. Capping is generally intended to limit erosion, eliminate direct contact with wastes and reduce infiltration of precipitation, thereby reducing groundwater contamination.

Typical capping materials include locally available soil and natural clay, bentonite-amended soil, geomembrane liners, geosynthetic clay liners (GCLs) geotextiles, and sand and gravel. A cap system must be less permeable than the materials underlying the waste to be capped to protect against water accumulation in the waste. The cap configuration required depends upon site-specific conditions, such as precipitation and surface flooding potential, depth to groundwater, characteristics of subsurface soils and groundwater and the nature of the waste materials.

Three general types of caps, differentiated by their barrier layer, are commonly constructed: soil or asphalt caps; geomembrane caps; and composite caps (geomembrane underlain by a compacted soil or geosynthetic clay liner). Soil and asphalt caps are simple to construct and maintain. The availability of suitable clay near the site must be considered if a low infiltration cover system is required. Asphalt provides a physical barrier and reduces infiltration. Geomembrane caps are relatively simple to construct and are generally more cost effective than soil if low infiltration is required and good quality clay is not available on-site. Composite caps are more expensive and difficult to construct, however they provide the greatest degree of infiltration control. The cap required for a particular application also depends on applicable regulatory requirements, such as those associated with the NYSDEC solid and hazardous waste regulations, or RCRA regulations, 40 CFR Part 264. USEPA guidance for RCRA hazardous waste landfills (USEPA, 1989) requires a cap that consists of multiple layers of clay and geosynthetic materials. The RCRA cap generally includes a composite barrier layer consisting of a geomembrane overlying a compacted clay liner.

Selection of Isolation and Control Technologies

For the Gastown Former MGP site the following representative isolation and control technologies have been selected for detailed analysis:

- Gradient controls wells
- Soil - bentonite cutoff wall installed via open excavation or sheet pile walls, depending on the application
- Geomembrane-based final cover system

For scenarios where control of groundwater levels is the primary objective, gradient control wells are selected. Groundwater treatment for the groundwater and NAPL collected by the gradient control system is discussed in the following section.

A soil - bentonite cutoff wall was selected for areas that may have utilities that would prevent the installation of sheet piling, i.e., along East Niagara Street. Open excavation of the trench would allow obstructions to be handled expediently, collection of contaminated groundwater and NAPL during construction and visual inspection of the key into the lacustrine clay layer. In the vicinity of existing on-site buildings and in areas where deep excavation is required adjacent to a road or rail line, steel sheetpiling, and possibly additional bracing, would be used to protect the building foundations and maintain excavation wall stability during construction.

A geomembrane-based final cover system, with an asphalt protection layer, was selected based on a preliminary evaluation of groundwater and infiltration flows into the contained waste. A geomembrane and asphalt cover would be equally effective as the more costly composite cover since the upper portions of the alluvium are relatively low permeability.

3.2.2 Source Area Groundwater Extraction and Treatment

Groundwater/NAPL Extraction

A source area collection/extraction-based response action provides reduction in mobility and volume of contaminants through the removal of the contaminated groundwater from the subsurface with the use of source area groundwater extraction wells or interceptor trenches. Groundwater extraction wells are generally installed with a drill rig. Well screens and filter packs are generally installed to intercept the saturated thickness of the contaminated water-bearing zone. Extraction wells can be installed to provide a hydraulic barrier for control of migration of contaminated groundwater, or at specific locations for source area remediation. The collection/ extraction response action is typically combined with ex-situ treatment of the extracted groundwater.

Groundwater extraction can be combined with vapor extraction in dual-phase extraction wells. Dual-phase extraction involves removal of contaminant-laden groundwater and vapor from the aquifer under high vacuum (generally up to 28 inches of mercury). Dual-phase extraction involves above ground treatment of extracted groundwater and vapors from the subsurface using other technologies prior to discharge/disposal.

At the Gastown MGP site, contaminated groundwater and NAPL are found within a heterogeneous alluvium composed of stratified fine silty sand and clayey silt soil. Designing a dual-phase extraction well system that would effectively interconnect all pore spaces containing contaminated groundwater, vapor or NAPL would be difficult and perhaps impossible. Dual-phase extraction wells can be combined with other technologies, e.g., lower groundwater levels thereby enhancing the effectiveness of an in situ treatment technology that depends on vapor extraction from the vadose zone.

Bulk groundwater and NAPL extraction would be most effectively achieved through the use of interceptor trenches which would maximize the connection with intermittent seams and stringers of NAPL.

Ex-situ Groundwater Treatment

Ex-situ treatment provides reduction in toxicity, mobility, or volume of contaminants following extraction of contaminated groundwater from the subsurface. Ex-situ treatment can be accomplished through biological or physical/chemical means and can be conducted on-site or off-site.

Selection of groundwater treatment technologies depends on the nature and concentrations of the groundwater contaminants, influent flow rates, and the duration that the treatment system would be used. For instance, a temporary groundwater treatment system to treat water generated during the removal of contaminated soil would be different than a permanent system designed to treat small quantities of groundwater extracted to maintain an inward gradient within a containment system. Regardless, all water treated on-site would be required to meet NYSDEC-specified permit requirements prior to being discharged to the ground, storm water drains or the local Publicly-owned treatment works (POTW).

In general, FS costs will be developed based on a groundwater treatment system comprised of an oil/water separator for initial removal of NAPL, a settling tank/clarifier to remove solids, bag filters and GAC. Air stripping or ultraviolet (UV) oxidation would be considered for groundwater treatment during design if long-term ex-situ treatment were to become part of the selected remedy.

Since NAPL is likely to contain high levels of contaminants and is likely to fail hazardous characterization testing, the assumption used for this FS is that NAPL would be transported off-site to be treated as a hazardous waste oil (incinerated).

Vapor phase treatment would only be necessary if air stripping or building sub-slab vapor extraction were being considered as part of the site remedy. Vapor phase treatment can be accomplished by advanced oxidation, thermal catalytic destruction, or GAC adsorption. GAC is the selected representative technology for vapors. If concentrations in the vapor are high, advanced oxidation or thermal catalytic destruction may be a more cost effective technology and this determination would be made based on pre-design studies.

3.2.3 In-Situ Soil/NAPL Treatment

In-situ treatment was discussed in detail in Section 2 and each technology will be carried through to the detailed analysis of alternatives.

3.2.4 Mitigation of Potential Air Hazards

The soil gas and indoor air survey conducted during the RI indicated that the presence of VOCs associated with the free-phase and dissolved-phase coal gas wastes have caused elevated levels of VOCs to be present in soil gas near certain residential houses. An intentional or unintentional breach in the foundation materials could result in the migration of contaminants to indoor air. The conventional approach to preventing or mitigating this potential problem is to construct and operate a sub-slab depressurization system designed to actively vent soil vapors from under the foundation materials to a discharge point outside the building. This technology can be used in combination with other technologies and should be considered for any alternative that leaves contaminants in place.

While contaminated soil vapors are likely present under the site buildings, potential impacts to ambient air are not likely to exceed OSHA permissible exposure limits for a working environment. While testing may be required to confirm this, for the purposes of the FS, it is assumed that no sub-slab depressurization system would be required to vent the site buildings.

3.2.5 Sediment Remediation

Small quantities of creek sediment have been identified as potentially being impacted by site-related sources. The sampling program was not sufficient to fully delineate the extent of impacted soil, so available data was used to develop assumed quantities for this FS. Three samples, SED-1, SED-6 and SED-7 contained total PAHs and naphthalene at levels above other samples collected in the creek. The impacted sediment was assumed to be limited to a lateral extent of approximately 100 feet along the shoreline. A navigation channel is present approximately 50 feet off shore, which has likely been periodically dredged. The channel represents a likely outer boundary of impacted sediment.

The maximum vertical extent of impacted sediments is assumed to be the lacustrine clay aquitard. While detailed bathymetry is not available for the area of concern, water depths in this area have been measured from 0 at the shoreline to between 10 and 20 feet. The depth to the aquitard on site is approximately 20 feet from ground surface. The average site elevation is around 575 feet and a typical creek water surface elevation is 565 (roughly 10 feet less). The water depths in the vicinity of the impacted sediment range from 7 to 13 feet (as measured on the day of sediment sampling). This indicates that the bottom of the creek is very nearly at the elevation of the top of clay. There is probably only a couple feet of impacted sediment in this area, but to be conservative the thickness of sediment to be removed was estimated to be 5 feet. Therefore, based on an assumed impacted area of 100 x 50 feet and an assumed average removal depth of 5 feet, the in-place volume of impacted soil is estimated to be 100 cubic yards.

No in situ or containment technology is practical for this small quantity of sediment. Removal and processing for off-site disposal is proposed as the technology for remediating the impacted sediment. A predesign investigation would be required to delineate the areas of impact and characterize the sediments and possible presence of debris prior to implementation of the sediment removal portion of this remedy.

3.2.6 Ex-Situ Soil Treatment

Soil washing, chemical extraction, thermal treatment and stabilization/solidification are all ex-situ treatment technologies that were retained for consideration because they could each effectively treat at least part of the contaminants in the impacted site soils. Low-temperature thermal desorption has been used successfully at numerous sites in New York State to remove organic contaminants from soil included VOCs, SVOCs and PCBs. Similarly, addition of fly ash, kiln dust, or an equivalent stabilizing agent, is a well-demonstrated method for immobilizing metals in soil.

Soil washing and chemical extraction may be effective for a variety of the site contaminants, but these technologies are not widely accepted as proven methods for on-site treatment. The availability of off-site facilities to treat or dispose of wastes and the small area available for on-site treatment tends to make off-site disposal/treatment a reasonable choice and is selected for the purposes of this FS. Other technologies might be considered when the remedy is implemented.

3.2.7 Disposal Options

Contaminated soil from MGP sites are typically transported to treatment facilities where thermal destruction is used to bring the soil contaminants to acceptable levels or disposed of at a non-hazardous waste landfill. The primary regulations dictating the disposal requirements are RCRA (due to the presence of high levels of VOCs and SVOCs that may fail hazardous characteristics testing; i.e., the toxicity characteristic leaching procedure or TCLP). MGP wastes are subject to certain exemptions under RCRA to allow for disposal at a non-hazardous waste landfill.

As much of the site NAPL was observed only in the deepest portions of the alluvium. Overlying clean soil removed to access the contaminated soil would be considered non-impacted and would be used for backfill.

3.3 DEVELOPMENT OF ALTERNATIVES

Based on the evaluation of the retained remedial technologies above, the selected representative technologies were combined to develop a list of remedial alternatives for the Gastown Former MGP site. Aside from "No Action" which is required to be considered as a baseline and "Long-Term Monitoring with Institutional Controls," which provides a more realistic minimal approach than No Action, the remedial alternatives that were developed were those that meet the site-specific SCGs, would be protective of human health and the environment and could be implemented within a reasonable time-frame. Disturbance to an actively used commercial property was also considered in the development of alternatives. The remedial alternatives, grouped relative to the degree of disturbance to the site, are:

Minimal Disturbance to Site Occupants

Alternative 1: No Action (retained in accordance with NCP for comparison only)
Alternative 2: Institutional Controls with Long-Term Monitoring
Alternative 3: NAPL/Groundwater Collection and Treatment

Temporary Disturbance to Site Occupants

Alternative 4: In-Situ Thermal/Biological Treatment
Alternative 5: Partial Removal, Partial Containment and In-Situ Treatment
Alternative 6: Full Isolation and Containment

Relocation of Site Occupants and Demolition of Buildings

Alternative 7: Full Removal
Alternative 8: Partial Removal and In-Situ Solidification

These alternatives are identified and briefly described below.

3.3.1 Alternative 1: No Action

The National Contingency Plan (NCP - 40 CFR Part 300.430[e][6]) requires that a No Action response action be considered in the detailed analysis of alternatives to provide a baseline from which other alternatives can be evaluated. Under the No Action alternative, it is assumed that no actions would be taken to reduce the potential impacts associated with site contaminants.

3.3.2 Alternative 2: Institutional Controls with Long-Term Monitoring

Institutional controls would restrict use of the site and warn prospective owners of hazards associated with subsurface excavation activities. Use of institutional controls is the minimum response sufficient to meet the remedial action objective of reducing the potential for direct human contact with impacted surface soils. Detailed modeling of site conditions and long-term monitoring at pre-designated compliance points would be used to monitor changes is plume size and concentrations which could be used to evaluate potential changes in risks to human health and the environment.

3.3.3 Alternative 3: NAPL/Groundwater Collection and Treatment

- Install collection trench or wells at main source area
- Install collection trench east of railroad line and on east side of East Street
- Install impermeable barrier wall on creek side of plume adjacent to East Niagara Street,
- Construct long-term treatment facility for removed water/NAPL
- Discharge treated water to stream
- Remove and dispose of impacted sediment
- Install sub-slab depressurization systems in nearby residential homes and buildings
- Long-term monitoring and institutional controls

The primary component of this alternative is NAPL collection and migration control. It does not involve any form of in situ treatment or soil removal. The alternative includes one of the least disruptive approaches to remediating the site, while actively mitigating contamination sources and migration pathways. A schematic of this alternative is show on Figure 3-1.

3.3.4 Alternative 4: In-Situ Thermal/Biological Treatment

- Install groundwater collection wells/trenches to lower water table
- Install system of heating elements and SVE extraction wells
- Construct an on-site water/vapor treatment system, discharge water to stream
- Construct a temporary cap, as necessary, to control release of soil vapors
- Address residual contaminants with enhanced bioremediation and long-term monitoring
- Remove and dispose of impacted sediment
- Install sub-slab depressurization systems in nearby residential homes and buildings

In-situ thermal treatment of the site MGP wastes, contaminated soil and groundwater is an innovative, yet demonstrated technology. High temperatures are applied to the subsurface via vertical probes or wells. The contaminants are driven to their boiling points and vapors are captured through a vapor extraction system including vapor extraction wells and a low permeability cap at the ground surface. Heating and vapor extraction wells would be installed around the site buildings but contaminants under the site buildings would not be accessible for in-situ treatment unless heating elements are placed through the building floors or angle borings are used. See Figure 3-2 for a schematic of this alternative.

The relatively shallow groundwater table and tight near-surface soils may limit the implementability of this technology at the site. A groundwater extraction system is proposed to lower the water table creating more potential for vapor extraction. A low permeability barrier wall is also proposed to limit groundwater recharge to the treatment area and to control migration of NAPL mobilized by the application of heat. A pilot study would be useful to evaluate the capacity for groundwater table depression and the area of influence of soil vapor wells in the vadose zone.

Installation of the heating elements and vapor extraction wells would be minimally disruptive to the site but construction of an impermeable cap to limit release of vapors could require temporary shut-down of site activities. Since the thermal treatment of soils system installation can be completed in a matter of days, the duration of this alternative could be sufficiently short that site occupants could accommodate the disruption.

In case of incomplete removal of contaminants through in-situ thermal treatment, in-situ bioremediation could be used as a follow-up to thermal treatment. Enhanced bioremediation involves injection of air or microorganisms to enhance the natural degradation of dissolved phase contaminants.

3.3.5 Alternative 5: Partial Removal, Partial Containment and In-situ Treatment

- Remove maximum possible extent of NAPL plume without significant disturbance of current buildings; off site disposal or treatment
- Demolish portions of building and reconstruct subsequent to removal of contaminated soil; house affected businesses in temporary site trailers
- Backfill excavation with clean, low permeability, imported soils
- Contain residual contaminants east of the rail line within an impermeable wall and cap
- Control residual contaminants west of rail line and east of Sportman's Club with barrier wall and NAPL collection system.
- In-situ chemical treatment of unexcavated contaminated soils
- Remove and dispose of impacted sediments
- Install sub-slab depressurization systems in nearby residential homes and buildings

This alternative removes a large portion of the coal tar, especially in the area of the holder. Residual NAPL would be controlled through a combination of impermeable barriers and collection sumps. An optional in-situ treatment component is added to enhance the overall reduction of volume and toxicity of wastes but if the technology is not effective due to site-specific limitations, the other remedial components would provide overall protection to human health and the environment. In-situ chemical treatment would not likely be effective for areas with highly stratified geology and significant quantities of NAPL. In-situ treatment is not proposed under the rail line because the rail company is not likely to permit any activity with even the smallest risk of changing the subsurface conditions such that destabilization of soil could occur (compression of soil due to destruction of organic material or changes in water levels). These issues would also apply to in-situ treatment of contaminants under buildings.

A schematic of the remedial elements is provided in Figure 3-3.

3.3.6 Alternative 6: Full Isolation and Containment

- Install impermeable barrier wall around perimeter of site, around any accessible area between East Street and railroad line; and around plume east of the site
- Install low permeability cap over each contained area (tie into barrier walls)
- Install pumping wells inside containment cell to maintain inward gradient
- Construct long-term treatment facility for removed water/NAPL
- Discharge treated water to stream

- Remove and dispose of impacted sediments
- Install sub-slab depressurization systems in nearby residential homes and buildings
- Long-term monitoring; Institutional controls

The intent of this alternative is to encapsulate the contaminants so they can no longer migrate or be a continuing source of groundwater contamination. Two contained areas would be created as shown on Figure 3-4. Vertical barrier walls would be installed around the perimeter of each containment area. The walls would be imbedded in the low permeability lacustrine clay. A cap would be tied to the barrier walls, completing the seal. The buildings would be left in place, which would require that the capping materials be carefully sealed against the building foundations to prevent leakage into the contained area.

The drawback to this alternative is that NAPL and contaminated soil are present under the rail line and this area cannot be readily contained. Jet grouting is anticipated to be difficult to implement and ensure a tight seal, and could be destabilized over time by the vibration of the passing trains. With no containment, the zone under the rail line could become an uncontrolled funnel for groundwater flow, potentially increasing the rate of contaminant migration towards the creek. As described above, in-situ treatment is not proposed for under the rail line because rail company is not likely to permit any activity with even the smallest risk of changing the subsurface conditions such that destabilization of soil could occur (compression of soil due to destruction of organic material or changes in water levels/dewatering). These issues would also apply to in-situ treatment of contaminants under buildings.

A treatment system would be constructed near the rail line to treat groundwater pumped from the contained areas to maintain inward gradients. Groundwater would be treated with carbon or an equivalent technology. Long-term monitoring would be required to evaluate the performance of the containment system. Institutional controls would be necessary to prevent breaches of the containment system.

3.3.7 Alternative 7: Full Removal

- Relocate site businesses; demolish site buildings
- Remove majority of NAPL plume; off site disposal or treatment
- Backfill with clean, imported soils
- Remove and dispose of impacted sediment
- Install sub-slab depressurization systems in nearby residential homes and buildings
- Long-term monitoring; Institutional controls

This alternative maximizes removal of NAPL and contaminated soil from the site, providing the highest degree of protection of human health and the environment (Figure 3-5). This alternative would include the demolition of the site building to remove underlying contaminated soil. Since these buildings are currently housing active businesses, this alternative would include the costs associated with relocating these businesses. This alternative would involve the excavation of all NAPL and soil exceeding the soil cleanup goals, except under the rail line. Removed material would be transported to several different disposal or treatment facilities based on the type and concentration of the contaminants contained in the waste. It is anticipated that the same quantity of backfill would be required to reestablish the original grade of the site. Groundwater and NAPL generated during the excavation of soil would be separated on-site in an oil/water separator. NAPL would be transported off site for treatment and groundwater would be treated on site prior to discharge to surface water. Groundwater treatment would consist of a clarifier, bag filters and GAC. Groundwater monitoring would be performed for an estimated two years to confirm the success of the remediation.

3.3.8 Alternative 8: Partial Removal and In-Situ Solidification

- Move site businesses; demolish buildings
- Remove thickest portions of NAPL plume; off site disposal or treatment
- Solidify remaining plume in situ
- Backfill with clean, imported soils
- Remove and dispose of impacted sediment.
- Install sub-slab depressurization systems in nearby residential homes and buildings
- Short-term monitoring to confirm no further potential impacts

This alternative is similar to Alternative 7, but presents some potential cost savings through the use of in situ solidification in lieu of excavation in areas with lower quantities of NAPL (Figure 3-6).

3.4 SCREENING OF ALTERNATIVES

Alternatives 1 through 8 range from no action to full removal and each are considered reasonable to be carried through the detailed evaluation, either as viable remedial alternatives (Alternatives 3 through 8) or for comparison purposes (Alternatives 1 and 2).

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section describes the evaluation criteria used in the detailed analysis of the remedial action alternatives retained after the preliminary screening. Section 4.1 identifies and describes the evaluation criteria. Section 4.2 presents the detailed analysis of the remedial action alternatives relative to the evaluation criteria. A summary of the tasks and costs associated with each of the remedial action alternatives is presented in Table 4-1. In each sub-section, the remedial alternative is briefly described, a conceptual model of the procedures used to implement the alternative is presented, and then the alternative is systematically assessed relative to each the evaluation criteria. In Section 4.3, the alternatives are compared relative to each other based on these evaluation criteria.

4.1 EVALUATION CRITERIA

NYSDEC's TAGM 4030 on the selection of remedial actions (NYSDEC, 1989; revised, 1990) presents seven (7) criteria to be used for evaluating remedial alternatives that have passed the preliminary screening process. The seven criteria are divided into two tiers. The first two criteria are threshold factors and the next five are primary balancing factors. These criteria are as follows:

- Compliance with New York State Standards, Criteria and Guidelines (SCGs);
- Overall protection of human health and the environment;
- Short-term effectiveness;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility or volume through treatment;
- Implementability; and
- Costs (capital, annual operation and maintenance, present worth).

Additionally, community acceptance would be considered as a modifying consideration. These tiers are reflected in the detailed analysis. Descriptions of the seven criteria are provided below.

4.1.1 Compliance with New York State SCGs

This evaluation criterion is used to assess compliance with promulgated chemical-specific, action-specific, and location-specific Standards, Criteria and Guidance (SCGs). SCGs for the Gastown Former MGP site are discussed in Section 1.7. Proposed remedial alternatives are analyzed to assess whether they achieve SCGs under Federal and State environmental laws, public health laws, and State facility siting laws. As a threshold factor, an alternative must be compliant with SCGs (or be eligible to receive a waiver) to be considered further.

4.1.2 Overall Protection of Human Health and the Environment

This evaluation criterion is used to determine whether a proposed remedial action alternative is adequate with respect to the protection of human health and the environment. The evaluation focuses on how each proposed alternative achieves protection over time, how site risks are eliminated, reduced, or controlled, and whether any unacceptable short-term impacts would result from implementation of the alternative. The overall protection of human health and the environment evaluation draws on the assessments for long-term effectiveness and permanence, short-term effectiveness, and compliance with SCGs. As a threshold factor, an alternative must be compliant with overall protection of human health and the environment to be considered further.

4.1.3 Short-Term Effectiveness

This evaluation criterion is used to assess short-term potential impacts associated with the construction and implementation phase of remediation. Alternatives are evaluated with regard to their effects on human health and the environment. These considerations include:

- Protection of the community during implementation of the proposed remedial action (i.e., dust, inhalation of volatile gases);
- Protection of workers during implementation;
- Environmental impacts that may result from the implementation of the remedial alternative and the reliability of measures to prevent or reduce these impacts; and
- Time until remedial response objectives are met, including the estimated time required achieving protection.

4.1.4 Long-Term Effectiveness and Permanence

This criterion addresses the long-term effectiveness and permanence of the remedial alternative with respect to the quantity of residual chemicals remaining at the site after response goals have been met. The principal focus of this analysis is the adequacy and reliability of controls necessary to manage any untreated media and treatment residuals. Characteristics of the residual chemicals such as volume, toxicity, mobility, degree to which they remain hazardous, and tendency to bioaccumulate must also be examined. Specifically, these considerations are:

- Magnitude of residual risk;
- Adequacy of controls; and
- Reliability of controls.

4.1.5 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion assesses the degree to which the remedial alternative utilizes recycling and/or treatment technologies that permanently decrease toxicity, mobility, or volume of the chemicals as their primary element. It also assesses the effectiveness of the treatment in addressing the predominant health and environmental threats presented by the site. The specific factors considered under this evaluation criterion include:

- Treatment process the remedy would employ and the materials it would treat;
- Amount of contaminants that would be treated or destroyed;
- Degree of expected reduction in toxicity, mobility, or volume (expressed as a percentage of reduction or order of magnitude);
- Degree to which the treatment would be irreversible;
- Type and quantity of treatment residuals that would remain following treatment accounting for persistence, toxicity, mobility and the tendency to bioaccumulate; and,
- Whether the alternative would satisfy the statutory preference for treatment as a primary element.

4.1.6 Implementability

This criterion assesses the technical and administrative feasibility of implementing a remedial alternative and the availability of various services and materials that would be required during its implementation. Factors considered include the following:

Technical feasibility includes:

- difficulty and unknowns related to construction and operation of a technology;
- reliability of the technology (including problems resulting in schedule delays);
- ease of performing additional remedial actions; and,
- ability to monitor the effectiveness of the remedy.

Administrative feasibility involves: Coordination with governmental agencies to obtain necessary permits or approvals.

Availability of services and materials includes:

- sufficiency of off-site treatment, storage and disposal capacity;
- access to necessary equipment, specialists and additional resources;
- potential for obtaining competitive bids especially for new and innovative technologies; and,
- availability of state-of-the-art technologies.

4.1.7 Costs

This criterion assesses the costs associated with a remedial action. It can be divided into capital costs, annual operation and maintenance (O&M) costs, and determination of the net present worth of the combined cost of capital and long-term costs. Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs.

Direct capital costs include:

- Construction and equipment costs: materials, labor, equipment required to install/perform a remedial action.
- Land and site development costs: land purchase and associated expenses, site preparation of existing property.
- Building and service costs: process and non-process buildings, utility connections, and purchased services.
- Disposal costs: transporting and disposing of materials.

Indirect capital costs include:

- Engineering expenses: administration, design, construction, supervision, drafting, and treatability testing.
- Legal fees and license or permit costs: administrative and technical costs expended to obtain licenses and permits for installation and operation.
- Start up costs incurred during initiation of remedial action.
- Contingency allowances: costs resulting from unanticipated or unpredictable circumstances (i.e., encountering unanticipated volumes of waste, contaminated soil, odor control, adverse weather, strikes, etc.).

Annual O&M costs:

Annual O&M costs are post-construction costs expended to maintain and ensure the effectiveness of a remedial action. The following are annual O&M costs evaluated:

- Labor costs: wages, salaries, training, overhead, and fringe benefits for operational labor.

- Maintenance materials and maintenance labor costs: labor and parts, etc. necessary for routine maintenance of facilities and equipment.
- Purchased services: sampling costs, laboratory fees, and professional fees as necessary.
- Administrative costs associated with the administration of O&M that have not already been accounted for elsewhere.
- Insurance, taxes, and licensing costs: liability and sudden accidental insurance, real estate taxes on purchased land or rights-of-way, licensing fees for certain technologies, permit renewal and reporting costs.
- Replacement costs: maintenance of equipment or structures that wear out over time.
- Cost of periodic site reviews if a remedial action leaves residual contamination.
- Net present worth consists of capital and O&M costs calculated over the lifetime of the remedial action and expressed in present day value. The lifetime of the remedial action is considered to be a maximum of 30 years for costing purposes.

Any remedial action that leaves hazardous waste at a site may affect future land use, resulting in a loss of business activities, residential development, and taxes. These unquantified cost are considered for the alternatives that would leave hazardous wastes on site.

4.1.8 Community Acceptance

This criterion assesses the anticipated level of community acceptance (or resistance) to a specific remedial action alternative. The public perception of a remedial action alternative may significantly impact the selection process and escalate the costs of implementation through delays caused by legal and political actions.

4.2 DETAILED ANALYSIS OF ALTERNATIVES

This detailed analysis evaluates the remedial action alternatives that passed the initial alternatives screening in Section 3.0 relative to the seven evaluation criteria detailed in Section 4.1 and the modifying factor of community acceptance. It focuses upon the relative performance of each alternative. The remedial alternatives that are evaluated in this detailed analysis are as follows:

Minimal Disturbance to Site Occupants

Alternative 1: No Action (retained in accordance with NCP for comparison only)
Alternative 2: Long-Term Monitoring with Institutional Controls
Alternative 3: NAPL/Groundwater Collection and Treatment

Temporary Disturbance to Site Occupants

Alternative 4: In-Situ Thermal/Biological Treatment
Alternative 5: Partial Removal, Partial Containment and In-Situ Treatment
Alternative 6: Full Isolation and Containment

Relocation of Site Occupants and Demolition of Buildings

Alternative 7: Full Removal
Alternative 8: Partial Removal and In-Situ Solidification

4.2.1 Alternative 1 - No Action

4.2.1.1 Description

Under this alternative, no action would be taken to contain, remove, stabilize, or treat the waste or to restrict the use of the Property or restrict access to the waste areas.

4.2.1.2 Assessment

Compliance with SCGs
This alternative does not satisfy any of the applicable SCGs. Under this alternative, impacted soil containing NAPL and concentrations of VOCs and carcinogenic PAHs that pose a potential threat to human health, would remain available for current or future direct contact and migration. Additionally, the NAPL and impacted soil would remain as a continuing source of groundwater contamination. The site would indefinitely remain an unmitigated Class 2 Inactive Hazardous Waste Disposal site.

Overall Protection of Human Health and the Environment
This alternative provides no means of controlling direct exposure to or migration of the contaminated soil or groundwater. It would not reduce potential risks to human health or the environment.

Short-Term Effectiveness
Community, worker and environmental protection: Since no action would be taken under this alternative to disturb the contaminated soil or groundwater, implementation would not pose any increased short-term risks to workers, the community, or the environment.

Long-Term Effectiveness and Permanence
Long-term risks due to exposure to impacted soil or groundwater would not be reduced under this alternative. The migration of the NAPL and contaminated groundwater would continue with an increasing potential for degradation of local environmental resources.

Residual risk: The residual risk is equivalent to the current risk and may increase over time through the continued migration of NAPL and contaminated shallow groundwater potentially impacting the nearby sediments and surface water. The long-term risk of direct exposure is not reduced and may increase as migration of NAPL and impacted groundwater occurs. Potential for degradation of environmental quality and the potential for direct human contact are likely to increase. The residual risk of direct exposure was determined in the HRA (see sec 3.1) to represent a significant potential threat to human health.

Adequacy of controls: Long-term human health and ecological risks due to exposure would not be reduced.

Reliability of controls: No controls would be implemented for this alternative.

Reduction of Toxicity, Mobility, and Volume through Treatment
The No Action Alternative would not result in a reduction in the toxicity, mobility or volume of the waste. Since treatment is not part of this alternative, irreversibility does not apply.

Implementability
No-Action would not be an administratively acceptable response. The site has been classified as a Class 2 Inactive Hazardous Waste Disposal site. The presence of free-phase hazardous NAPL constitutes an “imminent threat” to human health and the environment and requires a remedial response to “contain, isolate, and/or remove” the material Under 6 NYCRR Part 375.

No construction or operation would be required to implement the No Action Alternative. No treatment would be performed, and therefore, no permits or approvals are necessary. The No Action Alternative does not complicate or prevent any future remedial actions from being implemented at the site.

Cost
There are no immediate capital costs associated with this alternative. Continued erosion and migration of waste could result in significantly higher future costs to remediate the site and degradation of environmental quality over a much broader area. It would be difficult to predict potential future costs of remediation and potential liability associated with no action.

Community Acceptance
This alternative would not likely be acceptable to the local community. The site would continue to pose an unacceptable potential risk to human health and the environment. The site would remain a listed Class 2, Inactive Hazardous Waste Disposal site. The potential for degradation of valuable local environmental resources would remain.

4.2.2 Alternative 2 – Long-Term Monitoring and Institutional Controls

4.2.2.1 Description

Under Alternative 2, no action would be taken to actively remediate the site, but monitoring and administrative controls would be used to limit and evaluate risks. Institutional controls would restrict use of the site and warn prospective owners of hazards associated with subsurface excavation activities. Institutional controls would incorporate use of sub-slab depressurization systems to reduce risks associated with soil vapors. Use of institutional controls is the minimum response sufficient to meet the remedial action objective of reducing the potential for direct human contact with impacted surface soils. Detailed modeling of site conditions and long-term monitoring at pre-designated compliance points would be used to monitor changes is plume size and concentrations which could be used to evaluate potential changes in risks to human health and the environment.

Long-Term Monitoring
Extensive groundwater flow and fate and transport modeling of the site specific COCs would be conducted and verified in the field with a series of groundwater analytical sampling points and water table piezometers. Downgradient compliance points would be established and long-term monitoring at these points would be performed to evaluate potential changes to groundwater chemistry or the extent of NAPL.

Land Use Restrictions
Legally binding (to the extent practical) restrictions would be recorded on the property deed. Any future excavation or development of the affected areas would be prohibited until the potential risks had abated.

Sub-Slab Depressurization
Venting of the soil vapors beneath the floor slabs of five residential houses and a school located west of the site and the Gastown Sportsman's Club is proposed to mitigate risks associated with potential future vapor intrusion impacts to indoor air quality. No information is currently available on the construction of the foundations or floor slabs for each structure but it is assumed that there is sufficient gravel under the slab to allow venting of sub-slab vapors. The sub-slab vapor extraction system would consist of a series of vents drilled through the floor-slab or from outside the building, manifolded to an electric blower and vented to the outside air. The blower would be used to create a vacuum, depressuring the sub-slab materials (assuming they are sufficiently permeable) relative to the indoor air pressure to prevent

migration of soil gasses into the buildings. Off-gas vents located outside the building would be used to discharge the air drawn out from beneath the slab.

For estimating purposes, it is assumed that one vent would be installed per residential house, two vents for the commercial building and four for the school. Each vent would be fitted with an appropriately sized vacuum/blower unit capable of producing a sustained vacuum beneath the slab. It may also be necessary to reseal the floors and/or foundations to prevent leakage or loss of vacuum. It is assumed that a 100-watt high flow/low vacuum blower would be sufficient for each vent.

4.2.2.2 Assessment

Compliance with SCGs
Institutional controls do not meet the state SCGs for the proper disposition of an Inactive Hazardous Waste site under 6 NYCRR Part 375. The presence of free phase product may necessitate that some action be taken to remove the NAPL. Long-term monitoring with institutional controls would not result in the containment or removal of the NAPL.

The uncontrolled or continued presence of carcinogenic SVOCs in the soils at concentrations which exceed the threshold value of nuisance characteristics as defined by TAGM 4046 requires at a minimum that some remedial action be completed to reduce the toxicity, mobility, and/or volume of these materials. Alternative 2 does not meet these minimum requirements.

Overall Protection of Human Health and the Environment
Institutional controls would result in a reduction in the potential for future direct exposure to the waste materials by workers and therefore represents the minimal response capable of achieving the remedial action objective as defined in Section 2.2. However, institutional controls are difficult to enforce, which limits their degree protection. This alternative does not provide for overall protection of human health and the environment. The material would remain unconfined and continue to migrate, increasing the potential for direct exposure to humans, fish and wildlife.

Short-Term Effectiveness
Community, worker and environmental protection: No increased risk of exposure to the community or the environment would be present during implementation.

Long-Term Effectiveness and Permanence
Long-term risks related to exposure would not be eliminated or reduced under this alternative. The uncontained NAPL migration could negatively impact soil and groundwater.

Residual risk: The NAPL and contaminated soils and groundwater would remain on-site and continue to pose an unacceptable risk to human health through direct contact.

Adequacy of controls: This alternative provides no controls over the continued migration of contaminants.

Reduction of Toxicity, Mobility, and Volume through Treatment
Reduction of toxicity, mobility, and volume through treatment is not applicable to this alternative, as no effort would be made to immobilize, remove or treat the waste.

Implementability
Administrative: The presence of NAPL constitutes an imminent threat to human health and the environment and requires a remedial response to "contain, isolate, and/or remove" the material Under 6 NYCRR Part 375. Institutional controls could be implemented as part of another action and long-term

monitoring could be used in conjunction with source area removal and/or containment alternatives, but this alternative does not meet the SCGs and therefore, would not be administratively implementable.

Technical: This alternative presents no technical problems relative to implementation. Service providers are readily available and the technology is simple.

Cost
The estimated present worth cost for implementing Alternative 2, Institutional Controls with Long-term Monitoring, is $1.16M. The capital costs associated with this alternative include the installation of sub-slab depressurization systems estimated at $20,000. The present worth cost was estimated based on annual operation, maintenance and monitoring costs of approximately $74,000 per year over 30 years using a 5% discount rate. These costs are shown in comparison with the other remedial action alternatives on Table 4-1.

Community Acceptance
This alternative is not likely to gain community acceptance. The NAPL represents a significant potential hazard to the community and a potential source of degradation of local environmental resources. As a short-term, temporary measure or in combination with on-site containment, it may be more acceptable. The property owner is likely to object to any alternative that restricts the current or future use and/or development of the property.

4.2.3 Alternative 3: NAPL/Groundwater Collection and Treatment

4.2.3.1 Description

The primary component of this alternative is NAPL collection and migration control. It does not involve any form of in situ treatment or soil removal. The alternative includes one of the least disruptive approaches to remediating the site, while actively mitigating contamination sources and migration pathways. In addition to the collection trenches, a tar-filled, metal underground storage tank located on the northeast side of the site, along with some nearby naphthalene crystals, would be removed and disposed of or treated off-site as part of this alternative.

Collection Trench Installation
Three collection trenches, approximately 200 feet long, would be constructed at the locations shown on Figure 3.1 (near former gasiometer No. 1, east of the rail line, and along the east side of East Street). The trenches would be located in areas that can be constructed without significant disruption to site activities or local utilities/structures. The locations of the trenches would either target areas with the most frequent occurrences of observed NAPL or act as interceptors for the potential downgradient migration of NAPL. The trenches would be excavated into the lacustrine clay aquitard (approximately 20 feet below grade and slightly below the level of the aquitard) and perforated pipe would be placed in the trench with suitable bedding. Sumps would be included at pumping stations. Backfill would be permeable in areas where NAPL was observed. Collection wells could be considered as an alternative technology during design.

NAPL/Groundwater Collection and Treatment
NAPL and groundwater would be pumped from the collection trenches to a treatment system located on site. The NAPL would be separated from the groundwater and contained for off-site disposal. The groundwater would be treated with carbon or an equivalent technology prior to discharge to Tonawanda Creek or a local POTW. A discharge permit would be required. The influent and effluent of the water treatment system would be tested on a regular basis to monitor the performance of the system and to document compliance with the applicable regulations.

Barrier walls

Removal of groundwater would hydraulically control off-site migration of dissolved-phase contaminants. The NAPL collection system would reduce the pressure head of the NAPL, reducing the potential for migration away from the site. However, since DNAPL does not behave predictably, placement of a barrier wall between the NAPL plume and Tonawanda Creek would mitigate future migration of NAPL or associated groundwater contamination to the formation under Tonawanda Creek (Figure 3.1). The wall would not be sufficient in itself since water and potentially NAPL could move parallel with the wall, eventually moving into creek sediments or the underlying formation.

The barrier walls would be constructed of slurry-filled trenches or sheet piles embedded into the lacustrine clay or till. Many utilities are located along East Niagara Street, which could limit the use of one technology or the other. No barrier wall is proposed under the where the rail line crosses East Niagara Street because the feasibility of constructing an effective cutoff wall is limited by the accessibility to the space (limited head space under the bridge), presence of utilities, and a constant vibration caused by the rail road. The proposed collection trenches are anticipated to draw NAPL and contaminated groundwater parallel to the creek, mitigating flow through the gap in the barrier wall under the rail line.

Sub-Slab Depressurization

Venting of the soil vapors beneath the floor slabs of five residential houses and a school located west of the site and the Gastown Sportsman's Club is proposed to mitigate risks associated with potential future vapor intrusion impacts to indoor air quality.

No information is currently available on the construction of the foundations or floor slabs for each structure but it is assumed that there is sufficient gravel under the slab to allow venting of sub-slab vapors. The sub-slab vapor extraction system would consist of a series of vents drilled through the floor-slab or from outside the building, manifolded to an electric blower and vented to the outside air. The blower would be used to create a vacuum, depressuring the sub-slab materials (assuming they are sufficiently permeable) relative to the indoor air pressure to prevent migration of soil gasses into the buildings. Off-gas vents located outside the building would be used to discharge the air drawn out from beneath the slab.

For estimating purposes, it is assumed that one vent would be installed per residential house, two vents for the commercial building and four for the school. Each vent would be fitted with an appropriately sized vacuum/blower unit capable of producing a sustained vacuum beneath the slab. It may also be necessary to reseal the floors and/or foundations to prevent leakage or loss of vacuum. It is assumed that a 100-watt high flow/low vacuum blower would be sufficient for each vent.

Sediment Removal and Disposal

As described in Section 3.2.5, an estimated 100 cubic yards of impacted sediment is present in Tonawanda Creek, adjacent to the site. This sediment would be removed and disposed of off-site as a non-hazardous waste. The presence of East Niagara Street and the rail line prohibit access to the sediment from the shore. Therefore, the sediment removal process would be accomplished from barges or other vessels operated in Tonawanda Creek. The approximately 100 foot by 50 foot removal area would be isolated by silt barriers anchored into the lacustrine clay. The corner anchors would be driven piles which would be used for cabling the dredge to access points within the removal areas. The silt barriers would prevent migration of impacted sediment suspended during removal.

Sediment would be removed using conventional excavation equipment. An excavator on a barge with sludge boxes would be used to remove the sediment. The excavator would use a dredge bucket to remove the contaminated sediment and place into the sludge box(es). The sludge boxes would be shuttled to an off-loading area and transported to the site using a conventional roll-back truck. The material would be stabilized inside the roll-off box and disposed of off-site. If site soils still exist the material could be blended with on-site soils. The estimated quantity for disposal is 1,300 tons.

Approximately 20 post-dredge samples would be collected (1 per 200 square feet) and analyzed for SVOCs. The dredged area would be backfilled to the original grade with clean material. The silt barrier would be removed upon completion of backfilling.

Long-term monitoring; Institutional controls
This alternative would leave NAPL and contaminated groundwater in place for the foreseeable future. Long-term monitoring would be required to evaluate the performance of hydraulic controls. Institutional controls (deed restrictions or warnings) would be necessary to prevent future exposure to workers or the public as a result of excavation in contaminated areas. Future use of groundwater as a potable water supply is not likely due to the availability of local public water supplies.

A schedule of quarterly monitoring would be implemented to monitor groundwater quality and the continued effectiveness of the containment system. For cost estimating purposes it is assumed that ten existing monitoring wells would be included in the long-term monitoring program. For completing the cost analysis, it is assumed that Operations and Maintenance would consist of an annual inspection event, minimal repair to the treatment system, monthly groundwater monitoring (at 10 sampling points) for one year, quarterly monitoring for years 2 through 30 and the required five-year reviews.

4.2.3.2 Assessment

Compliance with SCGs:
Alternative 3 would satisfy the applicable Federal and State chemical-specific SCG's for water quality by containing the source of contamination, collecting contaminated groundwater and NAPL during and after construction and treating the collected groundwater to the applicable standards.

According to TAGM #4030, NYSDEC does not consider isolation and control technologies as a permanent remedy and therefore they are not preferred but in the absence of hierarchically preferable and equally cost-effective alternatives, they are acceptable. Provisions for long-term monitoring and site review have been included in the long-term O&M costs for the alternative. If hydraulic containment is selected, a statement must be included in the ROD detailing the rationale for selecting a non-permanent solution.

Removal of sediment within Tonawanda Creek, which is defined as navigable waters, would trigger location-specific SCG's such as ECL Article 15, Title 5 and ECL Article 17, Title 3, Use and Protection of Waters. These laws, as well as 6 NYCRR Part 608, establish permit requirements to change, modify, or disturb any protected stream, its bed or banks, or remove from its bed any material. A federal permit would be required to conduct the remedial activities associated with sediment remediation. A Section 10 (Rivers and Harbor Act) permit would likely be sufficient to cover the proposed dredging and backfilling activities.

Overall Protection of Human Health and the Environment
Overall protection of human health would be improved with this alternative. Potential direct exposure to future workers would still exist as NAPL would remain in the formation for the foreseeable future. Hydraulic containment would effectively prevent the horizontal migration of the NAPL and dissolved contaminants and the barrier walls would prevent lateral migration towards the creek. Containment would therefore provide a moderate level of overall long-term protection of the environment. Sediment

removal would permanently remove exposure routes to aquatic wildlife. Sub-slab depressurization would mitigate air quality risks associate with potential vapor intrusion.

Short-Term Effectiveness
Community, worker and environmental protection: An increased potential risk of exposure to the waste for the community, workers, and the environment would be present during construction of the barrier walls and collection trenches. The risk of direct exposure to the community could be reduced with work area access controls and appropriate warnings. The increased risk of direct exposure to workers can be mitigated by applying appropriate personal protective equipment.

Sediment removal presents short-term risks to the environment through the potential for suspension and migration of contaminated sediment during removal. These risks would be controlled through the use of silt curtains and use of appropriate dredging equipment.

Site activities are estimated to be completed in 4 months.

Long-Term Effectiveness and Permanence
Long-term risks related to direct exposure (future workers excavating in source areas) would not be significantly changed under this alternative. The hydraulic containment system would prevent lateral migration. The potential degradation of local environmental resources would be reduced. It is anticipated that a monitored and maintained hydraulic containment system would be effective indefinitely.

Residual risk: Although some NAPL and contaminated groundwater would be removed from the site, the residual risk relative to the toxicity and volume of the waste would be essentially unchanged from its current condition, as significant quantities of NAPL would remain trapped in the interstitial spaces between soil particles. The residual risk relative to the site would be reduced as the total area of impact is reduced, the impacted soil and groundwater contained, and NAPL continually removed.

Adequacy of controls: If properly constructed and maintained, the containment system is capable of preventing migration of contaminants for an indefinite period.

Reliability of controls: A properly designed hydraulic containment system is a proven effective and reliable technology for controlling contamination migration. The use of land use restrictions and physical barriers to protect the control and treatment systems also increases its reliability.

Reduction of Toxicity, Mobility, and Volume through Treatment
NAPL recovery by the hydraulic containment system would result in a reduction in the total volume of liquid waste and destruction of the NAPL by off-site treatment. Mobility would be significantly reduced or eliminated.

Implementability
Service providers and materials necessary to complete tasks for this alternative are readily available.

Administrative: Discharge permits would be necessary for operation of groundwater pumping and treatment system.

Technical: There are no technical feasibility issues related to the removal action or construction of the barrier wall unless complications are presented in the area of the rail line. The technologies are relatively simple, frequently used, and proven.

Cost

The estimated total present worth cost for implementing Alternative 3 is $3.66M with capital costs of $1.46 The present worth cost was estimated based on annual operation, maintenance and monitoring costs of approximately $118,000 per year over 30 years using a 5% discount rate. A summary of the estimated unit costs for Alternative 3 and a comparison with the cost estimates associated with other alternatives is provided in Table 4-1. Backup for the cost estimate is provided in Appendix B.

Community Acceptance
This alternative is likely to be somewhat objectionable to the local community because the waste would remain in place. The property owner would likely prefer this alternative because it involves minimal disturbance to the site.

4.2.4 Alternative 4: In-Situ Thermal/Biological Treatment

4.2.4.1 Description

In-situ thermal treatment of the site MGP wastes, contaminated soil and groundwater is an innovative, yet demonstrated technology. High temperatures are applied to the subsurface via vertical probes or wells. The contaminants are driven to their boiling points and vapors are captured through a vapor extraction system including vapor extraction wells and a low permeability cap at the ground surface. Heating and vapor extraction wells would be installed around the site buildings but contaminants under the site buildings would not be accessible for in-situ treatment unless angle borings were used.

The relatively shallow groundwater table and tight near-surface soils may limit the implementability of this technology at the site. A groundwater extraction system is proposed to lower the water table creating more potential for vapor extraction. A low permeability barrier wall is also proposed to limit groundwater recharge to the treatment area and to control migration of NAPL mobilized by the application of heat. A pilot study would be useful to evaluate the capacity for groundwater table depression and the area of influence of soil vapor wells in the vadose zone.

Installation of the heating elements and vapor extraction wells would be minimally disruptive to the site but construction of an impermeable cap to limit release of vapors could require temporary shut-down of site activities. Since the thermal treatment of soils system installation can be completed in a matter of days, the duration of this alternative could be sufficiently short that site occupants could accommodate the disruption.

In case of incomplete removal of contaminants through in-situ thermal treatment, in-situ bioremediation could be used as a follow-up to thermal treatment. Enhanced bioremediation involves injection of air or microorganisms to enhance the natural degradation of dissolved phase contaminants.

A tar-filled, metal underground storage tank located on the northeast side of the site, along with some nearby naphthalene crystals, would be removed and disposed of or treated off-site as part of this alternative.

The conceptual design for the in-situ thermal treatment includes the following elements:

Temporary Barrier Wall
Applying heat to subsurface soils containing NAPL can increase NAPL mobility. A temporary barrier wall would be installed around the perimeter of the work zone to contain mobilized NAPL. The barrier wall also serves to limit recharge of groundwater into the treatment area after groundwater levels are lowered through groundwater extraction. The wall would be constructed of sheet-piles or soil-bentonite

and would be installed from the ground surface to the lacustrine clay (approximately 20 feet below grade). The wall would be located at the perimeter of the thermal treatment zone (Figure 3.2).

Groundwater Table Depression
A series of groundwater extraction wells or trenches would be installed to lower the water table, thereby increasing the zone from which soil vapors could be removed. The location of extraction points would maximize the capture of NAPL should it become mobile due to the application of heat. A temporary water treatment system would be constructed on site to treat removed water. NAPL would be separated for off-site disposal or treatment. A permit would be required for discharge to the creek or local POTW. The extraction wells could be multiple phase extraction wells (vapor, groundwater and NAPL) and also used as heating points.

In-situ Thermal Treatment System
A system of heating elements and SVE extraction points would be installed in the contaminated zone (Figure 3.2). The heat would be applied above and below the water table. Vaporized contaminants would be captured by the SVE system. Mobilized NAPL and dissolved phase contaminants would be captured by the groundwater extraction system. In areas of very high heat, some compounds would be destroyed (pyrolized or oxidized). The vapor SVE system would be equipped with treatment components such as carbon to treat vapors prior to discharge in accordance with an air discharge permit. A temporary impermeable cap would likely be required to prevent short-circuiting of soil vapors from the surface unless near surface soils are sufficiently impermeable.

System Operation
The thermal treatment and multi-phase extraction system would be operated simultaneously. Operation would continue until the concentrations in the soil vapors met target levels. Soil borings would also be drilled and soil samples collected to evaluate the performance of the system. Once the potential for in-situ thermal treatment is exhausted, the heating elements, wells, cap and sheetpile walls (if used) would be removed. Selected points might be retained for use with enhanced bioremediation, if polishing is deemed warranted.

Enhanced Bioremediation
In the area west of the rail line, the NAPL occurs in very thin seams and small blebs. While bioremediation is not highly effective for NAPL, small quantities could be positively impacted. In the areas where thermal treatment may have left residuals, enhanced bioremediation could also be employed. Thermal treatment does not change the pH of the formation and therefore does not inhibit the subsequent use of bioremediation agents. Air and/or microorganisms would be injected through wells into the subsurface formation. Long-term monitoring would be required to evaluate performance of the bioremediation system.

Sub-Slab Depressurization
Venting of the soil vapors beneath the floor slabs of five residential houses and a school located west of the site and the Gastown Sportsman's Club is proposed to mitigate risks associated with potential future vapor intrusion impacts to indoor air quality.

No information is currently available on the construction of the foundations or floor slabs for each structure but it is assumed that there is sufficient gravel under the slab to allow venting of sub-slab vapors. The sub-slab vapor extraction system would consist of a series of vents drilled through the floor-slab or from outside the building, manifolded to an electric blower and vented to the outside air. The blower would be used to create a vacuum, depressuring the sub-slab materials (assuming they are sufficiently permeable) relative to the indoor air pressure to prevent migration of soil gasses into the buildings. Off-gas vents located outside the building would be used to discharge the air drawn out from beneath the slab.

For estimating purposes, it is assumed that one vent would be installed per residential house, two vents for the commercial building and four for the school. Each vent would be fitted with an appropriately sized vacuum/blower unit capable of producing a sustained vacuum beneath the slab. It may also be necessary to reseal the floors and/or foundations to prevent leakage or loss of vacuum. It is assumed that a 100-watt high flow/low vacuum blower would be sufficient for each vent.

Sediment Removal and Disposal
As described in Section 3.2.5, an estimated 100 cubic yards of impacted sediment is present in Tonawanda Creek, adjacent to the site. This sediment would be removed and disposed of off-site as a non-hazardous waste. The presence of East Niagara Street and the rail line prohibit access to the sediment from the shore. Therefore, the sediment removal process would be accomplished from barges or other vessels operated in Tonawanda Creek. The approximately 100 foot by 50 foot removal area would be isolated by silt barriers anchored into the lacustrine clay. The corner anchors would be driven piles which would be used for cabling the dredge to access points within the removal areas. The silt barriers would prevent migration of impacted sediment suspended during removal.

Sediment would be removed using conventional excavation equipment. An excavator on a barge with sludge boxes would be used to remove the sediment. The excavator would use a dredge bucket to remove the contaminated sediment and place into the sludge box(es). The sludge boxes would be shuttled to an off-loading area and transported to the site using a conventional roll-back truck. The material would be stabilized inside the roll-off box and disposed of off-site. If site soils still exist the material could be blended with on-site soils. The estimated quantity for disposal is 1,300 tons.

Approximately 20 post-dredge samples would be collected (1 per 200 square feet) and analyzed for SVOCs. The dredged area would be backfilled to the original grade with clean material. The silt barrier would be removed upon completion of backfilling.

4.2.4.2 Assessment

Compliance with SCGs
Destruction of the MGP wastes through in-situ thermal treatment would satisfy the applicable Federal and State chemical-specific SCG's for water quality by eliminating the source of contamination. Areas outside the thermal treatment zones (i.e., west of the rail line) would be treated with bioremediation techniques which may have limited effectiveness if NAPL is present in significant quantities.

During the in-situ thermal treatment process, SCGs would be the performance criteria for removal and off-site destruction of the liquid wastes and on-site treatment of contaminated air and groundwater. Minimum treatment standards would need to be achieved for all media treated.

Removal of sediment within Tonawanda Creek, which is defined as navigable waters, would trigger location-specific SCG's such as ECL Article 15, Title 5 and ECL Article 17, Title 3, Use and Protection of Waters. These laws, as well as 6 NYCRR Part 608, establish permit requirements to change, modify, or disturb any protected stream, its bed or banks, or remove from its bed any material. A federal permit would be required to conduct the remedial activities associated with sediment remediation. A Section 10

(Rivers and Harbor Act) permit would likely be sufficient to cover the proposed dredging and backfilling activities.

Overall Protection of Human Health and the Environment
In-situ destruction of the NAPL, soil and groundwater contaminants or removal and ex-situ destruction of the removed contaminants protects human health and the environment by destroying to acceptable levels organic contaminants and mitigating the potential for migration of contaminants to groundwater through stabilization. Contaminants remaining out side area of thermal treatment would continue to present long-term risks unless bioremediation is successful (which could involve long time periods). Sediment removal would permanently remove exposure routes to aquatic wildlife. Sub-slab depressurization would mitigate air quality risks associate with potential vapor intrusion.

Short-Term Effectiveness
Community, worker and environmental protection: A minimal increase of potential risk of exposure to the waste for the community, workers, and the environment would be present during construction of temporary barrier walls. The risk of direct exposure to the community could be reduced with site access controls and appropriate warnings to area residents to avoid the site during the period of remedial activities. The increased risk of direct exposure to workers can be mitigated by applying appropriate personal protective equipment.

Since no major soil removal is proposed, there is no significant short-term increased risks of community, worker and environmental exposure to contaminated site media in association with handling, stockpiling or treating of the material. An increased risk of exposure to vapors would be created. Appropriate engineering controls would mitigate most of the increased short-term risk to the environment during remedial operations.

Sediment removal presents short-term risks to the environment through the potential for suspension and migration of contaminated sediment during removal. These risks would be controlled through the use of silt curtains and use of appropriate dredging equipment.

The increased short-term risks would be present during the period of on-site remedial activities which are estimated to have a duration of approximately 4 months. Operation of the bioremediation elements would likely continue for years.

Long-Term Effectiveness and Permanence
Long-term risks due to exposure to the hazardous materials and residual wastes would be significantly reduced under this alternative. The majority of the organic compounds associated with the MGP wastes would be effectively eliminated reducing risks associated with direct contact and potential leaching to groundwater. Elimination of the organics would significantly reduce or eliminate the potential degradation of local environmental resources. Destruction of the organics would be permanent.

Residual risk: The residual risk relative to the toxicity and volume of the waste would be significantly reduced. The potential for direct exposure is reduced as long as the stabilized material remains undisturbed. The residual risk relative to the site would be significantly reduced compared to the previous alternatives.

Adequacy of controls: Organic compounds removed through this treatment process would be controlled and hazards eliminated. It may be difficult to assess the amount of residuals left in place, but these would be addressed with long-term enhanced bioremediation and monitoring.

Reliability of controls: Monitoring would be used to assess the effectiveness of on-site treatment of removed media (groundwater and air) as well as the bioremediation process for residual contaminants.

Reduction of Toxicity, Mobility, and Volume through Treatment
Thermal treatment would destroy a portion of the contaminants in situ effectively eliminating the toxicity and volume of the organic compounds. Removed contaminants would also be destroyed or permanently immobilized. NAPL left in place would likely provide a continuing source of contamination to groundwater which would be treated with enhanced bioremediation techniques, slowly degrading the contaminants.

Implementability
There are several service providers, including TerraTherm, who have successfully completed in-situ thermal treatment at sites with SVOC wastes.

Administrative: TAGM 4030 specifies a hierarchical preferential order for selecting remedial action alternatives. Alternatives that eliminate or reduce toxicity, volume, and mobility of contaminants are preferred. In-situ thermal treatment would be a preferred technology under this guidance.

Technical: Construction and operation of the in-situ thermal treatment system in such a way that site activities could continue may be technically infeasible. Developing the proper spacing of heating element and vapor extraction points may be challenging due to the relatively low permeability of the alluvium and the dispersed nature of the NAPL. The presence of the buildings limits access to the contaminants. Capturing vapors may be complicated by the presence of the site buildings.

Costs
The estimated total present worth cost for implementing Alternative 4 is $16.61M with capital costs of $16.19M The present worth cost was estimated based on annual operation, maintenance and monitoring costs of approximately $89,000 per year over 5 years using a 5% discount rate. A summary of the estimated unit costs for Alternatives 4 is included in Table 4-1. Back up information for this cost estimate is provided in Appendix B.

Community Acceptance
This alternative is likely to be somewhat disruptive to the businesses occupying the site. The technology may be objectionable to the local community due to the actual and perceived risks associated with releases of vaporized contaminants to the air.

4.2.5 Alternative 5: Partial Removal, Partial Containment and In-Situ Treatment

4.2.5.1 Description

Removal and containment are conventional approaches to remediation of MGP waste impacted soils. To address the complexities of the Gastown Former MGP Site, these technologies have been combined and the more innovative chemical treatment technology has been added provide a protective and reliable remedy. In-situ chemical treatment would not likely be effective for areas with highly stratified geology and significant quantities of NAPL. However, since chemical treatment is effective for the site groundwater contaminants and may be effective for smaller quantities of NAPL, this technology is combined with the conventional technologies to further reduce the volume and toxicity of site contaminants.

A combination of soil removal in major source areas (at the gas holder), containment walls and NAPL collection systems in areas where soil removal would be too disruptive, and in-situ treatment to destroy residuals maximizes remediation while minimizing costs and disturbance to the site buildings. A schematic of the remedial elements is provided in Figure 3-3.

No barrier wall is proposed under the where the rail line crosses East Niagara Street because the feasibility of constructing an effective cutoff wall is limited by accessibility (limited head space under the bridge), presence of utilities, and a constant vibration caused by the rail road. The migration of NAPL and contaminated groundwater through the barrier wall gap under the rail line is anticipated to be mitigated by the collection wells to be located adjacent to the barrier walls. Sub-slab depressurization and sediment removal would be included with this alternative.

Soil/NAPL Removal
The proposed soil removal area (Figure 3-3) addresses NAPL impacted soil in the area of the gas relief holder. Accessing these soils would necessitate the demolition of portions of the site buildings. The businesses that would be impacted by the demolition would be Niagara Construction and Advanced Electric. These businesses would be temporarily housed in a construction trailer until the soil removal is complete and the portions of the building reconstructed.

Since the NAPL is located at depths up to approximately 20 feet below grade, shoring would be required to maintain stable excavation walls. Excavation adjacent to site buildings would likely require additional bracing to ensure the structural integrity of the building foundations. A temporary sheet pile wall is proposed for the perimeter of each excavation area, with additional bracing as necessary. Subsurface investigation adjacent to the site building indicated that large obstructions (concrete and debris in the fill) are present that would prevent penetration of sheet piles. An innovative bracing approach would be required for this area (possibly an iterative approach of removal and bracing of short sections of wall). Soil would be excavated until cleanup levels are achieved. Excavation depths are anticipated to be to the top of lacustrine clay. The upper portions of the formation are expected to be free of contaminants in most areas. Clean soil would be segregated from contaminated soil. Both would be tested and sent off site for disposal. Low permeability, clean imported soils would be used for backfill. The nearest off site thermal treatment facility is in Ohio or Hudson Falls, NY.

Excavation of MGP wastes can produce odors that may be unacceptable to nearby receptors. Control of vapors and odors would be an integral part of the remedial action. Construction of a temporary building over the excavation is a common method for odor control but odor suppressing foams are also used. Temporary buildings may not be required for a successful excavation plan, but for the purposes of this FS the excavation costs include this type of odor control.

A tar-filled, metal underground storage tank located on the northeast side of the site, along with some nearby naphthalene crystals, would be removed and disposed of or treated off-site as part of this alternative.

Barrier Walls and Cap
NAPL not removed through excavation would be remediated using other technologies. Contaminated areas east of the rail line (under and around the site building) would be contained within barrier walls and a low permeability cap. The east side of the contained area would be controlled by the low permeability backfill in the excavation areas. For the remainder of the containment area, the barrier walls would be constructed of slurry-filled trenches or sheet piles embedded into the lacustrine clay or till. Many utilities are located along East Niagara Street, which could limit the use of one technology or the other.

Infiltration into the contained area would be prevented by constructing an impermeable cap. The cap would be constructed of geomembrane, cushion layers and a paved upper protective layer. This would be suitable considering the commercial use of the property. The cap would be constructed to create a seal around the base of the site buildings so that all leakage is prevented. The cap would require long term maintenance.

Barrier Walls with NAPL Collection Systems
At certain areas of the site fully containing barrier walls are not practical. West of the rail line and on the eastern portion of the site, residual NAPL would be controlled through a combination of barrier walls and NAPL collection wells (see Figure 3.3). The barrier walls would be constructed of slurry-filled trenches or sheet piles embedded into the lacustrine clay or till. A series of collection wells would be installed on the contamination side of the barrier walls. These well would be designed as NAPL collection sumps and would be used to lower water levels such that the barrier walls would not significantly impact the hydraulic gradients in the area, causing contaminated groundwater and associated NAPL to flow around to currently non-impacted areas.

Groundwater Removal and Treatment
The water table at the site is approximately 5 to 10 feet below ground surface. Therefore, groundwater would need to be pumped from the excavated area and treated. NAPL would be separated from the water and transported off site for disposal. Groundwater would be treated with carbon or an equivalent technology and discharged to a permitted discharge point. The treatment system would be maintained and operated to manage NAPL and groundwater removed from the collection wells.

In-Situ Oxidation Treatment
The proposed elements of this remedy would be sufficient to mitigate site risks, but according to TAGM #4030, NYSDEC does not consider isolation and control technologies as a permanent remedy and therefore they are not preferred, but in the absence of hierarchically preferable and equally cost-effective alternatives, they are acceptable. Therefore, in-situ oxidation is proposed to reduce the volume and toxicity of the residual MGP wastes. Oxidation is known to be effective at destroying VOCs and SVOCs in soil and groundwater and with sufficient time, can reduce quantities of NAPL.

This alternative would include a phased approach to employing in-situ chemical treatment. A pilot study would be performed initially within the contained area on site. Ozone sparging is likely the most applicable form of in-situ oxidation or the site. The pilot study would evaluate the effectiveness of this technology for the specific geologic conditions and contaminants at the site. Wells would be drilled and ozone would be bubbled from the base of the well, through the groundwater. Performance would be monitored through a combination of groundwater and soil sampling at strategic locations. Ozone treatment requires a significant amount of electricity to create the ozone on site. The ozone is continuously injected into the formation, destroying organic compounds that it encounters, a process that could take several years. If this technology can be applied successfully in the pilot study area, then it would be used in areas west of the rail line and in the vicinity of the Gastown Sportsmans Club.

Sub-Slab Depressurization
Venting of the soil vapors beneath the floor slabs of five residential houses and a school located west of the site and the Gastown Sportsman's Club is proposed to mitigate risks associated with potential future vapor intrusion impacts to indoor air quality.

No information is currently available on the construction of the foundations or floor slabs for each structure but it is assumed that there is sufficient gravel under the slab to allow venting of sub-slab vapors. The sub-slab vapor extraction system would consist of a series of vents drilled through the floor-slab or from outside the building, manifolded to an electric blower and vented to the outside air. The blower would be used to create a vacuum, depressuring the sub-slab materials (assuming they are sufficiently permeable) relative to the indoor air pressure to prevent migration of soil gasses into the buildings. Off-gas vents located outside the building would be used to discharge the air drawn out from beneath the slab.

For estimating purposes, it is assumed that one vent would be installed per residential house, two vents for the commercial building and four for the school. Each vent would be fitted with an appropriately sized vacuum/blower unit capable of producing a sustained vacuum beneath the slab. It may also be necessary to reseal the floors and/or foundations to prevent leakage or loss of vacuum. It is assumed that a 100-watt high flow/low vacuum blower would be sufficient for each vent.

Sediment Removal and Disposal
As described in Section 3.2.5, an estimated 100 cubic yards of impacted sediment is present in Tonawanda Creek, adjacent to the site. This sediment would be removed and disposed of off-site as a non-hazardous waste. The presence of East Niagara Street and the rail line prohibit access to the sediment from the shore. Therefore, the sediment removal process would be accomplished from barges or other vessels operated in Tonawanda Creek. The approximately 100 foot by 50 foot removal area would be isolated by silt barriers anchored into the lacustrine clay. The corner anchors would be driven piles which would be used for cabling the dredge to access points within the removal areas. The silt barriers would prevent migration of impacted sediment suspended during removal.

Sediment would be removed using conventional excavation equipment. An excavator on a barge with sludge boxes would be used to remove the sediment. The excavator would use a dredge bucket to remove the contaminated sediment and place into the sludge box(es). The sludge boxes would be shuttled to an off-loading area and transported to the site using a conventional roll-back truck. The material would be stabilized inside the roll-off box and disposed of off-site. If site soils still exist the material could be blended with on-site soils. The estimated quantity for disposal is 1,300 tons.

Approximately 20 post-dredge samples would be collected (1 per 200 square feet) and analyzed for SVOCs. The dredged area would be backfilled to the original grade with clean material. The silt barrier would be removed upon completion of backfilling.

4.2.5.2 Assessment

Compliance with SCGs:
The removal of the waste materials and associated impacted soils to below state soil clean-up guidance values would satisfy the SCGs relative to the site. Hazardous waste materials would be destroyed, treated and/or contained at permitted facilities in accordance with 6 NYCRR Part 375 incineration regulations, Part 360 disposal regulations and/or all applicable RCRA and TSCA requirements. Destruction of organic contaminants through oxidation would also achieve the SCGs. Minimum treatment standards would need to be achieved for all soil and water treatment systems.

On-site containment would satisfy the applicable action-specific SCGs relative to the impacted soil and groundwater. The proposed final cover system would be compliant with Part 360 and RCRA design requirements. In addition, a groundwater gradient control system would be included in the conceptual design that would have the capacity to collect all of the anticipated infiltration through the final cover, barrier wall and underlying alluvium. The plans and specifications would require compliance with SPDES runoff guidance during construction as well as NYSDEC TAGM 4031 fugitive dust suppression requirements.

In-situ oxidation of contained wastes satisfies the NYSDEC TAGM #4030, which does not consider isolation and control technologies as a permanent remedy and therefore they are not preferred. Provisions for long-term monitoring and site review have been included in the long-term O&M costs for the alternative.

Removal of sediment within Tonawanda Creek, which is defined as navigable waters, would trigger location-specific SCG's such as ECL Article 15, Title 5 and ECL Article 17, Title 3, Use and Protection of Waters. These laws, as well as 6 NYCRR Part 608, establish permit requirements to change, modify, or disturb any protected stream, its bed or banks, or remove from its bed any material. A federal permit would be required to conduct the remedial activities associated with sediment remediation. A Section 10 (Rivers and Harbor Act) permit would likely be sufficient to cover the proposed dredging and backfilling activities.

Overall Protection of Human Health and the Environment:
This alternative would result in the permanent removal of hazardous source materials from the site, and containment or treatment of residual contaminants in place. If effective, it provides a high level of overall long-term protection to human health and the environment. In-situ oxidation holds the potential for leaving substantial residuals in place, but the containment and control measures would provide continuing mitigation of contaminant migration. Sediment removal would permanently remove exposure routes to aquatic wildlife. Sub-slab depressurization would mitigate air quality risks associate with potential vapor intrusion.

Short-Term Effectiveness:
Community, worker and environmental protection: A significant increased potential risk of exposure to the contaminated media for the community, workers, and the environment would be present during waste removal activities. As a short-term measure, temporary physical barriers around the site and/or stockpiles would help to mitigate this increased risk. Supplying workers with proper personal protective equipment, monitoring air and water quality during waste removal, transport and disposal, and employing engineering controls, as necessary, would mitigate exposure risks.

Handling of contaminated material increases the potential risk for a release of contaminants to the environment, particularly under wet conditions. Careful site preparation prior to excavation would minimize this potential and protect the local ecology. The placement of barriers and sediment traps to collect particulates and prevent the release of potentially contaminated water generated during excavation activities would mitigate these increased risks. Additionally, proper management of temporary stockpiles of waste and processed reusable material would mitigate the increased risk to the environment during the removal action.

Due to the need to transport the material to an off-site facility, the potential for an accidental release in transit increases short-term risks to the community. Increased heavy vehicular traffic in a rural area also contributes to increased short-term risk to the community. During implementation, an average of twenty or more loaded heavy vehicles (32+ tons) carrying contaminated soils would leave the site per day. An additional number of heavy vehicles transporting clean fill would arrive at the site each day during restoration. Implementing appropriate traffic safety controls and warnings, careful attention to the appropriate transportation rules and regulations, and vehicle decontamination procedures during the removal action would mitigate some of the increased exposure risks to the community.

Sediment removal presents short-term risks to the environment through the potential for suspension and migration of contaminated sediment during removal. These risks would be controlled through the use of silt curtains and use of appropriate dredging equipment.

It is estimated that the total time to complete this remedial action alternative would be 6 months with chemical oxidation continuing two more years after to construction phase is complete.

Long-Term Effectiveness and Permanence
Removal and off-site disposal is an effective permanent solution relative to the site. Hazardous constituents would be destroyed or contained indefinitely at an off-site facility. Long-term risks due to exposure and migration of contaminants would be significantly reduced through construction of a cap (preventing infiltration of precipitation) and barrier walls (preventing lateral and vertical migration). If effective, in-situ oxidation would permanently destroy the residual contaminants. The low permeability, stratified nature of the alluvium limits the effectiveness of this technology.

Residual risk: The removal of impacted soils from the site and containment and in-situ treatment of residual contaminants would significantly reduce or eliminate the residual risks.

Adequacy of controls: The risks to potential future receptors would be mitigated effectively by the combination of removal and containment of the impacted materials. Treatment is less likely to be adequate at destroying all of the residual contaminants but is included only as a means of reducing the volume of wastes at the site, no as a primary remedial technology.

Reliability of controls: It is anticipated that the off-site treatment/disposal system could function properly for an indefinite period. It is anticipated that a monitored and maintained containment system would be effective indefinitely. The in situ oxidation treatment system would need to be operated and monitored to assess its continued effectiveness at reducing contaminants. It is difficult to estimate the likelihood for success with this technology.

Reduction of Toxicity, Mobility, and Volume through Treatment:
Contaminants that are destroyed through off-site treatment (incineration) would effectively eliminate the toxicity, volume and mobility of these contaminants. Transfer of contaminants to a permitted secure landfill (hazardous or non-hazardous waste) or containing the wastes in place would not reduce the volume or toxicity, but would limit the mobility of the contaminants. In-situ oxidation would reduce the toxicity, mobility and volume of the contaminants that are effectively treated by this technology. The potential for residual contamination exists.

Implementability
Permitted commercial disposal facilities are available to receive each and all of the site-specific waste streams. Service providers and materials necessary to install cap and barrier walls are readily available. Companies that employ in-situ oxidation exist who could perform this aspect of the remedial alternative.

Cost
The estimated total present worth cost for implementing Alternative 5 is $8.47M with capital costs of $7.82M The present worth cost was estimated based on annual operation, maintenance and monitoring costs of approximately $143,000 per year over 5 years using a 5% discount rate. A summary of the estimated unit costs for Alternative 5 is included in Table 4-1. Back up information for this cost estimate is provided in Appendix B.

Community Acceptance
Alternative 5 is likely to be accepted by the community because the combined approach maximizes the overall protection to human health and the environment while minimizing the impact to local business.

4.2.6 Alternative 6: Full Isolation and Containment

4.2.6.1 Description

The intent of this alternative is to encapsulate the contaminants so they can no longer migrate or be a continuing source of groundwater contamination. Two contained areas would be created as shown on Figure 3-4. Vertical barrier walls would be installed around the perimeter of each containment area. The walls would be imbedded in the low permeability lacustrine clay. A cap would be tied to the barrier walls, completing the seal. The buildings would be left in place, which would require that the capping materials be carefully sealed against the building foundations to prevent leakage into the contained area.

The drawback to this alternative is that NAPL and contaminated soil are present under the rail line and this area cannot be readily contained. Even if barrier walls could be constructed using jet grouting or an equivalent technology, it would be difficult if not impossible to create a watertight cap across the active rail line. If no barrier wall is placed at the intersection of the rail line and the Tonawanda Creek, then a migration pathway would still exist for a continuing source of groundwater contamination. For this alternative a barrier wall would be proposed adjacent to East Niagara Street and connecting the two northern-most walls of the two containment areas. Since groundwater would naturally build up behind this wall, groundwater pumping would be required to prevent leakage through the wall. A treatment system would be constructed near the rail line to treat groundwater pumped from the contained areas and the upgradient side of the barrier wall crossing the rail lines to control hydraulic gradients. Groundwater would be treated with carbon or an equivalent technology. Long-term monitoring would be required to evaluate the performance of the containment system. Institutional controls would be necessary to prevent breaches of the containment system.

Although soil removal is not proposed under this alternative, a tar-filled, metal underground storage tank located on the northeast side of the site, along with some nearby naphthalene crystals, would be removed and disposed of or treated off-site.

Barrier Wall and Cap
Under this alternative, waste materials and impacted soils would be physically and hydraulically contained on site. Physical containment would be accomplished with barrier walls and a low permeability final cover system. Hydraulic containment would be facilitated with a water table depression system consisting of groundwater recovery wells or trenches placed within the area of containment to depress the water table and create a small inward and upward gradient within the containment zone.

The barrier walls would be constructed of soil-bentonite backfill that would extend from grade and be toed into the underlying lacustrine clay. The barrier wall would be installed completely around the main source area (1,800 l.f.). The on-site buildings would be left in place and the cap would be constructed using an asphalt and geomembrane system designed to promote runoff and support vehicle parking.

The hydraulic containment system would include three recovery wells with free-product recovery technology to collect NAPL. An on-site water treatment system would be operated and maintained to treat removed groundwater and/or free product recovered by the water table depression system. Treated water would be discharged under permit to surface waters adjacent to the site and recovered product transported off-site for treatment/disposal. The influent and effluent of the water treatment system would be tested on a regular basis to monitor the performance of the system and to document compliance with the applicable regulations.

A schedule of quarterly monitoring would be implemented to inspect the cover and monitor the on-site groundwater quality to maintain and document the integrity and continued effectiveness of the containment system. For cost estimating purposes it is assumed that ten existing monitoring wells would be included in the long-term monitoring program. Future use of the contained area would be restricted to activities that would not erode or damage the cap materials. A review of the effectiveness of the containment system would be performed every five years (TAGM 4030, Sec 2.0) based on the data collected during the long-term monitoring and inspection program.

For completing the cost analysis, it is assumed that Operations and Maintenance would consist of an annual inspection event, minimal repair to the cover system, monthly groundwater monitoring (at 10 sampling points) for one year, quarterly monitoring for years 2 through 30 and the required five-year reviews.

Sub-Slab Depressurization

Venting of the soil vapors beneath the floor slabs of five residential houses and a school located west of the site and the Gastown Sportsman's Club is proposed to mitigate risks associated with potential future vapor intrusion impacts to indoor air quality.

No information is currently available on the construction of the foundations or floor slabs for each structure but it is assumed that there is sufficient gravel under the slab to allow venting of sub-slab vapors. The sub-slab vapor extraction system would consist of a series of vents drilled through the floor-slab or from outside the building, manifolded to an electric blower and vented to the outside air. The blower would be used to create a vacuum, depressuring the sub-slab materials (assuming they are sufficiently permeable) relative to the indoor air pressure to prevent migration of soil gasses into the buildings. Off-gas vents located outside the building would be used to discharge the air drawn out from beneath the slab.

For estimating purposes, it is assumed that one vent would be installed per residential house, two vents for the commercial building and four for the school. Each vent would be fitted with an appropriately sized vacuum/blower unit capable of producing a sustained vacuum beneath the slab. It may also be necessary to reseal the floors and/or foundations to prevent leakage or loss of vacuum. It is assumed that a 100-watt high flow/low vacuum blower would be sufficient for each vent.

Sediment Removal and Disposal

As described in Section 3.2.5, an estimated 100 cubic yards of impacted sediment is present in Tonawanda Creek, adjacent to the site. This sediment would be removed and disposed of off-site as a non-hazardous waste. The presence of East Niagara Street and the rail line prohibit access to the sediment from the shore. Therefore, the sediment removal process would be accomplished from barges or other vessels operated in Tonawanda Creek. The approximately 100 foot by 50 foot removal area would be isolated by silt barriers anchored into the lacustrine clay. The corner anchors would be driven piles which would be used for cabling the dredge to access points within the removal areas. The silt barriers would prevent migration of impacted sediment suspended during removal.

Sediment would be removed using conventional excavation equipment. An excavator on a barge with sludge boxes would be used to remove the sediment. The excavator would use a dredge bucket to remove the contaminated sediment and place into the sludge box(es). The sludge boxes would be shuttled to an off-loading area and transported to the site using a conventional roll-back truck. The material would be stabilized inside the roll-off box and disposed of off-site. If site soils still exist the material could be blended with on-site soils. The estimated quantity for disposal is 1,300 tons.

Approximately 20 post-dredge samples would be collected (1 per 200 square feet) and analyzed for SVOCs. The dredged area would be backfilled to the original grade with clean material. The silt barrier would be removed upon completion of backfilling.

4.2.6.2 Assessment

Compliance with SCGs:
Alternative 6 would satisfy the applicable Federal and State chemical-specific SCG's for water quality by containing the source of contamination, collecting contaminated groundwater and NAPL during and after construction and treating the collected groundwater to the applicable standards. Residual groundwater contamination which may be present outside the containment area would not meet SCGs for the foreseeable future if NAPL is present outside the containment area.

The proposed final cover system would be compliant with Part 360 and RCRA design requirements. In addition, a groundwater gradient control system is included in the conceptual design that has the capacity to collect all of the anticipated infiltration through the final cover, barrier wall and underlying alluvium. The plans and specifications would require compliance with SPDES runoff guidance during construction as well as NYSDEC TAGM 4031 fugitive dust suppression requirements. The effluent of the on-site groundwater treatment system would comply with the SPDES discharge requirements both during and after construction.

According to TAGM #4030, NYSDEC does not consider isolation and control technologies as a permanent remedy and therefore they are not preferred, but in the absence of hierarchically preferable and equally cost-effective alternatives, they are acceptable. Provisions for long-term monitoring and site review have been included in the long-term O&M costs for the alternative. If containment is selected, a statement must be included in the ROD detailing the rationale for selecting a non-permanent solution.

Removal of sediment within Tonawanda Creek, which is defined as navigable waters, would trigger location-specific SCG's such as ECL Article 15, Title 5 and ECL Article 17, Title 3, Use and Protection of Waters. These laws, as well as 6 NYCRR Part 608, establish permit requirements to change, modify, or disturb any protected stream, its bed or banks, or remove from its bed any material. A federal permit would be required to conduct the remedial activities associated with sediment remediation. A Section 10 (Rivers and Harbor Act) permit would likely be sufficient to cover the proposed dredging and backfilling activities.

Overall Protection of Human Health and the Environment
Overall protection of human health would be significantly improved by this alternative. Direct exposure would be effectively eliminated providing a moderate level of overall long-term protection to human health. Hydraulic containment within the containment zone would effectively prevent the lateral migration of the NAPL and dissolved contaminants. Residual contamination under the rail line would remain, presenting a minor risk to the Tonawanda Creek since the barrier wall on opposing sides of the rail line would create a funnel for groundwater flow. Sediment removal would remove exposure routes to aquatic wildlife but a small potential of recontamination would exist due to the potential for migration of contaminants from under the rail line. Sub-slab depressurization would mitigate air quality risks associate with potential vapor intrusion.

Short-Term Effectiveness
Community, worker and environmental protection: A minimal increase of potential risk of exposure to the waste for the community, workers, and the environment would be present during construction of barrier walls. The risk of direct exposure to the community could be reduced with site access controls and appropriate warnings to area residents to avoid the site during the period of remedial activities. The increased risk of direct exposure to workers can be mitigated by applying appropriate personal protective equipment.

Sediment removal presents short-term risks to the environment through the potential for suspension and migration of contaminated sediment during removal. These risks would be controlled through the use of silt curtains and use of appropriate dredging equipment.

Increased short-term risks would be present during the period of on-site remedial activities. Site activities are estimated to be completed in 4 months.

Long-Term Effectiveness and Permanence
Long-term risks due to exposure would be significantly reduced under this alternative. The cap would prevent infiltration of precipitation while the barrier walls and hydraulic containment system would prevent lateral and vertical migration. The potential degradation of local environmental resources would be reduced. It is anticipated that a monitored and maintained containment system would be effective indefinitely.

Residual risk: The residual risk relative to the toxicity and volume of the waste would be essentially unchanged from its current condition. The potential for direct exposure is reduced significantly while the containment system remains intact. A small residual risk to Tonawanda Creek would remain in association with the uncontained contamination (NAPL and impacted soil and groundwater) under the rail line.

Adequacy of controls: If properly constructed and maintained, the containment system is capable of preventing direct exposure for an indefinite period. The combination of a protective cover with lateral and vertical barrier/containment would prevent the migration and confine the material. No controls would be in place to prevent migration of contaminants under the rail line towards Tonawanda Creek.

Reliability of controls: A properly designed and constructed cap with barrier walls is a proven effective and reliable technology for isolating contamination from the surrounding environment. The use of land use restrictions and physical barriers to protect the cover also increases its reliability.

The low permeability final cover system prevents the infiltration of precipitation. Combined with the barrier wall, the semi-confining alluvium layer beneath the waste, and the induced inward and upward gradients created by the hydraulic containment system, this alternative would reliably provide significant protection to the local groundwater regime.

Reduction of Toxicity, Mobility, and Volume through Treatment
Containment would not significantly reduce the toxicity or volume of the solid waste but would reduce the mobility. NAPL recovery by the hydraulic containment system would result in a reduction in the total volume of liquid waste and destruction of the NAPL by off-site treatment. Residual contamination outside the contained areas would not be immobilized or reduced in toxicity or volume.

Implementability
Service providers and materials necessary to complete tasks for this alternative are readily available.

Administrative: Discharge permits would be necessary for operation of groundwater pumping and treatment system.

Technical: There are no technical feasibility issues related to the removal action or construction of the protective cover system. The technologies are relatively simple, frequently used, and proven.

Cost

The estimated total present worth cost for implementing Alternative 6 is $6.37M with capital costs of $3.63M The present worth cost was estimated based on annual operation, maintenance and monitoring costs of approximately $179,000 per year over 30 years using a 5% discount rate. A summary of the estimated unit costs for Alternative 6 and a comparison with the cost estimates associated with other alternatives is provided in Table 4-1. Backup for the cost estimate is provided in Appendix B.

The loss of current use and potential future use of the property has not been calculated in determining the cost estimate for implementation.

Community Acceptance
This alternative is likely to be somewhat objectionable to the local community because the waste would remain in place and construction of a cap around site buildings could be too disruptive and may limit future development of the property.

4.2.7 Alternative 7: Full Removal

4.2.7.1 Description

This alternative maximizes removal of NAPL and contaminated soil from the site, providing the highest degree of protection of human health and the environment. This alternative would include the demolition of the site buildings to remove underlying contaminated soil. Since these buildings are currently housing active businesses, this alternative would include the costs associated with relocating these businesses. This alternative would involve the excavation of all NAPL and soil exceeding the soil cleanup goals. Removed material would be transported to several different disposal or treatment facilities based on the type and concentration of the contaminants contained in the waste. It is anticipated that the same quantity of backfill would be required to reestablish the original grade of the site. Groundwater and NAPL generated during the excavation of soil would be separated on-site in an oil/water separator. NAPL would be transported off site for treatment and groundwater would be treated on site prior to discharge to surface water. Groundwater treatment would consist of a clarifier, bag filters and carbon. Groundwater monitoring would be performed for an estimated five years to confirm the success of the remediation.

Site Preparation
Site preparation would involve relocation of site businesses. An agent could be employed to identify suitable alternate locations for the business occupying the site. Once acceptable arrangements have been identified, all equipment, furniture and supplies would be moved to the new location. Specific capital improvements might be required to make the new locations functionally equivalent to the current locations. Costs associated with the relocation would include realtor fees, moving costs and capital improvements. Once the buildings have been vacated, they would be demolished and removed from the site, providing access to the underlying soils.

Removal of contaminated soil would require preparation activities including installation of fencing, provision for electrical service and miscellaneous installations. Fencing would prevent trespassers from encountering contaminated material or tampering with equipment during remedial construction.

Soil/NAPL Removal and Off-Site Treatment/Disposal
Since the NAPL is located at depths of approximately 20 feet below grade, dewatering of the excavation would be required. Also, shoring of the excavation walls may be necessary in some locations to achieve required depths. A temporary barrier wall would be installed around the perimeter of the excavation areas to reduce groundwater influx and provide stable excavation walls. Soil would be excavated until cleanup levels are achieved. Excavation depths are anticipated to be to the top of lacustrine clay. The upper portions of the formation are expected to be free of contaminants in most areas. Clean soil would be

segregated from contaminated soil. Both would be tested and sent off site for disposal. Low permeability clean imported soils would be used for backfill. The nearest off site thermal treatment facility is in Ohio or Hudson Falls, NY.

A tar-filled, metal underground storage tank located on the northeast side of the site, along with some nearby naphthalene crystals, would be removed and disposed of or treated off-site as part of this alternative.

Groundwater Removal and Treatment
The water table is approximately 5 to 10 feet below ground surface. Groundwater would need to be pumped from the excavated area and treated. NAPL would be separated from the water and transported off site for disposal. Groundwater would be treated with carbon or an equivalent technology and discharged to a permitted discharge point.

Short-term Monitoring
The groundwater at the site would be monitored for a required minimum of 5 years to evaluate the overall effectiveness of the remedy and risks associated with residual contaminants. It is assumed that 10 wells would be sampled quarterly and analyzed for the full suite of site contaminants for a minimum of 5 years after completion of the remediation.

Sub-Slab Depressurization
Venting of the soil vapors beneath the floor slabs of five residential houses and a school located west of the site and the Gastown Sportsman's Club is proposed to mitigate risks associated with potential future vapor intrusion impacts to indoor air quality.

No information is currently available on the construction of the foundations or floor slabs for each structure but it is assumed that there is sufficient gravel under the slab to allow venting of sub-slab vapors. The sub-slab vapor extraction system would consist of a series of vents drilled through the floor-slab or from outside the building, manifolded to an electric blower and vented to the outside air. The blower would be used to create a vacuum, depressuring the sub-slab materials (assuming they are sufficiently permeable) relative to the indoor air pressure to prevent migration of soil gasses into the buildings. Off-gas vents located outside the building would be used to discharge the air drawn out from beneath the slab.

For estimating purposes, it is assumed that one vent would be installed per residential house, two vents for the commercial building and four for the school. Each vent would be fitted with an appropriately sized vacuum/blower unit capable of producing a sustained vacuum beneath the slab. It may also be necessary to reseal the floors and/or foundations to prevent leakage or loss of vacuum. It is assumed that a 100-watt high flow/low vacuum blower would be sufficient for each vent.

Sediment Removal and Disposal
As described in Section 3.2.5, an estimated 100 cubic yards of impacted sediment is present in Tonawanda Creek, adjacent to the site. This sediment would be removed and disposed of off-site as a non-hazardous waste. The presence of East Niagara Street and the rail line prohibit access to the sediment from the shore. Therefore, the sediment removal process would be accomplished from barges or other vessels operated in Tonawanda Creek. The approximately 100 foot by 50 foot removal area would be isolated by silt barriers anchored into the lacustrine clay. The corner anchors would be driven piles which would be used for cabling the dredge to access points within the removal areas. The silt barriers would prevent migration of impacted sediment suspended during removal.

Sediment would be removed using conventional excavation equipment. An excavator on a barge with sludge boxes would be used to remove the sediment. The excavator would use a dredge bucket to remove the contaminated sediment and place into the sludge box(es). The sludge boxes would be shuttled to an off-loading area and transported to the site using a conventional roll-back truck. The material would be stabilized inside the roll-off box and disposed of off-site. If site soils still exist the material could be blended with on-site soils. The estimated quantity for disposal is 1,300 tons.

Approximately 20 post-dredge samples would be collected (1 per 200 square feet) and analyzed for SVOCs. The dredged area would be backfilled to the original grade with clean material. The silt barrier would be removed upon completion of backfilling.

4.2.7.2 Assessment

Compliance with SCGs:
The removal of the waste materials and associated impacted soils to below state soil clean-up guidance values would satisfy the SCGs relative to the site. Hazardous waste materials would be destroyed, treated and/or contained at permitted facilities in accordance with 6 NYCRR Part 375 incineration regulations, Part 360 disposal regulations and/or all applicable RCRA requirements. The small quantity of residual NAPL located under the rail line would not meet SCGs.

Removal of sediment within Tonawanda Creek, which is defined as navigable waters, would trigger location-specific SCG's such as ECL Article 15, Title 5 and ECL Article 17, Title 3, Use and Protection of Waters. These laws, as well as 6 NYCRR Part 608, establish permit requirements to change, modify, or disturb any protected stream, its bed or banks, or remove from its bed any material. A federal permit would be required to conduct the remedial activities associated with sediment remediation. A Section 10 (Rivers and Harbor Act) permit would likely be sufficient to cover the proposed dredging and backfilling activities.

Overall Protection of Human Health and the Environment:
This alternative would result in the permanent removal of most of the hazardous material from the site. It provides one of the highest levels of overall long-term protection to human health and the environment of the alternatives being considered. Residual contamination under the rail line would remain, presenting a minor risk to the Tonawanda Creek since the barrier wall on opposing sides of the rail line would create a funnel for groundwater flow. Sediment removal would remove exposure routes to aquatic wildlife but a small potential of recontamination would exist due to the potential for migration of contaminants from under the rail line. Sub-slab depressurization would mitigate air quality risks associate with potential vapor intrusion.

Short-Term Effectiveness:
Community, worker and environmental protection: A significant increased potential risk of exposure to the contaminated media for the community, workers, and the environment would be present during waste removal activities. As a short-term measure, temporary physical barriers around the site and/or stockpiles would help to mitigate this increased risk. Similar to Alternative 5, the excavation of the impacted soil would pose an increased short-term risk of worker exposure to site contaminants. Supplying workers with proper personal protective equipment, monitoring air and water quality during waste removal, transport and disposal, and employing engineering controls, as necessary, would mitigate exposure risks.

Handling of contaminated material increases the potential risk for a release of contaminants to the environment, particularly under wet conditions. Careful site preparation prior to excavation would minimize this potential and protect the local ecology. The placement of barriers and sediment traps to collect particulates and prevent the release of potentially contaminated water generated during excavation activities would mitigate these increased risks. Additionally, proper management of temporary stockpiles of waste and processed reusable material would mitigate the increased risk to the environment during the removal action.

Due to the need to transport the material to an off-site facility, the potential for an accidental release in transit increases short-term risks to the community. Increased heavy vehicular traffic in a rural area also contributes to increased short-term risk to the community. During implementation, an average of twenty or more loaded heavy vehicles (32+ tons) carrying contaminated soils would leave the site per day. An additional number of heavy vehicles transporting clean fill would arrive at the site each day during restoration. Implementing appropriate traffic safety controls and warnings, careful attention to the appropriate transportation rules and regulations, and vehicle decontamination procedures during the removal action would mitigate some of the increased exposure risks to the community.

Sediment removal presents short-term risks to the environment through the potential for suspension and migration of contaminated sediment during removal. These risks would be controlled through the use of silt curtains and use of appropriate dredging equipment.

It is estimated that the total time to complete this remedial action alternative would be 8 months.

Long-Term Effectiveness and Permanence
Removal and off-site disposal is an effective permanent solution relative to the site. Hazardous constituents would be destroyed or contained indefinitely at an off-site facility. Small quantities of residual contaminants would remain on the eastern and western ends of the NAPL plume and under the rail line.

Residual risk: The removal of impacted soils from the site would significantly reduce or eliminate the residual risks. A small residual risk to Tonawanda Creek would remain in association with the uncontained contamination (NAPL and impacted soil and groundwater) under the rail line. Similar residual risks would remain in association with residual contaminants under the residences near East Street and Carney Street.

Adequacy of controls: The risks to potential future receptors would be mitigated effectively by removal of the impacted materials. No controls would be in place to prevent migration of residual contaminants.

Reliability of controls: This alternative does not require any controls to manage residual risks in areas where contamination would be removed from the site. It is anticipated that the off-site treatment/disposal system could function properly for an indefinite period. Residual contaminants outside excavation areas would not be controlled and long-term risks would be evaluated through monitoring.

Reduction of Toxicity, Mobility, and Volume through Treatment:
Under Alternative 7 off-site treatment (incineration) would effectively eliminate the toxicity, volume and mobility of the contaminants. Transfer of contaminants to a permitted secure landfill (hazardous or non-hazardous waste) would not reduce the volume or toxicity, but would limit the mobility of the contaminants. Residual contamination outside the removal areas would not be immobilized or reduced in toxicity or volume.

Implementability
Permitted commercial disposal facilities are available to receive each and all of the site-specific waste streams.

Cost
The estimated total present worth cost for implementing Alternative 7 is $12.32M with capital costs of $12.12M The present worth cost was estimated based on annual operation, maintenance and monitoring costs of approximately $39,000 per year over 5 years using a 5% discount rate. A summary of the estimated unit costs for Alternatives 7 is included in Table 4-1. Back up information for this cost estimate is provided in Appendix B.

Community Acceptance
Alternative 7 would be disruptive to the community because several local businesses would have to be relocated. The removal of contaminants would improve the overall usability and potential for development of the site which would be beneficial to the property owner and community.

4.2.8 Alternative 8: Partial Removal and Solidification

4.2.8.1 Description

This alternative is similar to Alternative 7, but presents some potential cost savings through the use of in situ solidification in lieu of excavation in areas with lower quantities of NAPL.

Site Preparation
Site preparation would involve relocation of site businesses. An agent could be employed to identify suitable alternate locations for the business occupying the site. Once acceptable arrangements have been identified, all equipment, furniture and supplies would be moved to the new location. Specific capital improvements might be required to make the new locations functionally equivalent to the current locations. Costs associated with the relocation would include realtor fees, moving costs and capital improvements.

Once the buildings have been vacated, they would be demolished and removed from the site, providing access to the underlying soils.

Soil/NAPL Removal
Since the NAPL is located at depths of approximately 20 feet below grade, dewatering of the excavation would be required. Also, shoring of the excavation walls may be necessary in some locations to achieve required depths. A temporary barrier wall would be installed around the perimeter of the excavation areas to reduce groundwater influx and provide stable excavation walls. Soil would be excavated until cleanup levels are achieved. Excavation depths are anticipated to be to the top of lacustrine clay. The upper portions of the formation are expected to be free of contaminants in most areas. Clean soil would be segregated from contaminated soil. Both would be tested and sent off site for disposal unless the clean soil can be used for backfill. Otherwise clean imported soils would be used for backfill.

A tar-filled, metal underground storage tank located on the northeast side of the site, along with some nearby naphthalene crystals, would be removed and disposed of or treated off-site as part of this alternative.

Groundwater Removal and Treatment
The water table is approximately 5 to 10 feet below ground surface. Groundwater would need to be pumped from the excavated area and treated. NAPL would be separated from the water and transported off site for disposal. Groundwater would be treated with carbon or an equivalent technology and discharged to a permitted discharge point.

In-Situ Solidification

In situ solidification involves in situ mixing of soils with a stabilization agent such as cement or quicklime to immobilize contaminants. The materials can be mixed using a large diameter auger or conventional excavation equipment.

Sub-Slab Depressurization
Venting of the soil vapors beneath the floor slabs of five residential houses and a school located west of the site and the Gastown Sportsman's Club is proposed to mitigate risks associated with potential future vapor intrusion impacts to indoor air quality.

No information is currently available on the construction of the foundations or floor slabs for each structure but it is assumed that there is sufficient gravel under the slab to allow venting of sub-slab vapors. The sub-slab vapor extraction system would consist of a series of vents drilled through the floor-slab or from outside the building, manifolded to an electric blower and vented to the outside air. The blower would be used to create a vacuum, depressuring the sub-slab materials (assuming they are sufficiently permeable) relative to the indoor air pressure to prevent migration of soil gasses into the buildings. Off-gas vents located outside the building would be used to discharge the air drawn out from beneath the slab.

For estimating purposes, it is assumed that one vent would be installed per residential house, two vents for the commercial building and four for the school. Each vent would be fitted with an appropriately sized vacuum/blower unit capable of producing a sustained vacuum beneath the slab. It may also be necessary to reseal the floors and/or foundations to prevent leakage or loss of vacuum. It is assumed that a 100-watt high flow/low vacuum blower would be sufficient for each vent.

Sediment Removal and Disposal
As described in Section 3.2.5, an estimated 100 cubic yards of impacted sediment is present in Tonawanda Creek, adjacent to the site. This sediment would be removed and disposed of off-site as a non-hazardous waste. The presence of East Niagara Street and the rail line prohibit access to the sediment from the shore. Therefore, the sediment removal process would be accomplished from barges or other vessels operated in Tonawanda Creek. The approximately 100 foot by 50 foot removal area would be isolated by silt barriers anchored into the lacustrine clay. The corner anchors would be driven piles which would be used for cabling the dredge to access points within the removal areas. The silt barriers would prevent migration of impacted sediment suspended during removal.

Sediment would be removed using conventional excavation equipment. An excavator on a barge with sludge boxes would be used to remove the sediment. The excavator would use a dredge bucket to remove the contaminated sediment and place into the sludge box(es). The sludge boxes would be shuttled to an off-loading area and transported to the site using a conventional roll-back truck. The material would be stabilized inside the roll-off box and disposed of off-site. If site soils still exist the material could be blended with on-site soils. The estimated quantity for disposal is 1,300 tons.

Approximately 20 post-dredge samples would be collected (1 per 200 square feet) and analyzed for SVOCs. The dredged area would be backfilled to the original grade with clean material. The silt barrier would be removed upon completion of backfilling.

4.2.8.2 Assessment

Compliance with SCGs:
The removal of the waste materials and associated impacted soils to below state soil clean-up guidance values would satisfy the SCGs relative to the site. Hazardous waste materials would be destroyed, treated

and/or contained at permitted facilities in accordance with 6 NYCRR Part 375 incineration regulations, Part 360 disposal regulations and/or all applicable RCRA requirements.

Solidified wastes are assumed to be immobilized and therefore would meet the site remedial action objectives. According to TAGM #4030, NYSDEC recognizes solidification/chemical fixation of inorganic wastes as a permanent remedy. TAGM #4030 further adds that solidification/chemical fixation of wastes containing "low" level organic contaminants may be considered as a permanent remedy, if justified. The substantial cost savings offered through solidification would provide justification for using this technology in lieu of removal and off-site disposal/treatment.

The residual NAPL below the rail line would not be addressed under this alternative, which does not comply with the RAOs or SCGs.

Removal of sediment within Tonawanda Creek, which is defined as navigable waters, would trigger location-specific SCG's such as ECL Article 15, Title 5 and ECL Article 17, Title 3, Use and Protection of Waters. These laws, as well as 6 NYCRR Part 608, establish permit requirements to change, modify, or disturb any protected stream, its bed or banks, or remove from its bed any material. A federal permit would be required to conduct the remedial activities associated with sediment remediation. A Section 10 (Rivers and Harbor Act) permit would likely be sufficient to cover the proposed dredging and backfilling activities.

Overall Protection of Human Health and the Environment:
This alternative would result in the permanent removal or immobilization of the majority hazardous material from the site. It provides a high level of overall long-term protection to human health and the environment. Residual contamination under the rail line would remain, presenting a minor risk to the Tonawanda Creek since the solidified soils on opposing sides of the rail line would create a funnel for groundwater flow. Sediment removal would remove exposure routes to aquatic wildlife but a small potential of recontamination would exist due to the potential for migration of contaminants from under the rail line. Sub-slab depressurization would mitigate air quality risks associate with potential vapor intrusion.

Short-Term Effectiveness:
Community, worker and environmental protection: A significant increased potential risk of exposure to the contaminated media for the community, workers, and the environment would be present during waste removal activities. As a short-term measure, temporary physical barriers around the site and/or stockpiles would help to mitigate this increased risk. Similar to Alternative 5, the excavation of the impacted soil would pose an increased short-term risk of worker exposure to site contaminants. Supplying workers with proper personal protective equipment, monitoring air and water quality during waste removal, transport and disposal, and employing engineering controls, as necessary, would mitigate exposure risks.

Handling of contaminated material increases the potential risk for a release of contaminants to the environment, particularly under wet conditions. Careful site preparation prior to excavation would minimize this potential and protect the local ecology. The placement of barriers and sediment traps to collect particulates and prevent the release of potentially contaminated water generated during excavation activities would mitigate these increased risks. Additionally, proper management of temporary stockpiles of waste and processed reusable material would mitigate the increased risk to the environment during the removal action.

Due to the need to transport the material to an off-site facility, the potential for an accidental release in transit increases short-term risks to the community. Increased heavy vehicular traffic in a rural area also contributes to increased short-term risk to the community. During implementation, an average of twenty or more loaded heavy vehicles (32+ tons) carrying contaminated soils would leave the site per day. An additional number of heavy vehicles transporting clean fill would arrive at the site each day during restoration. Implementing appropriate traffic safety controls and warnings, careful attention to the appropriate transportation rules and regulations, and vehicle decontamination procedures during the removal action would mitigate some of the increased exposure risks to the community.

Sediment removal presents short-term risks to the environment through the potential for suspension and migration of contaminated sediment during removal. These risks would be controlled through the use of silt curtains and use of appropriate dredging equipment.

It is estimated that the total time to complete this remedial action alternative would be 9 months.

Long-Term Effectiveness and Permanence
Removal and off-site disposal is an effective permanent solution relative to the site. Hazardous constituents would be destroyed or contained indefinitely at an off-site facility. Similarly, solidification of contaminated soils provides a permanent remedy for areas with low levels of organic contaminants. Small areas not remediated by this alternative (such as under the rail line) would continue to contribute small quantities of contaminants to groundwater.

Residual risk: The removal of impacted soils from the site and immobilization in place would significantly reduce or eliminate the residual risks. Small quantities of residual contaminants would remain on the eastern and western ends of the NAPL plume and under the rail line.

Adequacy of controls: The risks to potential future receptors would be mitigated effectively by removal or immobilization of the impacted materials. A small residual risk to Tonawanda Creek would remain in association with the uncontained contamination (NAPL and impacted soil and groundwater) under the rail line. Similar residual risks would remain in association with residual contaminants under the residences near East Street and Carney Street.

Reliability of controls: It is anticipated that the off-site treatment/disposal system and in-situ immobilization could function properly for an indefinite period. Residual contaminants outside excavation and solidification areas would not be controlled and long-term risks would be evaluated through monitoring.

Reduction of Toxicity, Mobility, and Volume through Treatment:
Under Alternative 8 contaminants that are destroyed through off-site thermal treatment would effectively eliminate the toxicity, volume and mobility of these contaminants. Transfer of contaminants to a permitted secure landfill (hazardous or non-hazardous waste) and in-situ immobilization would not reduce the volume or toxicity, but would limit the mobility of the contaminants. Residual contamination outside the removal or solidified areas would not be immobilized or reduced in toxicity or volume.

Implementability
Permitted commercial disposal and treatment facilities are available to receive each and all of the site-specific waste streams. Suppliers of in-situ stabilization services are commercially available.

Cost
The estimated total present worth cost for implementing Alternative 8 is $14.16M with capital costs of $11.96M The present worth cost was estimated based on annual operation, maintenance and monitoring costs of approximately $143,000 per year over 5 years using a 5% discount rate. A summary of the

estimated unit costs for Alternatives 8 is included in Table 4-1. Back up information for this cost estimate is provided in Appendix B.

Community Acceptance
Alternative 8 would be disruptive to the community because several local businesses would have to be relocated. The removal of contaminants would improve the overall usability and potential for development of the site which would be beneficial to the property owner and community.

4.3 COMPARISON OF ALTERNATIVES

Alternatives 1 and 2 (No Action and Institutional Controls with Long-Term Monitoring) include no action to contain, remove or treat the site contaminants that pose a current or potential future threat to human health and the environment. While Alternative 2 would monitor the changes that naturally occur at the site and would protect human health by reducing the potential for direct contact through deed restrictions, this alternative would not meet the remedial action objectives (RAOs), as it is not sufficiently protective because it would not reduce the potential for migration of the site contaminants.

Alternatives 3, 5 and 6 (NAPL/Groundwater Collection and Treatment, Partial Removal, Containment and In-Situ Treatment, and Full Isolation and Containment) offer the most controlled and thorough means of achieving the RAOs but alternatives 3 and 6 are not favorable in terms of TAGM #4030, as isolation and control technologies do not constitute a permanent remedy. Alternative 3 (NAPL/Groundwater Collection and Treatment) is the least costly alternative (approximately $3.66 M present worth) and involves removal and destruction of at least a portion of the site contaminants. Alternative 6 (Containment) would have the smallest short-term risks as the hazardous material would primarily be left in place. The final cover system and barrier walls would require monitoring and maintenance indefinitely. For both alternatives operation and maintenance of a groundwater treatment system would be necessary to maintain hydraulic gradient control. Alternative 5 builds on the isolation and control technologies with in-situ treatment.

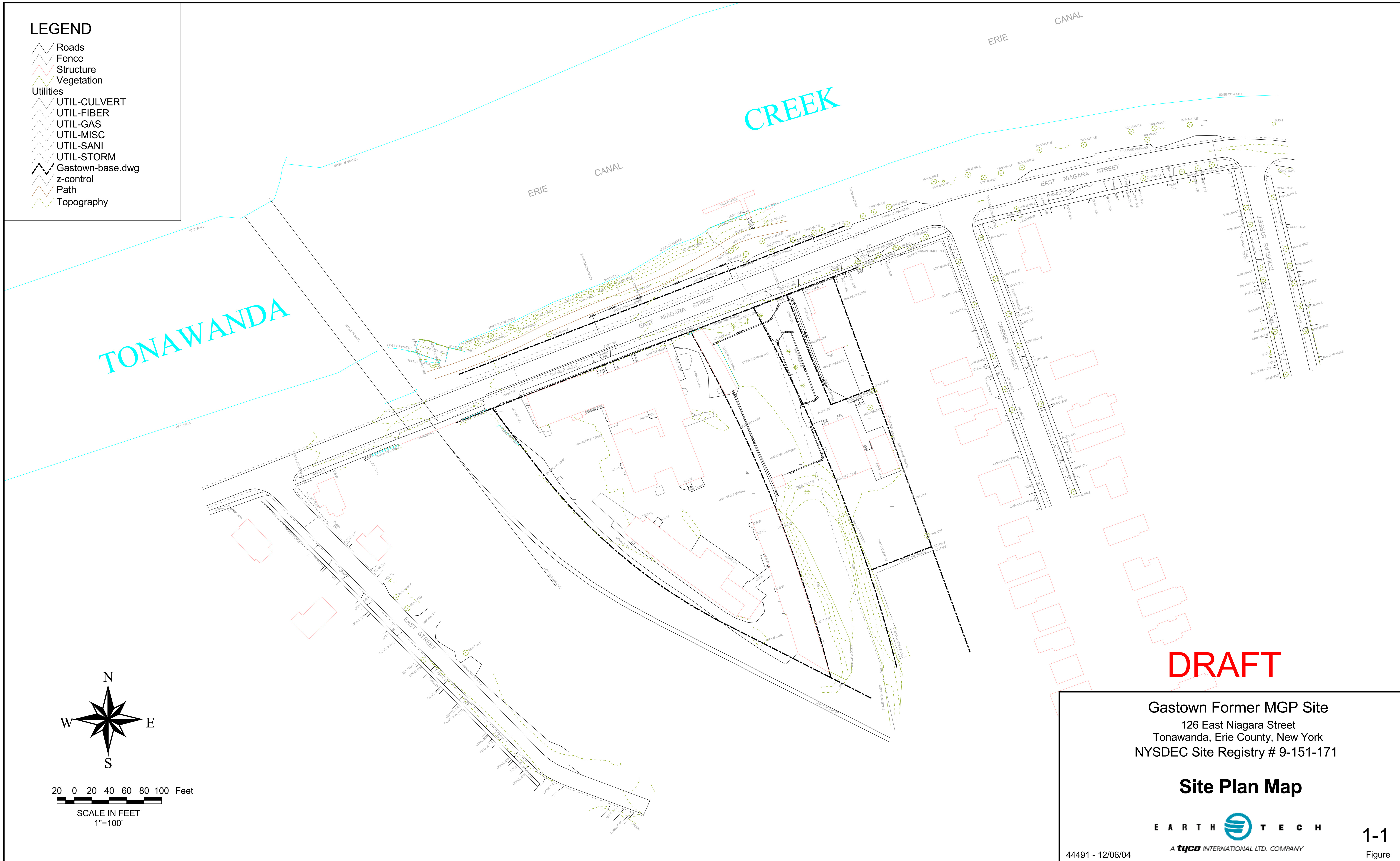
Alternatives 4 and 5 (in-situ thermal/biological treatment and partial removal, containment and in-situ treatment) are primarily dependant on the effectiveness of innovative in-situ treatment technologies. These technologies have been demonstrated to treat the MGP wastes thereby reducing the toxicity, volume and mobility of the contaminants. They offer costs savings over full removal scenarios and can be implemented with less disturbance to the property. However, the effectiveness of these technologies for the conditions specific to the Gastown Former MGP Site is not proven. The geological conditions are not ideal for transmitting liquid or air borne contaminants to or from collection or injection points. The degree of NAPL mobility potentially caused by in-situ remediation and the direction of flow is difficult to predict. Evaluating the effectiveness of treatment would require an extensive monitoring regime because the NAPL occurs intermittently throughout the formation. The potential costs savings for these alternatives should be closely weighed with the potential for incomplete remediation and further costs associated with additional phases of work.

Alternatives 7 and 8 (removal alone and with solidification) would be associated with higher short-term risks because a substantial amount of contaminated material at the site would be excavated and handled. Long-term risks would be significantly reduced compared to leaving the contaminants in place untreated. Alternative 7 is favorable as it offers the highest degree of long-term protection for the site and is a conventional and predictable remedial option. However, it is the most disruptive to the site and the local businesses.

5.0 REFERENCES

Federal Remediation Technology Roundtable, Remediation Technologies Screening Matrix and Reference Guide, Version 4.0, www.frtr.gov/matrix2,

Stabilization and Reuse of Heavy Metal Contaminated Soil by means of Quicklime Sulfate, Steven Bosart, Stevens Institute of Technology, October 1997



Gastown Former MGP Site

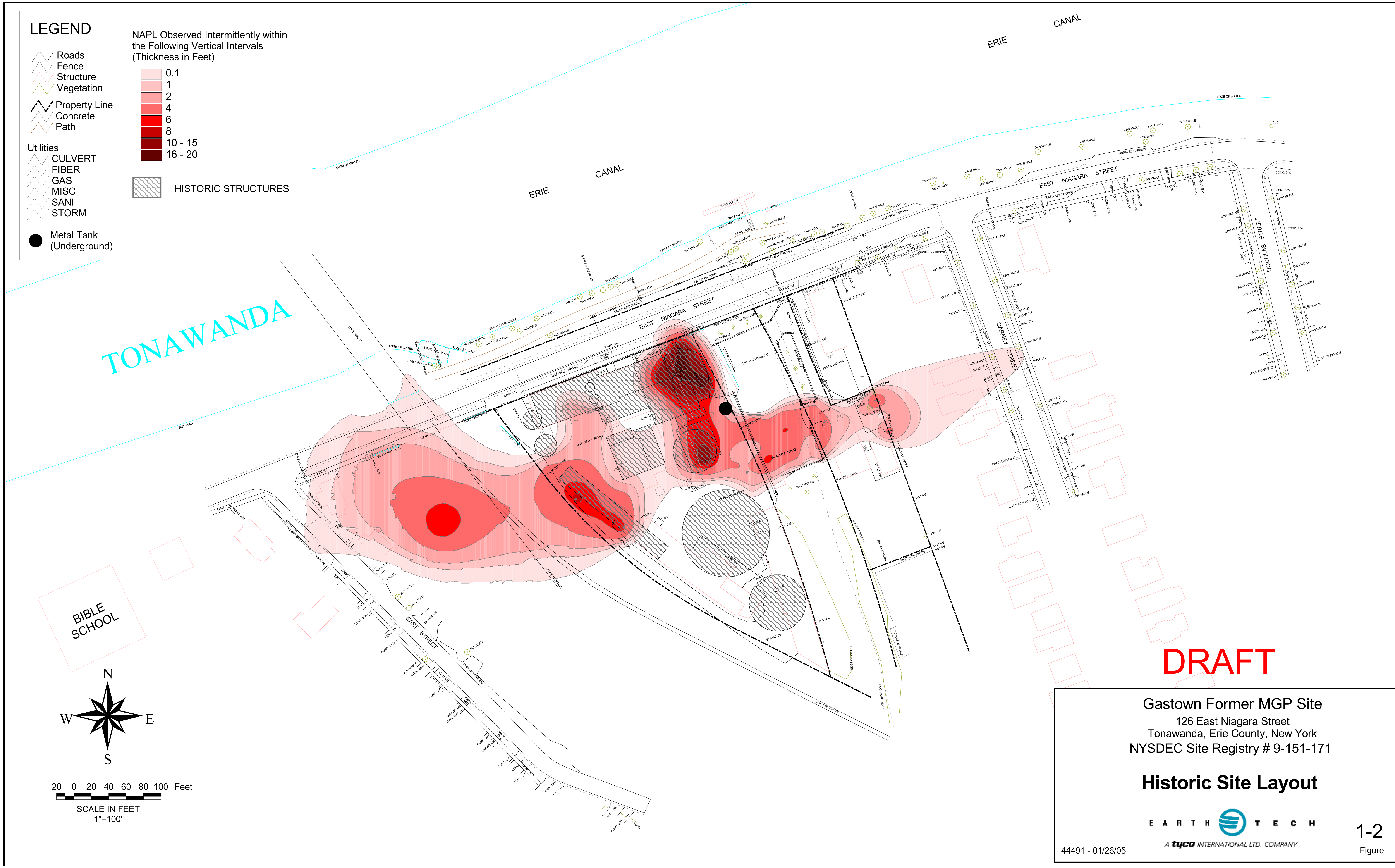
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171

Site Plan Map

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

44491 - 12/06/04

1-1
Figure



Gastown Former MGP Site

126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171

Historic Site Layout

EARTH TECH
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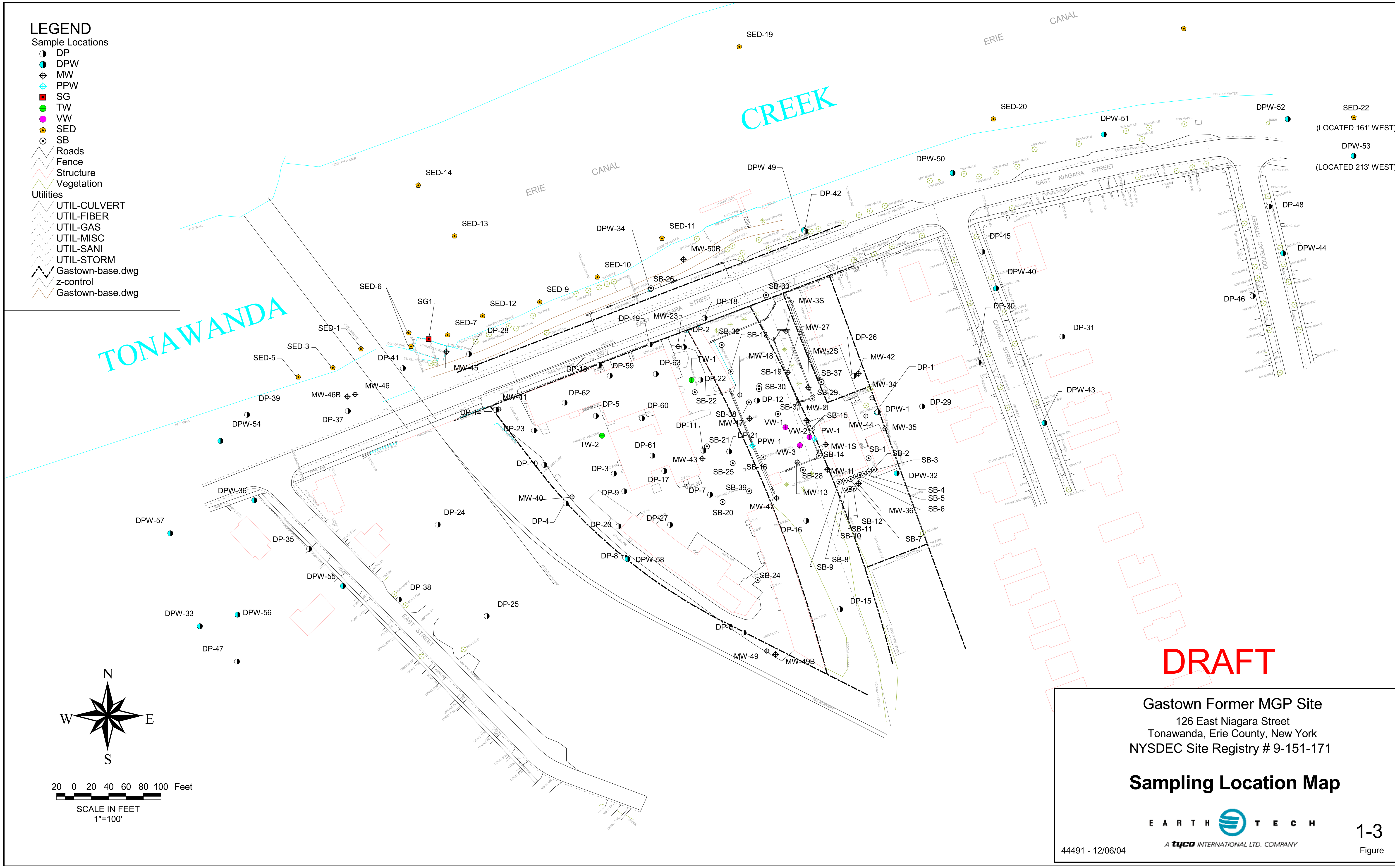
44491 - 01/26/05

1-2
Figure



Gastown Former MGP Site
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171

Sampling Location Map

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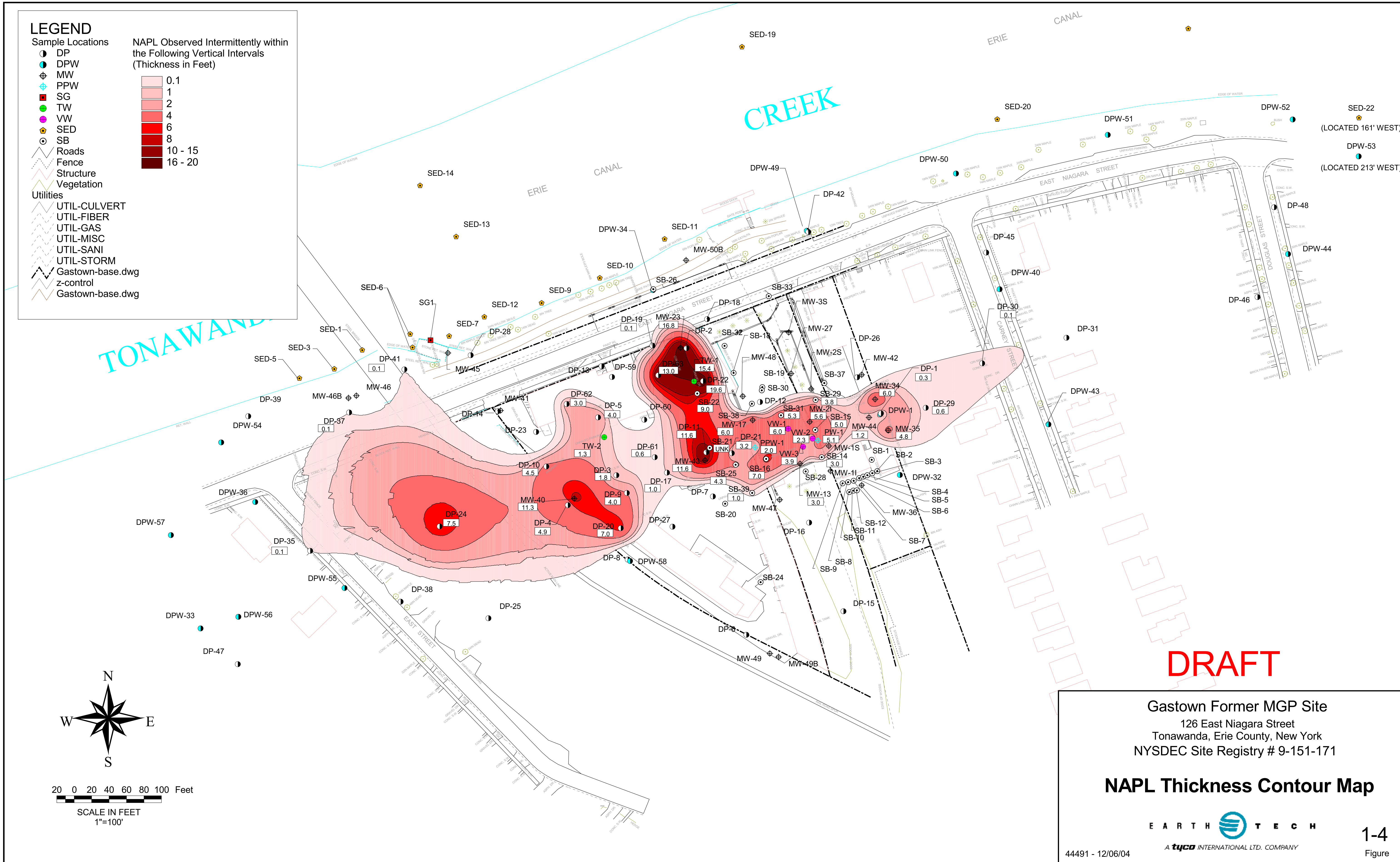
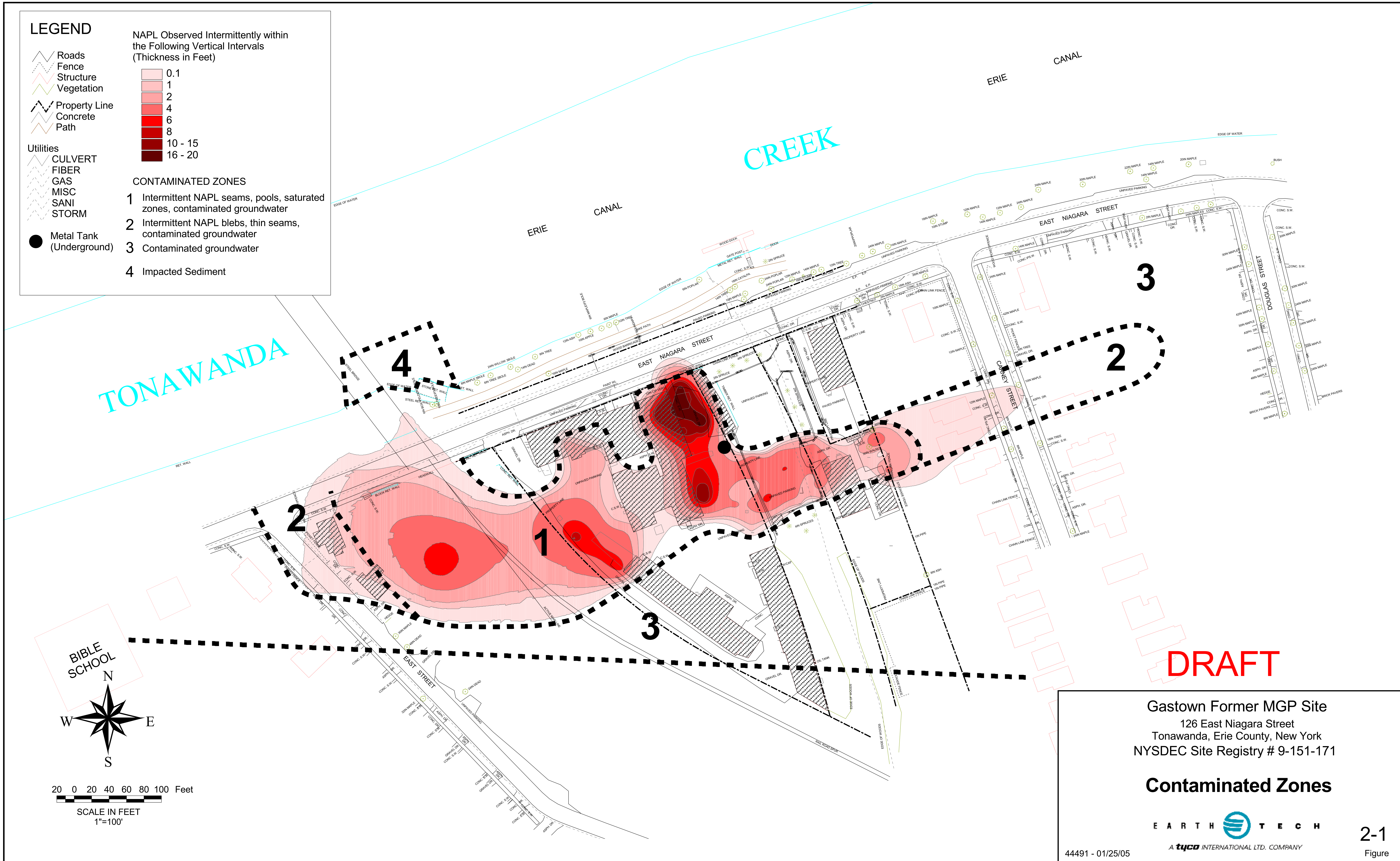
1-3
Figure


LEGEND
Sample Locations
DP
DPW
MW
PPW
SG
TW
VW
SED
SB
Roads
Fence
Structure
Vegetation
Utilities
UTIL-CULVERT
UTIL-FIBER
UTIL-GAS
UTIL-MISC
UTIL-SANI
UTIL-STORM
Gastown-base.dwg
z-control
Gastown-base.dwg
NAPL Observed Intermittently within the Following Vertical Intervals (Thickness in Feet)
0.1
1
2
4
6
8
10 - 15
16 - 20
TONAWANDA
CREEK
ERIE CANAL
EAST NIAGARA STREET
CARNEY STREET
DOUGLAS STREET
EAST STREET
(LOCATED 161' WEST)
(LOCATED 213' WEST)
DRAFT
N
E
S
W
20 0 20 40 60 80 100 Feet
SCALE IN FEET
1"=100'
Gastown Former MGP Site
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171
NAPL Thickness Contour Map
EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY
44491 - 12/06/04
1-4
Figure


LEGEND
Roads
Fence
Structure
Vegetation
Property Line
Concrete
Path
Utilities
CULVERT
FIBER
GAS
MISC
SANI
STORM
Metal Tank (Underground)
NAPL Observed Intermittently within the Following Vertical Intervals (Thickness in Feet)
0.1
1
2
4
6
8
10 - 15
16 - 20
CONTAMINATED ZONES
1 Intermittent NAPL seams, pools, saturated zones, contaminated groundwater
2 Intermittent NAPL blebs, thin seams, contaminated groundwater
3 Contaminated groundwater
4 Impacted Sediment
TONAWANDA CREEK
ERIE CANAL
EAST NIAGARA STREET
CARNEY STREET
DOUGLAS STREET
EAST STREET
BIBLE SCHOOL
1
2
3
4
N
S
E
W
20 0 20 40 60 80 100 Feet
SCALE IN FEET
1"=100'
DRAFT
Gastown Former MGP Site
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171
Contaminated Zones
EARTH TECH
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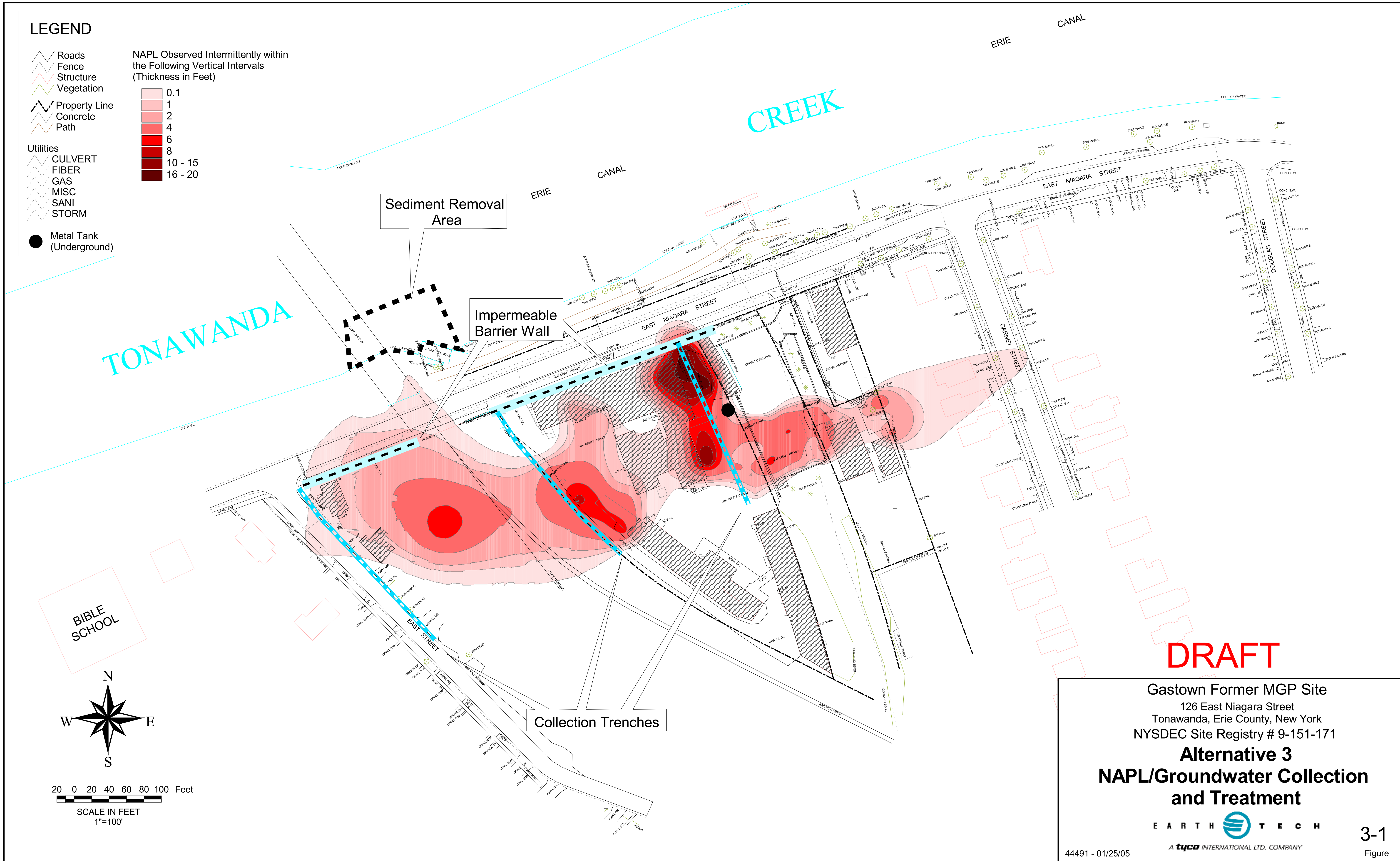
44491 - 01/25/05
2-1
Figure



Gastown Former MGP Site

126 East Niagara Street

Tonawanda, Erie County, New York

NYSDEC Site Registry # 9-151-171

Alternative 3

NAPL/Groundwater Collection and Treatment

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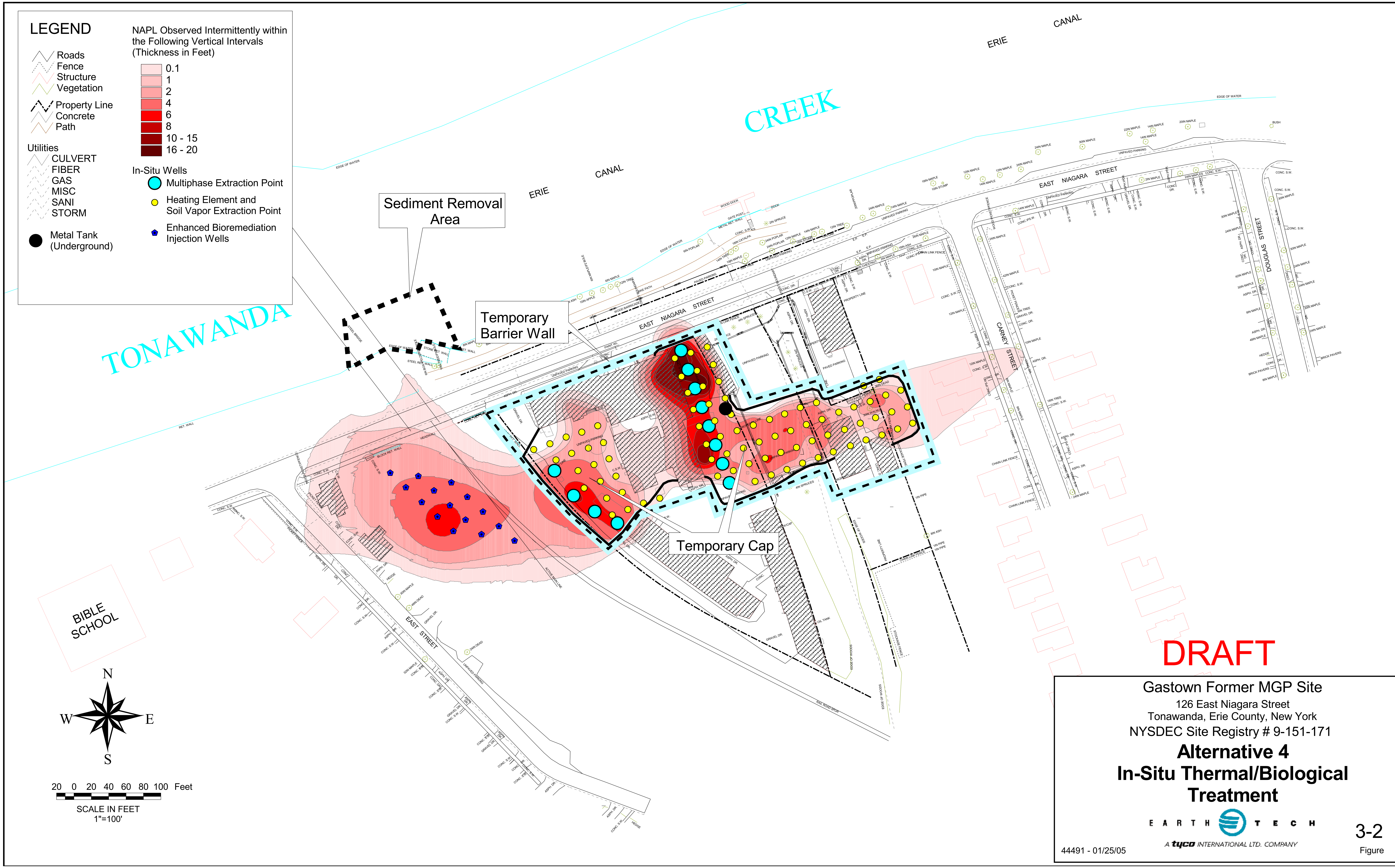
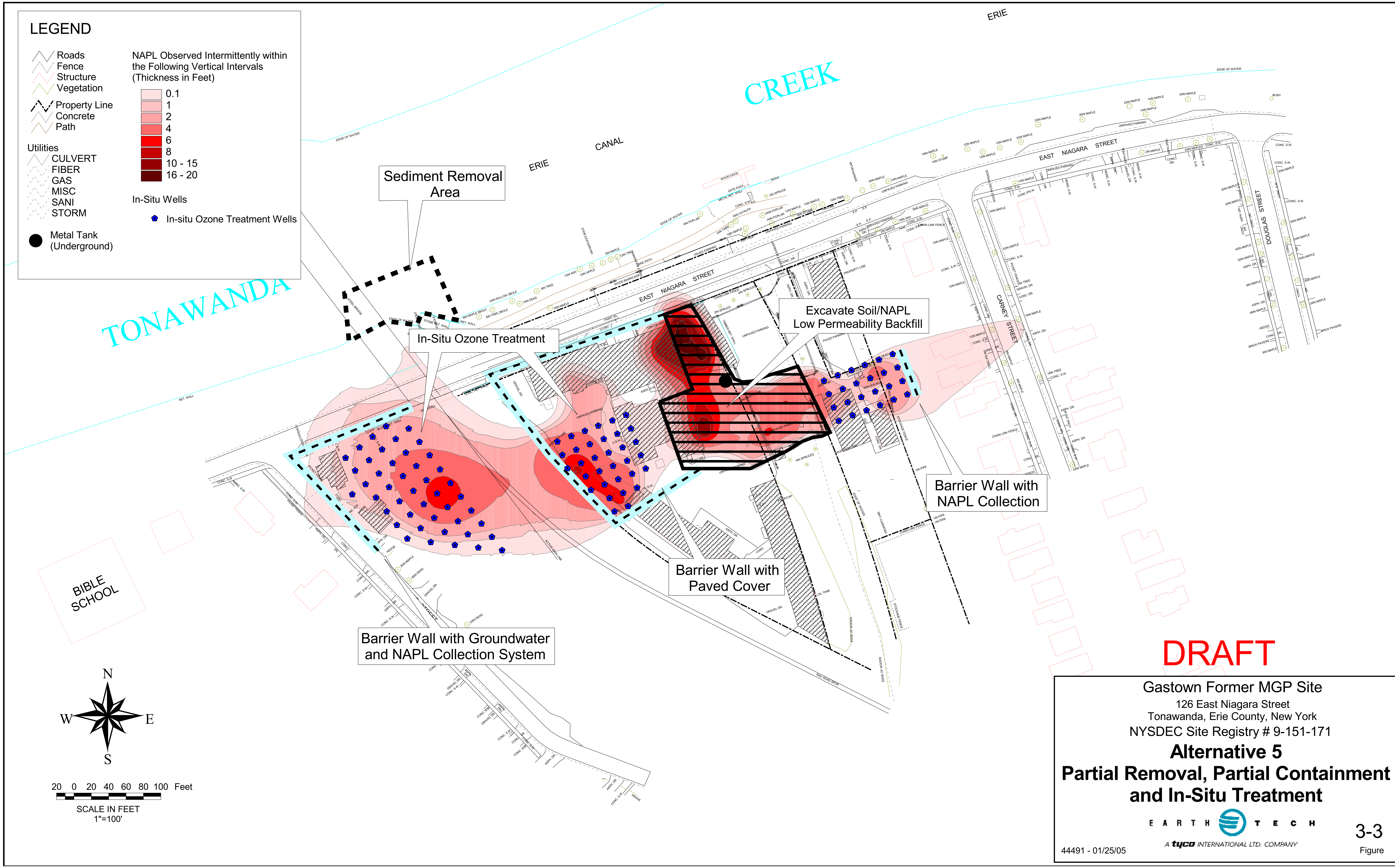
3-1

Figure


LEGEND
Roads
Fence
Structure
Vegetation
Property Line
Concrete
Path
Utilities
CULVERT
FIBER
GAS
MISC
SANI
STORM
Metal Tank (Underground)
NAPL Observed Intermittently within the Following Vertical Intervals (Thickness in Feet)
0.1
1
2
4
6
8
10 - 15
16 - 20
In-Situ Wells
Multiphase Extraction Point
Heating Element and Soil Vapor Extraction Point
Enhanced Bioremediation Injection Wells
Sediment Removal Area
Temporary Barrier Wall
Temporary Cap
TONAWANDA
CREEK
ERIE
CANAL
EAST NIAGARA STREET
CARNEY STREET
DOUGLAS STREET
EAST STREET
BIBLE SCHOOL
N
S
W
E
20 0 20 40 60 80 100 Feet
SCALE IN FEET
1"=100'
DRAFT
Gastown Former MGP Site
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171
Alternative 4
In-Situ Thermal/Biological Treatment
EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY
44491 - 01/25/05
3-2
Figure


LEGEND
Roads
Fence
Structure
Vegetation
Property Line
Concrete
Path
Utilities
CULVERT
FIBER
GAS
MISC
SANI
STORM
Metal Tank (Underground)
NAPL Observed Intermittently within the Following Vertical Intervals (Thickness in Feet)
0.1
1
2
4
6
8
10 - 15
16 - 20
In-Situ Wells
In-situ Ozone Treatment Wells
ERIE
CREEK
ERIE
CANAL
TONAWANDA
EAST NIAGARA STREET
CARNEY STREET
DOUGLAS STREET
BIBLE SCHOOL
Sediment Removal Area
In-Situ Ozone Treatment
Excavate Soil/NAPL Low Permeability Backfill
Barrier Wall with NAPL Collection
Barrier Wall with Paved Cover
Barrier Wall with Groundwater and NAPL Collection System
N
W
E
S
20 0 20 40 60 80 100 Feet
SCALE IN FEET
1"=100'
DRAFT
Gastown Former MGP Site
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171
Alternative 5
Partial Removal, Partial Containment and In-Situ Treatment
EARTH TECH
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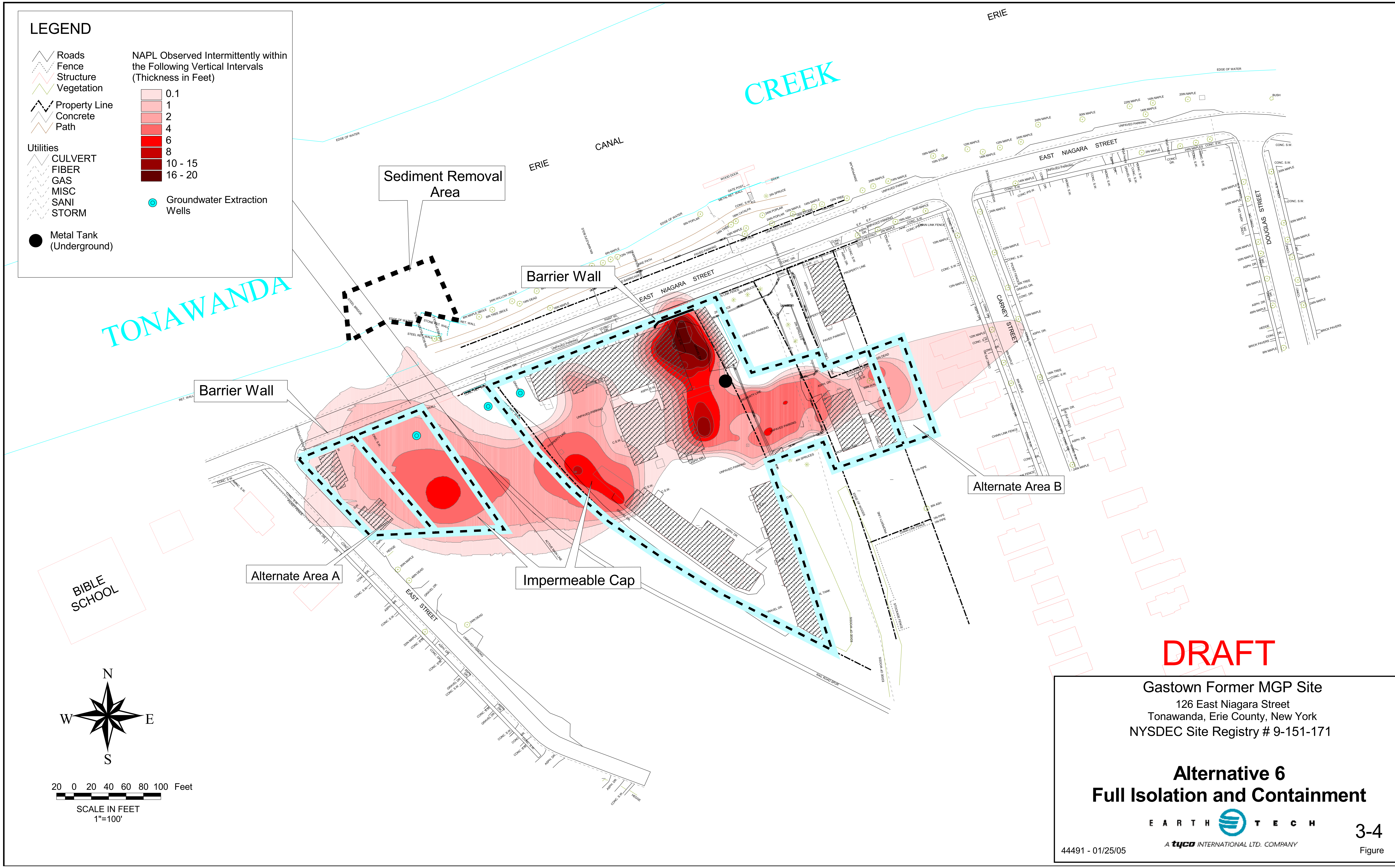
44491 - 01/25/05
3-3
Figure


LEGEND
Roads
Fence
Structure
Vegetation
Property Line
Concrete
Path
Utilities
CULVERT
FIBER
GAS
MISC
SANI
STORM
Metal Tank (Underground)
NAPL Observed Intermittently within the Following Vertical Intervals (Thickness in Feet)
0.1
1
2
4
6
8
10 - 15
16 - 20
Groundwater Extraction Wells
ERIE
CREEK
CANAL
ERIE
TONAWANDA
Sediment Removal Area
Barrier Wall
Barrier Wall
EAST NIAGARA STREET
CARNEY STREET
DOUGLAS STREET
EAST STREET
Alternate Area B
Alternate Area A
Impermeable Cap
BIBLE SCHOOL
N
W
E
S
20 0 20 40 60 80 100 Feet
SCALE IN FEET
1"=100'
DRAFT
Gastown Former MGP Site
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171
Alternative 6
Full Isolation and Containment
EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY
44491 - 01/25/05
3-4
Figure


LEGEND
Roads
Fence
Structure
Vegetation
Property Line
Concrete
Path
Utilities
CULVERT
FIBER
GAS
MISC
SANI
STORM
Metal Tank (Underground)
NAPL Observed Intermittently within the Following Vertical Intervals (Thickness in Feet)
0.1
1
2
4
6
8
10 - 15
16 - 20
TONAWANDA
CREEK
ERIE CANAL
ERIE
Sediment Removal Area
Removal Area
Alternate Area B
EAST NIAGARA STREET
EAST STREET
CARNEY STREET
DOUGLAS STREET
BIBLE SCHOOL
N
S
E
W
20 0 20 40 60 80 100 Feet
SCALE IN FEET
1"=100'
DRAFT
Gastown Former MGP Site
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171
Alternative 7
Removal
EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY
44491 - 01/25/05
3-5
Figure

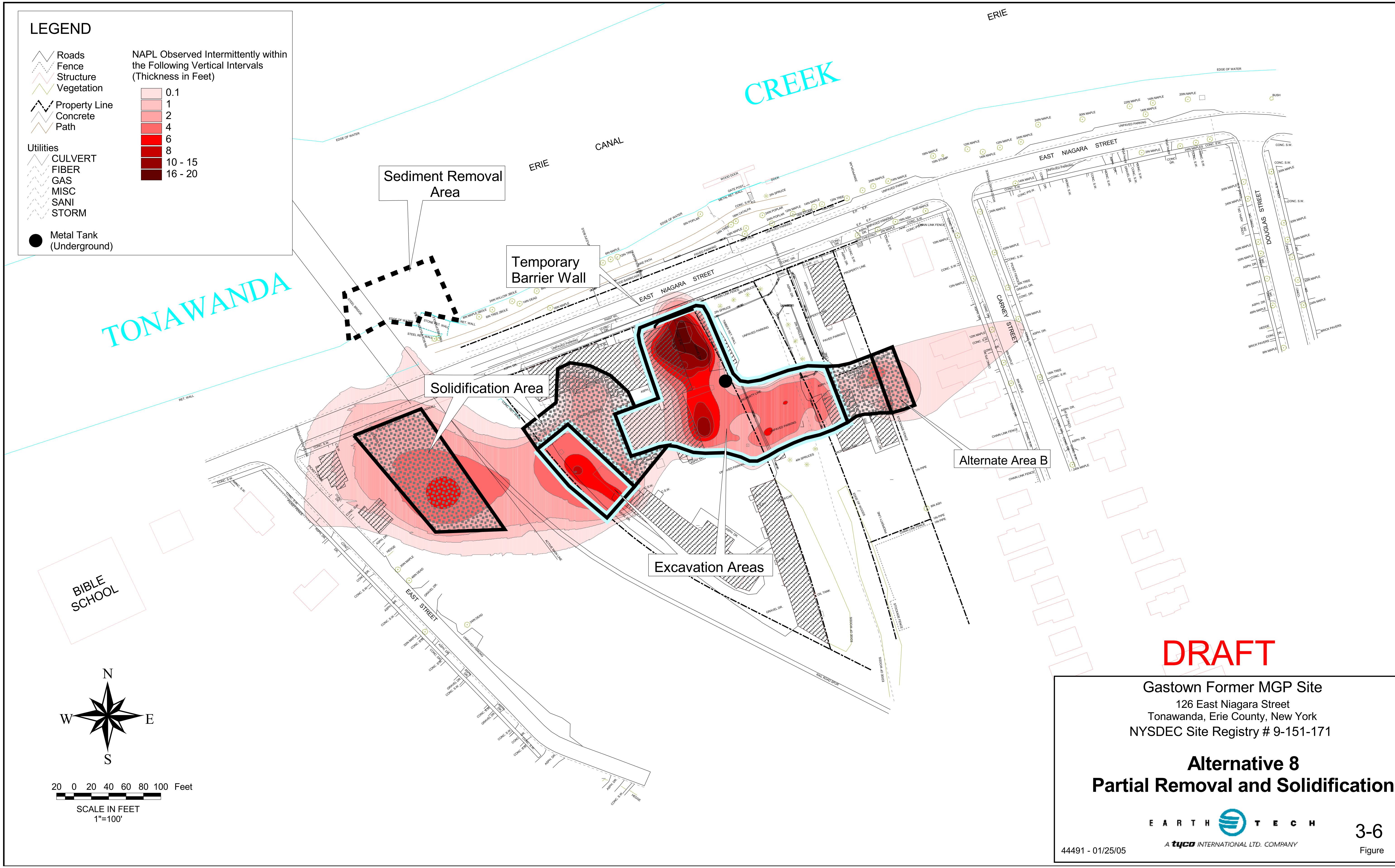

LEGEND
Roads
Fence
Structure
Vegetation
Property Line
Concrete
Path
Utilities
CULVERT
FIBER
GAS
MISC
SANI
STORM
Metal Tank (Underground)
NAPL Observed Intermittently within the Following Vertical Intervals (Thickness in Feet)
0.1
1
2
4
6
8
10 - 15
16 - 20
ERIE CANAL
TONAWANDA
CREEK
ERIE
Sediment Removal Area
Temporary Barrier Wall
Solidification Area
Excavation Areas
Alternate Area B
EAST NIAGARA STREET
CARNEY STREET
DOUGLAS STREET
EAST STREET
BIBLE SCHOOL
N
S
E
W
20 0 20 40 60 80 100 Feet
SCALE IN FEET
1"=100'
DRAFT
Gastown Former MGP Site
126 East Niagara Street
Tonawanda, Erie County, New York
NYSDEC Site Registry # 9-151-171
Alternative 8
Partial Removal and Solidification
EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY
44491 - 01/25/05
3-6
Figure

Table 4-1b
Remedial Action Alternative 2 (Long-Term Monitoring with Institutional Controls)
Gastown Former MGP Site-Feasibility Study

ITEM	QUANTITY		UNIT COST	TOTAL	*REF #
Site Preparation					
Installation of sub-slab depressurization systems - Install systems in 5 houses, 1 commercial structure, and 1 school.	1.00	ls	$ 20,000.00	$ 20,000	**a**
ITEM subtotal (rounded to nearest $1,000)				**$ 20,000.00**	

Subtotal Capital Costs	$ 20,000.00
Engineering (20% construction costs less cost of disposal of NAPL)	
Contingency (20% construction costs)	$ 4,000.00
Total Capital Costs	$ 24,000.00

ANNUAL O&M COSTS (Long-term)	
Annual Operation and Maintenance	$ 10,000.00
Annual Long-Term Monitoring	$ 60,000.00
Five-Year Review	$ 4,000.00
Total Annual O&M Costs	$ 74,000.00
Present Worth O&M Costs (5% discount Rate/30 yrs)	$ 1,137,600.00

OTHER COSTS (short-term O&M and Closeout)	
Site Closeout	$ -
Total Other Costs	$ -

PRESENT WORTH OF COSTS	
Total Capital Costs	$ 24,000.00
Total Present Worth O&M Costs	$ 1,137,600.00
Total Other Costs	$ -
TOTAL PRESENT WORTH	$ 1,161,600.00

COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE 2 **$ 1,162,000**

* REF # refers to line item in cost estimating software output located in appendix B-1

Table 4-1c
Remedial Action Alternative 3 (NAPL/Groundwater Collection and Treatment)
Gastown Former MGP Site-Feasibility Study

ITEM	QUANTITY		UNIT COST	TOTAL	*REF #
Site Preparation					
Permit and agreement - Costing for the various permits and access agreements necessary to perform work.	1.00	ls	$ 10,000.00	$ 10,000	b
Overhead Electrical Distribution - The overhead electrical system will supply the treatment facility. Assume approximately 100 feet to facility.	100.00	lf	$ 75.00	$ 7,500	b
Removal of metal UST - excavation and off-site disposal of underground metal tank identified on site.	1.00	ls	$ 10,000.00	$ 10,000	b
Disposal of UST contents - Off-siet disposal of approximately 10,000 gallons of NAPL present within UST.	10,000.00	gal	$ 6.00	$ 60,000	b
Installation of sub-slab depressurization systems - Install systems in 5 houses, 1 commercial structure, and 1 school.	1.00	ls	$ 20,000.00	$ 20,000	a
ITEM subtotal (rounded to nearest $1,000)				**$ 108,000.00**	
Barrier Wall					
Soil Bentonite Wall Construction - Construction of the wall involves excavating a trench with the average dimensions of 20 ft x 2 ft, importing suitable backfill, mixing bentonite with the backfill and placing in the trench.	16,800.00	sf	$ 15.00	$ 252,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 252,000.00**	
Collection Trench (NAPL and groundwater)					
Collection Trench Installation - Three 200 foot long, 20 ft deep collection trenches installed at three locations at the Site.	1,200.00	lf	$ 80.00	$ 96,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 96,000.00**	
Groundwater Treatment					
Oil/Water Separator - Oil water separation will be performed after ground water extraction.	1.00	ea	$ 7,500.00	$ 7,500	b
Carbon Adsorption (Liquid) - Assume 30 ppm of volatile organics concentration and 50 ppm of semi-volatile organics concentration.	1.00	ea	$ 15,000.00	$ 15,000	b
Off-site Transportation and Disposal of NAPL - this includes the costs for the disposal of collected NAPL from the collection trenches and groundwater extraction well. It is assumed that over the 30 years of operation approximately 5,100 gallons of NAPL will be recovered and removed for off-site disposal. Unit cost does NOT include inflation of costs over the 30 years.	5,100.00	gal	$ 6.00	$ 30,600	b
Pre-Engineered Metal Building - This is the cost associated with construction of a pre-engineered metal building to house the treatment facility. Included is the cost of the discharge pipe to the onsite stream $7,931.	1.00	ls	$ 50,000.00	$ 50,000	b
Operation and Maintenance Startup Costs - This cost is associated with work required to set up the operation and maintenance program.	1.00	ls	$ 15,000.00	$ 15,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 118,000.00**	
Soil Disposal					
Waste Disposal - Disposal of contaminated soil generated during barrier wall and collection trench installation (900 cy for trenches, 200 cy for wall).	1,540.00	tn	$ 65.00	$ 100,100	b
Sediment Removal and Disposal - Removal and disposal of approximately 1,300 tons of impacted sediment for non-hazardous waste disposal.	1.00	ls	$ 300,000.00	$ 300,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 400,000**	
Site Restoration					
Clean Up and Landscaping - This cost is to seed the entire site and pickup after all construction activities are completed. It is assumed that 0.5 acres will be seeded.	1.00	ls	$ 10,000.00	$ 10,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 10,000**	
YEAR 1 Monthly Groundwater Monitoring					
Assume 10 wells sampled monthly with ASP-CLP full class B deliverables with monthly reporting and Annual report.	1.00		$ 60,000.00	$ 60,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 60,000**	

Subtotal Capital Costs	$ 1,044,000.00
Engineering (20% construction costs less cost of disposal of NAPL)	$ 202,680.00
Contingency (20% construction costs)	$ 208,800.00
Total Capital Costs	$ 1,455,480.00

ANNUAL O&M COSTS (Long-term)	
Annual Operation and Maintenance	$ 114,458.00
Annual Long-Term Monitoring (Quarterly after year 1)	$ 25,000.00
Five Year Review	$ 4,000.00
Total Annual O&M Costs	$ 143,458.00
Present Worth O&M Costs (5% discount Rate/30 yrs)	$ 2,205,300.00

OTHER COSTS (short-term O&M and Closeout)	
Site Closeout	$ -
Total Other Costs	$ -

PRESENT WORTH OF COSTS	
Total Capital Costs	$ 1,455,480.00
Total Present Worth O&M Costs	$ 2,205,300.00
Total Other Costs	$ -
TOTAL PRESENT WORTH	$ 3,660,780.00

COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE 3	**$ 3,661,000**

Table 4-1c
Remedial Action Alternative 3 (NAPL/Groundwater Collection and Treatment)
Gastown Former MGP Site-Feasibility Study

ITEM	QUANTITY	UNIT COST	TOTAL	*REF #

* REF # refers to line item in cost estimating software output located in appendix B-1

Table 4-1d
Remedial Action Alternative 4 (In-Situ Thermal/Biological Treatment)
Gastown Former MGP Site-Feasibility Study

ITEM	QUANTITY		UNIT COST	TOTAL	*REF #
Site Preparation					
Permit and agreement - Costing for the various permits and access agreements necessary to perform work.	1.00	ls	$ 10,000.00	$ 10,000	**b**
Overhead Electrical Distribution - The overhead electrical system will supply the treatment facility. Assume approximately 100 feet to facility.	100.00	lf	$ 250.00	$ 25,000	**b**
Miscellaneous Field Installation - These costs include office trailers, and a paved area for the treatment system.	1.00	ls	$ 20,000.00	$ 20,000	**b**
Removal of metal UST - excavation and off-site disposal of underground metal tank identified on site.	1.00	ls	$ 10,000.00	$ 10,000	**b**
Disposal of UST contents - Off-siet disposal of approximately 10,000 gallons of NAPL present within UST.	10,000.00	gal	$ 6.00	$ 60,000	**b**
Installation of sub-slab depressurization systems - Install systems in 5 houses, 1 commercial structure, and 1 school.	1.00	ls	$ 20,000.00	$ 20,000	**a**
ITEM subtotal (rounded to nearest $1,000)				**$ 135,000**	
Barrier Wall					
Soil Bentonite Wall Construction - Construction of the wall involves excavating a trench with the average dimensions of 20 ft x 2 ft, importing suitable backfill, mixing bentonite with the backfill and placing in the trench.	49,200.00	sf	$ 15.00	$ 738,000	**b**
OR					
Sheet Pile Wall Construction - 35 ft average sheet piles will be driven as an alterative to the soil bentonite wall.	43,050.00	sf	$ 25.00	$ 1,076,250	**b**
ITEM subtotal (rounded to nearest $1,000)				**$ 1,076,000**	
In-Situ Thermal Treatment					
In -situ Thermal Treatment - Includes total turn-key costs for multi-phase extraction wells, cap construction, electrical equipment and demobilization	30,000.00	cy	$ 325.00	$ 9,750,000	**c**
ITEM subtotal (rounded to nearest $1,000)				**$ 9,750,000**	
Enhanced Bioremediation Treatment					
Bioremediation Injection Wells - This includes the installation of 11 air and microbe injection wells, blower and control systems. Also included are costs associated with Residual Waste Management, $1,400, for disposal of materials generated during well construction.	11.00	ea	$ 5,000.00	$ 55,000	**b**
ITEM subtotal (rounded to nearest $1,000)				**$ 55,000**	
Groundwater and NAPL Removal and Treatment					
Oil/Water Separator - Oil water separation will be performed after ground water extraction.	1.00	ea	$ 7,500.00	$ 7,500	**b**
Carbon Adsorption (Liquid) - Assume 30 ppm of volatile organics concentration and 50 ppm of semi-volatile organics concentration.	1.00	ea	$ 10,000.00	$ 10,000	**b**
Off-site Transportation and Disposal of NAPL - this includes the costs for the disposal of collected NAPL from the collection trenches and groundwater extraction well. It is assumed that over the 30 years of operation approximately 1,000 gallons of NAPL will be recovered and removed for off-site disposal. Unit cost does NOT include inflation of costs over the 30 years.	1,000.00	gal	$ 6.00	$ 6,000	**b**
Pre-Engineered Metal Building - This is the cost associated with construction of a pre-engineered metal building to house the treatment facility. Included is the cost of the discharge pipe to the onsite stream $7,931.	1.00	ls	$ 50,000.00	$ 50,000	**b**
Operation and Maintenance Startup Costs - This cost is associated with work required to set up the operation and maintenance program.	1.00	ls	$ 15,000.00	$ 15,000	**b**
ITEM subtotal (rounded to nearest $1,000)				**$ 89,000.00**	
Soil Disposal					
Soil Disposal - Disposal of soil generated extraction well installation.	30.00	tn	$ 75.00	$ 2,250	**b**
Sediment Removal and Disposal - Removal and disposal of approximately 1,300 tons of impacted sediment for non-hazardous waste disposal.	1.00	ls	$ 300,000.00	$ 300,000	**b**
ITEM subtotal (rounded to nearest $1,000)				**$ 302,000**	
Site Restoration					
Clean Up and Landscaping - This cost is to grade and pave 1 acre.	1.00	ls	$ 100,000.00	$ 100,000	**b**
ITEM subtotal (rounded to nearest $1,000)				**$ 100,000**	
YEAR 1 Monthly Groundwater Monitoring					
Assume 10 wells sampled monthly with ASP-CLP full class B deliverables with monthly reporting and Annual report.	1.00		$ 60,000.00	$ 60,000	**b**
ITEM subtotal				**$ 60,000**	

Subtotal Capital Costs	**$ 11,567,000.00**
Engineering (20% construction costs less treatment or disposal costs rounded to nearest $1,000)	$ 2,313,000.00
Contingency (20% construction costs rounded to nearest $1,000)	$ 2,313,000.00
Total Capital Costs	$ 16,193,000.00

ANNUAL O&M COSTS (Long-term)	
Annual Operation and Maintenance	$ 60,000.00
Annual Long-Term Monitoring (quarterly sampling and monitoring)	$ 25,000.00
Five Year Review	$ 4,000.00
Total Annual O&M Costs	$ 89,000.00
Present Worth O&M Costs (5% discount Rate/5 yrs)	$ 385,400.00

OTHER COSTS (short-term O&M and Closeout)	
Site Closeout	$ 30,647.00
Total Other Costs	$ 30,647.00

PRESENT WORTH OF COSTS	
Total Capital Costs	$ 16,193,000.00
Total Present Worth O&M Costs	$ 385,400.00
Total Other Costs	$ 30,647.00
TOTAL PRESENT WORTH	$ 16,609,047.00

COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE 4 **$ 16,609,000**

* REF # refers to line item in cost estimating software output located in appendix B-1

Table 4-1c
Remedial Action Alternative 5 (Partial Removal, Containment, and In-situ treatment)
Gastown Former MGP Site-Feasibility Study

ITEM	QUANTITY		UNIT COST	TOTAL	*REF #
Site Preparation					
Permit and agreement - Costing for the various permits and access agreements necessary to perform work.	1.00	ls	$ 10,000.00	$ 10,000	b
Overhead Electrical Distribution - The overhead electrical system will supply the treatment facility. Assume approximately 100 feet to facility	100.00	lf	$ 75.00	$ 7,500	b
Miscellaneous Field Installation - These costs include office trailers, and a paved area for the treatment systems.	1.00	ls	$ 20,000.00	$ 20,000	b
Structural and Environmental Review of Onsite Building - This is a program to review the current status of the onsite building.	1.00	ls	$ 25,747.00	$ 25,747	b
Demo Building - Assume a masonry building with 10% of the debris requiring hazardous waste disposal. Disposal facility is assumed to be approximately 200 miles from site. [CONTINGENCY ITEM BASED ON RESULTS OF EVALUATION]	1.00	ls	$ 210,000.00	$ 210,000	b
Tenant relocation - Costs to relocate tenant to similar facility for duration of excavation (six months).	1.00	ls	$ 68,000.00	$ 68,000	d
Building Reconstruction - Reconstruction of impacted buildings above proposed excavation area - two, 2000-square feet buildings.	4,000.00	sf	$ 50.00	$ 200,000	e
Installation of sub-slab depressurization systems - Install systems in 5 houses, 1 commercial structure, and 1 school.	1.00	ls	$ 20,000.00	$ 20,000	a
ITEM subtotal (rounded to nearest $1,000)				**$ 561,000.00**	
Soil Removal and Treatment					
Impacted Soil Excavation and Backfill - The costs for this item covers the excavation of 23,000 yds (or 32,200 tns at 1.4 tns per yard) of impacted material and clean overburden for disposal off-site. It also covers the cost of dewatering during the excavation activities.	32,200.00	tn	$ 75.00	$ 2,415,000	b
Sheet Pile Wall Construction - 630 lf of 35 ft average sheet piles to be driven around the outside perimeter of the excavation	22,050.00	sf	$ 25.00	$ 551,250	b
In-Situ Ozone Oxidation - This item is a cost estimate for using chemical oxidation (ozone) to treat the VOC, SVOC, and PAHs in 30,778 yds (or 43,089 tons at 1.4 tons per cy).	1.00	ls	$ 900,000.00	$ 900,000	f
Odor suppression system - sprung structures will be erected over the removal area with appropriate air treatment system.	1.00	ls	$ 385,000.00	$ 385,000	g
ITEM subtotal (rounded to nearest $1,000)				**$ 4,251,000.00**	
Barrier Wall and Cover					
Soil Bentonite Wall Construction - Construction of the wall involves excavating a trench with the average dimensions of 20 ft x 2 ft, importing suitable backfill, mixing bentonite with the backfill and placing in the trench.	26,000.00	sf	$ 15.00	$ 390,000	b
Cover Construction - The cover will consist of a graded site with a 12" crushed stone layer overlaid by 4" of course asphalt and a 2" top coat of asphalt.	0.50	acre	$ 200,000.00	$ 100,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 490,000.00**	
Collection Trench (NAPL and groundwater)					
Collection Trench Installation - Two 25-ft deep collection trenches installed at the Site with a total length of 215 feet.	215.00	lf	$ 80.00	$ 17,200	b
Groundwater Extraction Systems - This includes installation of 2 NAPL/groundwater extraction systems. The east system will consist of 3 groundwater extraction wells along with 4" submersible pumps with 5 gpm capacity for a total of 15 gpm capacity and the northwest system will consist of 10 groundwater extraction wells along with 4" submersible pumps with 5 gpm capacity each for a total of 50 gpm capacity. Also included are costs associated with Residual Waste Management, $1,371, for disposal of materials generated during well construction.	13.00	ea	$ 10,000.00	$ 130,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 147,000.00**	
Groundwater Treatment					
Oil/Water Separator - Oil water separation will be performed after ground water extraction.	2.00	ea	$ 7,000.00	$ 14,000	b
Carbon Adsorption (Liquid) - Assume 30 ppm of volatile organics concentration and 50 ppm of semi-volatile organics concentration.	2.00	ea	$ 15,000.00	$ 30,000	b
Off-site Transportation and Disposal of NAPL - this includes the costs for the disposal of collected NAPL from the collection trenches and groundwater extraction systems. It is assumed that over the five years of operation approximately 5,100 gallons of NAPL will be recovered and removed for off-site disposal. Unit cost does NOT include inflation of costs over the 5 years. It is assumed aapproximately 700 additional gallons of NAPL will be recovered during excavation dewatering and removed for off-site disposal and another 10,000 gallons of NAPL will be removed during the underground metal tank excavation.	15,800.00	gal	$ 6.00	$ 94,800	b
Pre-Engineered Metal Building - This is the cost associated with construction of 2 pre-engineered metal buildings to house the treatment facilities. Included is the cost of the discharge pipe to the POTW $7,931.	2.00	ls	$ 50,000.00	$ 100,000	b
Operation and Maintenance Startup Costs - This cost is associated with work required to set up the operation and maintenance program.	1.00	ls	$ 15,000.00	$ 15,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 254,000.00**	
Soil Disposal					
Waste Disposal - Disposal of contaminated soil generated during barrier wall and collection trench installation (535 cy for trenches, 800 cy for wall).	1,866.67	tn	$ 65.00	$ 121,333	b
Sediment Removal and Disposal - Removal and disposal of approximately 1,300 tons of impacted sediment for non-hazardous waste disposal.	1.00	ls	$ 300,000.00	$ 300,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 421,000**	
Site Restoration					
Clean Up and Landscaping - This cost is to seed the entire site and pickup after all construction activities are completed. It is assumed that 0.5 acres will be seeded	1.00	ls	$ 10,000.00	$ 10,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 10,000**	
YEAR 1 Monthly Groundwater Monitoring					
Assume 10 wells sampled monthly with ASP-CLP full class B deliverables with monthly reporting and Annual report.	1.00		$ 60,000.00	$ 60,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 60,000**	

Subtotal Capital Costs	$ 6,194,000.00
Engineering (20% construction costs less treatment or disposal costs)	$ 388,600.00
Contingency (20% construction costs)	$ 1,238,800.00
Total Capital Costs	$ 7,821,400.00
ANNUAL O&M COSTS (Long-term)	
Annual Operation and Maintenance	$ 114,458.00
Annual Long-Term Monitoring (Quarterly after year 1)	$ 25,000.00
Five Year Review	$ 4,000.00
Total Annual O&M Costs	$ 143,458.00
Present Worth O&M Costs (5% discount Rate/5 yrs)	$ 621,200.00
OTHER COSTS (short-term O&M and Closeout)	
Site Closeout	$ 30,647.00
Total Other Costs	$ 30,647.00
PRESENT WORTH OF COSTS	
Total Capital Costs	$ 7,821,400.00
Total Present Worth O&M Costs	$ 621,200.00
Total Other Costs	$ 30,647.00
TOTAL PRESENT WORTH	$ 8,473,247.00
COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE 3	**$ 8,473,000**

* REF # refers to line item in cost estimating software output located in appendix B-1

Table 4-1e
Remedial Action Alternative 6 (Full Isolation and Containment)
Gastown Former MGP Site-Feasibility Study

ITEM	QUANTITY		UNIT COST	TOTAL	*REF #
Site Preparation					
Permit and agreement - Costing for the various permits and access agreements necessary to perform work.	1.00	ls	$ 10,000.00	$ 10,000.00	b
Temporary Fencing - 5 ft high boundary fence with that will enclose the site during construction.	1,500.00	lf	$ 9.17	$ 13,762	b
Overhead Electrical Distribution - The overhead electrical system will supply the treatment facility. Assume approximately 100 feet to facility.	100.00	lf	$ 75.00	$ 7,500	b
Miscellaneous Field Installation - These costs include office trailers, and a paved area for the treatment system.	1.00	ls	$ 20,000.00	$ 20,000	b
Removal of metal UST - excavation and off-site disposal of underground metal tank identified on site.	1.00	ls	$ 10,000.00	$ 10,000	b
Disposal of UST contents - Off-siet disposal of approximately 10,000 gallons of NAPL present within UST.	10,000.00	gal	$ 6.00	$ 60,000	b
Installation of sub-slab depressurization systems - Install systems in 5 houses, 1 commercial structure, and 1 school.	1.00	ls	$ 20,000.00	$ 20,000	a
ITEM subtotal (rounded to nearest $1,000)				**$ 131,000.00**	
Isolation and Containment					
Cap Construction - The cap will consist of a graded site with a geotextile protective layer, a 40 mil LLDPE liner overlaid by another geotextile cushion layer. The rest of the cap with consist of a 12" crushed stone layer overlaid by 4" of course asphalt and a 2" top coat of asphalt. The boundary's of the cap are the cutoff walls.	2.60	acre	$ 200,000.00	$ 520,000	b
Soil Bentonite Wall Construction - Construction of the wall involves excavating a trench with the average dimensions of 20 ft x 2 ft, importing suitable backfill, mixing bentonite with the backfill and placing in the trench.	88,800.00	sf	$ 15.00	$ 1,332,000	b
OR					
Sheet Pile Wall Construction - 25 ft average sheet piles used as an alternative to the soil bentonite wall.	55,500.00	sf	$ 25.00	$ 1,387,500	b
Permanent Fencing - 5 ft high boundary fence with that will enclose the extent of the capped area.	1,300.00	lf	$ 9.19	$ 11,952	b
ITEM subtotal (rounded to nearest $1,000)				**$ 1,919,000.00**	
Groundwater and NAPL Removal and Treatment					
Groundwater Extraction Wells - This includes the installation of 4 groundwater extraction wells along with 4" submersible pumps with 5 gpm capacity each for a total of 20 gpm capacity. Also included are costs associated with Residual Waste Management, $1,371, for disposal of materials generated during well construction.	4.00	ea	$ 10,000.00	$ 40,000	b
Oil/Water Separator - Oil water separation will be performed after ground water extraction.	1.00	ea	$ 7,500.00	$ 7,500	b
Carbon Adsorption (Liquid) - Assume 30 ppm of volatile organics concentration and 50 ppm of semi-volatile organics concentration.	1.00	ea	$ 10,000.00	$ 10,000	b
Off-site Transportation and Disposal of NAPL - this includes the costs for the disposal of collected NAPL from the collection trenches and groundwater extraction well. It is assumed that over the 30 years of operation approximately 8,500 gallons of NAPL will be recovered and removed for off-site disposal. Unit cost does NOT include inflation of costs over the 30 years.	8,500.00	gal	$ 6.00	$ 51,000	b
Pre-Engineered Metal Building - This is the cost associated with construction of a pre-engineered metal building to house the treatment facility. Included is the cost of the discharge pipe to the onsite stream $7,931.	1.00	ls	$ 50,000.00	$ 50,000	b
Operation and Maintenance Startup Costs - This cost is associated with work required to set up the operation and maintenance program.	1.00	ls	$ 15,000.00	$ 15,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 174,000.00**	
Soil Disposal					
Sediment Removal and Disposal - Removal and disposal of approximately 1,300 tons of impacted sediment for non-hazardous waste disposal.	1.00	ls	$ 300,000.00	$ 300,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 300,000**	
Site Restoration					
Clean Up and Landscaping - This cost is to seed the entire site and pickup after all construction activities are completed. It is assumed that 3.5 acres will be seeded.	1.00	ls	$ 15,000.00	$ 15,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 15,000**	
YEAR 1 Monthly Groundwater Monitoring					
Assume 10 wells sampled monthly with ASP-CLP full class B deliverables with monthly reporting and Annual report.	1.00		$ 60,000.00	$ 60,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 60,000**	

Subtotal Capital Costs	$ 2,599,000.00
Engineering (20% construction costs less cost of disposal of NAPL)	$ 509,600.00
Contingency (20% construction costs)	$ 519,800.00
Total Capital Costs	$ 3,628,400.00

ANNUAL O&M COSTS (Long-term)	
Annual Operation and Maintenance	$ 114,458.00
Annual Long-Term Monitoring (Quarterly after year 1)	$ 60,000.00
Five Year Review	$ 4,000.00
Total Annual O&M Costs	$ 178,458.00
Present Worth O&M Costs (5% discount Rate/30 yrs)	$ 2,743,300.00

OTHER COSTS (short-term O&M and Closeout)	
Site Closeout	$ -
Total Other Costs	$ -

PRESENT WORTH OF COSTS	
Total Capital Costs	$ 3,628,400.00
Total Present Worth O&M Costs	$ 2,743,300.00
Total Other Costs	$ -
TOTAL PRESENT WORTH	$ 6,371,700.00

COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE 3	**$ 6,372,000**

* REF # refers to line item in cost estimating software output located in appendix B-1

Table 3
Remedial Action Alternative 6 (Full Removal)
Gastown Former MGP Site-Feasibility Study

ITEM	QUANTITY		UNIT COST	TOTAL	*REF #
Site Preparation					
Permit and agreement - Costing for the various permits and access agreements necessary to perform work.	1.00	ls	$ 20,000.00	$ 20,000.00	**b**
Temporary Fencing - 5 ft high boundary fence with that will enclose the site during construction.	1,500.00	lf	$ 9.17	$ 13,762	**b**
Overhead Electrical Distribution - The overhead electrical system will supply the treatment facility. Assume approximately 100 feet to facility.	100.00	lf	$ 75.00	$ 7,500	**b**
Miscellaneous Field Installation - These costs include office trailers, and a paved area for the treatment system.	1.00	ls	$ 20,000.00	$ 20,000	**b**
Structural and Environmental Review of Onsite Building - This is a program to review the current status of the onsite building.	1.00	ls	$ 25,747.00	$ 25,747	**b**
Demo Building - Assume a masonry building with 10% of the debris requiring hazardous waste disposal. Disposal facility is assumed to be approximately 200 miles from site. [CONTINGENCY ITEM BASED ON RESULTS OF EVALUATION]	1.00	ls	$ 210,000.00	$ 210,000	**b**
Tenant relocation - Costs to relocate tenants to similar facility for duration of excavation (six months).	1.00	ls	$ 340,000.00	$ 340,000	**d**
Building Reconstruction - Reconstruction of impacted buildings above proposed excavation area - five, 2000-square feet buildings.	10,000.00	sf	$ 50.00	$ 500,000	**e**
Installation of sub-slab depressurization systems - Install systems in 5 houses, 1 commercial structure, and 1 school.	1.00	ls	$ 20,000.00	$ 20,000	**a**
ITEM subtotal (rounded to nearest $1,000)				**$ 1,137,000.00**	
Soil Removal and Treatment					
Impacted Soil Excavation and Backfill - The costs for this item covers the excavation of 62,000 yds (or 86,800 tns at 1.4 tns per yard) of impacted material and disposal off-site. It also covers the cost of dewatering during the excavation activities.	86,800.00	tn	$ 75.00	$ 6,510,000	**b**
Sheet Pile Wall Construction - 1,280 lf of 35 ft average sheet piles to be driven around the outside perimeter of the excavation	44,800.00	sf	$ 25.00	$ 1,120,000	**b**
Odor suppression system - sprung structures will be erected over the removal area with appropriate air treatment system.	1.00	ls	$ 585,000.00	$ 585,000	**g**
Sediment Removal and Disposal - Removal and disposal of approximately 1,300 tons of impacted sediment for non-hazardous waste disposal.	1.00	ls	$ 300,000.00	$ 300,000	**b**
ITEM subtotal (rounded to nearest $1,000)				**$ 8,515,000.00**	
Groundwater and NAPL Treatment during excavation					
Oil/Water Separator - Oil water separation will be performed after ground water extraction.	1.00	ea	$ 7,500.00	$ 7,500	**b**
Carbon Adsorption (Liquid) - Assume 30 ppm of volatile organics concentration and 50 ppm of semi-volatile organics concentration.	1.00	ea	$ 10,000.00	$ 10,000	**b**
Off-site Transportation and Disposal of NAPL - this includes the costs for the disposal of NAPL collected during excavation. It is assumed approximately 1000 gallons of NAPL will be recovered and removed for off-site disposal and another 10,000 gallons of NAPL will be removed during the underground metal tank excavation.	11,000.00	gal	$ 6.00	$ 66,000	**b**
Pre-Engineered Metal Building - This is the cost associated with construction of a pre-engineered metal building to house the treatment facility. Included is the cost of the discharge pipe to the onsite stream $7,931.	1.00	ls	$ 50,000.00	$ 50,000	**b**
Operation and Maintenance Startup Costs - This cost is associated with work required to set up the operation and maintenance program.	1.00	ls	$ 15,000.00	$ 15,000	**b**
ITEM subtotal (rounded to nearest $1,000)				**$ 149,000**	
Site Restoration					
Clean Up and Landscaping - This cost is to seed the entire site and pickup after all construction activities are completed. It is assumed that 3.5 acres will be seeded.	1.00	ls	$ 15,000.00	$ 15,000	**b**
ITEM subtotal (rounded to nearest $1,000)				$ 15,000	
YEAR 1 Monthly Groundwater Monitoring					
Assume 10 wells sampled monthly with ASP-CLP full class B deliverables with monthly reporting and Annual report.	1.00		$ 60,000.00	$ 60,000	**b**
ITEM subtotal (rounded to nearest $1,000)				$ 60,000	

Subtotal Capital Costs	$ 9,876,000.00
Engineering (20% construction costs less treatment or disposal costs rounded to nearest $1,000)	$ 272,000.00
Contingency (20% construction costs)	$ 1,975,200.00
Total Capital Costs	$ 12,123,200.00

ANNUAL O&M COSTS (Long-term)	
Annual Operation and Maintenance	$ 10,000.00
Annual Long-Term Monitoring (Quarterly after year 1)	$ 25,000.00
Five Year Review	$ 4,000.00
Total Annual O&M Costs	$ 39,000.00
Present Worth O&M Costs (5% discount Rate/5 yrs)	$ 168,900.00

OTHER COSTS (short-term O&M and Closeout)	
Site Closeout	$ 30,647.00
Total Other Costs	$ 30,647.00

PRESENT WORTH OF COSTS	
Total Capital Costs	$ 12,123,200.00
Total Present Worth O&M Costs	$ 168,900.00
Total Other Costs	$ 30,647.00
TOTAL PRESENT WORTH	$ 12,322,747.00

COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE 6	**$ 12,323,000**

* REF # refers to line item in cost estimating software output located in appendix B-1

Table 3
Remedial Action Alternative 7 (Partial Removal and In-Situ Solidification)
Gastown Former MGP Site-Feasibility Study

ITEM	QUANTITY		UNIT COST	TOTAL	*REF #
Site Preparation					
Permit and agreement - Costing for the various permits and access agreements necessary to perform work.	1.00	ls	$ 20,000.00	$ 20,000.00	b
Temporary Fencing - 5 ft high boundary fence with that will enclose the site during construction.	1,500.00	lf	$ 9.17	$ 13,762	b
Overhead Electrical Distribution - The overhead electrical system will supply the treatment facility. Assume approximately 100 feet to facility.	100.00	lf	$ 75.00	$ 7,500	b
Miscellaneous Field Installation - These costs include office trailers, and a paved area for the treatment system.	1.00	ls	$ 20,000.00	$ 20,000	b
Structural and Environmental Review of Onsite Building - This is a program to review the current status of the onsite building.	1.00	ls	$ 25,747.00	$ 25,747	b
Demo Building - Assume a masonry building with 10% of the debris requiring hazardous waste disposal. Disposal facility is assumed to be approximately 200 miles from site. [CONTINGENCY ITEM BASED ON RESULTS OF EVALUATION]	1.00	ls	$ 210,000.00	$ 210,000	b
Tenant relocation - Costs to relocate tenant to similar facility for duration of excavation (six months).	1.00	ls	$ 68,000.00	$ 68,000	d
Building Reconstruction - Reconstruction of impacted buildings above proposed excavation area - five, 2000-square feet buildings.	10,000.00	sf	$ 50.00	$ 500,000	e
Installation of sub-slab depressurization systems - Install systems in 5 houses, 1 commercial structure, and 1 school.	1.00	ls	$ 20,000.00	$ 20,000	a
ITEM subtotal (rounded to nearest $1,000)				**$ 885,000.00**	
Soil Removal and Treatment					
Impacted Soil Excavation and Backfill - The costs for this item covers the excavation of 27,500 yds (or 38,500 tns at 1.4 tns per yard) of impacted material and disposal off-site. It also covers the cost of dewatering during the excavation activities.	38,500.00	tn	$ 75.00	$ 2,887,500	b
Sheet Pile Wall Construction - 630 lf of 35 ft average sheet piles to be driven around the outside perimeter of the excavation	22,050.00	sf	$ 25.00	$ 551,250	b
Odor suppression system - sprung structures will be erected over the removal area with appropriate air treatment system.	1.00	ls	$ 385,000.00	$ 385,000	g
Sediment Removal and Disposal - Removal and disposal of approximately 1,300 tons of impacted sediment for non-hazardous waste disposal.	1.00	ls	$ 300,000.00	$ 300,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 4,124,000.00**	
In Situ Solidification					
In-Situ Solidification - The costs for this item covers the solidification of the remaining 20,000 yds (or 28,000 tns at 1.4 tns per yard) of impacted material at the Site.	20,000.00	cy	$ 195.00	$ 3,900,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 3,900,000**	
Groundwater and NAPL Treatment during excavation					
Oil/Water Separator - Oil water separation will be performed after ground water extraction.	1.00	ea	$ 7,500.00	$ 7,500	b
Carbon Adsorption (Liquid) - Assume 30 ppm of volatile organics concentration and 50 ppm of semi-volatile organics concentration.	1.00	ea	$ 10,000.00	$ 10,000	b
Off-site Transportation and Disposal of NAPL - this includes the costs for the disposal of NAPL collected during excavation. It is assumed approximately 700 gallons of NAPL will be recovered and removed for off-site disposal and another 10,000 gallons of NAPL will be removed during the underground metal tank excavation.	10,700.00	gal	$ 6.00	$ 64,200	b
Pre-Engineered Metal Building - This is the cost associated with construction of a pre-engineered metal building to house the treatment facility. Included is the cost of the discharge pipe to the onsite stream $7,931.	1.00	ls	$ 50,000.00	$ 50,000	b
Operation and Maintenance Startup Costs - This cost is associated with work required to set up the operation and maintenance program.	1.00	ls	$ 15,000.00	$ 15,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 147,000**	
Site Restoration					
Clean Up and Landscaping - This cost is to seed the entire site and pickup after all construction activities are completed. It is assumed that 3.5 acres will be seeded.	1.00	ls	$ 15,000.00	$ 15,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 15,000**	
YEAR 1 Monthly Groundwater Monitoring					
Assume 10 wells sampled monthly with ASP-CLP full class B deliverables with monthly reporting and Annual report.	1.00		$ 60,000.00	$ 60,000	b
ITEM subtotal (rounded to nearest $1,000)				**$ 60,000**	

Subtotal Capital Costs	$ 9,131,000.00
Engineering (20% construction costs less treatment or disposal costs rounded to nearest $1,000)	$ 1,001,000.00
Contingency (20% construction costs)	$ 1,826,200.00
Total Capital Costs	$ 11,958,200.00

ANNUAL O&M COSTS (Long-term)	
Annual Operation and Maintenance	$ 114,458.00
Annual Long-Term Monitoring (Quarterly after year 1)	$ 25,000.00
Five Year Review	$ 4,000.00
Total Annual O&M Costs	$ 143,458.00
Present Worth O&M Costs (5% discount Rate/30 yrs)	$ 2,205,300.00

OTHER COSTS (short-term O&M and Closeout)	
Site Closeout	$ -
Total Other Costs	$ -

PRESENT WORTH OF COSTS	
Total Capital Costs	$ 11,958,200.00
Total Present Worth O&M Costs	$ 2,205,300.00
Total Other Costs	$ -
TOTAL PRESENT WORTH	$ 14,163,500.00

COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE 7	**$ 14,164,000**

* REF # refers to line item in cost estimating software output located in appendix B-1

Table 1-1
Location-Specific Standards and Criteria
Gastown Former MGP Site

Program/Authority/Citation	Synopsis	Project Application
STATE:		
- Use and Protection of Waters - ECL Article 15, Title 5 and ECL Article 17, Title 3 - 6 NYCRR Part 608	Establishes permit requirements to change, modify, or disturb any protected stream, its bed or banks, or remove from its bed or banks sand or gravel or any other material; or to excavate from or place fill in any of the navigable waters of the state or in any marsh, estuary or wetland that are adjacent to and contiguous at any point to any of the navigable waters of the state and that are inundated at mean high water level or tide. Also establishes requirement that any application for a federal license or permit to conduct any activity which may result in a discharge into navigable water must obtain a State Water Quality Certification under Section 401 of the Federal Water Pollution Control Act, 33 USC § 1341.	Applicable. Tonawanda Creek is located adjacent to the site and is a protected stream and a navigable water. Remedial activities may encompass disturbance of Tonawanda Creek. The remedial activities must be designed and conducted consistent with the Part 608 requirements and typical NYSDEC permit conditions. If discharge of treated water to the creek is part of the remedial plan, a Section 401 Water Quality Certification would be required.
- Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern - ECL Article 11, Title 5 - 6 NYCRR Part 182	Establishes prohibition for the taking or possession of any NYS endangered or threatened species, except in accordance with permit issued under this Part. "Taking" may include destruction or degrading of critical habitat of any such species.	Applicable. Two threatened species of Fish or Wildlife have been identified at the site, the common tern (*Sterna hirundo*) and the stiff-leaved goldenrod (*Solidago rigida*), as being located within a 2 mile radius.
- Freshwater Wetlands - ECL Article 24, Title 7 - 6 NYCRR Parts 662-665	Establishes prohibition on alteration or disturbance of freshwater wetlands and adjacent areas except in accordance with permit issued under this Part. Establishes procedural requirements and standards for issuance of freshwater wetlands permit.	Not applicable. There are no Designated wetlands present adjacent to the site in association with Tonawanda creek.
FEDERAL:		
- Discharge of dredged or fill material into navigable waters of the US (CWA Section 404) - 33 U.S.C § 1344 - 33 CFR Parts 320-329	Establishes prohibition for discharge of dredged or fill material into navigable waters of the US except in accordance with a permit issued by the USACE.	Potentially applicable, in the event that the remedial activities encompass discharge of dredged or fill material into navigable waters of the US (Tonawanda Creek).
- Work in or affecting navigable waters of the US (Rivers and Harbor Act of 1899) - 33 U.S.C. § 322 - 33 CFR Part 322	Establishes prohibition that any work encompassing excavation or fill, or any work that alters or modifies the course, location, condition or capacity of the channel of any navigable water of the US except in accordance with a permit issued by the USACE under this part.	Potentially applicable. If Tonawanda creek is a deemed navigable water of the US and remedial activities may encompass excavation of the creek bed. A Section 10 (Rivers and Harbor Act) permit would be required from the USACE for the remedial activities.

Table 1-1
Location-Specific Standards and Criteria
Gastown Former MGP Site

Program/Authority/Citation	Synopsis	Project Application
FEDERAL:		
- Fish and Wildlife Coordination Act - 16 U.S.C. § 662 - Citation N/A	Establishes requirement that whenever any stream or other body of water is proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose, by any department or agency of the United States, such department or agency must first consult with the US Fish and Wildlife Service, Department of the Interior and with the head of the agency exercising administration over the wildlife resources of the particular State in which the action is proposed, with a view to the conservation of wildlife resources by preventing loss of and damage to such resources.	Potentially applicable. If remedial action involves removal of sediments from, or discharge of water to Tonawanda Creek, US Fish and Wildlife would need to be consulted, since Tonawanda Creek is a class C stream. The USACE would provide the required consultation with appropriate federal and state agencies as part of the permit application review process.
- Endangered Species Act - 16 U.S.C §§ 1531-1544 - 40 CFR Part 17, Subpart I - 40 CFR Part 402	Establishes requirement that federal agencies must confirm that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of a critical habitat of such species, unless the agency has been granted an appropriate exemption by the Endangered Species Committee.	Potentially Applicable. Two threatened species of Fish or Wildlife have been identified at the site. Both the common tern (*Sterna hirundo*) and the stiff-leaved goldenrod (*Solidago rigida*) have been identified within 2 miles of the site.

Table 1-1
Location-Specific Standards and Criteria
Gastown Former MGP Site

FEDERAL:		
- Statement of Procedures on Floodplain Management and Wetlands Protection - Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands) - 40 CFR Part 6, Appendix A	Establishes EPA policy and guidance for implementing Executive Orders 11988 and 11990. Executive Order 11988 required federal agencies to evaluate potential effects of actions they may take in a floodplain to avoid, to the extent possible, adverse effects associated with development within a floodplain. The agencies must avoid adverse impacts or minimize them if no practical alternative exists. Executive Order 11990 requires federal agencies conducting certain activities, to avoid, to the extent possible, the adverse impacts associated with destruction or loss of wetlands if practicable alternatives exist. The agencies must avoid adverse impacts or minimize them if no practicable alternative exists.	Potentially applicable (on the basis of a required Section 10 permit issuance for the remedial activities by the USACE), in the event the remedial activities occur in a floodplain or federal-jurisdiction wetland. In this event the USACE would provide the review and evaluation of the consistency of the proposed remedial activities with these two policies as part of its Section 10 permit application review process.
- Farmland Protection Policy Act of 1981 - 7 U.S.C. § 4201 - 7 CFR Part 658	Regulates the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses.	Not applicable. Remedial activities do not encompass irreversible conversion of farmland to non-agricultural uses.

Table 1-2
Chemical-Specific Standards and Criteria
Gastown Former MGP Site

Program/Authority/Citation	Synopsis	Project Application
STATE:		
- Water Quality Regulations - ECL Article 15, Title 3 and ECL Article 17, Titles 3 and 8 - 6 NYCRR Parts 700 – 706	Establishes water body classifications and ambient water quality standards for surface waters and groundwaters of NYS. Provides ambient water quality standards for approximately 200 listed chemical contaminants.	Applicable, in the event that the remedial activities include a discharge of pollutants to Tonawanda Creek or would otherwise have an adverse impact on the water quality of Tonawanda Creek. At the site location, Tonawanda Creek is classified as a Class C water body, with associated ambient water quality standards, including standards for most of the chemicals of concern associated with the remedial activities. Water quality standards would be used, in part, to design a process water treatment system for discharge to Tonawanda Creek, if such a system is to be a component of the remedial activities.
FEDERAL:		
- Toxic Pollutant Effluent Standards - Clean Water Act [Federal Water Pollution Control Act, as amended], 33 U.S.C §§ 1251-1387 - 40 CFR Part 129	Establishes toxic pollutants and toxic pollutant effluent standards for water discharges to navigable waters	Not Applicable. None of the chemicals of concern for the remedial activities are defined as a toxic pollutant.
- National Drinking Water Standards - Safe Drinking Water Act, 42 U.S.C. §§ 300f – 300j-26 - 40 CFR Parts 141 through 143	Establishes primary and secondary standards for public water supply systems.	Not Applicable. Tonawanda Creek is not utilized as a public drinking water supply.

Table 1-3
Action-Specific Standards and Criteria
Gastown Former MGP Site

Program/Authority/Citation	Synopsis	Project Application
STATE:		
- Siting of Industrial Hazardous Waste Facilities - ECL Article 27, Title 11 - 6 NYCRR Part 361	Establishes criteria and application procedures for siting of new industrial hazardous waste treatment, storage and disposal facilities.	Potentially Applicable, in the event the remedial activities include construction of a new industrial hazardous waste treatment, storage and/or disposal facility.
- Permitting of Hazardous Waste Treatment, Storage and Disposal Facilities - ECL Article 27, Title 9 - 6 NYCRR Subpart 373-1	Establishes criteria and application procedures for permitting of hazardous waste storage, treatment and disposal facilities.	Potentially Applicable, in the event the remedial activities include construction of a new industrial hazardous waste treatment, storage and/or disposal facility.
- Hazardous Waste Management Regulations - ECL Article 27, Title 3, 7 , 9 and 13 - ECL Article 3, Title 3 - 6 NYCRR Parts 370-372; 6 NYCRR Subpart 373-2; 6 NYCRR Parts 374 6 NYCRR Part 376	Establishes definition of hazardous wastes and associated handling and disposal requirements. Establishes standards and requirements for generators and transporters of hazardous waste.	Potentially Applicable, in the event that hazardous wastes (as defined Part 371) are generated by the remedial activities. In this event, the generator and transporter standards would apply to the remedial activities.
- Standards for Waste Transportation - ECL Article 27, Title 3 - 6 NYCRR Part 364	Establishes permitting requirements and management standards for collection, transport and delivery by vehicles of regulated wastes, which includes, in part, NYS-defined solid hazardous wastes and non-hazardous industrial process wastes.	Potentially Applicable, in the event that the remedial activities include transport of regulated wastes in vehicles. All vehicles transporting regulated wastes must be permitted by the NYSDEC under Part 364.
- Solid Waste Management Facilities - ECL Article 27, Title 7 - 6 NYCRR Part 360	Establishes standards and requirements for construction, permitting and operation of solid waste management facilities.	Potentially Applicable, in the event that the remedial activities include construction of a new solid waste management facility for disposal of solid (i.e., non-hazardous) wastes generated by the remedial activities.
- Air Pollution Control Regulations - ECL Article 19, Title 3 - 6 NYCRR Parts 200, et al	Establishes strict prohibition on emission of air contaminants that jeopardize human, plant or animal life, or is ruinous to property, or causes a level of discomfort. Establishes prohibition for emission of an air contaminant source except in accordance with a permit or registration certificate issued under Part 201. Identifies exempt and trivial air emission activities that are exempt from the Part 201 permitting requirements.	Potentially Applicable, in the event that the remedial activities include a regulated air emission source, which is not an exempt or trivial air emission source. In this event the remedial activities (as they pertain to the regulated air emission source) must be designed and conducted consistent with the Part 201 requirements and typical NYSDEC permit conditions.

Table 1-3
Action-Specific Standards and Criteria
Gastown Former MGP Site

Program/Authority/Citation	Synopsis	Project Application
STATE:		
- New York State Pollutant Discharge Elimination System (SPDES) Requirements - ECL Article 17, Title 5 - 6 NYCRR Parts 750 through 758	Establishes prohibitions and standards for discharge of pollutants to Waters of the State, which includes both surface waters and ground waters. Establishes prohibition of discharge of pollutants to Waters of the State except in accordance with a permit issued under Part 752.	Potentially Applicable, in the event that the remedial activities include discharges of pollutants to Waters of the State. In the event that the remedial activities include discharge of any process water to Waters of the State, an individual SPDES permit would be required. In this event, the remedial activities (as they pertain to the process water discharge, such as for a process water treatment system with effluent discharge to Tonawanda Creek) must be designed and conducted consistent with the Part 752 requirements and the NYSDEC's associated typical permit conditions. In the event that the remedial activities include construction disturbance of greater than 0.5 acres and an associated offsite discharge of stormwater, a SPDES permit would be required. Typically, such permit requirements are addressed by appropriate coverage under the NYSDEC's SPDES General Permit for such activities. In this event, the remedial activities (as they pertain to the stormwater runoff from disturbed areas) must be designed and conducted consistent with the NYSDEC's SPDES General Permit for such activities.
- Fish and Wildlife Law – Water Pollution Prohibition - ECL Article 11, Title 5 - Citation N/A	Establishes that no deleterious or poisonous substances shall be thrown or allowed to run into any public or private waters in quantities injurious to fish life, protected wildlife or waterfowl inhabiting those waters, or injurious to the propagation of fish, protected wildlife or waterfowl therein.	Applicable. General "performance" standard that would apply to the overall remedial activities.
- Contravention of Water Quality Standards - ECL Article 17, Title 5 - Citation N/A	Establishes as an unlawful act for any person, directly or indirectly, to throw, drain, run or otherwise discharge into waters of the State organic or inorganic matter that shall cause or contribute to a condition in contravention of the applicable ambient water quality standards established at 6 NYCRR § 701.1.	Applicable. General "performance" standard that would apply to the overall remedial activities.

Table 1-3
Action-Specific Standards and Criteria
Gastown Former MGP Site

Program/Authority/Citation	Synopsis	Project Application
FEDERAL:		
- Hazardous Materials Transportation - 49 U.S.C. §§ 5101-5127 - 49 CFR Part 171	Establishes Federal Department of Transportation standards for transport of hazardous materials, including standards for packaging, labeling, manifesting and transporting hazardous materials.	Potentially Applicable, in the event that the remedial activities include transport of hazardous materials. Hazardous materials include, in part, hazardous wastes. Remedial activities encompassing transport of hazardous materials must comply with the Part 171 standards.
- PCBs Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions - 15 U.S.C. § 2605 (TSCA) - 40 CFR Part 761	Establishes definitions for PCBs and various PCB-containing materials. Establishes disposal requirements for various PCB waste types. Establishes cleanup and disposal options for PCB remediation waste, which includes PCB-contaminated sediments and dredged materials. Disposal options for PCB remediation waste include disposal in a high-temperature incinerator, an approved chemical waste landfill or a facility with coordinated approval (40 CFR Part 761.77). Confirms that PCB remediation wastes containing less than 50 PPM of PCBs may be disposed of at an approved land disposal facility for the management of municipal solid waste. Allows for an EPA Regional Administrator to approve a risk-based disposal method that will not pose an unreasonable risk of injury to human health or the environment. Establishes technical requirements for temporary storage of PCB wastes prior to treatment or disposal. Establishes decontamination standards and procedures for removing PCBs that are regulated for disposal from various environmental media.	Not Applicable. Site soils do not meet the definition for PCBs and PCB wastes.
- PCBs Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions - 15 U.S.C §2601 (TSCA) - 40 CFR Part 761	Establishes permitting requirements and criteria for PCB storage facilities, chemical waste landfills and incinerators.	Not Applicable. Remedial activities do not include construction of a PCB storage facility, chemical waste landfill or incinerator.
- CWA Discharge to Publicly-Owned Treatment Works (POTW) (40 CFR 403)	Applies to POTWs that receive wastewater from sources subject to National Pretreatment Standards.	Potentially Applicable, in the event that the remedial activities include discharge of wastewaters to a POTW.

Table 1-4

Potential Guidance
Gastown Former MGP Site

FEDERAL	C USEPA Office of Water Regulations and Standards, Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Contaminants; May 1988, Updated for specific contaminants (primarily PAHs) in 1993; C USEPA Health Effects Assessment (HEAs); C Toxicological Profiles, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service; C Policy for the Development of Water-Quality-Based Permit Limitations for Toxic Pollutants (49 Federal Register 9016); C Cancer Assessment Group (National Academy of Science Guidance); C Waste Load Allocation Procedures; C USEPA Soil Screening Guidance (EPA/540/R-94/101); C Fish and Wildlife Coordination Act Advisories; C Policy on Floodplains and Wetlands Assessments for CERCLA Actions, EPA, August 1985; C Rule of Thumb for Superfund Remedy Selection (EPA/540/R-97-013, August 1997). C Land Use in the CERCLA Remedy Selection Process (EPA OSWER Directive No. 9355.7-04, May 1995); and C Contaminated Sediment Strategy (EPA/823/R-98-001, April 1998).
STATE	C NYS Division of Fish, Wildlife and Marine Resources, Technical Guidance for Screening Contaminated Sediments, January 1999; C Guidelines for Remedial Investigations and Feasibility Studies (TAGM #HWR 4025); C Selection of Remedial Actions at Inactive Hazardous Waste Sites (TAGM #HWR 4030); C Determination of Soil Cleanup Objectives and Cleanup Levels (TAGM #HWR 4046). This TAGM provides a basis and procedure to determine soil cleanup levels at State Superfund sites, when the Director of the Division of Hazardous Waste Remediation (DHWR) determines that cleanup of a site to predisposal conditions is not possible or feasible. C NYSDEC Spill Technology an Remediation Series, STARS Memo #1; C New York State Analytical Detectability for Toxic Pollutants; C New York State Toxicity Testing for the SPDES Permit Program (TOGS 1.3.2); C New York State Regional Authorization for Temporary Discharges (TOGS 1.6.1); C Air Guide 1 – Guidelines for the Control of Toxic Ambient Air Contaminants, 2000' C Ambient Water Quality Standards and Guidance Values (TOGS 1.1.1) C Industrial SPDES Permit Drafting Strategy for Surface Waters (TOGS 1.2.1); C Technical Guidance for Regulating and Permitting Air Emissions from Air Strippers, Soil Vapor Extraction Systems and Cold-Mix Asphalt Units (Air Guide 29); C Waste Assimilative Capacity Analysis and Allocation for Setting Water Quality Based Effluent Limits (TOGS 1.3.1). C Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites (TAGM 4031); and C Interim Guidance on Freshwater Navigational Dredging, NYSDEC Division of Water, October 1994.

TABLE 2-1
Remedial Action Objectives and General Response Actions
Former Gastown MGP Site No. 9-15-171

REMEDIAL ACTION OBJECTIVES	
1	Prevent or minimize, to the extent practical, human and environmental exposure to hazardous waste, impacted surface and subsurface soils, groundwater, and non-aqueous liquids (NAPL).
2	Prevent or minimize, to the extent practical, the migration of impacted groundwater from the Site.

GENERAL RESPONSE ACTIONS	
No Action	Required under the NCP and NYSDEC guidance to estblish baseline for evaluation of remedial alternatives.
Monitored Natural Attenuation	Long-term monitoring of groundwater at selected downgradient compliance points used to demonstrate attenuation of dissolved contaminants of concern by natural processes before reaching sensitive receptors. Process may also be enhanced by addition of compounds designed to altetr groundwater chemistry to increase attenuation rates of target compounds.
Institutional Controls	Institutional controls involves land use restrictions, groundwater withdrawal restrictions, and various other ordinances to protect human health by preventing contact with contamination. No technologies are involved, and therefore this general action will not be evaluated in the technology screening process but will be retained and include as a potential remedial alternative either alone and/or in conjunction with other alternatives.
Engineering Controls	Engineering controls involve use of various technologies designed to prevent exposure to contamination by isolating the materials from the surrounding environment generally without removal or treatment of the contaminants. Controls may include capping, hydraulic containment with extraction wells or grout barriers, point-of-entry systems, air cleaners, etc. Some engineering controls (such as hydraulic containment) may require that treatment technologies be employed.
In-situ Treatment	Various in-situ treatment technologies exist for the reduction and/or elimination of contamination from soils and/or groundwater without removing the impacted media. Most of these technologies involve the injection of chemical or biological reactive agents designed to reduce residual concentrations by interacting directly and /or indirectly with the contaminants of concern.

TABLE 2-1
Remedial Action Objectives and General Response Actions
Former Gastown MGP Site No. 9-15-171

Removal, treatment, and/or disposal of impacted media.	Direct removal of contaminated media may be accomplished through the application of various proven technologies. Treatment and disposal technologies will consider both on-site and off-site options.

Table 2-2
Summary of Remedial Technologies, Affected Media, and General Process Options
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Effected Media	General Process Options
Monitored Natural Attenuation	Long-Term Monitoring	GW	Environmental Media Sampling (groundwater, soil gas, soil)
Institutional Controls	Access Restrictions	Soil	Land Use/Deed Restrictions
		Soil	Physical barriers (fencing)
		Soil and GW	Business or Residence Relocation
		Soil and GW	Resource Usage Restrictions
Engineering Controls	Containment	GW	Grout Barriers/Slurry Walls
		GW	Hydraulic Containment
		Soil and GW	Capping
In-situ Treatment	Biological	GW	Enhanced Bioremediation
		Soil	Phytoremediation
		Soil and GW	Bioventing
	Chemical	GW	Permeable Reactive Barrier Wall
		Soil	Solidification/Stabilization
		Soil and GW	Chemical Oxidation
	Physical	Soil	Thermal Treatment
		Soil	In-situ Thermal Desportiopn (ISTD)
		Soil	Vitrification
		Soil and GW	Electrokinetic Separation
		Soil and GW	Flushing
Removal, treatment, and/or disposal of impacted media.	Removal	GW	Air Sparging/In Well Air Stripping
		GW	GW Extraction (Wells/Trenches/Directional Wells)
		GW	Permeable Passive/Reactive Treatment Walls
		Soil	Vapor Extraction
		Soil	Excavation
		Soil and GW	Dual Phase Extraction
	Ex-Situ Treatment	Groundwater (assumes collection or removal)	Advanced Oxidation Processes
			Air Stripping
			Adsorption/Absorption (Granulated Activated Carbon)
			Ion Exchange
			Separation
			Sprinkler Irrigation
		Soil and Waste (assumes excavation)	Landfarming (Treatment Cells)
			Biopiles Bioreactor
			Solidification/Stabilization
			Soil Washing
			Chemical (Solvent) Extraction/Supercritical Extraction
			High Temperatue Thermal
			Low Temperature Thermal Supercritical CO2 Fluid Extraction
			Co-Burning
			Cold-Mix Asphalt Batching
			Hot-Mix Asphalt Batching
		Soil Gas and Treatment of Generated Vapor	High Energy Destruction
			Biofiltration
			Membrane Separation
			Vapor Phase Oxidation
			Scrubbers
			Vapor Phase Carbon Adsorption
	Dispsoal	Treated GW	Direct (permitted) Surface Discharge
		Treated GW	Shallow reinjection
		NAPL and GW	Deep Well Injection
		All	On-Site Disposal
		All	Off-site dispsoal

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
No Action	**Non-technology Based**	**Not Applicable**	No Action assumes that no remedial activities will be conducted. Evaluation is required under the NPL to establish the baseline for screening remedial alternatives.	No Action conditions will be evaluated.	**Y**
Monitored Natural Attenuation	**Monitoring**	**Environmental Sampling**	Routine sampling of groundwater for contaminants of concern, breakdown products, and water quality parameters to monitor natural attenuation of dissolved phase plume on-site and at downgradient compliance points.	The presense of MGP waste-related NAPL at the site provides a continuous source of contaminantion to groundwater, therefore natural attenuation of dissolved phase contaminants cannot be expected to occur within a measurable or predictable time frame. Long-term monitoring would be useful for evaluting potential changes in site conditions, but MNA cannot be considered an effective remedy for the site.	**N**
Institutional Controls	**Access Restrictions**	**Land Use/Deed Restrictions and/or Notification**	Municipal Land usage and/or deed restrictions or notification used to limit on-site activities and future property development.	Used in conjunction with other response actions and technologies or a sole remedy under appropriate site-specific conditions.	**Y**
		Physical Barriers	Fencing and hazard warnings used to prevent direct exposure to soils by restricting physical access to site.	Used separately or in conjunction with other technologies. May be necessary for site security under certain remedial options.	**Y**
		Business or Residence Relocation	Businesses and/or residences are financially motivated to relocate or property is obtained through eminent domain.	Used to in conjunction with remedial technologies requiring full access to subsurface contamination (i.e., excavation). Relocation of residences would be considered a last resort.	**Y**
		Resource Usage Restrictions	Municipal restrictions imposed on future area groundwater usage.	Used in conjunction with other response actions and technologies or a sole remedy under appropriate site-specific conditions.	**Y**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
Engineering Controls	**Containment**	**Grout/Slurry or Pile Walls**	Barrier wall consisting of injected grouting material, or excavation and installation of impermeable slurry wall, or driven sheet piles used to isolate waste mass and prevent lateral movement of liquid waste and groundwater.	May be useful for isolating source areas preventing shallow groundwater from flowing through the waste mass and limiting mobility of NAPL.	**Y**
		Hydraulic Containment	Groundwater withdrawn from a series of withdrawal points (wells, trenches, drains, etc.) with overlapping piezometric cones of depression to prevent escape of contaminants from area of concern.	May require treatment and discharge/disposal of groundwater. Requires long-term operation to remain effective.	**Y**
		Capping	Impermeable barrier layer installed at (or near) surface to prevent direct exposure to waste and/or impacted soils and escape of volatilized contaminants. Also, limits additional groundwater contamination by reducing amount of water flowing through contamination above water table.	Generally used to prevent direct contact with impacted media and dissolution of contaminants through infiltration of precipitation. May be useful in conjunction with other technologies such as product recovery collection systems. Requires deed restrictions and access controls and may require long-term maintenance to remain effective.	**Y**
In-situ Treatment	**Biological Processes**	**Enhanced Bioremediation**	Enhanced bioremediation is a process in which indigenous or inoculated micro-organisms (e.g., fungi, bacteria, and other microbes) degrade (metabolize) organic contaminants found in soil and/or ground water, converting them to innocuous end products.	Nutrients, oxygen, or other amendments may be used to enhance bioremediation and contaminant desorption from subsurface materials. Nutrient and substrate injection is a proven technology for dehalogenating chlorinated hydrocarbons. Inefficient and/or ineffective in the presence of free product. May be useful as secondary "polishing" treatment after source removal.	**Y**
		Phyto-remediation	Use of plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. The mechanisms of phytoremediation include enhanced rhizosphere biodegradation, phyto-extraction (also called phyto-accumulation), phyto-degradation, and phyto-stabilization.	Primarily used for binding heavy metals in near surface environment. Limited application with VOCs in soils but ineffective with free product.	**N**

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
In-situ Treatment (cont)	Biological Processes (cont)	**Bioventing**	Oxygen is delivered to contaminated unsaturated soils by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation. Bioventing stimulates the natural in situ biodegradation of any aerobically degradable compounds in soil by providing oxygen to existing soil microorganisms.	Bioventing techniques have been successfully used to remediate soils contaminated by petroleum hydrocarbons, nonchlorinated solvents, some pesticides, wood preservatives, and other organic chemicals. Inefficient or ineffective in the presence of free product. May be useful as secondary "polishing" treatment after source removal.	**Y**
	Chemical Processes	**Permable Reactive Barrier Wall**	Passive in-situ remediation which relies on the natural flow of groundwater through a permeable barrier designed to bind or neutralize the dissolved or particulate contaminants.	Potentially effective for site contaminants.	**Y**
		Solidification /Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Primarily a soil-based technology used to contain inorganic compounds. Limited effectiveness with PCBs, SVOCs, and ineffectvie with VOCs.	**Y**
		Chemical Oxidation	Direct injection of oxidation agents chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, chlorine dioxide and permanganate.	Very useful for rapid elimination of NAPL. Subsurface materials must be sufficiently permeable to allow complete distribution of oxidation agents to all repositories of NAPL or "rebound" effects are likely.	**Y**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
In-situ Treatment (cont)	Physical Processes	**Thermal Treatment**	Heat, in the form of steam or hot gas is forced into an aquifer through injection wells to vaporize volatile and semivolatile contaminants. Volitilized gasses are extracted from the injection wells and/or through a vapor recovery system and treated prior to discharge to the air.	Vaporized components removed by vacuum extraction and then treated. Hot water or steam-based techniques include Steam Injection and Vacuum Extraction (SIVE), In-Situ Steam-Enhanced Extraction (ISEE), and Steam-Enhanced Recovery Process (SERP).	**Y**
		In-situ Thermal Desorption (ISTD)	A system or array of surface and /or in-well heaters or electrodes combined with vacuum wells to heat contaminated soils and extract the resulting vaporized/volatilized fluids and contaminants.	Requires gas/vapor collection and treatment system. Not efficient for areas with significant quantities of NAPL.	**Y**
		Vitrification	Specialized physical process form of solidification. Electrical current used to melt soils at high temperatures, destroying organic contaminants by pyrolysis and imobilizing inorganics in soildified crystalline mass (glass).	Effective for rapid elimination of organics in shallow environments and containment/solidifcation of solid/inorganic materials. Requires gas/vapor collection and treatment system.	**Y**
		Electrokinetic Separation	The Electrokinetic Remediation (ER) process removes metals and organic contaminants from low permeability soil, mud, sludge, and marine dredging. ER uses electrochemical and electrokinetic processes to desorb, and then remove, metals and polar organics. This in situ soil processing technology is primarily a separation and removal technique for extracting contaminants from soils.	Process ineffectve with non-polar organics. Site soils are not consistently low permeability. Not useful given site-specific conditions.	**N**
		Soil Flushing	Flushing is the extraction of contaminants with water or other suitable aqueous solutions. Flushing is accomplished by passing the extraction fluid through the aquifer with an injection or infiltration and recollection process. Cosolvents are generally used to enhance the solubility of sequestered residual free products. Flushing requires substantial in-place control technologies to prevent escape of flushing solution. Extraction fluids must be recovered from the aquifer and, when possible, they are recycled.	Applicable to site contaminants. Requires other processes including hydraulic or physical containment and/or treatment of the flushing fluids. Subsurface materials must be sufficiently permeable to allow complete flushing of soils containing NAPL or "rebound" effects are likely (residual NAPL mobilizes to flushed areas and provides a continued source of groundwater contamination). The characteristics of the primary unit containing NAPL (fine sand interlayered with silty clay) are not conducive to even distribution of flushing water.	**N**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
Removal of impacted media	Removal Processes	**Air Sparging**	Air is injected into saturated matrices to remove contaminants through volatilization. Vapors are collected and treated through a vapor extraction system.	Primarily used for groundwater remediation of VOCs. Not applicable to PAHs or DNAPL wastes.	**N**
		In-Well Air Stripping	Air injected into a double screened well, lifts water and forces it out the upper screen. Simultaneously, additional water is drawn in the lower screen. VOCs in the contaminated groundwater are transferred from the dissolved phase to the vapor phase by air bubbles. Generated vapors are drawn off and treated by a vapor extraction system.	Primarily used for groundwater remediation of VOCs. Not applicable to PAHs or DNAPL wastes. Also not effective for thin, low permeability aquifers.	**N**
		Directional Wells	Drilling techniques are used to position wells horizontally, or at an angle (off-vertical) , to reach contaminants not accessible by direct vertical drilling.	Used to reach areas that are otherwise inaccessible due to structures, physical or legal boundaries, or other access restrictions. Specifically applicable to areas under the railroad located adjacent to the site.	**Y**
		Interceptor Trench(es)	Excavation and installation of trench drains may be used to intercept migrating product or dissolved phase plume, create hydrologic barrier,and/or used for reinjection of treated groundwater.	Very useful and cost efficient method for recovering product from shallow and/or tight soils as present at the Site.	**Y**
		Groundwater Pumping/ Pump&Treat	Groundwater is removed from aquifer and treated prior to reinjection or discharge.	Primarily used to capture impacted groundwater, depress water table within the waste mass to prevent dissolution of waste, and/or to prevent migration of the plume to sensitive receptors.	**Y**
		Vapor Extraction	Soil vapor extraction (SVE) is an in situ unsaturated (vadose) zone soil remediation technology in which a vacuum is applied to the soil to induce the controlled flow of air and remove volatile and some semivolatile contaminants from the soil. The gas leaving the soil may be treated to recover or destroy the contaminants.	Proven technology for removal of soil gas. May also be used in conjunction with other technologies (hot-air, steam injection, etc) to strip volatiles from groundwater. No effect on solid or inorganic wastes.	**Y**
		Excavation	Excavation of waste mass(es) and impacted soils to remove impacted zone(s) and facilitate free-product and impacted groundwater recovery. Used in conjunction with ex-situ treatment and/or disposal options.	Simplest and generally most effective means of removing shallow contamination. Incomplete technology, requires conjunctive supporting technologies such as product recovery, ex-situ remediation, and/or disposal.	**Y**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
Removal of impacted media (cont)	**Removal Processes (cont)**	**Dual-Phase Extraction**	Dual-phase extraction (DPE) uses a high vacuum system to remove various combinations of contaminated ground water, separate-phase product, and vapor from the subsurface. Extracted liquids and/or vapors are treated and collected for disposal, or re-injected to the subsurface (where permissible under applicable state laws).	DPE, also known as multi-phase extraction, vacuum-enhanced extraction, or sometimes bioslurping is applicable. Free-phase product (DNAPL) has been successfully extracted at the site. Dual-phase extraction of water and NAPL from wells or an extraction trench may be applicable.	**Y**
Treatment of impacted media (continued)	**Ex-Situ Treatment (assumes collection or removal) Groundwater**	**Advanced Oxidation Processes**	Advanced Oxidation Processes including ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off gases from the treatment tank and downstream units where ozone gas may collect, or escape.	Common component of groundwater pump and treat remedial systems which may be considered for use with groundwater or dual-phase extraction systems.	**Y**
		Air Stripping	Volatile organics are partitioned from extracted ground water by increasing the surface area of the contaminated water exposed to air. Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.	Common component of groundwater pump and treat remedial systems which may be considered for use with groundwater or dual-phase extraction systems.	**Y**
		Adsorption/ Absorbtion	Groundwater is passed through a filtering system composed of an adsorptive material that removes dissolved phase contaminants from the water. The most common adsorbent is granulated activated carbon (GAC). Other natural and synthetic adsorbents include: activated alumina, forage sponge, lignin adsorption, sorption clays, and synthetic resins.	Common component of groundwater pump and treat remedial systems which may be considered for use with groundwater or dual-phase extraction systems.	**Y**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
Treatment of impacted media (continued)	**Ex-Situ Treatment (assumes collection or removal) Groundwater**	**Ion Exchange**	Ion exchange removes ions from the aqueous phase by the exchange of cations or anions between the contaminants and the exchange medium. Ion exchange materials may consist of resins made from synthetic organic materials that contain ionic functional groups to which exchangeable ions are attached. They also may be inorganic and natural polymeric materials. After the resin capacity has been exhausted, resins can be regenerated for re-use.	Case studies indicate technology is not successful with dissolved or gaseous halogenated hydrocarbons. Limited field applications, considered experimental.	**N**
		Separation	Separation processes seek to detach contaminants from their medium (i.e., ground water and/or binding material that contain them). Ex situ separation of waste stream can be performed by many processes: (1) distillation, (2) filtration/ultrafiltration/microfiltration, (3) freeze crystallization, (4) membrane pervaporation and (5) reverse osmosis.	The ex-situ separation process is used mainly as a pretreatment or post-treatment process to remove contaminants from waste water. The target contaminant groups for ex-situ separation processes are VOCs, SVOCs, pesticides, and suspended particles. Dual-phase extraction would require separation as part of the treatment process.	**Y**
		Sprinkler Irrigation	Sprinkler irrigation is a relatively simple treatment technology used to volatilize VOCs from contaminated wastewater. The process involves the pressurized distribution of VOC-laden water through a standard sprinkler irrigation system. Sprinkler irrigation transfers VOCs from the dissolved aqueous phase to the vapor phase, whereby the VOCs are released directly to the atmosphere.	Relatively new technology. No applicable for PAHs. Requires large tracts of areable land to be effective. May also be considered a disposal technology.	**N**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
Treatment of impacted media (continued)	Ex-Situ Treatment (assumes excvation of waste and soils)	**Landfarming (Treatment Cells)**	Landfarming is a full-scale bioremediation technology, which usually incorporates liners and other methods to control leaching of contaminants, which requires excavation and placement of contaminated soils, sediments, or sludges. Contaminated media is applied into lined beds and periodically turned over or tilled to aerate the waste.	Ex-situ landfarming has been proven most successful in treating petroleum hydrocarbons. Because lighter, more volatile hydrocarbons such as gasoline are treated very successfully by processes that use their volatility (i.e., soi vapor extraction), the use of above ground bioremediation is usually limited to heavier hydrocarbons. As a rule of thumb, the higher the molecular weight (and the more rings with a PAH), the slower the degradation rate. The difficulty in treating recalcitrant PAHs such as anthracene and chrysene, and the lack of available space at the site reduces the viability of this technology.	**N**
		Biopiles	Biopile treatment is a variation of composting in which excavated soils are usually mixed with soil admendments and placed in piles on a treatment area. Biopiles often include leachate collection systems and some form of aeration. In most cases, indigenous microganisms are used. Soil admendments may include nutrients, moisture, or bulking agents such as woods chips	Biopiles would not likely be effective for source area soils because of the presence of NAPL. The recalcitrent PAHs (4, 5, and 6 compounds) are difficult to bioremediate so treatment might be incomplete. Fringe soils are not amenable to excavation so ex-situ treatment is not applicable.	**N**
		Bioreactor	Destruction of organic compounds in contaminated soils by microorganisms. Treatment occurs in an enclosed reactor vessel	Not effective for higher molecular weight-hydrocarbons	**N**
		Solidification/ Stabilization	Similar to in-situ process except soils/waste are removed processed into solidified/stabilized (S/S) mass. After processing wastes are encapsualted on-site or removed for off-site disposal. Process frequently used to minimize risks associated with off-site transport of waste materials.	The target contaminant group for ex-situ S/S is inorganics. Most S/S technologies have limited effectiveness with organics and pesticides, especially with NAPL present, except vitrification which destroys most organic contaminants and quicklime which can treat and stabilize PAH contaminated soils.	**Y**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
		Soil Washing	Contaminants sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.	The target contaminant groups for soil washing are SVOCs, fuels, and heavy metals. The technology can be used on selected VOCs and pesticides. Not effective on fine-grained soils or DNAPLs.	**N**
Treatment of impacted media (continued)	**Ex-Situ Treatment (assumes excavation of waste and soils (continued)**	**Chemical (Solvent) Extraction**	Waste contaminated soil and extractant are mixed in an extractor, thereby dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for treatment and further use.	Solvent extraction has been shown to be effective in treating sediments, sludges, and soils containing primarily organic contaminants such as PCBs, VOCs, halogenated solvents, and petroleum wastes. Acid extraction is suitable to treat sediments, sludges, and soils contaminated by heavy metals. Combined process train could eliminate all of the COCs but no small, portable chemical extraction systems are known to be available and construction of an on-site system would not be cost-effective for the quantity of soil requiring treatment.	**N**
		High Temperature Thermal Treatment	High temperatures, 870-1,200 °C (1,600- 2,200 °F), are used to combust (in the presence of oxygen) organic constituents in hazardous wastes. Waste and impacted soils incinerated on or off-site to destroy organic/combustible COC's including VOCs, SVOCs, PCBs, chlorinated solvents, and pesticides. Processess included fluidized beds, rotary kilns, circulating bed combusters, and/or infrared combustion chambers.	Generates potentially hazardous bottom ash, concentrated heavy metals, requires off-gas treatment, and may produce other hazardous substances. Often difficult to get a permit.	**Y**
		Low Temperature Thermal Treatment	Wastes heated to 90-320 ºC to VOCs without destroying them. Volatile vapor stream generally treated with high temperature catalytic thermal oxidizers or GAC prior to discharge.	Does not significantly alter the nature of impacted media accept with respect to removal of organics.	**Y**
		Supercritical CO2 Fluid Extraction	Similar to solvent extraction, the liquid or supercritical fluid transports the contaminant out of the matrix.	Technology is likely to be effective but it is not readily available in the marketplace.	**N**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
		Co-Burning	Combustion of MGP residues such as coal tar and tar-contaminated soil alongs with coal in utility boilers and cement kilns.	Co-burning increases the amount of ash requiring management. For example, a 10 percent co-burning mixture doubles the amount of ash generated by a boiler.	**N**

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
Treatment of impacted media (continued)	Ex-Situ Treatment (assumes excvation) of Waste and Soils (continued)	Cold-Mix Asphalt Batching	Encapsulation of contaminents by blending residues, wet aggregate and ashalt emulsion at ambient temperature. The product is used as pavement.	Not viable for fine-grained materials (e.g., clays)	N
		Hot-Mix Asphalt Batching	Encapsulation of contaminents by blending residues, wet aggregate and ashalt emulsion at high temperature. The product is used as pavement.	Not viable for fine-grained materials (e.g., clays)	N
Treatment of impacted media (continued)	Ex-Situ Treatment (of gaseous phase)	High Energy Destruction	The high energy destruction process uses high-voltage electricity to destroy VOCs at room temperature.	Experimental technology, not portable to field at this time.	N
		Biofiltration	Vapor-phase organic contaminants are pumped through a soil bed and sorb to the soil surface where they are degraded by microorganisms in the soil.	Proven technology for VOC and SVOCs. Ineffective with halogenated compounds and inorganics.	Y
		Membrane Separation	A high pressure membrane separation system has been designed by DOE to treat feedstreams that contain dilute concentrations of VOCs. The organic vapor/air separation technology involves the preferential transport of organic vapors through a nonporous gas separation membrane (a diffusion process analogous to pumping saline water through a reverse osmosis membrane).	Experimental technology, not portable to field at this time.	N
		Vapor Phase Oxidation	Organic contaminants are destroyed in a high temperature 1,000°C (1,832 °F) combustor. Trace organics in contaminated air streams are destroyed at lower temperatures, 450 °C (842 °F), than conventional combustion by passing the mixture through a catalyst.	Effective and advantageous for vapor streams with high levels of contaminants (that would otherwise quickly load carbon canisters).	Y
		Scrubbers	Scrubber is an air washer with refinement device which is used for cleaning gases from soluble or particulates.	Generally a fixed emplacement technology used on an industrial scale. Limited field applications, emerging technology for temporary site uses.	N
		Vapor Phase Carbon Adsorption	Vapor-phase organic contaminants are pumped through a series of GAC tanks where VOCs are sorbed to the carbon.	Common component of groundwater pump and treat remedial system and or vapor phase treatment systems	Y

Table 2-3
Preliminary Remedial Technologies Screening
Former Gastown MGP Site No. 9-15-171

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments	Retain
Disposal	Disposal	**Direct (Permitted) Discharge of treated water and/or vapor.**	Treated media is discharged directly to the ground, air, sewer system, or surface water body. Discharge receptors affect permit requirements.	Common component of groundwater pump and treat remedial system and/or vapor phase treatment systems.	**Y**
		Shallow Reinjection	Treated groundwater reinjected into aquifer, usually upgradient of affected area to create cyclic loop, and/or a hydraulic barrier. Similar to in-situ soil-flushing. Enhancements may be mixed with reinjected groundwater to increase dissolution of contaminants and facilitate recovery.	Commonly used in shallow water table and soil aquifers with confining semi-impermeable basal unit. May significantly alter hydrologic regime.	**Y**
		Deep Well Injection	Treated (and potentially untreated) groundwater and/or liquid wastes injected into deep confined strata.	Concentrated hazardous liquids injected into deep (>1000 ft) litholgic structures (such as salt domes).	**N**
		On-site disposal	Treated and/or untreated wastes and/or media disposed of in a properly constructed on-site permitted containment cell(s).	Consolidation and on-site containment may be used when quantities and/or risks associated with disturbing the wastes are sufficient to justify this option. Requires land use and access restriction and long-term maintenance to remain effective.	**Y**
		Off-site disposal	Treated and/or untreated wastes and/or impacted media transported off-site to permitted disposal facility .	Generally most cost-effective means of disposing of limited quantities of hazardous solid wastes. Commonly used for small quantities of removed groundwater in place of on-site treatment plant. Not cost effective or practical for use with pumping systems withdrawing substantial quantities of water for long durations.	**Y**

TABLE 3-1
SUMMARY OF REMEDIAL ALTERNATIVES
Former Gastown MGP Site

Alternative	Major Elements of Alternative
Alternatives that do not require movement of businesses occupying site	
1	No Action
2	Long-Term Monitoring with Institutional Controls • Institutional controls (limiting subsurface excavation, use of site groundwater) • Long-term monitoring
3	NAPL/Groundwater Collection and Treatment • Install collection trench or wells at main source area • Install collection trench east of railroad line and on east side of East Street • Install impermeable barrier wall on creek side of plume adjacent to East Niagara Street, • Construct long-term treatment facility for removed water/NAPL • Discharge treated water to stream • Remove and dispose of impacted sediment • Install sub-slab depressurization systems in nearby residential homes and buildings • Long-term monitoring and institutional controls
4	In-Situ Thermal/Biological Treatment • Install groundwater collection wells/trenches to lower water table • Install system of heating elements and SVE extraction wells • Construct an on-site water/vapor treatment system, discharge water to stream • Construct a temporary cap, as necessary, to control release of soil vapors • Address residual contaminants with enhanced bioremediation and long-term monitoring • Remove and dispose of impacted sediment • Install sub-slab depressurization systems in nearby residential homes and buildings
5	Partial Removal, Partial Containment and In-situ Treatment • Remove maximum possible extent of NAPL plume without significant disturbance of current buildings; off site disposal or treatment • Demolish portions of building and reconstruct subsequent to removal of contaminated soil; house affected businesses in temporary site trailers • Backfill excavation with clean, low permeability, imported soils • Contain residual contaminants east of the rail line within an impermeable wall and cap • Control residual contaminants west of rail line and east of Sportman's Club with barrier wall and NAPL collection system. • In-situ chemical treatment of unexcavated contaminated soils • Remove and dispose of impacted sediments • Install sub-slab depressurization systems in nearby residential homes and buildings
6	Full Isolation and Containment • Install impermeable barrier wall around perimeter of site, around any accessible area between East Street and railroad line; and around plume east of the site • Install low permeability cap over each contained area (tie into barrier walls) • Install pumping wells inside containment cell to maintain inward gradient • Construct long-term treatment facility for removed water/NAPL • Discharge treated water to stream • Remove and dispose of impacted sediments • Install sub-slab depressurization systems in nearby residential homes and buildings • Long-term monitoring; Institutional controls

TABLE 3-1
SUMMARY OF REMEDIAL ALTERNATIVES
Former Gastown MGP Site

Alternatives that require movement of businesses occupying site	
7	Full Removal • Relocate site businesses; demolish site buildings • Remove majority of NAPL plume; off site disposal or treatment • Backfill with clean, imported soils • Remove and dispose of impacted sediment • Install sub-slab depressurization systems in nearby residential homes and buildings • Long-term monitoring; Institutional controls
8	Partial Removal and In-Situ Solidification • Move site businesses; demolish buildings • Remove thickest portions of NAPL plume; off site disposal or treatment • Solidify remaining plume in situ • Backfill with clean, imported soils • Remove and dispose of impacted sediment. • Install sub-slab depressurization systems in nearby residential homes and buildings • Short-term monitoring to confirm no further potential impacts

Odor Suppression System Estimates

Partial Excavaton Alternative

Installation	Relocations	Relocation Costs	Structure Square Footage	Fabric purchase - Cost per SF	Fabric purchase cost	Framework rental per month	Months to Rent	Total rental	Air Handling System
$ 50,000	0	$ -	15,000	$ 12	$ 180,000	$ 1,000	4	4,000	$ 150,000

Total	$ 384,000
Total (less air handling)	$ 234,000

Total Excavation Alternative

Assumes reinstalling structure three times to cover entire removal area.

Installation	Relocations	Relocation Costs	Structure Square Footage	Fabric purchase - Cost per SF	Fabric purchase cost	Framework rental per month	Months to Rent	Total rental	Air Handling System
$ 50,000	4	$ 200,000	15,000	$ 12	$ 180,000	$ 1,000	4	$ 4,000	$ 150,000

Total	$ 584,000
Total (less air handling)	$ 434,000

Gastown Ozone Treatment Calculations

Treatment area	Total Number of injection points	Cost per point	Total costs for injection points	Number of Ozone Units	Cost per unit	Unit Manifolding	Total Costs to purchase units	Unit Rental Costs	Total Costs to rent units	Operating time (mos.)	Electricity unit costs per unit per month	Total electricity per unit
1	11	$ 1,500.00	$ 16,500	1	$ 25,000	$ 12,000	$ 25,000	$ 5,000	$ 180,000	36	$ 630	$ 22,680
2	11	$ 1,500.00	$ 16,500	1	$ 25,000	$ 12,000	$ 25,000	$ 5,000	$ 180,000	36	$ 630	$ 22,680
3	10	$ 1,500.00	$ 15,000	1	$ 25,000	$ 12,000	$ 25,000	$ 5,000	$ 180,000	36	$ 630	$ 22,680
4	10	$ 1,500.00	$ 15,000	1	$ 25,000	$ 12,000	$ 25,000	$ 5,000	$ 180,000	36	$ 630	$ 22,680
5	13	$ 1,500.00	$ 19,500	1	$ 25,000	$ 12,000	$ 25,000	$ 5,000	$ 180,000	36	$ 630	$ 22,680
6	14	$ 1,500.00	$ 21,000	2	$ 25,000	$ 24,000	$ 50,000	$ 5,000	$ 360,000	36	$ 630	$ 45,360
7	10	$ 1,500.00	$ 15,000	1	$ 25,000	$ 12,000	$ 25,000	$ 5,000	$ 180,000	36	$ 630	$ 22,680
8	10	$ 1,500.00	$ 15,000	1	$ 25,000	$ 12,000	$ 25,000	$ 5,000	$ 180,000	36	$ 630	$ 22,680
9	9	$ 1,500.00	$ 13,500	1	$ 25,000	$ 12,000	$ 25,000	$ 5,000	$ 180,000	36	$ 630	$ 22,680
10	15	$ 1,500.00	$ 22,500	2	$ 25,000	$ 24,000	$ 50,000	$ 5,000	$ 360,000	36	$ 630	$ 45,360
Totals	113		$ 169,500	12		$ 144,000	$ 300,000		$ 2,160,000	36		$ 272,160

Alternative Total (purchase)	$ 885,660
Alternative Total (rental)	$ 2,745,660
Annual electricty costs	$ 90,720

Injection points are estimated with single depth installations.
Each ozone unit will supply approximately 10 injection points

Tenant Relocation

Tenant SF	Number of tenants	Moving Costs per SF	Total moving costs	Number of tenants	New Lease Costs per month SF	Months	Total new lease costs	Total move and lease
2,000	1	$ 10.00	$ 20,000	1	$ 4.00	6	$ 48,000	$ 68,000
2,000	5	$ 10.00	$ 100,000	5	$ 4.00	6	$ 240,000	$ 340,000

Moving cost estimate from CMH eng. Est.
Monthly lease rate from Remax Commercial

Table 4-1
Remedial Action Alternatives-Cost Estimate Summary
Gastown Former MGP Site-Feasibility Study

Item	Item Description	Alt 1 No Action	Alt 2 Long Term Monitoring with Institutional Controls	Alt 3 NAPL / Groundwater Collection and Treatment	Alt 4 In-Situ Thermal / Biological Treatment	Alt 5 Partial Removal, Containment and In-Situ Treatment	Alt 6 Full Isolation and Containment	Alt 7 Removal	Alt 8 Partial Removal and In-Situ Solidification
	CAPITAL COSTS								
	Site Preparation	$ -	$ 20,000	$ 108,000	$ 135,000	$ 561,000	$ 131,000	$ 1,137,000	$ 885,000
	Isolation and Containment	$ -	-	$ 348,000	$ 1,076,000	$ 637,000.00	$ 1,919,000	$ -	
	Groundwater and NAPL Removal and Treatment	$ -	$ -	$ 118,000	$ 89,000	$ 254,000	$ 174,000	$ 149,000	$ 147,000
	Soil Removal and Treatment	$ -	$ -	$ 100,000	$ 9,805,000	$ 4,251,000	$ -	$ 8,215,000	$ 7,724,000
	Sediment removal and disposal	$ -	$ -	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00	$ 300,000.00
	Transport and Off-Site Disposal (assume 10% markup on disposal costs)	$ -	$ -	$ -	$ 2,000	$ 121,000	$ -	$ -	
	Groundwater Monitoring Well Installations				$ -	$ -	$ -	$ -	
	YEAR 1 Groundwater monitoring (MONTHLY)			$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000
	Site Restoration	$ -	$ -	$ 10,000	$ 100,000	$ 10,000	$ 15,000	$ 15,000	$ 15,000
	Subtotal Capital Costs	**$ -**	**$ 20,000**	**$ 1,044,000**	**$ 11,567,000**	**$ 6,194,000**	**$ 2,599,000**	**$ 9,876,000**	**$ 9,131,000**
	Engineering (20% construction costs less treatment or disposal costs)	$ -	-	$ 203,000	$ 2,313,000	$ 388,600	$ 509,600.00	$ 272,000.00	$ 1,001,000.00
	Contingency (20% construction costs)	$ -	$ 4,000	$ 209,000	$ 2,313,000	$ 1,238,800	$ 519,800.00	$ 1,975,200.00	$ 1,826,200.00
	TOTAL CAPITAL COSTS	**$0**	**$24,000**	**$1,456,000**	**$16,193,000**	**$7,821,400**	**$3,628,400**	**$12,123,200**	**$11,958,200**
	ANNUAL O&M COSTS (Long-term)								
	Annual Operation and Maintenance	$ -	$ 10,000	$ 89,000	$ 60,000	$ 114,458	$ 114,458.00	$ 10,000.00	$ 114,458.00
	Annual Long-Term Monitoring	$ -	$ 60,000	$ 25,000	$ 25,000	$ 25,000	$ 60,000.00	$ 25,000.00	$ 25,000.00
	Five-Year Review (annualized average cost)	$ -	$ 4,000	$ 4,000	$ 4,000	$ 4,000	$ 4,000.00	$ 4,000.00	$ 4,000.00
	Subtotal Annual O&M Costs	**$ -**	**$ 74,000**	**$ 118,000**	**$ 89,000**	**$ 143,458**	**$ 178,458**	**$ 39,000**	**$ 143,458**
	Present Worth O&M Costs (5% discount Rate -30yr A-2,3,6; 5yr A-4,5,7,8)	**$ -**	**$ 1,138,000**	**$ 2,205,000**	**$ 385,400**	**$ 621,200**	**$ 2,743,300.00**	**$ 168,900.00**	**$ 2,205,300.00**
	OTHER COSTS (short-term O&M and Closeout)								
	Site Closeout	-	-	-	$ 30,647	$ 30,647		$ 30,647.00	
	Total Other Costs	**$ -**	**$ -**	**$ -**	**$ 31,000**	**$ 31,000**	**$ -**	**$ 31,000**	**$ -**
	TOTAL PRESENT WORTH OF COST TO IMPLEMENT ALTERNATIVE								
	Total Capital Costs	$ -	$24,000	$1,456,000	$16,193,000	$ 7,821,400	$ 3,628,400	$ 12,123,200	$ 11,958,200
	Total Present Worth O&M Costs	$ -	$ 1,138,000	$ 2,205,000	$ 385,400	$ 621,200	$ 2,743,300	$ 168,900	$ 2,205,300
	Total Other Costs	$ -	$ -	$ -	$ 31,000	$ 31,000	$ -	$ 31,000	$ -
	TOTAL COST	**$ -**	**$1,162,000**	**$ 3,661,000**	**$ 16,609,400**	**$ 8,473,600**	**$ 6,371,700**	**$ 12,323,100**	**$ 14,163,500**

All costs rounded to the nearest $1000

Initial cost estimates prepared utilizing Earth Tech's Proprietary Remedial Action Cost Engineering & Requirements (RACER) Software developed under contract with USAF, vendor quotations and internal engineering estimates.
Unit and technology costs used in RACER based on the RS MEANS Company 2003 ECHOS database (2003 Dollars)
Quantities of materials based limited data collected in the RI concerning vertical and areal extent of debris, waste, and geologic units and assumptions specified in cost estimating work sheets
A Pre-Design investigation required to refine estimated quantities and costs.
Present worth rate of %5 for O&M assumed from NYSDEC guidance range of 3%-10%.
Sensitivity to changes in discount factors does not change ranking order of alternative costs.
Sensitivity to time estimates for required long-term monitoring does not change relative ranking order of alternative costs.