REVISED DRAFT
FOCUSED FEASIBILITY STUDY REPORT
Red Devil Paint Company
(Site No.:3-60-031)
Mount Vernon, New York

Prepared for

New York State Department of Environmental Conservation

Investigation and Design Engineering Services

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Executive Summary

The following Revised Draft Focused Feasibility (FFS) Report is for the impacted area along the Bronx River adjacent to the former Red Devil Paint Company located at 30 Northwest Street in the City of Mt. Vernon in Westchester County was prepared by Camp Dresser & McKee Inc. (CDM) for the New York State Department of Environmental Conservation (NYSDEC). This FFS was developed with the purpose of identifying treatment and remedial technologies that may feasibly remediate the offsite light non-aqueous phase liquid (LNAPL) plume currently discharging into the Bronx River.

Industrial activities occurred on the property for over 80 years; functioning as a bakery between 1908 and 1940, until becoming a paint manufacturing facility in the late forties and early fifties. Operations ceased on the property in 1990, at which time the property began operating as a self storage facility. Self storage operations presently continue onsite by SUSA Mt. Vernon, LLC, the current property owner. As a result of the onsite activities related to the manufacture and distribution of paints and lacquers on the property, contamination of the subsurface beneath the site and extending offsite downgradient of the site occurred. ERM-Northeast (ERM) was hired by Insilco Corporation, a division of Red Devil Paint Company, to conduct a decommissioning program at the property. During the decommissioning activities, a Spill Incident Report was made to NYSDEC when tank releases were found to have impacted soil and groundwater beneath the facility. On June 29, 1992 Red Devil Paint Company was listed on the State Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 Site (No. 360031). In April 1993, an Order of Consent requiring a Remedial Investigation/Feasibility Study (RI/FS) and an Interim Remedial Measures (IRM) program was executed by Insilco Corporation and NYSDEC. In March 1996, a Record of Decision (ROD) that addressed the presence of LNAPL and paint material both on and offsite was issued. However, in April 2003, all remedial operations at the property were stopped as Insilco initiated bankruptcy proceedings. In 2005, SUSA Mt. Vernon, LLC entered into a Brownfields Cleanup Agreement to remediate the onsite portion of the Red Devil site, and hired Legette, Brashers and Graham, Inc. as their environmental consultant. The offsite portion of contamination was referred to the State Superfund Program in 2007.

Several previous environmental activities have occurred both on and offsite consisting of, but not limited to; a Preliminary Investigation and Proposed Phase II Site Investigation in July of 1991 conducted by ERM, a Remedial Investigation in May 1992 conducted by ERM, Interim Remedial Measures in September 1993 conducted by ERM, a Feasibility Study in June 1995 conducted by ERM, a Draft Design Investigation Report in July 1997 conducted by ERM, supplemental reporting consisting of pilot studies and effectiveness monitoring reports between 2001 and 2002 by ERM, and a Remedial Investigation by LBG in March 2009. This FFS is the first environmental activity to focus solely on the offsite contamination and is aimed at eliminating discharge of LNAPL into the Bronx River.

The site is located in Westchester County, Mt. Vernon, New York within an industrially zoned area surrounded by mixed residential and industrial/commercial developments. The former Red Devil facility is a multi-floored building occupying approximately 37,035 square feet. The site is bordered directly to the northwest by the Metro-North Railroad, to the northeast by Oak Street, to the southeast by North West Street and to the southwest by Mount Vernon Street. The portion of the site specifically subject to this Focused Feasibility Study is the area along the Bronx River adjacent to the rail lines, which includes an approximately 380 foot long segment of the shore between the Mt. Vernon Avenue Bridge and the Oak Street Bridge. This portion of the Bronx River is classified as a Class C stream and flows southward discharging into the Long Island Sound, near the head of the East River. This portion of the river is roughly 30 feet wide, 3 to 5 feet deep and is bordered to the northwest by the Bronx River Parkway. The river channel has been stabilized by a vertical concrete wall on the north bank and riprap material and boulders along the south bank. The retaining wall on the north bank and dense vegetation along the south bank physically restrict access to this area. The south bank of the river is approximately 150 feet in length and 20 to 25 feet in width. The south bank is bordered to the southeast by a steep roughly 30 foot embankment, and tapers off toward the northeast as the Oak Street Bridge is approached, further restricting access to this area.

The geology in this offsite portion of the former Red Devil facility consists of brown unconsolidated fine and medium sand with some gravel in the first four to five feet bgs. A significant fill layer was encountered beneath this layer, which consists of heavy cobbles and boulders, and extends roughly 12 feet below ground surface. Below the fill layer is a thinning layer of glacial/alluvial material, consisting of poorly graded gravel, sand and silt. This layer is thin in the direction of the riverbank, and is underlain by bedrock. Bedrock is exposed along the river bed. The main source of groundwater in the area is precipitation. There are no major aquifers in southern Westchester County. All potable water in the area is supplied by a public water system which is derived principally from surface water sources located north of the site. The depth to groundwater varied throughout the site from 13 to 25 feet below ground surface. Overall, groundwater appears to be flowing westward toward the Bronx River.

Previous investigations conducted in the study area led to periodic LNAPL thickness measurements, monitoring, implementation of the boom system in the river and implementation of an offsite product only recovery pumping system. During the ERM Design Investigation, some preliminary LNAPL sampling was conducted. ERM concluded that the samples were primarily composed of gasoline or petroleum distillates, based on odor, and a polymeric material, which was similar to the reference FTIR spectra of alkyd resin. Based on visual similarities of the off-site LNAPL to the less viscous LNAPL observed in Area C on site, ERM determined that the LNAPL only recovery utilized in Area C was the most effective method of removing the offsite LNAPL. However, as discussed in detail below, based on the 2009 CDM offsite LNAPL sampling and analysis, it has been determined that the onsite and offsite LNAPL chemistry differs and therefore the removal approach should be unique to the offsite LNAPL. These differences may have attributed to the failed offsite LNAPL recovery system implemented in 1999.

LNAPL sampling was conducted by CDM in early 2009 in order to characterize the LNAPL both onsite and offsite. On January 20, 2009, 7 wells located onsite were sampled for LNAPL. On April 27, 2009, the 4 delineation wells located offsite were sampled for LNAPL. The recovered LNAPL samples were sent to Inovatia Laboratories, LLC for analysis and characterization. The laboratory reports can be found in **Appendix A**.

The results of the analysis indicated that the LNAPL found onsite consists mainly of weathered mineral spirits that contain the compound toluene 2,4-diisocyanate. It is believed that the toluene 2,4-diisiocyanate reacts at the LNAPL-aqueous phase interface with the alcohols and amines present in the aqueous phase to form polyurethanes, polyureas and polyesters. Toluene 2,4-diisiocyanate will also react with water and most acids to produce unstable carbonic acids, which decarboxylate to yield relatively chemically inert polymeric urea. **Table 3-3** contains the distribution of the major components detected in the on-site LNAPL collected from wells DW-14D, R04D and DW-2C.

The offsite LNAPL exhibits different characteristics than the onsite LNAPL. The offsite LNAPL does not contain toluene 2,4-diisocyanate, but rather is a mixture of weathered mineral spirits and linear polymers (polyurethanes, polyesters and polyureas), with C3 and C4 benzene compounds that may be solvents used in the manufacture of polyurethanes, lacquers, polyesters and polyol-amides. It is believed that the toluene 2,4-diisocyanate in the LNAPL reacts to completion with the alcohols, amines, water and other compounds containing active hydrogen atoms in the aqueous phase as the plume migrates offsite, since no toluene 2,4-diisocyanate was detected offsite.

The higher concentrations of toluene 2,4-diisocyanate participating in the reaction at the site result in a higher degree of reaction and crosslinking during polymer formation at the site. This results in the more viscous material found on site, compared to offsite. The linear polymers seen offsite are likely the result of the decreasing concentration of toluene 2,4-diisocyanate in the LNAPL layer as it travels. The LNAPL seep material that collects in the boom appears to either further react or agglomerate to form a plastic sheet-like material. It is unknown whether the formation of this material in the boom is simply due to the polymers coagulating, or if another mechanism is involved. **Figures 3-2 and 3-3** provide additional understanding of the LNAPL plume as it migrates offsite.

The Remedial Action Objective (RAO) for the offsite portion of the property, based on applicable state and federal standards, criteria and guidance is to prevent LNAPL discharge into the Bronx River, thereby limiting exposure to aquatic life. Preliminary Remedial Goals (PRGs) were not selected for this FFS, as the presence of LNAPL prevents the ability to address the contamination present in the dissolved phase. However, CDM is also conducting a RI/FS concurrently with this FFS which focuses on residual soil, groundwater and sediment contamination in the offsite portion of the property. Separate RAOs and PRGs will be identified as part of that effort.

Based on the established RAO and site conditions, general response actions (GRAs) were identified; consisting of no action, institutional/engineering controls, monitored natural attenuation, containment, removal/extraction, and treatment. Several potential remedial technologies and process options associated with each GRA were identified and screened based on effectiveness, implementability and relative cost. The outcome of the screening of remedial technologies is outlined in the Screening of Remedial Technologies table below. Environmental easements, secant piling, pre-disposal, total fluids recovery (TFR), air lift pumps, hot water flushing, steam injection, in-situ solidification and electrical resistance heating (ERH) were retained for further consideration and combined into Remedial Action Alternatives that would achieve the site specific RAO.

Table E1. Screening of Remedial Technologies

Technology	Effective	Implementable	Relative Cost	Retained
No Action	No	Yes	None	Yes
Institutional/ Engineering Controls				
Environmental Easements	No	Yes	Low capital cost	Yes
Access Restrictions	No	Yes	Low capital cost	No
Monitored Natural Attenuation	No	Yes	Low capital cost	No
Containment				
Slurry/Grout Injection	Yes	No	Moderate to high capital cost	No
Sheet Pile Barriers	Yes	No	High capital cost	No
Secant Piling	Yes	Yes	High capital cost	Yes
Hydraulic Containment	No	No	High capital cost and moderate to high O&M	No
Removal/Extraction				
Extraction Trenches	No*	No	Moderate to high capital and O&M	No
Pre-Disposal	Yes	Yes	High Capital Cost and no O&M	Yes
Manual Passive Recovery	No	Yes	Low capital cost and O&M	No
Total Fluids Recovery	Yes	Yes	High capital cost and moderate O&M	Yes
Belt Skimmers	No	Yes	Moderate capital cost and O&M	No
Multiphase Extraction	No	Yes	High capital cost and moderate O&M	No
Airlift Pumps	Yes	Yes	Moderate to high capital cost and O&M	Yes
Treatment				
Hot Water Flushing	Yes*	Yes	Moderate to high capital cost	Yes
Steam Injection	Yes*	Yes	High capital cost and moderate O&M	Yes
In situ Stabilization/Solidification	Yes*	Yes*	High capital cost and no O&M cost	Yes

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Technology	Effective	Implementable	Relative Cost	Retained
Solvent/Surfactant Flushing	Unknown	No	Unknown	No
Treatment				
Electrical Resistance Heating	Yes*	Yes	High capital cost & moderate to high O&M	Yes

* Depends on results of Treatability Study and Design Investigation

Due to the lack of previous extensive offsite investigation, several key pieces of information are necessary before selection of the appropriate remedial technology is possible. Information pertaining to the groundwater parameters, lithology and nature of the offsite LNAPL are necessary before moving forward with the final FFS. As part of the treatability study, the following tests are recommended: measurement of the dissolved oxygen, pH, conductivity, temperature and oxidation reduction potential (ORP) in offsite groundwater; determination of the hydraulic gradient via slug or pumping tests, determination of the hydraulic conductivity, determination of the water and LNAPL recharge rates via bail down testing; determination of offsite lithology and porosity via subsurface investigation; and, determination of LNAPL characteristics via extensive LNAPL testing. Once these analyses are completed, and an appropriate remedial technology is selected and deemed feasible, additional treatability and/or pilot testing may need to be done before the system is designed. Following NYSDEC review of the recommended investigation activities, CDM will submit a scope of work and schedule for the agreed upon tasks.

The following remedial action alternatives were established based on the present knowledge of the offsite contamination and lithology. Based on the results of the treatability study and design investigation, it may be determined that these remedial action alternatives do not sufficiently achieve the RAO and may need to be refined in the final FFS.

<u>Alternative 1</u> - The first alternative is no action, which was reserved for comparison purposes as required by the NCP. Alternative 1 has no associated costs.

<u>Alternative 2</u> - The second alternative is pre-disposal, which utilizes extensive excavation and site restoration to retune the off-site parcel to its condition prior to the presence of contamination. Alternative 2 has an estimated cost of $23.7 million..

<u>Alternative 3</u> – Alternative 3 consists of the implementation of *in-situ* solidification. The cost of Alternative 3 is estimated to be $11.6 million.

<u>Alternative 4</u> – Alternative 4 consists of the implementation of extraction via total fluids recovery (TFR) or air lift pumps. The cost of Alternative 4 is estimated to be $1.2 million utilizing TFR and $0.9 million utilizing air lift pumps.

<u>Alternative 5</u> - Alternative 5 combines extraction using the technologies in Alternative 4 with containment via secant piling. This alternative assumes that extraction alone would not eliminate discharge of LNAPL to the river and therefore would need to be slowed via containment to achieve the RAO. The cost of Alternative 5 utilizing TFR is estimated to be $4.8 million, while the cost utilizing air lift pumps is estimated to be $4.3 million.

Alternative 6 - Alternative 6 combines extraction technologies with one of the following thermal technologies, hot water flushing, steam injection or ERH. This alternative assumes that the LNAPL is too viscous in nature to be effectively recovered utilizing only extraction and assumes that heating of the LNAPL will increase its mobility and therefore recovery rate. The cost of Alternative 6 utilizing TFR is estimated to be $2.5 million, while the cost utilizing air lift pumps is estimated to be $2.3 million.

Alternative 7 - Alternative 7 combines the use of extraction, secant piling and thermal technologies. The cost of alternative 7 utilizing TFR is estimated to be $6.1 million, while the cost utilizing air lift pumps is estimated to be $5.8 million.

Section 1
Introduction

This Revised Draft Focused Feasibility (FFS) Report for the impacted area along the Bronx River adjacent to the former Red Devil Paint Company located at 30 Northwest Street in the City of Mt. Vernon in Westchester County (herein referred to as the "Site") was prepared by Camp Dresser & McKee Inc. (CDM) for the New York State Department of Environmental Conservation (NYSDEC) under the Engineering Services for Investigation and Design, Standby Contract No. D006131. This FFS was developed in accordance with the New York State guidance entitled "*Draft DER-10 Technical Guidance for Site Investigation and Remediation*", dated December 2002 (NYSDEC 2002).

1.1 Purpose

The purpose of this FFS is to identify treatment and remedial technologies that may feasibly remediate the offsite light non-aqueous phase liquid (LNAPL) plume. This FFS includes the following:

- Presentation of a summary of work performed by other consultants
- Presentation and discussion of chemical analysis of the LNAPL
- Identification and evaluation of the feasible treatment/remedial technologies
- Order of magnitude costing for treatment implementation, operations and maintenance

This revised draft FFS also includes recommendations for an FFS investigation. Future drafts will recommend and any pilot or bench-scale treatability testing that is deemed necessary for finalizing the FFS. The final FFS will provide refined alternatives and costing, based on the results of the FFS Investigation and Treatability Study.

1.2 Organization of Focused Feasibility Study Report

This FFS Report is comprised of nine sections. The following identifies the organization of the report and the contents of each section.

Section 1: Introduction. This section provides the background information regarding the purpose and the organization of this FFS report.

Section 2: Site Description and History. This section provides the Site location and description, site history, and a summary of previous investigations.

Section 3: Summary of Remedial Investigation. This section includes a discussion of physical characteristics of the site and the results of the recent LNAPL sampling and analysis conducted by CDM.

Section 4: Remedial Goals and Remedial Action Objectives. This section presents the site specific remedial action objective (RAO) and preliminary remediation goal (PRG) based on the characterization of contaminants, the risk assessments, and compliance with standard, criteria, and guidance (SCGs).

Section 5: General Response Actions. This section identifies general response actions that will address the RAOs.

Section 6: Identification and Screening of Remedial Technologies. This section identifies remedial technologies and process options for treatment of the LNAPL and screens the technologies based on effectiveness, implementability and relative cost.

Section 7: FFS Investigation and Treatability Study. This section outlines the components of the recommended FFS Investigation and Treatability Study to be conducted prior to completion of the final FFS. The final FFS will also include a brief summary of FFS Investigation and Treatability Study results.

Section 8: Development and Analysis of Remedial Alternatives. For the draft FFS, this section presents the remedial alternatives developed by combining the feasible technologies and process options. This information was used to develop an order of magnitude cost estimate for each alternative.

Upon completion of the FFS Investigation and Treatability Study, this section will be revised to include a detailed analysis of each alternative with respect to the following eight criteria: overall protection of public health and the environment; compliance with SCGs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume with treatment; short-term effectiveness; implementability; cost; community acceptance; and land use. An overall comparison between the various remedial alternatives is also examined in this section.

Section 9: Recommended Remedy. This section will be included in the final FFS following the FFS Investigation and Treatability Study and will provide the recommended remedy for the LNAPL. This section is not included in the draft FFS.

Section 2
Site Description and History

The following subsections describe the site location and description, operational history, and a summary of previous investigations.

2.1 Site Location and Description

The former Red Devil Paint facility, here in referred to as “the site”, is located at 30 North West Street in the City of Mount Vernon, Westchester County, New York. The location of the property, as seen in **Figure 2-1**, is 40° 54’54” north latitude and 73° 51’35” west longitude. The property is approximately 50,500 square feet (sq. ft.), of which 37,035 sq. ft. is improved with the former multi-floored paint manufacturing facility. Due to the size and complexity of the facility, previous investigations divided the property into four areas of interest. These areas of interest were designated as Areas A, B, C and D and were determined based on the physical layout of the property and the primary operations which occurred in each portion of the facility during active manufacturing (**Figure 2-2**). Area A, located on the ground floor, consisted of an office area and a courtyard. Area B was located in the basement and was used for raw material storage and also contained the boiler room. Area C, which was also located in the basement, consisted of the former production area. Area D, located in the basement, contained the packing operations and a garage/storage area.

The property is located within an industrial zoned area. The surrounding land use is urban with mixed residential and industrial/commercial developments. All of the immediate surrounding properties are industrial or commercial in nature. The property is directly bordered to the northwest by the Metro-North Railroad. Oak Street is located on the northeast side of the property, with North West Street located on the southeast side of the property. A small furniture outlet store, a grocery market and a taxi dispatching service are located to the southwest. Approximately 115 feet further northwest of the property, opposite the Metro-North Railroad tracks, is the Bronx River. Further northwest, on the opposite bank of the Bronx River, the Bronx River Parkway runs adjacent to the river.

The portion of the site specifically subject to this Focused Feasibility Study is the area along the Bronx River adjacent to the rail lines, which includes an approximate 380 foot long segment of the shore between the Mt. Vernon Avenue Bridge and the Oak Street Bridge. This segment of the Bronx River will herein be referred to as “the offsite” portion of the site.

2.2 Operational History

Industrial activities have been occurring on the property for more than 80 years. The earliest Building Department records indicate that Egler and Sons Baking Company constructed a baking factory on the property in 1908. Between 1908 and 1940, the property was owned and operated by several bakeries including Shults Bread

Company, Bakery Services Corporation and Continental Baking Corporation. Over this period of time, additional structures including sheds, a mill, and a garage were constructed on the property. During the late forties and early fifties, Red Devil Paints and Chemicals, Inc., related to Technical Color and Chemical Works, Inc., began operations on at the property. In 1971, Insilco Corporation acquired Red Devil Paint and purchased the property in 1985. Insilco sold the assets of the Red Devil Paint division to Thompson and Formby in 1989. Until mid-1990, Insilco continued to operate the facility under a supply agreement. Operations ceased in 1990, at which time Thompson and Formby removed a majority of the operating equipment and all of the remaining stock, and transported the materials to other facilities. Metro Self Storage Bronx, Inc. began leasing the property and the building from Insilco in 1991, and self storage operations presently continue onsite by SUSA Mt. Vernon LLC.

Based on available records, it is believed that most of the construction on the property was completed by Red Devil Paints and Chemicals, Inc. Areas C and D, consisting of the production area, the packing and the garage areas, respectively, are believed to have been built in 1915. A paint remover building was built in 1956, which was located in the parking lot adjacent to area A, but has since been razed to its foundation. Area B, consisting of the raw material storage, machine shop, and boiler room was constructed in 1963. The western portion of Area C, which contained the packing and mixing kettle rooms, was added as an addition to Area C in 1966. The building on the southern portion of Area A was completed in 1987 and was utilized as the final office structure. The following outlines the chronology of the property owners and operators.

- SUSA Mt. Vernon, LLC 1991-present
- Insilco 1989-1991
- Red Devil Paint Division of Insilco 1971-1989
- Red Devil Paints and Chemicals, Inc. 1959-1971
- Technical Color and Chemical Works, Inc. 1955-1963
- Continental Bakery Corporation 1926-1940
- Bakery Services Corporation 1927-1930
- Shults Bread Company 1911-1915
- Egler and Sons Bakery Company 1908

To the knowledge of CDM, there have been no reported activities of significance along the Bronx River, with the exception of remedial investigations and activities. This area has remained highly vegetated and access restricted as it is bordered by the Metro North rail line to the southeast, the Mount Vernon Avenue Bridge to the southwest, the Oak Street Bridge to the northeast and the Bronx River to the northwest.

2.3 Summary of Previous Environmental Activities

This section provides overview of the current environmental regulatory status and previous environmental activities which have taken place both on and offsite.

2.3.1 Environmental Regulatory Status

As mentioned previously, Red Devil Paint and Chemicals, Inc. operated a paint varnish blending and manufacturing facility from 1959 until 1971. From 1971 to 1989 Red Devil continued to operate as a division of Insilco Corporation. The facility ended its operation at the property in 1990. At that time, ERM-Northeast (ERM) was hired by Insilco to implement a decommissioning program that encompassed the identification of environmental management requirements for facility deactivation. The decommissioning program aimed to identify items requiring decontamination, removal, and/or special handling, in order to prepare equipment and facilities for plant closure, and to assess areas of the site that had negatively impacted the environment through historical onsite facility activities. In June 1991, during facility decommissioning, a Spill Incident Report was made to the NYSDEC when tank releases were found to have impacted soil and groundwater beneath the facility. During the period of facility operations, materials were reportedly released from leaking USTs, ASTs and associated piping. It is unclear from available reports if material releases were a result of poor housekeeping, infiltration from the facility floor drain and sump system which was comprised of unlined floor drains and sumps, or dumping into abandoned drywells.

On June 29, 1992, the Red Devil Paint Company was listed on the State Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 Site (No. 360031). This classification indicates that the site poses a significant threat to public health or the environment. In April 1993, an Order of Consent requiring a Remedial Investigation/Feasibility Study (RI/FS) and an Interim Remedial Measures (IRM) program was executed by Insilco Corporation and NYSDEC. Two operable units, OU-1 and OU-2, were identified for the site. OU-1, would address the presence of light non-aqueous phase liquid (LNAPL) and paint material both on and offsite, while OU-2 would address residual groundwater and soil contamination after the LNAPL has been recovered. Based on the findings of the RI/FS, a Record of Decision (ROD) for Operable Unit 1 (OU-1) was issued by NYSDEC in March 1996. The ROD (and subsequent Consent Order) for OU-1 identified several remedial alternatives consisting of the following:

- Recovery of LNAPL from onsite groundwater;
- Recovery of offsite paint materials from the Bronx River; and,
- Investigation and design implementation of offsite LNAPL recovery.

Insilco signed a second Consent Order agreeing to implement the ROD in March 1997. However, in April 2003, Insilco stopped all remedial operations after initiating bankruptcy proceedings. In 2005, a non-Potentially Responsible Party (PRP) entered into a Brownfields Cleanup Agreement (BCA) to remediate the Red Devil site. The current owner of the site, SUSA Mt. Vernon, LLC, has hired Legette, Brashears and Graham, Inc. (LBG) as their environmental consultant for the BCA. In 2007, the offsite portion of the contamination along the Bronx River was referred to the State Superfund (SSF) program.

2.3.2 Previous Environmental Activities

After manufacturing operations ceased in 1990, Insilco initiated a program to mitigate any potential environmental damages associated with the property. These initial activities were conducted by ERM. A summary of each document produced by ERM or LBG follows.

2.3.2.1 Preliminary Investigation and Proposed Phase II Site Investigation by ERM, July 1991

The purpose of the "Summary of Preliminary Investigation and Proposed Phase II Site Investigation" prepared in July 1991 was to provide a description and the results of the preliminary site investigation. However, as a result of the preliminary investigation, the necessity for additional work was identified and a detailed Phase II Investigation Work Plan was also developed outlining the activities necessary to complete the tank closures and delineate the impacts of any tank releases.

Initially the program started in 1990 and consisted of the permanent closure of underground storage tanks (USTs) and vaulted aboveground storage tanks (ASTs). During the tank closure activities, a spill was reported to NYSDEC (NY Spill #91-01562) and the initial activities were expanded to include a Preliminary Site Assessment (PSA) conducted in May 1991. The PSA included sample collection in the vicinity of the USTs and ASTs to determine if soil and groundwater had been impacted due to leaking tanks. The PSA consisted of soil sampling, field screening of soil borings using a photoionization detector (PID), soil gas sampling, and ground water sampling. During this preliminary investigation, the Area designations A through D were assigned for reporting and analysis purposes.

According to ERM, Area A originally contained eleven USTs; five of these USTs were removed prior to ERM's work, and six USTs were removed during the initial tank closures. An overview of the tanks located throughout the property, the closure activities of this investigation, as well as following investigations, and tank contents can be seen in **Table 2-1**. Soil samples taken from the vicinity of these tanks contained toluene, ethylbenzene, and xylenes at depths between 16 and 25 feet. This led to the excavation of approximately 150 cubic yards of contaminated soil for offsite disposal.

ERM identified four USTs and nine vaulted ASTs in Area B. Eight of the nine ASTs were removed, and one was left in place. The tank that was not removed was used to store fuel oil for the boiler room, which remained in place. The four USTs were cleaned, inspected, filled with an amino based inert foam and abandoned in place. These tanks were not removed because one of the tanks was located under a load bearing wall.

Four vaulted ASTs were identified in Area C. All of the ASTs were cleaned and removed. One UST was also located, cleaned and abandoned in place due to its proximity to a foundation wall. Soil samples collected from the areas where the UST was located showed concentrations of chlorinated volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). No soil was removed from this area at that time.

In Area D, four USTs were located in the commercial space, while three were located outside in the alley. The indoor USTs contained fluids and sludge upon inspection. These tanks had been historically used to store mineral spirits, polyurethane varnish, and waste oil. Holes of up to 0.25 inches were observed in the USTs that contained mineral spirits. These USTs were cleaned and removed. Soil samples collected from the areas where the USTs were located contained toluene, ethylbenzene and xylene. Thirty cubic yards of contaminated soils were removed and disposed of offsite. At the time of the excavation, two of the tanks located in the alley were left in place as they were used for storm water control during heavy rain events. The third UST in the alley was used to store waste solvent. This tank was cleaned, filled with an inert foam and abandoned in place.

Where soils appeared to be significantly impacted, field screening of the water table was also conducted using a Hydropunch. Data collected from borings advanced in the Courtyard and Garage/Storage Areas (Areas A and D, respectively) indicated that the underlying groundwater in these areas had been impacted. Free phase product was also identified in a temporary piezometer that was placed in one of the Hydropunch borings in Area D. As mentioned previously, in response to the findings of this investigation, a Phase II work plan aimed at obtaining the following objectives was generated:

- Comprehensively characterize the type and concentration of contaminants found around the tanks in Areas A and D;
- Delineate the extent of soil contamination surrounding the tanks in both areas to enable the design of a remedial system;
- Delineate the extent of free phase product in Area D; and
- Develop a ground water monitoring network to evaluate upgradient and downgradient ground water quality.

2.3.2.2 Remedial Investigation by ERM, May 1992

Following the PSA, it was determined that additional work was needed to delineate the extent of contamination on the site. It appears from the limited information available that the Phase II work plan, which was combined with the PSA report, was not deemed sufficient and a complete Remedial Investigation (RI) was needed. As such, RI was conducted by Insilco's consultant, ERM, between November 1992 and December 1994. The purpose of the RI was to determine the vertical and horizontal extent of soil contamination resulting from historical paint manufacturing operations, and to characterize the ground water flow and ground water quality.

Soil quality was characterized in each area of the property through soil gas sampling, laboratory analysis of soil samples, and PID screening of split spoon soil cores. The first stage of the investigation, as referred to in the RI, appears to be the results of the preliminary investigation as discussed above. The second stage of the investigation consisted of the following.

In Area A, an additional eight soil borings were advanced; three extended to the water table and the remaining five were varied based field screening. The results of these borings indicated the only target compound with significant concentrations detected was toluene.

Soils in Area B of the facility were not investigated further based on the results of the preliminary investigation. Soil borings and soil gas sampling conducted during the PSA indicated that the soils in this area had not been impacted by operations performed in the basement/storage area. It was noted that the USTs removed from this area were in very good condition at the time of closure activities and therefore no further investigations were needed for soils in this area during the RI.

Soils in Area C do not appear to have been further investigated during the RI, however the PSA results indicated that Area C contained soil contamination above the clean up levels for toluene, xylene and tentatively identifiable compounds (TICs).

Area D soils were further investigated during the RI, through the advancement of ten additional soil borings. The RI identified VOCs including toluene, ethylbenzene and xylene that were above their respective cleanup levels. Soils in this area appeared to be contaminated to a depth of 14 feet. Additional VOCs found in low concentrations included chlorinated compounds such as tetrachloroethene (PCE), 1,1,1-trichloroethane (TCA), 1,1-dichloroethane (DCA) and 1,1-dichloroethene (DCE). Semivolatile data also showed several compounds in low levels, including naphthalene and di-n-butyl phthalate. Metals were also detected in this area in soils collected between 11 and 13 ft bgs. The Recommended Soil Cleanup Objectives (RSCO) were exceeded in this area for chromium, iron, nickel and zinc. Additionally magnesium exceeded the eastern USA background concentration range.

During the ERM RI, a total of 20 wells were installed in a phased effort. Three of the wells were monitoring wells, while the remaining seventeen were product delineation wells. The three monitoring wells were utilized for groundwater sampling, while the delineation wells were utilized to determine the thickness and presence of LNAPL onsite. Both were used to understand the ground water flow regime. As the phased effort of well installation occurred, LNAPL was discovered in Areas A, C and D.

During the RI, it was determined that the LNAPL which underlies the site is composed of an amber colored paint product or paint intermediate that looked much like varnish in appearance. When exposed to the air, the LNAPL solidified. The RI determined that the LNAPL ranged in thickness between 0.02 feet in Area C to 3.72 feet in Area D. The thickest recorded measurements of product were in Area D, with all but four of the twelve delineation wells having greater than 1 foot of product when measured on March 31, 1992. The delineation well in Area A contained 0.32 ft of product while the four delineation wells in Area C ranged between 0.02 ft to 1.31 ft of product.

ERM concluded that from the groundwater analysis conducted during the RI indicated that based on the magnitude of free product, the associated dissolved plume at the site appeared dilute. The results suggested that the solubility of the free product was low, as constituents contained in the groundwater consisted primarily of petroleum hydrocarbons along with chlorinated solvents. The detected concentrations of VOCs and SVOCs at each sampling location exceeded the New York State Ambient Ground Water Guidelines which set suggested criteria. The metals identified in the samples from two of the monitoring wells exhibited concentrations above the standards for iron and magnesium. Sodium and manganese were also found at levels exceeding the guidelines in all samples.

2.3.2.3 Interim Remedial Measures by ERM, September 1993

Several of the environmental activities occurring at the Red Devil facility, conducted by ERM on behalf of Insilco, occurred simultaneously. The above RI was completed in conjunction with a Risk Assessment and a Feasibility Study (FS). As the RI/FS were on going at the site, a need for Interim Remedial Measures (IRM) arose to address onsite LNAPL. As part of the IRM, pilot testing and product containment measures were implemented.

At the time of the IRM, a total of 26 delineation wells had been installed and monitored to determine the extent and thickness of onsite LNAPL. It is not clear in the IRM report when all of these wells were installed. Twenty were installed as part of the RI as discussed in the proceeding section, six additional wells were installed onsite between the RI report and the IRM. No information is available regarding the installation of these six additional wells. Offsite delineation wells could not be installed at that time due to access restrictions, thus offsite investigations were limited to a search of the Bronx River bank for product seeps. During a January 5, 1993 assessment of the river bank adjacent to the facility, product seeps were identified leading to the initiation of offsite IRMs as well.

During the IRM, the onsite LNAPL was characterized as a light amber material of very low viscosity (Area C) to a medium amber material of moderate viscosity (Area D). Both products solidified when exposed to air and had an appearance similar to polyurethane varnish. Several of the onsite delineation wells were selected for characterization sampling. Sampling of the onsite LNAPL indicated that the product was not hazardous in terms of corrosivity and reactivity, however it was hazardous with respect to ignitability, and four of the seven samples collected were hazardous with respect to the toxicity characteristic for benzene. The pH of the collected LNAPL samples were all nearly neutral, while the specific gravity varied significantly between Areas C and D as anticipated. The product recharge characteristics of the wells were also examined through a product baildown test to determine LNAPL recharge, and the potential for active onsite recovery. During the Area C baildown test, it was not possible to remove the LNAPL to zero thickness and the product recovered within one to two minutes of baildown to its initial thickness. Three of the wells in Area D (DW-1D, DW- 4D, and DW-13D) exhibited good recharge capability, while the results of others varied.

Based on the product recharge observed onsite, ERM initiated pilot pumping tests in Areas C and D to evaluate the feasibility of removing LNAPL from the onsite delineation wells. The pilot tests utilized a "Spillbuster" product-only recovery pump manufactured by Clean Earth Technology. This small rotary vane pump utilized an automatic level sensor to seek out the water/LNAPL interface and adjust the pump inlet to the appropriate height within the well casing. This system appeared effective in Area C, while use of this same pump in Area D was not successful due to the high viscosity of the LNAPL in this area. An upgraded "Spillbuster" pump was developed by Clean Earth for use in Area D, but the specifics of the upgrades were not outlined by ERM. Based on the pump tests, it was determined that active recovery of the LNAPL in Areas C and D was feasible and was suggested for full-scale implementation. Area A was not tested for such recovery, as further investigations determined that the thickness of LNAPL in these areas was not sufficient for this technology.

Prior to the IRM, a bench-scale treatability study to examine the feasibility of immobilizing the free product via aeration was proposed. However, at the time of the IRM, this technology was no longer deemed feasible, as the product thickness was much greater than initially anticipated. Therefore this technology was disregarded prior to testing. It was noted that this technology may be useful when the product thickness is reduced and was therefore reserved for further investigation in the future.

An additional IRM was implemented offsite during the pilot testing. When seeps were discovered at the Bronx River, a five-inch disposable absorbent boom was placed in the river to collect the discharging product. To address conditions during high precipitation events, a heavy duty, six-inch boom with a twelve-inch weighted skirt was installed around the smaller disposable boom. Continued use of the passive product containment offsite was suggested based on the success of the boom implementation coupled with the access difficulties to the River.

In March 1994, the design documents for the onsite active recovery IRM were approved by NYSDEC and construction of the system was completed in July 1994.

The system consisted of eleven product recovery wells, four product-only "Spillbuster" pumps, one 300-gallon AST for Area D product, one 500-gallon AST for product storage in Area C, piping, tubing and associated controls. The pumps were rotated between recovery wells located in each area to allow time for LNAPL recharge into the wells. Offsite passive recovery using the boom system also continued to be utilized to collect the material seeping into the Bronx River.

2.3.2.4 OU-1 Feasibility Study by ERM, June 1995

As mentioned previously, while the RI/RA and IRM were being conducted at the former Red Devil facility, an FS was also being developed by ERM to identify remedial alternatives that would achieve the remedial action objectives for the site. The baseline public health and ecological risk assessment results are also presented in the FS.

The June 1995 ERM FS notes that four additional monitoring wells were installed onsite during the RI, and that the six additional delineation wells referred to in the IRM were indeed installed during the RI. It also notes that when seep material was first encountered on the Bronx River, five surface water and nine sediment samples were collected offsite. An indoor air monitoring program was also conducted during the RI. The results of surface water sampling, sediment sampling, baseline Risk Assessment and indoor air monitoring program are presented below.

During the discovery of seep material along the Bronx River, three separate seeps were identified; two between 15 and 25 feet in length, and a third roughly five feet in length. Upon further ERM investigation, it was determined that it was difficult to distinguish individual seeps, potentially as a result of changes in the river level. As of November 1994, there appeared to be roughly 250 feet of bank from which small seeps occurred frequently. In general, the seeps were located within the riprap and rock lining the river embankment, both above and below the river surface, on the southwestern side of the river bank. Material was discharged along the seeps into the river, where it solidified, and formed discontinuous, irregularly shaped patches of hardened material on the surface of the water. It was not possible for ERM to determine a seepage rate at that time due to the relatively small volume of material being discharged.

The three seep samples collected from the Bronx River were analyzed using a Flame Ionization Detector (FID) and gas chromatograph (GC). The analysis revealed that the samples were similar in composition to mineral spirits. The 300 foot boom system continued to be used for passive collection offsite and was maintained weekly by Enviroclean. The seep material as well as the inner disposable boom was removed periodically and containerized for proper disposal.

Surface water samples from the Bronx River were also collected and discussed in the FS in order to determine if the seep material was impacting the surface water. Five samples were collected and with the exception of trace levels of 2,6-dinitrotoluene in one of the upstream samples, no VOC's or SVOC's were found in the samples from the river. One sample was taken from within the boomed area and ERM concluded it contained "trace" concentrations of VOCs. It was concluded that even within the boomed area, where the maximum contact with seep material could occur, there was limited impact to the surface water body from organic compounds in the seep material. In general, inorganics identified in the surface water samples were consistent between the upstream and downstream samples, with the exception of iron, lead and manganese, which increased in the downstream sample. However, the increased concentrations downstream were not believed to be a result of the seep material, as all levels were generally within background levels and only one area of localized elevated inorganics was identified onsite. Furthermore, an active discharge pipe, several inactive discharge pipes, and run off from the Vernon Avenue Bridge were believed to be potential sources of impact to the river downstream. **Appendix C** contains Table 1-11 from the ERM OU1 Feasibility Study Report (1995) detailing contamination detected in surface water samples.

Nine sediment samples were also collected along the Bronx River. All of the samples were analyzed for VOCs and four were analyzed for SVOCs and inorganics. Some of the samples were also analyzed for total organic carbon (TOC). The mean TOC concentration identified was approximately 0.58% TOC (5,861 mg/kg). VOCs were present in "trace" amounts in two of the samples collected adjacent to the seep material, and were non-detect in all other samples. A number of SVOCs were detected in the sediment samples. However in general, ERM concluded that these samples had been impacted by a downstream source, as only two of the compounds had been identified onsite and the impacted sediments dissipated after a short distance beyond the Mount Vernon Avenue bridge runoff. Three trends in inorganic concentrations were identified in the sediment samples. For one group of metals, the highest concentrations were found in the upstream location; for another group the highest concentrations were found in the downstream location; and in a third group of metals there appeared to be no significant change in concentration based on location. From these trends, ERM reported that the sediments had been impacted by upstream and downstream sources, and that the seep material had minimal impact on the sediments in the river. This conclusion was not acceptable to NYSDEC.

An indoor air quality monitoring investigation was also conducted onsite under worst case conditions (i.e. during the winter while the facility windows and doors were closed and while test borings were being drilled) to determine whether site soil or ground water was impacting the ambient air quality in the facility. This sampling confirmed that the concentrations of organics found in the air in the basement were several orders of magnitude below the Occupational Safety and Health Agency (OSHA) Time Weighted Average (TWA) Permissible Exposure Limits (PELs). Therefore ERM concluded that the ambient air concentrations should not present a hazard to adult workers.

ERM also performed a comprehensive baseline public health and ecological risk assessment at the former Red Devil facility using data gathered during the RI. The risk assessment established an overall degree of hazard posed by the existing conditions at the site. In summary, the RA concluded the following:

- No significant exposures of site soil or ground water to humans were expected under either current or projected conditions;
- No significant impacts to ecological resources at the site itself were expected to occur as a result of chemicals in Site soil and ground water;
- No adverse impacts to NYSDEC significant habitats, endangered or threatened species, species of special concern, regulated wetlands, or wild and scenic rivers were expected to result from chemicals from the site;
- No adverse impacts were expected to result from direct contact with the Bronx River or ingestion of fish from direct contact with the Bronx River or ingestions of fish from the Bronx River. This conclusion was not acceptable to NYSDEC;
- The concentrations of chemicals in the air would not represent a health hazard to an adult worker present in the basement of the facility 8 hours/day, 40 hours/week;
- Due to its viscous nature, the seep material discharging into the Bronx River represented a physical threat to aquatic life associated with the Bronx River
- The site had only minor impact on surface water and sediment quality of the Bronx River. This conclusion was not acceptable to NYSDEC; and
- Other potential sources, including the actively flowing discharge pipe and runoff from the Mount Vernon Avenue bridge, were impacting the surface water and sediment quality in the Bronx River. This conclusion was not acceptable to NYSDEC;

Between the implementation of the IRM onsite product recovery system in July 1994 and the FS in December of 1994, a total of 1,565 gallons of LNAPL had been collected from Area C and 110 gallons of LNAPL had been collected from Area D. The onsite recovery in Area C continued, while the recovery in Area D was discontinued in November 1994. Numerous operational difficulties were encountered in Area D due to the viscous nature of the LNAPL. Following discontinuation of automated recovery, bench-scale testing was conducted with Area D LNAPL and two types of manual product recovery methods were tested. Bench scale testing entailed a preliminary evaluation of solvent addition to decrease product viscosity, and a test of belt skimming devices for possible use in Area D. Manual product recovery devices tested included canisters and sorbent socks. These alternatives were further discussed in the remedial technologies proposed to achieve the site specific remedial action objectives discussed below.

As mentioned previously, the OU-1 media of interest are on-site LNAPL, off-site surface water LNAPL, and Area A soils. The specific remedial action objectives for OU-1 included:

- On-site LNAPL: mitigating potential impacts to ground water posed by LNAPL, to the extent practicable
- Off-site LNAPL: preventing exposure to fish in the Bronx River; and
- Soil; addressing soils in Area A during LNAPL recovery activities.

The remedial action technologies identified to achieve the remedial action objectives of the site were:

1. Access Restrictions
2. Use Restrictions
3. Active On-site Product Recovery
4. Passive Off-Site Surface Water Product Recovery
5. Vertical Barriers
6. *In Situ* Chemical Fixation\Stabilization
7. Excavation and Off-Site Disposal
8. Vacuum Extraction
9. Vacuum Extraction with Air Sparging
10. Passive Soil Venting
11. Off-Site Product Disposal

Each of these technologies was initially screened for their ability to meet the medium-specific remedial action objectives, implementability, and short-term and long-term effectiveness. Based on these evaluations, vertical barriers were eliminated as a possibility as they would not meet the remedial action objective for on-site LNAPL. Furthermore the effectiveness of the vertical barriers would be highly dependent upon site-specific conditions. Due to severe access restrictions, on-site LNAPL containment via vertical barriers would not be implementable.

In situ chemical fixation\stabilization was also deemed unacceptable for achieving the remedial action objective for on-site LNAPL. This technology would not be easily implemented either, as heavy equipment with augers capable of providing large amounts of torque would be required. Due to the size of the equipment and the heavy access restrictions, implementation was not deemed feasible.

Excavation and off-site disposal was also eliminated as a feasible technology due to a lack of implementability of on-site excavation. To implement excavation of LNAPL, on-site buildings would need to be demolished and shoring along the rail road embankment is not feasible.

Vacuum extraction for removal of the on-site LNAPL was also eliminated as a feasible technology, as ERM felt it would only remove VOCs from the top of the LNAPL layer and solidify this portion of the LNAPL. This therefore would not achieve the remedial action objective for the on-site LNAPL.

Vacuum extraction with air sparging was also eliminated, as it would solidify the top and bottom of the LNAPL layer. This would impede the movement of the injected air to other portions of the product and result in an inaccessible middle layer of mobile product, therefore not achieving the remedial action objective.

Six remedial technologies, including access restrictions, use restrictions, active onsite product recovery, passive offsite surface water recovery, passive soil venting and offsite product disposal, passed the initial screening criteria and were further investigated. Each technology generally satisfied some but not all of the remedial action objectives. Technologies were therefore combined to form comprehensive approaches to adequately satisfy all of the remedial action objectives. Three Remedial Action Alternatives were developed:

- Alternative I: No Action
- Alternative II: Access and Use Restrictions
- Alternative III: Active On-Site recovery and Passive Off-Site Surface Water Product Recovery

Each of these alternatives was evaluated for the following criteria:

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

Based on the analysis of each alternative using the above criteria, Alternative III was thought to have more significant short-term effects, present more implementability problems and to be considerably more expensive than Alternatives I and II. However, Alternative III had the following benefits: (1) provided the highest degree of protection to human health and the environment; (2) complied with the SCGs and other regulatory criteria identified for the site; (3) provided the highest degree of long-term protection to human health and the environment; and (4) provided the greatest reduction in toxicity, mobility or volume of on-site LNAPL, off-site surface water LNAPL and site chemicals in soil. As part of the analysis, scoring of each alternative's ability to address the above seven criteria was conducted in accordance with NYSDEC FS guidance. The total scores for these three alternatives were 60 (Alternative I), 60.7 (Alternative II) and 78 (Alternative III). Based on the above comparative analysis of alternatives and scoring of the criteria, Alternative III, active on-site product recovery and passive off-site surface water product recovery, was the preferred remedial action alternatives for this OU-1 FS.

2.3.2.5 Draft Design Investigation Report by ERM, July 1997

Upon completion of the OU-1 FS, it was determined that the following activities would be conducted at the Site:

- Continued on-site recovery of Area C LNAPL;
- Additional investigation to determine alternate technologies for recovery of the more viscous Area D LNAPL;
- Maintenance of the boom system in the Bronx River to prevent direct human or animal contact with floating LNAPL;
- Completion of a Design Investigation to evaluate the feasibility of active off-site LNAPL recovery from the banks of the Bronx River;
- Cleanout of the indoor floor and trench drain systems; and
- Performance of a quarterly ground water monitoring program.

The Draft Design Investigation Report (DIR) submitted to NYSDEC in July 1997 outlined the results of the two IRMs (active on site LNAPL recovery and off site passive recovery of LNAPL) as well as the results of the Design Investigation.

As of July 1997, a total of 7,041 gallons of LNAPL had been recovered using the product only removal system in Area C. Beginning in December 1996, a decrease in Area C LNAPL recovery had been observed, mainly due to pump failures. At the time of the Design Investigation the recovery pumps were scheduled for maintenance, which was believed would correct the problem. Area D LNAPL removal had not been successful due to the higher viscosity and poor flow characteristics of LNAPL in the area. Only 277 gallons of LNAPL had been removed from Area D as of July 1997. As mentioned previously the IRM in this area was discontinued in November 1994.

Based on a meeting with NYSDEC, as of December 1994, it was agreed that passive recovery equipment would be utilized in Area D. The last 157 gallons of LNAPL removed from this area were through the use of sorbents in the wells, removed weekly or bi-weekly. It was also agreed that an alternative method of recovery would be evaluated for Area D LNAPL. The off-site boom system remained in use on the Bronx River and approximately 535 gallons of seep material had been removed from the river as of mid-May 1997.

The purpose of the Draft DIR was to collect information needed to design the OU-1 remedial action and to evaluate the potential for an off-site upgradient source of volatile organics. The following tasks were completed as part of the Design Investigation:

- Investigation of subsurface conditions on the banks of the Bronx River to determine whether LNAPL recovery from beneath the banks was feasible;
- Evaluation of alternative LNAPL recovery technologies for Area D LNAPL;
- Installation of a ground water monitoring well downgradient of Area A along the bank of the Bronx River and performance of a quarterly ground water monitoring program; and
- Cleanout and mapping of the indoor floor drain and trench system.

As part of the DIR, several technologies were screened for use in Area D, including manual recovery using hydrophobic sorbents (SoakEase) and hydrophobic collection canisters (Keck Canisters). Automated technologies screened consisted of LNAPL-only recovery pumps, hydrophobic collection canisters with transfer systems, total fluids recovery systems and hydrophobic belt skimmers. LNAPL-only recovery pumps were not selected for field testing, due to the ineffectiveness exhibited previously in Area D. It was also decided that process modifications discussed in the FS would not be pursued. Despite bench-scale testing indicating that both linseed and canola oil could be used to reduce the viscosity of Area D LNAPL, this alternative was not pursued. ERM was concerned about the addition of solvents to a relatively immobile subsurface LNAPL plume. Hydrophobic collection canisters with transfer pumps were not selected for field testing, as manual canister removal would be field tested. Total fluids recovery was not field tested either, as it would not induce a change in the flow characteristics of Area D LNAPL and thus would not increase the volume or rate of LNAPL recovery. Therefore, manual removal using sorbents and collection canisters and hydrophobic belt skimming were field tested in Area D.

Based on field testing, the SoakEase sorbents were capable of recovering very high, high and lower viscosity LNAPL from the recovery wells they were tested on. The Keck Canisters were successful in recovering low viscosity LNAPL, but could not recover high viscosity LNAPL as it would not pass through the screens within the canisters. The belt skimmer removed the more viscous LNAPL more effectively than the less viscous LNAPL, but removal of the LNAPL from the belt itself was very difficult and required extensive downtime. While capable of removing the free product in Area D, none of these technologies exhibited a high enough recovery rates to be time and cost effective in removal of Area D LNAPL. The estimated time for complete LNAPL removal using these three technologies ranged from 47 to 90 years, and would therefore not be implemented long term on site. It was determined that total fluids recovery technologies would be further investigated to determine the feasibility of Area D LNAPL removal in the future.

A simultaneous investigation of the offsite LNAPL was conducted to determine the characteristics and feasibility of recovering product from wells located on the bank of the Bronx River. As part of this investigation, five wells, four delineation wells and one ground water well, were installed along the river bank on property owned by Westchester County. Individual grab samples were taken from three of the delineation wells; LNAPL was not observed in one of the delineation wells and was therefore not sampled. A composite sample from the three wells was also collected to evaluate the physical and chemical properties of the combined LNAPL stream and its waste classification. Visual observations during the sample collection suggested that the river bank LNAPL resembled the less viscous product observed in Area C onsite. LNAPL thickness measurements were collected and a product bail down test was implemented to determine the recharge characteristics of the newly installed wells.

A pilot test was implemented to determine if in-well LNAPL recovery, or a LNAPL pumping system, and transfer of the recovered LNAPL from the well head to a storage tank was appropriate and implementable. Due to the visual similarities of the offsite LNAPL to that observed in Area C, and the successful removal of product using LNAPL only recovery on site in that area, LNAPL only recovery was deemed the most effective offsite technology. An upgraded "Spillbuster" system was chosen for pilot testing off site. The "Product Terminator" system contained a probe which housed a pump and a non-contact sensor to detect the LNAPL/water interface. The system also included an automatic level sensor, which rested on the top of the well head. The "Product Terminator" was tested in the three wells which LNAPL was constantly observed.

The pilot testing indicated that LNAPL located beneath the bank of the Bronx River could be recovered using LNAPL-only recovery pumps, as utilized in Area C onsite. Remedial alternatives were developed for recovery, transfer and storage of the LNAPL. The two alternatives were as follows:

- **Alternative I:** LNAPL only recovery with transfer of recovered LNAPL to the Former Red Devil facility for storage in an existing aboveground storage tank; and
- **Alternative II:** LNAPL only recovery with transfer of recovered LNAPL to an aboveground storage tank located adjacent to the recovery wells on the Bronx River bank.

These two alternatives were evaluated based on the same seven criteria used for previous remedial alternative comparison. Both alternatives would provide adequate and equal protection of human health and the environment, compliance with the SCGs and long-term effectiveness and permanence. Both alternatives posed potential short term effects. It was believed that due to the difficulties associated with LNAPL pumping that Alternative I would have considerably more implementability concerns than Alternative II. With regard to reduction of toxicity, mobility and volume, both alternatives would reduce mobility through recovery and reduce toxicity through offsite treatment. However, the addition of low viscosity oil to enable transfer and recovery of LNAPL under Alternative I would increase the volume of LNAPL requiring disposal. Alternative I was believed to have a total present worth of annual and capital costs of approximately $37,000 more than Alternative II. As such, Alternative II was selected as the preferred alternative for recovery, transfer and disposal of LNAPL located beneath the Bronx River.

In summary, the final components of the OU-1 remedy based on the Design Investigation were to continue active LNAPL recovery in Area C, additional investigation of recovery technologies (total fluids recovery) for Area D LNAPL, and installation and operation of Alternative II for LNAPL located beneath the bank of the Bronx River. No further actions were required for the floor drain and sump system, which was successfully traced, mapped and sealed where appropriate. An IRM was identified for Area A soil and ground water during the Design Investigation as well. It was proposed that collection of soil samples from Area A be implemented to identify the source of toluene in ground water and, if applicable, identify source removal technologies.

Following completion of the Design Investigation, an ***Operation and Maintenance Plan for the Automated Off-site LNAPL Recovery System*** was completed which outlined the unit process operation and maintenance requirements for the offsite recovery system. This system consisted of a product "seeking" pump located in each of the four recovery wells, a 500 gallon storage tank located in a concrete block building on the river bank and associated piping and process controls. A fiberglass vault housed each of the recovery wells to prevent water infiltration. This system was installed and began automated LNAPL recovery in June 1999.

2.3.2.6 Supplemental Reporting by ERM

Following the implementation of offsite LNAPL recovery, several reports were generated by ERM which consisted of an "***Area D Fluid Recovery Pilot Study***", an "***Effectiveness Monitoring Plan***", and "***Area D Extended Fluids Recovery Pilot***". They are discussed below.

2.3.2.6.1 Area D Total Fluid Recovery Pilot Study Report by ERM, November 2001

Based on the unsuccessful results of Area D LNAPL recovery in the DIR, a more aggressive recovery technology, total fluids recovery (TFR), was suggested. Total fluids recovery entails the recovery of LNAPL along with a small amount of water, which then requires fluids separation and possible groundwater treatment. This report outlined the procedures and results of the TFR pilot study conducted in Area D, which utilized a more durable rugged peristaltic pump, rather than the "Spillbusters" used in Area C. Due to inadequate recharge in the Area D wells, a significant quantity of LNAPL could only be removed from well DW-13D.

There were also several operational difficulties encountered during the pilot test. LNAPL had a propensity to harden in the transfer tubing, and was continually flushed to avoid clogging. In addition, a slug of hardened LNAPL was also encountered, and the hoses in the peristaltic pumps utilized during the testing tended to swell and crack due to the LNAPL viscosity. The system required frequent O&M to address such issues. Based on the results of the study, an extended TFR pilot study was suggested for use in DW-13D, which was the only well that exhibited reasonable recharge; TFR in all other delineation wells in Area D was deemed infeasible for LNAPL recovery. The conceptual design for the extended pilot was outlined in this report and is discussed in further detail below.

2.3.2.6.2 Effectiveness Monitoring Plan, by ERM, September 2002

The purpose of the Effectiveness Monitoring Plan was to evaluate the performance of the OU-1 remedy components and to identify performance criteria for continued implementation or shutdown of the components. The components investigated were onsite LNAPL recovery in Area C, onsite LNAPL recovery in Area D, offsite LNAPL recovery and offsite LNAPL recovery using the Bronx River boom system.

In 1996, a more viscous LNAPL had appeared in Area C wells, requiring rotation of down time of the pumping system through the end of 2001. By September 2002, LNAPL recovery in Area C had been steadily declining and active recovery using a "Spillbuster" pump was only occurring in one well, while a Soakease sorbent was placed in another. The decline in recovery significantly increased the cost per gallon of LNAPL recovered, prompting ERM to propose shutdown of the system when four consecutive quarters showed LNAPL removal of less than 15 gallons per quarter.

Area D LNAPL recovery continued to pose problems due to its viscous nature. As previously discussed, automated LNAPL-only recovery was conducted from July through November of 1994 and proved ineffective due to routine pump burn outs and hardening of LNAPL in the transfer piping. Soakease sorbents were placed in seven of the Area D delineation wells to continue manual LNAPL removal for 13 months. The use of alternative technologies (e.g. Keck Canisters, belt skimming and total fluids recovery) were also unsuccessful in this area. As determined in the total fluids recovery pilot study for Area D, an extended pilot test for the one well DW-13 would be implemented. This would be the last technology investigated before determining that LNAPL recovery in Area D was technically infeasible.

In September 2002, it was observed that LNAPL recovery had also declined since the implementation of the offsite LNAPL recovery system. This was thought to be due to a decline in Area C LNAPL volume and migration offsite, a steeper hydraulic gradient, influence of the river on water tables, and the difficulty of recovering the

LNAPL. Operational problems also plagued the system, with LNAPL hardening in the transfer tubing and storage tank, electrical problems, and cold weather causing recovery line clogging. Similar to the Area C recovery, this significantly increased the cost per gallon of LNAPL recovered. It was determined that this system would be shutdown either when the Area C system was shutdown or when the offsite LNAPL recovery for four quarters was less than 10 gallons per quarter, which ever occurred first.

A decline in the volume of Area C LNAPL as a result of onsite recovery also led to a decrease in the amount of discharged material into the Bronx River. Coupled with the decline in offsite LNAPL recovery, the boom system remained important for recovery of offsite LNAPL. It was concluded that the boom system would continue to operate until seeps were no longer observed.

2.3.2.6.3 Area D Well DW-13 Extended Fluids Recovery Pilot, by ERM, October 2002
This report documented the results of the extended total fluids recovery pilot test conducted on well DW-13D. Due to slow LNAPL recharge observed during the extended fluids recovery pilot, pumping downtime was required and therefore made the recovery ineffective, difficult to implement long term, and cost ineffective. It was ERM's opinion based on this final pilot test, and the previously unsuccessful technologies tested in Area D wells, that Area D LNAPL recovery was not considered technically feasible.

2.3.2.7 Remedial Investigation by LBG, March 2009

LBG conducted a RI for SUSA Mount Vernon, LLC between 2007 and 2009. The report summarized below, dated March 2009, is in the process of being revised in accordance with the Department comments provided to the LBG in correspondence dated August 13, 2009 and August 27, 2009. Due to ongoing additional investigation activities, the information below may be subject to change.

This RI was extensive and consisted of the following components:

- Preliminary site evaluation activities; composed of
  - Identifying status of remediation systems
  - Groundwater monitoring wells, production wells, and extraction well inventory
  - Groundwater sampling and analysis
  - Storage tank inventory
  - Bronx River monitoring well inventory
- Site demolition activities; including
  - Boiler room dismantling

  - Storage unit removal
  - Subsurface pipe tracing and ground penetrating radar survey
  - Removal of abandoned overhead piping
- Soil and vapor investigations; comprised of
  - Soil vapor intrusion investigation
  - Sub-slab vapor sampling point installation
  - Soil vapor point installation
  - Sub-slab soil vapor and soil vapor sampling
- Installation of groundwater monitoring and product delineation wells;
- Installation of one vertical and two horizontal groundwater extraction wells;
- Vertical and horizontal well pumping tests;
- Installation of one vertical and one horizontal soil vapor extraction wells;
- Vertical and horizontal soil vapor extraction pilot tests;
- Completion of a qualitative fish/wildlife exposure assessment; and
- Completion of a human health exposure assessement.

In addition to the RI activities, SUSA Mt. Vernon, LLC, conducted routine maintenance of the offsite boom system located along the bank of the Bronx River. Maintenance and removal of the disposable inner boom was conducted periodically, with activities being scheduled in response to observed field conditions. It was further noted in the RI Report (RIR), completed in March 2009, that the amount of seep material observed along the banks of the Bronx River has decreased since September 2006.

Three additional IRMs were conducted at the site during the performance of the RI, as a means of effectively addressing contamination prior to its completion. These IRMs consisted of closure activities for USTs and ASTs remaining on site, excavation and removal of impacted site soils, and application of a chemical oxidation compound to address dissolved phase contamination in Area D.

As a result of the subsurface investigation activities, as well as the IRM activities performed at the Site, the Site was comprehensively characterized. The site characterization consisted of defining the extent of soil vapor/indoor air, soil and groundwater contamination in the subsurface beneath the facility.

The results of the onsite soil vapor intrusion sampling indicated that soil vapor VOC concentrations beneath the facility were minimal. None of the indoor air samples collected contained concentrations of PCE, TCE and/or methylene chloride above the NYSDOH air guidance values. Based on the NYSDOH Soil Vapor/Indoor Air Matrices, the most conservative recommended courses of action for each area were: Monitor/Mitigate in Area A; Monitor/Mitigate in Area B; Monitor in Area C; and take reasonable and practical actions to identify source(s) and reduce exposures in Area D. Despite ERMs conclusion that there was no potential risk for vapor intrusion, LBG conducted the following mitigation activities in Areas A, B, C and D. In Area C, these activities consisted of removing the asphalt cap, UST closure activities, and excavation/removal of contaminated soil within the parking lot. In Areas B, C, and D, mitigation activities consisted of: removal of the slab on grade; UST closure activities; excavation/removal of contaminated soil and free-phase product; backfill with a highly permeable gravel; the installation of several sub-slab depressurizations pipes within the gravel layer; and installation of new reinforced concrete slab. The sub-slab depressurization pipes are currently passive venting to the atmosphere via a roof-mounted wind turbine. This system can be converted into an active system in the future if the need arises.

During the LBG UST and AST closure and excavation activities, several tanks which were never identified by ERM were encountered. Several of the tank volumes associated with ERM closure activities were also incorrectly recorded by ERM. Table 2.1 provides a concise overview of the site UST and AST information, and closure activities as conducted by ERM and LBG.

The results of the onsite soil sampling activities, which consisted of hollow-stem auger split spoon sampling, Geoprobe macro-core sampling and post excavation sampling, indicated that residual soil contamination existed throughout the subsurface of the site. The location of the former drywell in the parking lot of Area A, the western perimeter and northeast corner of Area C, and the south/southwestern portion of Area D, contained the highest concentrations and distribution of VOC impacted soils. This is the area of the site where the majority of soil excavation/disposal activities were focused. The elevated metals in the subsurface soils could be attributed to historic use of coal ash, urban fill, and regional site background concentrations resulting from surrounding area history.

The result of the onsite groundwater sampling, which consisted of GeoProbe sampling, groundwater monitoring and production well sampling, indicated that groundwater contamination exists in the subsurface throughout the site. Based on the site investigation, the areas where the highest concentration and distribution of VOC impacted groundwater was present include: the location of the former drywell in the parking lot of Area A; the western perimeter of Area C; and in the southwestern portion of Area D, where the highest concentration of VOC contamination was detected. As mentioned above, this was the portion of the site where most of the excavation occurred, thereby removing a significant volume of source material and free phase product. Laboratory results indicated that nearly all SVOC and metal concentrations were below the NYSDEC Technical & Operational Guidance Series (TOGS) values.

Although soil and groundwater contamination remain present beneath the site, groundwater is not a potential drinking source in the area, and the entire site is capped with asphalt/concrete. Therefore, LBG concluded that the potential for exposure due to dermal contact or ingestion was insignificant. Furthermore, they felt that engineering controls could be utilized to limit exposure to residual soil and groundwater contamination as well as free phase product.

The pilot tests and pumping tests, as well as the IRMs, performed during this RI were effective in removing a significant volume of contaminated LNAPL from the facility, as well as determining the feasibility of potential future remedial alternatives at the site. As a result of tank closure and excavation activities sixteen bulk storage tanks and their contents were removed, more than 2,550 tons of non-hazardous soil was removed, more than 11 tons of hazardous construction debris was removed, and, more than 224 tons of hazardous contaminated soil was removed from the site.

The results of the vertical well pumping test indicated that due to the limited saturated thickness and the low transmissivity of the unconsolidated water bearing unit, vertical groundwater wells were not a feasible remedial alternative for treating contaminated groundwater or for removal of LNAPL. The results of the soil vapor extraction well pilot test revealed that due to the low permeability of subsurface material, neither high or low vacuum from a vertical soil vapor extraction well yielded a significant radius of influence to effectively remediate residual soil contamination onsite. The grout injection pilot test also determined that low permeability soils limited grout infiltration and therefore could not be used to create a containment barrier to prevent or slow offsite migration of LNAPL.

Potentially effective remedial technologies were also identified by LBG during this RI. The horizontal extraction well pumping tests demonstrated that a low volume pumping rate coupled with an increased saturated length of well screen exposed to soils had the potential to remove groundwater with dissolved phase VOCs and possibly free-phase product from the subsurface. LBG also concluded that horizontal extraction pumping had the potential to control the onsite hydraulic gradient even with the low permeability soils. LBG believes that with continuous pumping, a cone of depression sufficient to control further migration of LNAPL and groundwater with dissolved VOCs would be induced. This technology also has the potential to draw free-phase product into the wells for extraction from the subsurface. It also indicated that groundwater extraction in an aquifer with low permeability can be effectively achieved through the use of horizontal extraction wells. Accordingly, groundwater and LNAPL remediation could be accomplished through pump and treat technology utilizing a series of horizontal groundwater/product extraction wells in conjunction with periodic product removal from vertical monitoring/delineation/extraction wells. The horizontal soil vapor extraction well pilot also demonstrated that it was effective in removing vapor phase from the subsurface of the site.

LBG also performed a field pilot test utilizing chemical oxidation in Area D. The objective of the application was to determine the effect of chemical oxidation applied to the subsurface. Facilitated by the former excavation being back filled with more permeable material. LBG will monitor the efficiency of this technology in reducing concentrations of dissolved phase VOCs in the groundwater through quarterly groundwater monitoring. RegenOxTM was applied to the ½-inch highly permeable pea stone which was placed in excavated Area D, and took place from October 14th through 18th, 2008. The outcome of this application has not yet been determined, as LBG intends to use quarterly groundwater monitoring data to determine the impact of the application on groundwater in Area D. It was also mentioned that if this application was considered successful, that direct injection via existing onsite wells may be utilized.

A qualitative Fish and Wildlife Resources Impact Assessment (FWRIA) was also completed by EcolSciences during the completion of the LBG RI. The results of this assessment, as well as a brief human health exposure assessment performed by LBG, were included in the March 2009 RI.

The purpose of the FWRIA was to: identify and describe fish and wildlife resources on and around the site; indentify contaminant pathways and any fish and wildlife exposure pathways; and to identify contaminants of ecological concern as defined in Section 1.3 of the DER-10. EcolSciences concluded that no areas of potential ecological concern resulting from past or present land use practices and/or facility operations existed with the exception of the seepage areas along the Bronx River. As a means of identifying contaminants of ecological concern, EcolSciences evaluated the analytical results of surface water and sediment samples collected by ERM as part of the 1992-1994 RI. The following was concluded, based on the data evaluation:

- Chemical constituents detected in the Bronx River sediments and surface waters included VOCs, SVOCs and metals.

- Groundwater conveyance of dissolved or floating contaminants present in the groundwater could be a potential migration pathway that adversely impacts fish and wildlife resources due to the observation of seepage areas.

- VOCs, SVOCs, and metals were present at concentrations in surface water and sediments samples exceeding their respective screening criteria for ecological risk.

- A comparison of concentrations of contaminants exceeding the screening criteria indicates that the exceedances are largely due to other sources in the watershed, not the site.

- TCE and PCE, which were not detected in the sediment samples taken adjacent to the seepage area, were the only constituents identified as contaminants of environmental concern associated with the site.

- The material discharging from the seepage area is being contained by a heavy weighted skirted boom in combination with a sorbent inner boom. Additionally, interim remedial measures were installed in 2007 for the purpose of reducing the volume of NAPL beneath the site, further minimizing the impacts to the Bronx River and offsite area from the site.

Overall, EcolSciences concluded that the seepage into the Bronx River had only a minor impact on the sediments in the immediate vicinity, and did not recommend further investigation of possible adverse impacts on fish and wildlife resources due to site contamination. However, these conclusions are not acceptable to NYSDEC.

The human health exposure assessment, performed at the same time as the above FWRIA, determined that there exists the potential for exposure to VOCs via inhalation of vapor, or via incidental ingestion or dermal contact with contaminated subsurface soils. However, because the site is entirely capped with asphalt/concrete, EcolScience concluded that the potential for exposure via ingestion or dermal contact was insignificant. The risk of exposure via inhalation of vapors was also low due to the fact that the basement and excavated areas of the first floor have been fitted with a sub-slab depressurization system (SSDS).

As a result of the RI and pilot testing, LBG concluded that additional remedial actions are required to actively remediate the onsite groundwater and control offsite migration. LBG has proposed to perform remedial alternatives analysis for submittal to NYSDEC. This submittal appears to be occurring at the same time as CDM conducts the FFS.

Section 3
Summary of Remedial Investigation

This section presents the physical characteristics of the Site, a summary of the recent LNAPL sampling and analysis conducted by CDM, a summary of the draft conceptual site model completed by CDM, and a summary of previously completed risk assessments.

An offsite RI/FS is being conducted concurrently with this FFS by CDM. The CDM RI/FS will focus on the soil and groundwater contamination offsite and is aimed at identifying existing data gaps and the need for additional sample collection and contaminant delineation.

3.1 Physical Characteristics of the Site

The physical characteristics of the Site and surrounding area are important to understanding the current nature and extent of contamination and future transport of contaminants. These characteristics are described in terms of the demography and land use, surface features, surface water and drainage, geology and hydrogeology.

3.1.1 Demography and Land Use

The Site is located in Westchester County, Mt. Vernon, New York. According to the 2000 Census from the United States Census Bureau, 68,381 people reside in Mt. Vernon, which covers an aerial extent of 4.4 square miles, and is the third most densely populated city in Westchester County.

Mount Vernon is bounded by the New York City Borough of the Bronx to the south, Yonkers to the west, Bronxville and Eastchester to the north and Pelham and Pelham Manor to the east. The Metro North Railroad runs northeast to southwest directly adjacent to the northwest of the study area, while the Bronx River and Bronx River Parkway run parallel to the railroad approximately 150 feet further to the northwest. Land use in Mount Vernon is predominantly industrial with retail trade, manufacturing, wholesale trade occupying the largest percentage of establishments. Health care and social assistances businesses and other services, with the exception of public administration, also occupy a large portion of the industry.

3.1.2 Surface Features

The former Red Devil property is mostly occupied by the 37,035 square feet (sq. ft.) multi-floored building. The first floor of this building is approximately at the same elevation as North West Street. North West Street runs along the front of the property, while a slight embankment runs behind the property before the Metro North rail lines are encountered. Beyond the railroad is a steeply sloped roughly 30 foot embankment that abuts a small flat parcel of land. This flat parcel of land is the offsite study area of concern. The area is roughly 400' by 20' and is heavily vegetated and overgrown. A fence runs southeast to northwest along the flat parcel directly north of DW-16. Two old railroad communication towers are also located in the study area further restricting access to the parcel. This small area is the location of the abandoned offsite treatment system, monitoring well, delineation wells and boom system. The offsite portion of the property also tapers off to the northeast when approaching the Oak Street Bridge. Beyond the location of the wells, another 10 to 15 foot sloped embankment is encountered adjacent to the Bronx River.

3.1.3 Surface Water and Drainage

The former site of the Red Devil property is located within approximately 115 feet of the southeastern bank of the Bronx River. Storm water-run off through the site drains to one of three locations: an onsite drywell located in the parking lot of Area A; a drywell located in the alleyway to the west-northeast of Areas C and D; and, through percolation through the topsoil in unpaved areas present to the south and west of Area A as well as to the west of Areas B, C and D. The majority of storm-water runoff flows along the surrounding roads (North West Street, Oak Street, and Mount Vernon Avenue), into storm-water catch basins, and through storm-water sewers (located along the surface topography to the northwest) ultimately discharging to the Bronx River. The majority of the storm water runoff in the offsite study area runs overland to the Bronx River. The Bronx River flows southward, and discharges into the Long Island Sound near the head of the East River.

The main source of groundwater in Westchester County is precipitation, which averages 48 inches per year. Runoff averages 22 inches per year. The volume of water that percolates down to the water table and recharges the groundwater is the remainder of the total precipitation not returned to the atmosphere by evapotranspiration or lost by runoff to the surface water drainage systems.

The 500 foot segment of the Bronx River that is part of the study area is classified as a Class C stream, indicating that it is fresh water suitable for fishing, fish propagation and survival, and primary and secondary contact recreation. The river flows southward and discharges into the Long Island Sound, near the head of the East River. The river is 30 feet wide and 3 to 5 feet deep, having an average flow of 60 cubic feet per second (cfs). The river channel consists of a vertical concrete wall on the north bank and riprap material and boulders along the south bank. The retaining wall on the north bank and the dense vegetation along the south bank physically restrict access to this area. It is believed that the riverbed is exposed bedrock in some locations based on visual field observations, but sediment disposition levels have been proven to vary depending on location

3.1.4 Site Geology

The site is located within the Lower Hudson River Valley of the New England physiographic province. The topography in the area consists of northeast trending ridges, separated by rivers that flow southward in narrow valleys.

Regional bedrock geology in this portion of southern Westchester County consists of the Manhattan Schist and Hartland Formation. The metamorphic bedrock is, overlain by a thin layer of unstratified glacial deposits. The Manhattan Schist is a highly-folded, coarsely-crystalline, micaceous schist. Outcrops of the Manhattan Schist can be found in road cuts and on ridges through the area, although no outcrops are present on the site. The Manhattan Schist is relatively impermeable and does not serve as an important source of water. Previous well records indicated that an average of 40 gallons per minute (gpm) is yielded from wells that average 320 feet in depth in the schist. The overburden typically consists of an unsorted mixture of clay, boulders, and glacial deposited as ground moraine. The glacial deposits generally have a low permeability and are a poor source of water. In stream valleys, such as the Bronx River, the overburden can be much thicker and consist of stratified glacial deposits, recent stream sediments and reworked glacial material. The water yielding capacity of the unconsolidated stream valley deposits is highly variable, but can be significant in places.

The site geology was determined by LBG through subsurface borings and excavations performed throughout the property for environmental characterization, which were typically 15 to 35 feet in depth. Immediately below the property is approximately 5 to 15 feet of fill material. The fill is predominantly sand, plus a mixture of coal dust, bricks, concrete rubble, boulders, and construction and demolition debris. The natural sediments below the fill are a mixture of glacial material and recent alluvial deposits. The unconsolidated glacial material is silty with lesser amounts of fine to medium sand and trace amounts of gravel; the glacial sediments are also poorly stratified. Bedrock was encountered throughout the site at approximately 20 to 25 feet below ground surface (bgs) in Areas C and D, or northern portion of the site. The bedrock appears to follow the contour of ground surface topography which rises to the south-southwest.

In order to characterize the subsurface materials on the property, LBG also utilized geologic logs recorded during the installation of the product delineation wells, GeoProbe borings, and descriptions of soils exposed during excavation activities. The Area A soils and first floor Area B soils consisted of approximately 10 feet of construction and demolition debris with high percentages of coal ash. This debris layer was approximately two to five feet thick in the basement of Area B as well as all areas of Area C and D. The underlying soils consisted primarily of very fine sand and silt with traces of silt and gravel. The amounts of silt and clay were higher in the northern portion of the site and decreased southwardly. These conditions were present prior to the extensive excavations conducted by LBG during their RI, as described in Section 2.3.2, and therefore may vary from the present conditions onsite.

Offsite, in the vicinity of the four delineation wells and one monitoring well, the subsurface consists of brown unconsolidated fine and medium sand with some gravel in the first four to five feet bgs. A significant fill layer was encountered beneath this layer, which consists of heavy cobbles and boulders, and extends roughly 12 feet below ground surface. Below the fill layer is a thinning layer of glacial/alluvial material, consisting of poorly graded gravel, sand and silt. This layer is thin in the direction of the riverbank, and is underlain by bedrock. Bedrock is exposed along the river bed.

3.1.5 Site Hydrogeology

As mentioned above, the main source of groundwater at the site is precipitation. There are no major aquifers in southern Westchester County. Both the Manhattan Schist and the glacial sediments are capable of yielding small quantities of water to wells, but these aquifers are no longer used. Wells tapping these aquifers have been abandoned due to urbanization. All potable water in the area is supplied by a public water system which is derived principally from surface water sources located north of the site. LBG noted that the depth to groundwater varied throughout the site from 13 to 25 feet below ground surface. Overall, groundwater appears to be flowing westward toward the Bronx River. To the knowledge of CDM, none of the previous investigations characterized the permeability or transmissivity of the study area.

3.2 LNAPL Sampling and Analysis

The FFS specifically addresses the offsite LNAPL in the subsurface and discharging into the river currently. The RI/FS being conducted by CDM will further characterize the nature and extent of the offsite groundwater, soil and sediment contamination.

3.2.1 Nature and Extent of LNAPL

Previous investigations conducted in the study area led to periodic LNAPL thickness measurements, monitoring and the implementation of the boom system in the river. The historic LNAPL thickness measurements can be seen in Tables 3-1 and 3-2. The most recent available LNAPL thicknesses recorded by LBG in January 2009 are also presented in **Figure 3-1**. ERM believed that the onsite plume present in Area C, which consisted of the less viscous LNAPL, was the source of the LNAPL discharging into the river as it migrated offsite. This conclusion was based on visual observation of the offsite LNAPL discharge and the belief that the more viscous Area D LNAPL was not mobile and remained onsite. Such assumptions were not confirmed by testing of the LNAPL characteristics and an offsite product only recovery pumping system was implemented based on demonstrated success in Area C onsite. However, as discussed in detail below, based on the 2009 CDM offsite LNAPL sampling and analysis, it has been determined that the onsite and offsite LNAPL chemistry differs and therefore the removal approach should be unique to the offsite LNAPL. Extensive pilot testing of offsite LNAPL removal was never explored and CDM believes that further characterization of the offsite LNAPL is necessary, as demonstrated by the failed offsite product only recovery system.

During the ERM Design Investigation, some preliminary LNAPL sampling was conducted. One sample of the offsite LNAPL from the boom system and four LNAPL samples from the delineation wells were collected and analyzed by gas chromatography (GC), infrared spectroscopy (FTIR) and wet chemical analysis. The boom sample was described as an amber, cloudy, non-viscous liquid with an odor similar to gasoline. It was nearly insoluble in water, had a viscosity of 7.5 centipoise (cps), a specific gravity of 0.806 and a pH of 4.7. At that time, ERM concluded that the sample was primarily composed of gasoline, based on odor, and a polymeric material, which was similar to the reference FTIR spectra of alkyd resin. The four LNAPL samples collected by ERM from the offsite delineation wells along the river bank were also submitted to the lab for the same analyses. These samples consisted of two layers, and only the top LNAPL layer was analyzed, according to ERM's report. The sample from DW-16 did not receive all of the analyses due to a lack of LNAPL volume in the well at the time of sampling. The samples were also described as an amber, cloudy, non-viscous liquid with an odor similar to gasoline. The samples had viscosities ranging from 7 to 8 cps, specific gravities between 0.804 and 0.814 and a pH between 5.38 and 5.55. These samples were also determined to consist of petroleum distillate and were similar to alkyd resins.

3.2.2 Recent Onsite LNAPL Analysis

LNAPL sampling was conducted by CDM in early 2009 in order to characterize the LNAPL both onsite and offsite. On January 20, 2009, 7 wells located onsite were sampled for LNAPL: DW-14D, DW-21D, R-4D, DW-5C, DW-1C, DW-2C and DW-20B. The recovered LNAPL samples were sent to Inovatia Laboratories, LLC for analysis and characterization using custom analytical methods to identify unknowns.

The aqueous phase of all seven samples was analyzed for light alcohols by gas chromatography with flame ionization detection (GC/FID) and for VOCs by gas chromatography with mass selective detection (GC/MS). The LNAPL phase was separated from the aqueous phase of each sample. The separated aqueous phase was then extracted and run through a GC/MS to analyze for the major components of the aqueous phase. The laboratory reports can be found in **Appendix A**.

The LNAPL phase of DW-14D, R-4D and DW-1C were diluted and run through a GC/FID. The GC/FID results were then compared to the GC/FID for a comparable solution of mineral spirits. Based on this analysis, the LNAPL phase of the samples from DW-14D, R-4D and DW-1C were found to be similar in composition to mineral spirits. The diluted LNAPL phase was then run through a GC/MS to analyze for the major components of the non-aqueous fraction. See Table 3-3 for the distribution of the major components of the LNAPL phase of the three samples collected from these wells and the depths to water and depths to product recorded in these wells on January 19, 2009. All the samples showed the presence of a significant amount of toluene 2,4-diisocyanate, which is a monomer used to produce the polymer polyurethane. The samples taken at DW-14D, R-4D and DW-1C contained 0.9%, 1.1% and 0.3% of toluene 2,4-diisocyanate, respectively. Two of the samples, R-4D and DW-14D, contained a gelatinous layer between the aqueous phase and the light organic phase. An aliquot of each samples gelatinous layer was diluted in acetone and analyzed by GC/MS.

The same gelatinous layer located between the aqueous phase and light organic phase in two of the samples, DW-14D and DW-21D, was dissolved in dichloromethane to remove remaining water and soil. The dichloromethane was removed by evaporation, and the samples were extracted using pentane to remove the remaining mineral spirits. The solid was then redissolved in dichloromethane. The dissolved sample was analyzed by gel permeation chromotography (GPC) and FTIR, in order to determine the size and the functional groups of the polymer chains. The FTIR showed the samples from both wells had the same makeup, which was a combination of polyurethane, polyester and polyurea. The GPC for each sample showed two peaks. For the sample from DW-14D, 43% of the substance had a molecular weight of approximately 16,300, while 57% of the substance had a molecular weight of approximately 3,900. For the sample from DW-21D, 36% of the substance had a molecular weight of approximately 14,800, while 64% of the substance had a molecular weight of approximately 2,800. It should be noted that since the solids were only sparingly soluble in dichloromethane that the GPC could have underestimated the molecular weight of the substance.

Since Toluene 2,4-diisocyanate reacts in the presence of alcohols and amines to produce polyurethanes and polyureas, respectively, titrations were performed to determine the alcohol and amine concentration of the aqueous phase of each sample. The aqueous phase of each of the seven samples was isolated, acidified and reduced to dryness in a rotary evaporator to remove volatiles and semi-volatiles. The sample was then resuspended in 200 mL of deionized water and split to be used in two different titrations: one for amines and one for alcohols. All seven samples showed significant amounts of amines and alcohols. This is significant since these compounds, when dissolved in the aqueous phase and in contact with the LNAPL phase, react with the toluene 2,4-diisocyanate in the LNAPL to form polymers. Toluene 2,4-diisiocyanate will also react with water and most acids to produce unstable carbonic acids, which decarboxylate to yield relatively chemically inert polymeric urea.

3.2.3 Recent Offsite LNAPL Analysis

On April 27, 2009, the 4 delineation wells located offsite, DW-16, DW-17, DW-18, and DW-19, were sampled for LNAPL. The LNAPL samples were also sent to Inovatia Laboratories, LLC for analysis and characterization using custom analytical methods to identify unknowns. The laboratory reports can be found in **Appendix A**.

The aqueous phase of all four samples was analyzed for light alcohols by GC/FID and for VOCs by GC/MS. The LNAPL phase was separated from the aqueous phase for each sample using a separatory funnel. The separated aqueous phase was then extracted and run through a GC/MS to analyze for the major components of the aqueous phase.

The LNAPL phase of DW-17 and DW-18 were then diluted by a factor of 100 with dichloromethane and run through a GC/FID. The GC/FID results were compared to a 2000 μg/mL solution of mineral spirits. The LNAPL phase of the samples from DW-17 and DW-18 were found to have a 19% and 61% FID response of equal mass of mineral spirits, respectively. Based on this analysis, although the LNAPL phase of the samples from DW-17 and DW-18 were found to be similar in composition to mineral spirits, some differences were found due to the presence of C3 and C4 benzene compounds. C3 and C4 compounds are commonly used as solvent additives for polyurethanes, lacquers, polyureas and polyol-amines. The LNAPL phase diluted in dichloromethane was then run through a GC/MS to analyze for the major components of the non-aqueous fraction.

The organic fraction of this set of samples appeared cloudy, and were observed to be short chain polymers suspended in mineral spirits. The cloudy organic fractions found in the samples from DW-17 and DW-18 were passed through filter paper. The gelatinous substance retained was dried and dissolved in dichloromethane. The dissolved sample was analyzed by gel permeation chromatography (GPC) and FTIR, in order to determine the size and the functional groups of the polymer chains. The major peaks of the FTIR showed the samples from both wells had both ester and amide character. The GPC for each sample showed one peak. For the sample from DW-17, the substance had a molecular weight of approximately 100,000. For the sample from DW-18, the substance had a molecular weight of approximately 91,000. The results from the FTIR and GPC indicate the solid material is a mixture of polyurethane, polyester and polyurea.

3.2.4 Conclusions from Recent LNAPL Analysis

Based on the laboratory analysis discussed above, the LNAPL found in onsite Areas C and D consists mainly of weathered mineral spirits that contain the compound toluene 2,4-diisocyanate. **Figure 3-2** illustrates the relationship between the LNAPL, toluene 2,4-diisocyante and the groundwater (aqueous phase). It is believed that the toluene 2,4-diisiocyanate reacts at the LNAPL-aqueous phase interface with compounds containing active hydrogen atoms, such as alcohols, amines and water, present in the aqueous phase to form polyurethanes, polyureas and polyesters. The areas of highest toluene 2,4-diisocyante concentrations in the LNAPL are believed to be associated with higher degrees of cross linking in the polymers as the reaction proceeds to further completion in the presence of higher concentrations, while the lower concentrations of toluene 2,4-diisocyante result in shorter chain polymer creation. The rate of this reaction and the degree of crosslinking in the polymer product is may also be increased by the addition of heat or turbulence.

The offsite LNAPL exhibits different characteristics than the onsite LNAPL. The offsite LNAPL does not contain toluene 2,4-diisocyanate, but rather is a mixture of weathered mineral spirits and linear or shorter chained polymers (polyurethanes, polyesters and polyureas), with C3 and C4 benzene compounds that may have been solvents used in the manufacture of polyurethanes, lacquers, polyesters and polyol-amides. It is believed that the toluene 2,4-diisocyanate in the LNAPL reacts to completion with the alcohols and amines in the aqueous phase as the plume migrates offsite, since no toluene 2,4-diisocyanate was detected offsite. **Figure 3-3** provides a conceptual model of the LNAPL and polymer migration from the site to the Bronx River.

The higher concentrations of toluene 2,4-diisocyanate participating in the reaction on site promotes the reaction further to completion resulting in crosslinking during polymer formation at the site. The higher the concentration of toluene 2,4-diisocyanate involved in the reaction, the more likely that crosslinking of polymers will occur. This results in the more viscous material found on site, compared to offsite. It is also believed that the cross-linked polymers, because of their size, are not readily mobile in the geology and may remain trapped within the aquifer matrix on the site. The short chained polymers seen offsite are likely created in areas with lower concentrations of toluene 2,4-diisocyanate in the LNAPL. It is believed that the concentrations of toluene 2,4-diisocyante decrease as it reacts with the components of the aqueous phase as it migrates offsite. Once the toluene 2,4-diisocyanate has reacted to completion, there is no new polymer creation.

As shown in **Figure 3-3**, the short chain polymers are believed to travel in colloidal suspension with the LNAPL and eventually discharge into the Bronx River. As the short chain polymers extrude onto the river, they agglomerate to for a plastic sheet-like material. It is unknown whether the formation of this material in the boom is simply due to the polymers coagulating, or if another mechanism, such as mixing, exposure to oxygen or temperature change, is involved. The FFS Investigation and Treatability Study discussed in Section 7 include additional LNAPL analysis to help determine this mechanism.

3.3 Conceptual Site Model

A separate draft conceptual site model (CSM) was completed by CDM and submitted to the NYSDEC on July 7, 2009. The complete draft CSM is provided in **Appendix B**.

3.4 Risk Assessment

ERM completed a comprehensive baseline public health and ecological risk assessment using data gathered during the completion of their RI. This risk assessment focused on establishing an overall degree of hazard posed by the existing conditions at the site and are included in further detail in Section 2.3.2.2. A qualitative Fish and Wildlife Resources Impact Assessment (FWRIA) was also completed by EcolSciences during the completion of the LBG RI. The results of this assessment, as well as a brief human health exposure assessment performed by LBG, were included in the March 2009 RI and are discussed in Section 2.3.2.7.

An additional FWRIA is also being conducted by CDM as part of the offsite RI/FS and will be submitted to NYSDEC under separate cover.

Section 4
Remedial Goals and Remedial Action Objectives

Remedial action objectives (RAOs) are media-specific goals for protecting human health and the environment that serve as guidance for the development of remedial alternatives. The process of identifying the RAOs follows the identification of affected media and contaminant characteristics; evaluation of exposure pathways, contaminant migration pathways and exposure limits; and the evaluation of chemical concentrations that will result in acceptable exposure. The RAOs are based on regulatory requirements that may apply to the various remedial activities being considered for the site. This section of the FFS reviews the affected media and contaminant exposure pathways and identifies Federal, State, and local regulations that may affect remedial actions.

4.1 Standards, Criteria, and Guidance

To determine whether the free phase product discharging into the Bronx River is of concern, State and Federal SCGs were assessed. The applicable SCGs are summarized in the following sections.

Potential SCGs are divided into three groups:

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

4.1.1 Chemical-specific Standards, Criteria, and Guidance

Chemical-specific SCGs are health- or technology-based numerical values that establish concentration or discharge limits for specific chemicals or classes of chemicals. Groundwater at the Site currently is not being used as a source of drinking water, but NYSDEC classifies all fresh groundwater in the state as "Class GA fresh groundwater", for which the assigned best usage is as a source of potable water supply. Therefore, although there are no known current users of groundwater at or near the Site, the groundwater is assumed to be a source of drinking water in the future. Therefore, New York State Groundwater Quality Standards are applicable requirements and the Federal and New York State primary drinking water standards are applicable if an action involves future use of groundwater as a public supply source.

4.1.1.1 Federal Standards, Criteria, and Guidance

Federal Drinking Water Standards

- National Primary Drinking Water Standards (40 CFR 141). Potentially applicable if an action involves future use of groundwater as a public supply source.

4.1.1.2 New York Standards, Criteria, and GuidanceGroundwater Standards and Guidance

- New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (Technical and Operational Guidance Series (TOGS) 1.1.1). Used for setting numerical criteria for groundwater cleanups. This guidance does not include reference to LNAPL and is therefore not applicable.

- New York State Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6 New York Environmental Conservation Rules and Regulations (NYCRR) Part 703). Applicable, as the regulations state "No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease" in Class C surface water, such as the Bronx River.

4.1.2 Location-specific Standards, Criteria, and Guidance

Location-specific SCGs are those which are applicable or relevant and appropriate due to the location of the Site or area to be remediated. There are no applicable regulations at the Site relevant to location specific SCGs.

4.1.3 Action-specific Standards, Criteria, and Guidance

Action-specific SCGs are requirements which set controls and restrictions to particular remedial actions, technologies, or process options. These regulations do not define Site cleanup levels but do affect the implementation of specific remedial technologies. These action-specific SCGs are considered in the screening and evaluation of various technologies and process options in subsequent sections of this report.

4.1.3.1 Federal Standards, Criteria, and Guidance

General - Site Remediation

- Occupational Safety and Health Administration (OSHA) Worker Protection (29 CFR 1904, 1910, 1926)

- Federal Resource Conservation and Recovery Act - Identification and Listing of Hazardous Waste (40 CFR 261); Standards Applicable to Generators of Hazardous Waste (40 CFR 262); Standards Applicable to Owners and Operators of Treatment, Storage, and Disposal Facilities (40 CFR 264)

Transportation of Hazardous Waste

- Hazardous Materials Transportation Regulations (49 CFR 107, 171, 172, 177, and 179)

- Federal Resource Conservation and Recovery Act - Standards Applicable to Transporters of Hazardous Waste (40 CFR 263)

Disposal of Hazardous Waste

- Federal Resource Conservation and Recovery Act - Land Disposal Restrictions (40 CFR 268)

Discharge of Groundwater

- Federal Clean Water Act - National Pollutant Discharge Elimination System (40 CFR 100 et seq.); Effluent Guidelines and Standards for the Point Source Category (40 CFR 414); Ambient Water Quality Criteria (40 CFR 131.36)

- Federal Safe Drinking Water Act - Underground Injection Control Program (40 CFR 144, 146)

4.1.3.2 New York Standards, Criteria, and Guidance

New York Solid and Hazardous Waste Management Regulations (6 NYCRR)

- Hazardous Waste Management System - General (Part 370)

- Solid Waste Management Regulations (Part 360)

- Identification and Listing of Hazardous Waste (Part 371)

Transportation of Hazardous Waste (6 NYCRR)

- Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities (Part 372)

- Waste Transporter Permit Program (Part 364)

Disposal of Hazardous Waste (6 NYCRR)

- Standards for Universal Waste (Part 374-3)

- Land Disposal Restrictions (Part 376)

Discharge of Groundwater (6 NYCRR)

- The State Pollutant Discharge Elimination System (SPDES) (Part 750-757)

- New York State Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6 NYCRR Part 703)

- New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS 1.1.1)

Discharge to Surface Water (6 NYCRR)

- Use and Protection of Waters (Part 608)
- Technical Guidance for Screening Contaminated Sediments

4.2 Remedial Action Objective

Based on previous evaluations of the nature and extent of the LNAPL discharge, and the previous assessments of human and environmental risk associated with exposure to the LNAPL, the recommended RAO is to prevent LNAPL discharge into the Bronx River, thereby limiting exposure to aquatic life.

4.3 Preliminary Remediation Goals

Preliminary remediation goals (PRGs) are typically selected based on federal or state promulgated SCGs, background concentrations, and with consideration also given to other requirements such as analytical detection limits and guidance values. However, PRGs have not been established for the FFS, as the presence of LNAPL prevents the ability to address the contamination present in the dissolved phase.

Section 5
General Response Actions

Based on the established RAO and site conditions, general response actions (GRAs) were identified. GRAs are those actions that, singly or in combination, satisfy the RAO for the LNAPL by reducing the concentrations of hazardous substances or reducing the likelihood of contact with hazardous substances. The GRAs appropriate for addressing the offsite LNAPL include:

5.1 No Action

The National Contingency Plan (NCP), CERCLA and New York State guidance entitled "Draft DER-10 Technical Guidance for Site Investigation and Remediation" require the evaluation of a No Action alternative as a basis for comparison with other remedial alternatives. Under the No Action alternative, remedial actions are not implemented, the current status of the Site remains unchanged, and no action would be taken to reduce the potential for exposure to contamination.

5.2 Institutional/Engineering Controls

Institutional/Engineering Controls typically are restrictions placed to minimize access (e.g., fencing) or future use of the site (e.g., well drilling restriction). These limited measures are implemented to provide some protection of human health and the environment from exposure to site contaminants. They are also used to continue monitoring contaminant migration (e.g., long-term monitoring). Institutional/ Engineering Controls are generally used in conjunction with other remedial technologies; alone they are not effective in preventing contaminant migration or reducing contamination.

5.3 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is a response action by which the volume and toxicity of contaminants are reduced by naturally occurring processes in the groundwater. Processes which reduce contamination levels in groundwater include dilution, dispersion, volatilization, adsorption, biodegradation, and chemical reactions with other subsurface constituents. This naturally occurring attenuation is not expected to reduce LNAPL quantities to achieve the RAO within a reasonable timeframe and/or within a reasonable physical boundary.

5.4 Containment

Containment actions use physical, low permeability barriers and/or extraction wells to minimize or eliminate contaminant migration. Containment technologies do not involve treatment to reduce the toxicity or volume of contaminants. The response actions require long-term monitoring to determine whether containment actions are performing successfully.

5.5 Removal/Extraction

Removal response actions refer to methods typically used to excavate and handle soil, sediment, waste, and/or other solid materials, and are therefore not applicable to this FFS. An extraction-based response action provides reduction in mobility and volume of contaminants by removing the LNAPL from the subsurface using such means as extraction wells or interceptor trenches. Extraction can provide hydraulic control to prevent migration of LNAPL. Extraction is usually used in conjunction with other technologies, such as treatment or disposal options, to achieve the RAOs for the removed media.

5.6 Treatment

Treatment involves the destruction of contaminants in the affected media, transfer of contaminants from one medium to another, or alteration of the contaminants thereby making them innocuous. The result is a reduction in toxicity, mobility, or volume of the contaminants. Treatment technologies vary among environmental media and can consist of chemical, physical, thermal, and biological processes. Treatment can occur in place or above ground. This GRA is usually preferred unless the site, or contaminant-specific characteristics, makes it infeasible from an engineering and implementation perspective, or too costly.

Section 6
Identification and Screening of Remedial Technologies

Potential remedial technologies and process options associated with each GRA are identified and screened in this section. Representative remedial technologies and process options that have been retained are used to develop remedial action alternatives.

The technology screening approach is based upon the procedures outlined in *Draft DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC 2002). The evaluation process uses three criteria: Effectiveness, Implementability, and Relative Cost. Among these three, the effectiveness criterion outweighs the implementability and relative cost criteria. These criteria are described below:

Effectiveness. This evaluation criterion focuses on the effectiveness of process options to reduce the toxicity, mobility, or volume of contamination for long term protection and for meeting the RAO. It also evaluates the potential impacts to human health and the environment during construction and implementation, and how proven and reliable the process is with respect to site specific conditions.

Implementability. This evaluation criterion encompasses both the technical and administrative feasibility of the technology or process option. It includes an evaluation of pretreatment requirements, residuals management, and the relative ease or difficulty in performing the operation and maintenance (O&M) requirements. Process options that are clearly ineffective or unworkable at the site are eliminated by this criterion.

Relative Cost. Cost plays a limited role in the screening process. Both capital costs as well as O&M costs are considered. The cost analysis is based on engineering judgment and each process is evaluated as to whether costs are low, moderate, or high relative to the other options within the same technology type.

Retained remedial technologies and process options are used to develop remedial action alternatives, either alone or in combination with other technologies.

6.1 No Action

The No Action alternative is not a technology. The No Action alternative is considered as a basis for comparison.

Effectiveness - The No Action alternative is used as a baseline, it generally does not provide measures that would comply with SCGs, or otherwise meet RAOs.

Implementability - The No Action alternative is implementable given there is no action required.

Relative Cost - The No Action alternative involves no capital or O&M costs.

Conclusion – The No Action alternative is retained for further consideration.

6.2 Institutional/Engineering Controls

Institutional and Engineering Controls do not reduce the toxicity, mobility, or volume of contamination, but can be implemented to reduce the probability of exposure to contaminants. Institutional controls consist of administrative actions which control use of the site (e.g., well drilling restrictions) to reduce direct human contact to the LNAPL. Institutional controls generally require long term monitoring. Engineering controls consist of installing physical barriers to minimize site access.

6.2.1 Environmental Easements

Environmental easements can be used to restrict the use of a property to specified categories, or to require the long-term operation, maintenance and monitoring of engineering controls. Environmental easements are implemented to protect public health and the environment, requiring property owners to periodically certify to DEC that the restrictions and requirements of the easement remain in place and effective.

Effectiveness - Environmental easements would not effectively restrict or eliminate exposure of contaminated surface water in the Bronx River, or reduce the migration and the associated environmental impact of the LNAPL discharge.

Implementability - Environmental easements are implementable through the existing administrative system for the land adjacent to the River.

Relative Cost - The cost to implement an environmental easement is low. Some administrative, long-term monitoring and periodic assessment cost would be required.

Conclusion – Environmental easements will be retained as a component of any remedy that does not fully meet 'pre-release' and all site specific standards, criteria and guidance.

6.2.2 Access Restrictions

Access Restrictions consist of installing physical barriers to limit the exposure to contaminated media, and can also involve the maintenance of existing structures to ensure exposure remains limited.

Effectiveness - Access restrictions could effectively restrict or eliminate use of the land adjacent to the LNAPL discharge. However, access is currently restricted and these restrictions would not achieve the RAO or reduce the toxicity, mobility, or volume of contamination for long term protection. While exposure to the LNAPL would be limited, discharge to the river would still actively occur.

Implementability - Access restrictions would be easily implemented offsite.

Relative Cost - The cost to implement access restrictions is low compared to active recovery or remedial technology implementation. Maintenance and long-term monitoring of the implemented restrictions would be required.

Conclusion – Access restrictions will not be retained for further consideration, as they do not achieve the RAO.

6.3 Monitored Natural Attenuation

MNA refers to the remedial action that relies on naturally occurring attenuation processes to achieve site-specific RAOs within a reasonable time frame. Natural attenuation processes that reduce contaminant concentrations in groundwater include destructive (biodegradation and chemical reactions with other subsurface constituents) and nondestructive mechanisms (dilution, dispersion, volatilization, and adsorption). Periodic groundwater and LNAPL sampling would also be required as part of this effort.

Effectiveness – A natural attenuation process that would reduce the level of LNAPL is not known and MNA would therefore not be effective in achieving the RAO.

Implementability – Implementation is possible, as groundwater and LNAPL sampling would be the only requirement of MNA and are easily implemented offsite.

Relative Cost – MNA would involve low capital cost.

Conclusion – MNA will not be retained for further consideration due to its inability to achieve the RAO.

6.4 Containment

Low-permeability vertical barrier walls are typically installed downgradient of source areas or plumes to control LNAPL migration and discharge. The walls would be constructed using slurry or sheet piling to the top of a low permeability layer. Barrier walls are most effective in areas where a high water table, a shallow depth of the aquifer and a confining clay unit are found. Within these areas, both types of barrier walls (i.e., slurry or sheet pile) would be effective for redirecting contaminated groundwater and LNAPL flow. Barrier walls can be used in combination with an extraction system; the walls would minimize the amount of pumping required to maintain hydraulic control by acting as a physical barrier, restricting clean groundwater inflow from side-gradient areas into the capture zone. Less invasive technologies such as a passive boom system can also be utilized for containment of contaminant migration.

6.4.1 Slurry Walls/Grout Injection

Slurry walls are constructed by pumping a low-permeability slurry, typically consisting of either a soil-bentonite or cement-bentonite mixture, into an excavated trench or direct injection point. Installation utilizing excavation can be completed using a long-arm excavator and a clam shovel to meet the required depth, while grout injection can be installed using several techniques; including permeation, compaction grouting, claquage and jet grouting.

Effectiveness - Slurry walls and grout injection could effectively achieve hydraulic control if they are compatible with offsite lithology and built properly. Upon the completion of remedial activities, the walls would remain in place and continue to influence groundwater flow patterns on a localized scale. To effectively meet the RAO, this technology would be used to slow discharge to the river, but would need to be coupled with an extraction or recovery technology in order to remove the LNAPL.

Implementability - Slurry walls are not implementable and grout injection is very difficult to implement offsite due to limited access and the presence of heavy gravel, cobbles and boulders located between five and twelve feet bgs, according to the ERM boring logs. The implementation of a slurry wall is further infeasible due to the limited space of the offsite area; there is not sufficient room for an excavation trench. Grout injection may prove implementable once further information is obtained about the offsite geology. Very limited information is currently available for the geology adjacent to the river. However, LBG conducted a pilot grout injection test onsite which was unsuccessful due to the low permeability soils limited grout infiltration. During the installation of the offsite monitoring well and delineation wells, ERM borings logs were recorded and they are the only geological information present at this time. Further study during the FFS Investigation is planned to provide additional geologic information to determine if implementability of ground injection is possible.

Relative Cost - Slurry walls and grout injection involve moderate capital costs. The access restrictions and nature of the subsurface material offsite would likely further increase capital cost. Drill rigs and any excavation equipment would need to be moved via crane to the river bank and extensive clearing of vegetation, including trees, would be necessary. The removal of existing fencing and old railroad communication towers (two abandoned towers are currently present offsite near the existing well locations) may also be needed to allow for adequate access to boring locations. This in turn would significantly increase the cost of implementing such technologies.

Conclusion - Slurry walls and grout injection will not be retained for further consideration due to difficulties with implementability. However, if further geological information indicates compatibility with grout injection, the technology may be revisited to determine applicability and is therefore reserved for future consideration.

6.4.2 Sheet Pile Barriers

Sheet pile barriers are constructed by driving or vibrating sections of steel sheet piling into the ground. Each sheet pile section is interlocked at its edges, and the seams are often grouted to prevent leakage.

Effectiveness - Sheet pile walls can be effective at providing hydraulic control. Upon the completion of remedial activities, the sheet piles can be vibrated out of the ground, disassembled, and removed from the site, provided that the sheeting and joints are still of good structural integrity at the time of removal. Otherwise, the sheets would be cut off below ground surface, and the walls would continue to influence groundwater flow patterns on a localized scale. Sheet pile material may deteriorate overtime due to reaction with constituents in groundwater. To achieve the offsite RAO, this technology would need to be coupled with LNAPL extraction or recovery technology.

Implementability - Sheet pile walls along the Bronx River are not implementable, due to access restrictions for heavy equipment, lack of adequate offsite area and the suspected presence of boulders in the subsurface.

Relative Cost - Sheet pile walls involve high capital cost, which would be increased due to accessibility issues.

Conclusion - Sheet pile walls will not be retained for further consideration due to lack of implementability.

6.4.3 Secant Piling

Secant piles are a form of containment typically used for the construction of retaining systems used during deep excavations. Secant pile walls are formed by intersecting reinforced concrete piles installed via mud drilling or augering. The piles range in diameter from 12 inches to 36 inches and primary piles are installed first with secondary overlapping piles installed once the primary piles have gained sufficient strength. Secant piling can be utilized in difficult subsurface material, such as cobbles and boulders, where other containment barriers cannot.

Effectiveness – If installed properly, secant pilling should create a durable barrier that would slow the migration of LNAPL and its discharge to the river. To effectively achieve the RAO, this technology would need to be coupled with extraction.

Implementability – Secant piles can be installed in rough subsurface materials, such as cobbles and boulders, which are anticipated in the offsite subsurface. Installation of secant piling is implementable in the offsite geology but will be challenging due to the limited space and access restrictions offsite.

Relative Cost – The installation of secant piling would involve high capital costs and no O&M costs.

Conclusion – Secant piling will be retained for further consideration.

6.5 Removal/ Extraction

Extraction and removal technologies intercept the flow of LNAPL and/or LNAPL and contaminated groundwater to hydraulically prevent contamination from migrating downgradient. This technology is also used for dewatering when it is necessary to lower the water table to facilitate installation/operation of other remedial technologies. The extracted groundwater is typically treated ex situ and disposed of on site or off site.

6.5.1 Pre-Disposal

The pre-disposal remedial alternative focuses on the restoration of the off-site portion of the property to pre-disposal conditions. This pre-disposal condition is anticipated to be achieved through extensive excavation of the shore, off-site disposal of soil and LNAPL above the unrestricted Soil Cleanup Objectives (soil collection and analysis pending) and extensive site restoration.

Effectiveness –Assuming that the excavation can be carried to bedrock, the pre-disposal remedy is highly effective, as it involves the physical removal of contaminants from the site. However, for this remedial alternative to be effective, it is assumed that LNAPL onsite and beneath the Metro North Railroad has been contained or remediated to avoid recontamination of the offsite parcel.

Implementability – The implementability of this remedial alternative hinders on several constraints, including severely restricted site access and difficult geology. It is assumed that the excavation will not extend below the Metro North Railroad, due to a lack of implementability and that the excavation of the shore will extend to bedrock to account for possible contamination. The presence of cobbles and boulders at 5′ to 15′ bgs greatly increase the difficulty of excavating to depth. The size constraints and rough, unstable surface of the shore will require extensive coordination and planning in regards to the methods of excavation employed. The excavation will extend to the bedrock to ensure that the full extent of the contamination is captured. The stream bed of the Bronx River will not be excavated; as it is exposed bedrock. The implementability of this technology is further hindered by the limited site access. However, per Part 375, this technology will be carried through to the remedial alternatives analysis and costing. Several assumptions about the offsite geology and extent of the LNAPL will be made, as the results of the FFS Investigation are required for more accurate detail. Assumptions regarding excavation, offsite disposal, backfilling and site restoration are also discussed in further detail in Section 8.

Relative Cost – Due to the many constraints discussed above, the pre-disposal technology will require high capital cost and will not require any O&M costs.

Conclusion – This technology will be retained for further consideration.

6.5.2 Extraction Trenches

This technology involves construction of a trench or trenches, perpendicular to the direction of groundwater flow, to intercept and prevent downgradient migration of LNAPL and groundwater. A bio-polymer slurry is typically used to temporarily support the sidewalls of the trench, preventing collapse of the trench sidewalls. The trench is typically backfilled with material of higher permeability than the native

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aquifer (e.g., gravel) to create a zone of preferential flow, and perforated piping or well screens are typically installed in the trench to collect the intercepted groundwater.

Effectiveness -Extraction trenches are typically effective in capturing groundwater to provide hydraulic control. Extraction trenches are usually used at sites with low permeability and may not be as effective offsite if further investigation into the lithology yields higher permeability soils.

Implementability - Extraction trenches are difficult to implement due to the presence of heavy cobbles and boulders between 5′ bgs and 15′ bgs offsite, as discussed above. Limited space constraints also make excavation offsite hard to implement, as excavation along the approximately 20 foot wide parcel would be very difficult with large equipment. In addition, the extracted groundwater may require treatment to remove the contaminants prior to discharge, while the LNAPL would be collected and disposed of offsite. Due to space constraints, implementability would be reduced if large treatment vessels were required (too large for the currently abandoned offsite treatment building).

Relative Cost – Typical extraction trenches involve moderate capital costs and low O&M costs. However, the nature of the site would further add to the capital costs. As mentioned previously, a crane would need to be used to locate excavation equipment along the river bank and extensive clearing of vegetation would be needed. Removal of the LNAPL and groundwater from the recovery and treatment systems would increase O&M costs, as a vacuum truck located on the Mount Vernon Avenue Bridge would be necessary to remove the groundwater and LNAPL from the site of the current treatment building. Traffic control and close supervision for each removal event would be needed to ensure proper removal and worker safety.

Conclusion - Extraction trenches will not be retained for further consideration due to issues concerning implementability offsite.

6.5.3 Manual Passive Recovery

Manual passive recovery technologies consist of hydrophobic sorbents and hydrophobic collections canisters placed in wells and are typically utilized in situations where small amounts of LNAPL are present.

Effectiveness – Passive sorbents and canisters would have limited effectiveness offsite, since they only eliminate the LNAPL they come into direct contact with in the wells. Therefore, they would likely not eliminate discharge to the river. Therefore, the RAO would not be achieved through use of these technologies, nor would the toxicity or mobility of the LNAPL be decreased. Blinding of the sorbents and canisters screens by polyurethane or polyurea polymers may also limit their long term effectiveness (as demonstrated during onsite passive recovery efforts in Area D). Placement of such sorbents and canisters in wells DW-16 and DW-19, which typically do not exhibit significant LNAPL for measurement may be effective for sheen removal. This technology may also be utilized in all of the delineation wells as an IRM to assist in decreasing discharge to the river, while the chosen remediation technology is implemented.

Implementability – Placement of sorbents or canisters in existing offsite wells is easily implemented and would require periodic monitoring and periodic removal of the sorbents and recovered LNAPL.

Relative Cost – Manual passive recovery requires low capital cost and low O&M cost.

Conclusion – The manual passive recovery technologies will not be retained for further consideration, as they do not meet the site specific RAO. However, this technology is retained for further use as an IRM if deemed necessary by NYSDEC to reduce discharge to the Bronx River prior to the final remediation system commencing operation.

6.5.4 Hydraulic Containment

Hydraulic containment involves the extraction of groundwater below the LNAPL layer to reverse the hydraulic gradient and eliminate offsite migration or discharge of the associated plume. The groundwater extraction pumps would need to be located sufficiently deep and operated such that LNAPL is not drawn into the pumps, while a second pumping system (TFR or equivalent) would be used to recover the LNAPL. Hydraulic containment can be achieved through the use of either vertical or horizontal extraction wells. Horizontal wells are sometimes preferable to vertical wells because they provide greater access to contamination that is migrating horizontally and can reach subsurface areas without damaging surface structures. Horizontal wells are also used to enhance other technologies such as soil vapor extraction and air sparging.

Effectiveness – For this technology to be effective in eliminating discharge of LNAPL into the Bronx River, the extraction would likely need to be implemented upgradient near the Metro North Railroad in order to have enough of sufficient impact on the hydraulic gradient. If performed far enough from the discharge location and with enough recovery, the technology would be effective. It is unknown if vertical or horizontal wells would provide more effective hydraulic containment at this time. However, LBG conducted a horizontal extraction pumping test onsite which they concluded that groundwater containment in an aquifer with low permeability can be effectively achieved through the use of horizontal extraction wells. The more effective well extraction method will be determined based on the results of the FFS Investigation and Treatability Study.

Implementability – Based on the proximity of the offsite portion of the property to the rail lines and the steeply sloped embankment located between the rail lines and well locations, there is no feasible location for the placement of groundwater extraction wells. In addition, hydraulic containment would involve the extraction of a large quantity of contaminated groundwater that would likely need to be treated before it was discharged. Therefore, hydraulic containment is not implementable offsite. The ongoing remedial alternative analysis conducted by LBG for onsite contamination appears to also be investigating hydraulic containment and this technology may be more suitable for such efforts.

Relative Cost – Hydraulic containment would involve high capital cost and moderate to high O&M costs.

Conclusion – Due to the lack of implementability offsite, hydraulic containment will not be retained for further consideration.

6.5.4 Total Fluids Recovery

Total fluids recovery (TFR) entails collection of both LNAPL and groundwater from recovery wells using a single pump. Total fluid recovery pumps operate pneumatically and collect fluids that enter the pump by gravity. The pump is then emptied by air pressure on a timer cycle. This is a more aggressive technology than product only-recovery, and requires fluids separation equipment and possible groundwater treatment equipment. The recovered LNAPL and groundwater would need to be pumped to an onsite storage vessel and possible treatment equipment. Groundwater treatment equipment may be needed in order to allow the extracted groundwater to be discharged to the sewer or river, rather than hauled offsite. TFR could also be implemented using horizontal or vertical extraction wells to increase access to the migrating LNAPL.

Effectiveness – The effectiveness of this technology hinges upon several characteristics of the subsurface and offsite hydrology that are unknown at this time. As part of the proposed FFS Investigation, the ambient gradient, porosity of the subsurface, and hydraulic conductivity will need to be determined in order to accurately define the groundwater seepage velocity. The LNAPL recharge rate will also need to be determined as part of the FFS Investigation/Treatability Study to size and rate the pumps for adequate recovery. If the LNAPL recharge rate is insufficient, this technology may not be effective. The use of vertical versus horizontal extraction wells will also be determined based on the results of the FFS Investigation and Treatability Study.

In addition, a better understanding of the LNAPL behavior when exposed to air, temperature changes and mixing is needed for adequate design of a TFR system. Several LNAPL tests will be performed as part of the FFS Investigation and Treatability Study to determine the LNAPL's propensity to harden. If oxygen directly relates to the LNAPL hardening, this technology may be made more effective through the use of nitrogen, and possible nitrogen blanketing within the storage tank and associated treatment equipment.

If the lithology, hydrology and LNAPL are compatible with TFR this method should be effective for offsite LNAPL removal. Upon further investigation, it may be determined that recovery alone will not be sufficient to eliminate complete discharge to the river, and this technology may need to be coupled with containment. If the LNAPL proves to be too viscous for active recovery, this technology may also be coupled with heating or in situ treatment to reduce the LNAPL viscosity and increase product recovery.

Implementability – The TFR should be more easily implemented than other more invasive recovery methods. A small treatment building is already present offsite and the four delineation wells are equipped with well vaults from previous product only recovery efforts. Use of these existing structures will make implementation offsite more feasible. If a larger onsite treatment system is implemented in the future as part of the offsite groundwater remediation efforts, water and LNAPL recovered using TFR could be diverted to the larger system. Complete recovery may also require the installation of additional offsite recovery wells. Installation of new wells would be difficult due to access and space restrictions, but with the use of a crane and vegetative clearing installation via air rotary drilling is possible. Extraction of the LNAPL from the offsite treatment building via a vacuum truck located on the Mount Vernon Avenue Bridge will also need to be implemented due to site access difficulties.

Relative Cost – Total fluids recovery involves high capital cost due to the need for treatment of recovered groundwater prior to discharge to the sewer system. Moderate O&M costs are also anticipated.

Conclusion – Total fluids recovery will be retained for further consideration.

6.5.6 Belt Skimmers

Belt skimmers utilize the installation of a hydrophobic belt material in a recovery well or sump. The belt is rotated, passes through the water LNAPL interface, and the collected product is skimmed from the belt into a collection tank located above grade.

Effectiveness – The offsite LNAPL should be effectively removed from the delineation/recovery wells through the use of belt skimmers. However, the viscosity of the LNAPL may make it difficult to remove or scrape the product from the belt for collection. Previous pilot studies onsite did not yield effective removal of the LNAPL because of difficulty removing the product from the belt, which resulted in frequent downtime and extensive maintenance.

Implementability – Belt skimmers should be easily implemented in existing offsite delineation well vaults. If additional wells are needed for complete recovery, installation would occur in the same manner as TFR. While additional well installation would make implementation more complicated, the belts should still be implementable offsite.

Relative Cost – Installation of belt skimmers in existing offsite delineation wells would require moderate capital cost and moderate O&M cost. If installation of additional wells is needed, the capital cost of belt skimmer implementation would increase accordingly.

Conclusion – Belt skimmers will not be retained for further consideration due to the anticipated lack of effectiveness. If further LNAPL testing determines compatibility with such technologies they will be revisited in the Final FFS.

6.5.7 Multiphase Extraction

Multiphase extraction utilizes a stinger tube connected to a liquid ring or other high vacuum pump. The stinger tube is placed at the LNAPL and air interface and extracts LNAPL, air and water. LNAPL and water separation, combined with groundwater treatment would also be needed for the implementation of this technology.

Effectiveness – The use of multiphase extraction offsite may result in fouling problems due to hardening of the LNAPL and the potential formation of emulsions during recovery. If such fouling occurs, this technology will not be effective for LNAPL recovery. Emulsification may also cause serious difficulties in the separating and treatment processes upon removal.

Implementability – Installation of stinger tubes in existing offsite delineation wells would be easily implemented. If additional recovery wells were needed for adequate recovery, the implementation of this technology would be further complicated but is feasible. The existing offsite treatment building could be utilized to house the associated storage and treatment processes of this technology, unless a larger onsite system is implemented as discussed above.

Relative Cost – Multiphase extraction would involve high capital costs and moderate O&M costs.

Conclusion – Multiphase extraction will not be retained for future consideration due to the lack of anticipated effectiveness.

6.5.8 Airlift Pumps

An airlift pump is a simple pump powered by compressed air. These pumps are often used in deep dirty wells where gritty material would quickly abrade mechanical parts. The compressor is located outside the well and there are no mechanical parts located within the well itself. Compressed air is piped down a shaft or smaller diameter pipe and the air returns up a discharge pipe, or large diameter pipe carrying water with it. The pump aerates the water in the discharge piping, in turn lowering the specific gravity of the mixture and lifting it to the surface.

Effectiveness – The effectiveness of this technology depends largely on the LNAPL's response to air and mixing. If the LNAPL testing conducted during the Treatability Study determines that it is compatible with this technology, it should be effective in removing LNAPL and groundwater from the site. If exposure or mixture with oxygen is determined to increase the LNAPL's propensity to harden, this system could utilize compressed nitrogen to avoid such hardening. The recovery rate may not be sufficient to eliminate discharge to the river and therefore may need to be combined with the implementation of a barrier, heating or in situ treatment. Water and product separation, as well as groundwater treatment would also need to be implemented as described in the TFR section above.

Implementability- The implementation of this system is similar to that discussed in Section 6.4.3, and may be difficult but is possible.

Relative Cost – Air or nitrogen lift pumps would involve moderate to high capital costs and O&M costs.

Conclusion – Air or nitrogen lift pumps will be retained for further consideration.

6.6 *In Situ* Treatment

In situ treatment technologies either intercept and immobilize or degrade contaminants in the subsurface passively (for example: phytoremediation and permeable reactive barriers), or mobilize and/or destroy contaminants in the subsurface aggressively and significantly shorten the required remediation time (such as *in situ* chemical oxidation and *in situ* bioremediation). Many of the passive technologies require little maintenance. The active technologies significantly speed up the removal rate of residual free phase or adsorbed contaminants, which would not be possible via conventional pump-and-treat technology. *In situ* treatment also reduces the possibility of exposure of contaminants. Several *in situ* treatment technologies were identified as potentially applicable offsite and are discussed below.

6.6.1 Hot Water Flushing

Hot water flushing is a thermal technology that has been used successfully to remove hydrocarbon LNAPLs from the subsurface. Hot water is injected or recirculated and mobilizes the LNAPL, which is then collected via wells or trenching.

Effectiveness – The effectiveness of this technology depends on the affect of heat on the offsite LNAPL, as determined during the FFS Investigation. If heating does not promote further cross linking of the polymers offsite and does not promote a reaction between the polyurethanes, polyureas and mineral spirits which would negatively affect recovery, this system could increase LNAPL recovery. This technology would need to be coupled with one of the removal and extraction technologies in order to achieve the RAO.

Implementability - Hot water flushing offsite would be difficult to implement, as complete recovery of the hot water before discharge into the river would be difficult to guarantee. With the Bronx River located approximately fifteen to twenty feet from the possible injection locations, (DW-16 throughDW-19) effects of temperature on aquatic life and vegetation are unknown. There is not enough area adjacent to the railroad to allow for flushing further upgradient to avoid negative impact on the river. Hot water injection coupled with aggressive recovery onsite may be more suitable than the application of this technology offsite.

Relative Cost – The relative cost of hot water flushing would require moderate to high capital costs.

Conclusion – Hot water flushing will be retained for further consideration.

6.6.2 Steam Injection

Steam injection is typically utilized during the extraction of heavy oils from the subsurface and is considered an enhanced oil recovery method. Steam injection at this particular site would be aimed at decreasing the viscosity of the offsite LNAPL, thereby increasing recovery.

Effectiveness – The effectiveness of this technology is based on the reaction of the offsite LNAPL to heat. If the FFS Investigation and Treatability Study determine a decrease in LNAPL viscosity due to heating, then this technology should effectively increase LNAPL recovery.

Implementability – Steam injection would be difficult to implement offsite for the same reason that hot water flushing is difficult to implement. Injection of steam so close to the river may have secondary groundwater and surface water impacts, as well as a negative impact on vegetation and aquatic life. However, steam injection onsite may be used effectively as a means of promoting polymerization of the toluene 2,4-diisocyanate. This approach would effectively be *in situ* stabilization of the material onsite, which may or may not be acceptable to regulatory agencies.

Relative Cost – Implementation of steam injection would involve high capital costs, and if coupled with recovery would involve moderate O&M costs.

Conclusion – Steam injection will be retained for further consideration.

6.6.3 *In Situ* Stabilization/Solidification

In situ stabilization and solidification involves the injection of chemicals or other materials into the subsurface to immobilize the contaminants, to prevent leaching, or to solidify the contaminants and prevent contact with water. This technology can be utilized in several different ways. Cement, grout, bentonite, organophillic clays or other materials could be injected to solidify the LNAPL and prevent further migration. A coagulant, such as ferric chloride, or a flocculant, such as polymer, could be added to result in coagulation, polymerization, flocculation, or precipitation of the existing polymeric materials in the LNAPL that lead to hardening.

Effectiveness – The effectiveness of *in situ* stabilization/solidification depends entirely on the results of LNAPL testing and its response to the proposed treatment methods. It is not possible at this time to determine if such treatment would be effective due to the complexity of the migrating LNAPL plume and its many chemical constituents.

The effectiveness of this technology will also be based on the lithology as determined during the FFS Investigation. However, in the interest of retaining and *in*-situ technology, at this stage this technology will be carried forward to analysis and costing. It is assumed that a hollow stem auger or multiple auger rig will be utilized to inject and mix Portland cement with an undetermined additive into the subsurface to the depths of the LNAPL. It will therefore be assumed that this reagent and method will effectively immobilize the plume.

Implementability – The implementability of *in situ* stabilization/solidification hinges on the regulatory acceptance of the technology, as well as the ability to auger through the potential cobbles and boulders encountered during drilling. It has been assumed that due to the challenging implementation of this technology offsite, a second air rotary drill rig will be utilized when cobbles or boulders are encountered to auger to the appropriate depth, before in place mixing can occur via the means described above.

Relative Cost – The cost of *in situ* stabilization/solidification would require high capital cost and no O&M cost.

Conclusion - *In situ* stabilization/solidification will not be retained for further consideration unless regulatory acceptance is given.

6.6.4 Solvent/Surfactant Flushing

Solvent or surfactant flushing involves the injection of a solvent or surfactant mixture, which often consists of water and a miscible organic solvent or a special surfactant, into the vadose and/or saturation zones to extract organic contaminants. Injection typically occurs upgradient of the contaminated zone and is simultaneously extracted downgradient to maintain hydraulic control over the movement of the solvent/surfactant mixture and mobilized contaminants. In this particular offsite application, the goal would be to increase the LNAPL solubility in water and reduce the interfacial tension between the aqueous and organic phases in order to improve LNAPL recovery.

Effectiveness – The effectiveness of such a method cannot be determined at this time and would involve extensive testing of the LNAPL and its behavior when introduced to various solvent and surfactant mixtures. If it were determined that introduction of such a mixture increases the solubility of the LNAPL it would be coupled with active recovery in order to effectively achieve the RAO. When choosing a solvent/surfactant mixture one must also be chosen that would not have a negative impact on the river if accidental discharge were to occur.

Implementability – Implementability of such a technology is not possible along the bank of the Bronx River. There would likely not be the sufficient time or space required to fully recover the injected solvent/surfactant mixture and mobilized contaminants before discharge into the river. To ensure that accidental discharge did not occur, an excavation trench with active recovery located behind a retaining wall would need to be implemented. The space for such an arrangement offsite is not available.

Relative Cost – Determination of a relative cost is not possible until further LNAPL testing has been conducted.

Conclusion – Solvent/surfactant flushing will not be retained for further consideration as implementation so close to the river is not possible.

6.6.5 Electrical Resistance Heating

Electrical resistance heating (ERH) is an *in situ* remediation method that uses the flow of three phase (and less frequently six phase) alternating current electricity to heat soil and groundwater and evaporate contaminants. Subsurface electrode elements installed via drilling are used to pass electrical current through a targeted soil volume to promote the evaporation of volatile contaminants. The contaminants are typically captured by a subsurface vapor recovery system. The recovered air, steam and volatized contaminants are then treated at the surface to regulatory standards.

Effectiveness – ERH is most effective on volatile organic compounds, while chlorinated compounds such as perchloroethene, trichloroethene and cis or trans 1,2-dichloroethene are also easily remediated using ERH. Less volatile contaminants such a xylenes and diesel can also be remediated using ERH, but the energy requirements significantly increase as the volatility of the compounds decrease. However, for use on the offsite portion of the former Red Devil facility, ERH would not be used for removal of volatile organics, but rather as a means of increasing the recovery of LNAPL offsite by lowering LNAPL viscosity. It is not possible at this time to determine the effectiveness of this method on LNAPL removal. If the FFS Investigation and Treatability Study determine that the addition of heat decreases the viscosity and increases mobility of the LNAPL, the method would be coupled with active recovery to increase removal efforts. Use of this technology may also aid in the treatment of residual groundwater and soil contamination which is part of the ongoing RI/FS efforts.

Use of ERH onsite may also be beneficial, but as a means of solidifying the plume in place to eliminate further migration offsite. As described in Section 3.3, the addition of heat in the presence of toluene 2,4-diisocyanate may promote the polymeric reaction leading to further cross-linking and the potential onsite solidification of the contaminants that ultimately seep into the Bronx River as single chain polymers.

Implementability – The implementability of offsite ERH is possible, but as mentioned in previous technologies, installation via drilling would require the use of a crane and extensive clearing. The installation of several subsurface electrodes, as suggested by the ERH vendor, would also be necessary. The implementability also hinges on the response of the NYSDEC to heating of the subsurface so close to the Bronx River. It is not known what the effects on aquatic life or vegetation would be due to heating of the subsurface. Implementability may not be possible if heating directly impacts the surface water or groundwater discharge temperature. The capture and treatment of VOCs are required as part of the remedial efforts, and are implementable offsite through a small vapor extraction system. If determined effective, implementable and cost efficient, then use of this technology for increased LNAPL recovery will be considered.

Relative Cost – ERH would involve high capital costs and moderate to high O&M costs. This technology would also require moderate utility costs for continued heating of the subsurface during recovery efforts.

Conclusion – Despite limited knowledge pertaining to the effectiveness and implementability of this *in situ* technology, it will be carried forward for consideration. An order of magnitude costing will allow for better determination of feasibility, and for further consideration of the technology in achieving the RI/FS RAOs.

Section 7
FFS Investigation and Treatability Study

Due to the lack of previous extensive offsite investigation, several key pieces of information are necessary before selection of the appropriate remedial technology is possible. Information pertaining to the groundwater parameters, lithology and nature of the offsite LNAPL are necessary before moving forward with the final FFS. Once these analyses are completed, and an appropriate remedial technology is selected and deemed feasible, additional treatability and/or pilot testing may need to be done before the system is designed. Following NYSDEC review of the recommended investigation activities, CDM will submit a scope of work and schedule for the agreed upon tasks.

7.1 Physical/Chemical Parameters

Determining the groundwater parameters offsite will enable appropriate selection of remedial technologies. As part of the treatability study, measurement of the dissolved oxygen, pH, conductivity, temperature and ORP in wells DW-16 and DW-19 via low flow sampling is proposed. The lack of product in these wells should make such measurements possible.

The ambient hydraulic gradient of the offsite portion of the property will also need to be determined based on available depth to water data. Additional synoptic water levels are proposed as part of the RI/FS effort and will be utilized when determining the drop in head per linear distance across the site. A slug test or constant rate pumping test will also need to be conducted in the offsite wells to determine the hydraulic conductivity. The ambient gradient, hydraulic conductivity and porosity, as discussed below, are needed to determine the groundwater seepage velocity. This information is necessary for appropriate design of an offsite recovery system.

A bail down test in delineation wells DW-17 and DW-18 is also proposed as part of this treatability study. The rates of LNAPL and water recovered during bail down testing will be measured and utilized to determine the recharge rate of LNAPL in the offsite wells. The water and LNAPL recharge rates will be used to determine the appropriate recovery rates, if deemed achievable.

7.2 Lithology

The lithology of the offsite portion of the property is not well defined, and could significantly impact the implementability of possible offsite remedial technologies. To date, the only information available are the ERM monitoring well construction logs which were logged during the installation of monitoring well MW-9 and delineation wells DW-16 through DW-19. These logs indicate the presence of heavy gravel, cobbles and boulders between approximately three feet and fourteen feet bgs. The presence of such lithology eliminates the potential use of certain containment barriers and will make the installation of additional wells and subsurface probes offsite more difficult to install and more costly. Therefore, further investigation into the offsite lithology is necessary.

As part of the investigation into the offsite lithology, it is necessary to determine the subsurface porosity. This can be estimated based on the results of the geophysical investigation. If more information is required, and the lithology allows, an undisturbed sample using a Shelby tube can also be collected during drilling. It is important to obtain improved understanding of the subsurface porosity, as it will aid in determining the groundwater seepage velocity.

7.3 LNAPL Testing

Several tests will also be conducted on the offsite LNAPL to determine the nature of the LNAPL when exposed to different stimuli. The following testing is suggested as part of the Treatability Study.

It is important to understand if the LNAPL is further polymerizing or coagulating when exposed to the oxygen in air. As mentioned in Section 6, some of the technologies screened can utilize nitrogen rather than air if such a reaction is promoted by exposure to oxygen. In order to determine the effects of the oxygen in air on the LNAPL four offsite LNAPL samples will be collected simultaneously from each of the two well locations containing product. The four samples from each well will include one LNAPL sample without headspace or water, one LNAPL sample with headspace and no water, one LNAPL sample with water and no headspace, and one LNAPL sample with both water and headspace. The four samples will be visually observed for skin formation at the surface of the LNAPL and at the aqueous layer/LNAPL interface, as well as changes in color, viscosity, opacity, etc. over time. If the behavior of the LNAPL is significantly different when exposed to the oxygen in air, groundwater extraction systems utilizing nitrogen, rather than air, will be considered.

The viscosity of the LNAPL will also be tested under different conditions. The LNAPL viscosity will be measured upon initial collection of an offsite sample as a baseline. The viscosity will then be measured after portions of the sample have been exposed to air for a period of time, mixed through mechanical means, and exposed to light. Observations will also be made after each of these tests regarding skin formation. This test will help to determine if the exposure of the LNAPL to these conditions should be limited in the final remediation system in order to prevent solidification, and subsequent downtime.

The LNAPL's response when heated is of particular importance in order to determine if a decrease in viscosity is possible, and if technologies such as hot water flushing, steam injection or ERH may be implemented to increase LNAPL mobility. In order to determine the LNAPL's response to heat, the baseline LNAPL viscosity will be measured upon initial collection of a fresh offsite LNAPL sample in the absence of oxygen. The viscosity of that LNAPL sample will be measured as the sample is being heated in the absence of oxygen in order to determine the viscosity of the LNAPL as a function of temperature. This same test should also be performed on a sample that has been exposed to air, as well as a sample which has formed a skin or coagulated. This will determine if the presence of oxygen affects the LNAPL viscosity as well as if the more viscous LNAPL can be back dissolved into the less viscous LNAPL upon heating. If sample collection does not yield a sample with skin formation, a sample from the boom system will be collected for such testing.

Section 8
Development and Analysis of Remedial Alternatives

Potential remedial technologies and process options associated with each general response action are identified and screened in this section. Representative remedial technologies and process options that have been retained are used to develop remedial action alternatives.

8.1 Evaluation Criteria for Detailed Screening of Technologies

The typical technology screening approach is based upon the procedures outlined in "Draft DER-10 Technical Guidance for Site Investigation and Remediation" (NYSDEC 2002) and title 6 of the Official Compilation of New York Codes, Rules and Regulations Part 375. However, in the Draft FFS, extensive comparison of the remedial action alternatives based on the following criteria will not be conducted, since the results from the Treatability Study/Design Investigation tests detailed in Section 7 are needed for the comparisons to be fully developed. Upon completion of the FFS Investigation and Treatability Study, the remedial action alternatives will be screened based on the following criteria.

Threshold Criteria. Threshold criteria are requirements that each alternative must meet in order to be considered for selection.

- **Overall Protection of Human Health and the Environment.** This criterion is an evaluation of the remedy's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced or controlled through removal, treatment, engineering controls or institutional controls. The remedy's ability to achieve each of the RAOs is evaluated.

- **Compliance with New York State Standards, Criteria, and Guidance (SCGs).** Compliance with SCGs addresses whether a remedy will meet environmental laws, regulations, and other standards and criteria. In addition, this criterion includes the consideration of guidance which the Department has determined to be applicable on a case-specific basis.

Primary Balancing Criteria. These criteria are used to distinguish the relative effectiveness of each alternative so that decision makers compare the positive and negative aspects of each of the remedial strategies.

- **Long-term Effectiveness and Permanence.** This criterion evaluates the long-term effectiveness of the remedial alternatives after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the engineering and/or institutional controls intended to limit the risk, and 3) the reliability of these controls.

- **Reduction of Toxicity, Mobility or Volume.** Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the site.

- **Short-term Effectiveness.** The potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and/or implementation are evaluated. The length of time needed to achieve the remedial objectives is also estimated and compared against the other alternatives.

- **Implementability.** The technical and administrative feasibility of implementing each alternative are evaluated. Technical feasibility includes the difficulties associated with the construction of the remedy and the ability to monitor its effectiveness. For administrative feasibility, the availability of the necessary personnel and materials is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, institutional controls, and so forth.

- **Cost-Effectiveness.** Capital costs and annual operation, maintenance, and monitoring costs are estimated for each alternative and compared on a present worth basis. Although cost-effectiveness is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the other criteria, it can be used as the basis for the final decision.

Modifying Criterion. This criterion is taken into account after evaluating those above. It is evaluated after public comments on the FS and Proposed Remedial Action Plan (PRAP) have been received. This criterion is not evaluated in this FS.

- **Community Acceptance.** Concerns of the community regarding the RI/FS reports and the PRAP are evaluated. A responsiveness summary will be prepared that describes public comments received and the manner in which the Department will address the concerns raised. If the selected remedy differs significantly from the proposed remedy, notices to the public will be issued describing the differences and reasons for the changes.

- **Land use.** The current, intended and reasonably anticipated future land uses of the site and its surroundings will be considered during the selection of the remedy. The land use selection will take into consideration the factors outlined in Part 375 - 1.8 (f)(9)(iii) and any other foreseen factors.

8.2 Development and Detail Analysis of Remedial Action Alternatives

For the purpose of the draft FFS, the technologies screened in Section 6 will be grouped into remedial action alternatives and an order of magnitude cost for each alternative will be presented. Remedial action alternatives have been developed based on the potential for these alternatives to meet the SCGs and RAO described in Section 4. Once a better understanding of the offsite groundwater parameters, lithology, and LNAPL characteristics is obtained through the FFS Investigation, each alternative will be screened fully, including the addition of Operation and Maintenance (O&M) costs, based on the preceding criterion. It should be noted that environmental easements are retained as a component of each alternative, if the alternative does not fully meet 'pre-release" and all site specific standards, criteria and guidance.

8.2.1 Alternative 1 – No Action

The No Action alternative was retained for comparison purposes as required by the NCP. No remedial actions would be implemented as part of the No Action alternative. The LNAPL plume would continue to migrate and discharge into the Bronx River.

Cost

The cost under this alternative would remain unchanged and consists solely of the O&M costs associated with routine boom maintenance. As the Department is currently overseeing and funding monthly/bimonthly boom maintenance, this will not receive an order of magnitude cost estimate in this report. The costs for Alternatives 2 through 7 are detailed in Tables 8-1 to 8-6.

8.2.2 Alternative 2 – Pre-Disposal

This alternative consists of the extensive excavation of the shore, off-site disposal of the excavated materials and site restoration to return the offsite parcel to its condition prior to the presence of contamination. This alternative requires the use of many assumptions and has been carried forward at the request of NYSDEC. It should be stated, that the methods discussed below are technically feasible but extremely difficult to implement and require several assumptions to allow for analysis and costing.

As mentioned in Section 6, excavation below the Metro North Railroad is not implementable and therefore will not occur as part of this remedial alternative. It should also be noted that the railroad is supported by a wall that extends from the Oak Street Bridge to roughly 120' to the west. Along this portion of the Bronx River there is no shore to be excavated and therefore no access to the shore from the Oak Street Bridge. The shore is bordered to the west by the Mount Vernon Bridge and access to the shore via crane is feasible. However, to avoid shutting down the Mt Vernon Ave. Bridge, this remedial alternative assumes that each task will be achieved through the use of barges located in the Bronx River. This alternative also accounts for the frequent flash flooding which occurs in this portion of the River, ensuring that during high flow events the equipment, operators and laborers are able to exit the area quickly and safely. This alternative also assumes that real estate and barge access along the Bronx River within a reasonable distance of the site would be obtained by NYSDEC. This lot would be used as a Contractor staging and support zone, to house temporary facilities and dewatering activities and to provide access to the Bronx River for heavy machinery deployment via barges. These barges would be ferried to and from the excavation location during each activity.

This remedial alternative begins with the clearing and grubbing of the offsite parcel. The extensive overgrown vegetation, shrubs and trees will be removed, chipped in the contractor staging area and properly disposed of. After clearing, the northern portion of the shore, adjacent to the Metro North Railroad, must be supported via soldier pile and lagging prior to any excavation. It is assumed that NYSDEC will obtain an easement from the Metro North Railroad to excavate within fifteen feet of the embankment. The soldier pile and lagging will be installed to a depth of 23′ to 35′ below ground surface. The final depth of the soldier piles will rely on the results of the FFS Investigation which will determine the geology of the area adjacent to the railroad. The excavation will extend to bedrock, and therefore the soldier pile and lagging must extend to the appropriate depth within the bedrock to provide the required support. The bracing or lagging will be installed as excavation proceeds in lifts. To avoid flooding of the excavated area, secant piling along the entire perimeter of the shore will be installed via barge deployment. Secant piling is the only available technology for containment of the river, as no other technologies can be employed in bedrock.

The entire shore will be excavated to bedrock through the use of a crawler mounted long reach excavator. The long reach excavator will allow excavation to proceed via two methods; excavating the material directly onto one of the barges, with the transfer of the excavated soil from the barge to a dump truck in the offsite staging area, or by loading each bucket directly into dump trucks located along the Mount Vernon Bridge. The excavator boom may also need to be equipped with a hydraulic hammer to allow for excavation of the cobbles and boulders anticipated at 5′ to 15′ bgs. Several assumptions were also made regarding the dewatering, transportation and disposal of the excavated materials. A drying pad and dewatering area will be located in contractor staging area, to account for drying of the moist material removed from below the water table. It has also been assumed that all of the water generated will be hauled offsite for disposal via a tanker truck and that the water will need to be treated due to the presence of contaminates. The dewatering costs reflect these assumptions. Additionally, without any soil sampling of the shore, it has been assumed that 50% of the soils will need to be disposed of via thermal incineration, while 25% will be disposed of in a Subtitle C Landfill, with the remaining 25% disposed of in a Subtitle D Landfill.

Backfilling of the excavated area will also be achieved via barge, but the soil placement can be achieved via the Mount Vernon Bridge and long reach excavator or directly from a barge adjacent to the shore. A dozer and sheeps foot roller will be used for backfilling and compaction. It has been assumed that common fill will be used, with a 6'' layer of top soil. Please note that the when calculating and costing excavation quantities, disposal quantities and backfill quantities, Figure 2-1 and Figures 3 and 4 of Appendix B, combined with best engineering judgments were utilized. Exact quantities are not possible to determine without access to the LBG survey conducted as part of the March 2009 RI and the results of the FFS Investigation. Vegetative cover and site restoration will be implemented upon the completion of backfilling activities, as the final stage of this remedial alternative.

Cost

Based on the assumptions above, the cost for this alternative is estimated to be $23.7 million.

8.2.3 Alternative 3 – *In-situ* Stabilization/Solidification

This alternative assumes that Portland cement and an additive will be injected and mixed into the subsurface using a hollow stem auger or multiple auger rig to immobilize the migration of the LNAPL plume. It should be noted that for this alternative to be deemed effective, it is also assumed that the onsite LNAPL has been treated or extracted and therefore is not likely to continue to migrate offsite. Without the removal of the onsite LNAPL, it is possible that the onsite plume will continue to migrate around the solidified offsite LNAPL and find alternative path ways and continue to discharge into the Bronx River. It should be noted that the results of the FFS Investigation are vital to the feasibility and implementation of this technology, as the in situ mixing is not feasible if cobbles and boulders are encountered in the subsurface as anticipated.

Due to the limited information available regarding the extent of the offsite plume, it has been assumed that the entire shore of the offsite parcel will be solidified to bedrock. It has also been assumed, as stated in Alternative 2, that all site mobilization and demobilization will occur via barge, to account for limited site access and potential flood events. The entire offsite parcel will be thoroughly cleared and grubbed prior to augering. Debris will be stockpiled on the barges, and transferred and disposed of from the offsite contractor support zone and staging area. The in situ mixing using hollow stem augers or multiple auger rigs will take place across the entire area of the shore, each hole placed adjacent to the next. To account for encountered cobbles and boulders in the subsurface, it was assumed that an air rotary drill rig will be utilized when difficult geology is encountered. For the purposes of costing this alternative, it was assumed that a five foot by five foot grid overlain on the offsite parcel would account for the number of holes drilled by the air rotary drill rig. It was also assumed that 20% of the total volume of the shore, as estimated in Alternative 2, would account for the volume of Portland cement needed, while 1% of that volume would represent the volume of the additive introduced. Upon completion of the solidification, a 6" layer of top soil will be added to the surface of the offsite parcel and cover material will be planted in an effort to restore the site.

Cost

Based on the assumptions above, the cost for this alternative is estimated to be $11.6 million.

8.2.4 Alternative 4 – Extraction

This alternative consists of LNAPL extraction offsite through the use of air lift pumps or TFR. Both technologies require separation and treatment of the extracted groundwater and LNAPL. TFR may be implemented offsite using either vertical or horizontal wells, based on the outcome of the FFS Investigation and ease of implementation. Costs for TFR extraction for both vertical and horizontal wells were estimated in each of the alternatives involving extraction. LNAPL extraction from the treatment building via vacuum truck will also be implemented for both technologies. However, only the vertical well scenario is discussed in all of the cost descriptions for Alternatives 2-5.

When costing this alternative, several assumptions were made. It was assumed that to eliminate discharge to the river, additional wells would need to be installed for LNAPL recovery. For the purposes of the draft FFS, it was assumed the installation of four recovery wells offsite, located equidistant from the existing delineation wells would be necessary. One well would be located between DW-16 and DW-17, two wells would be located between DW-17 and DW-18 and an additional well would be installed between DW-18 and DW-19. The method of installation was assumed to be air rotary, since the existing wells were installed using this technology. It was further assumed that only six of the eight wells would require recovery, as LNAPL is not present in DW-16 and DW-19. Extraction would utilize six air lift or TFR pumps that would be hard piped to the existing abandoned offsite treatment building. A new open top separation tank, equipped with a weir or baffle, would be installed in the existing building for fluids separation. It was also assumed that the separated groundwater would be be pumped from the separation tank through cartridge filters and then through a GAC unit before being discharged to the sewer. The LNAPL would be manually pumped and/or skimmed from the top of the separation tank, containerized and eventually removed from the site.

The number of wells, number of pumps, groundwater treatment system, etc. will be further refined and sized based on the outcome of the FFS Investigation and Treatability Study detailed in Section 7.

Cost

Based on the assumptions above, the cost for this alternative, if TFR is used is estimated to be $1.2 million. The cost for this alternative, if air lift pumps are used is estimated to be $0.9 million.

8.2.4 Alternative 5 – Extraction and Secant Piling

If the results of the FFS Investigation and Treatability Study determine that recovery alone will not eliminate discharge of LNAPL into the Bronx River, Alternative 3 incorporates recovery, via TFR or air lift pumps, and containment, using secant piling. If elimination of LNAPL discharge is not possible through extraction alone based on the groundwater seepage velocity, and groundwater and LNAPL recovery rates, then containment of the LNAPL prior to the discharge point in the Bronx River may be necessary. The same assumptions made for Alternative 2 pertaining to extraction are also used for the cost estimate of this alternative. In addition, it was assumed that the secant piling will be shaped like a crescent and extend around the existing delineation wells. It was also assumed that the piling would extend to 25 feet bgs, where it is anticipated that bedrock will be encountered.

Cost

Based on the assumptions above, the cost for this alternative, if TFR is used is estimated to be $4.8 million. The cost for this alternative, if air lift pumps are used is estimated to be $4.3 million.

8.2.5 Alternative 6 – Extraction and Thermal Technologies

If the results of the FFS Investigation and Treatability Study determine that extraction alone will eliminate discharge, but that the LNAPL is too viscous for effective extraction, hot water flushing, steam injection or ERH may be used to increase recovery from the extraction wells. The use of these three assumes that the FFS Investigation reveals a decrease in offsite LNAPL viscosity when heated. The same assumptions made in Section 8.2.1 pertaining to extraction are also used to estimate the cost for Alternative 4. Only the cost for ERH is presented below. Steam injection and hot water flushing were estimated at similar orders of magnitude to ERH.

Cost

Based on the assumptions above, the cost for this alternative, if TFR is used is estimated to be $2.5 million. The cost for this alternative, if air lift pumps are used is estimated to be $2.3 million.

8.2.6 Alternative 7 – Extraction, Thermal Technologies and Secant Piling

Alternative 5 assumes that the results of the FFS Investigation determine that recovery coupled with hot water flushing, steam injection or ERH will not completely eliminate discharge into the river and therefore containment, using secant piling, must also be utilize. The same assumptions discussed in previous sections remain for implementation of Alternative 5. Only the cost for ERH is presented below. Steam injection and hot water flushing were estimated at similar orders of magnitude to ERH.

Cost

Based on the assumptions above, the cost for this alternative, if TFR is used is estimated to be $6.1 million. The cost for this alternative, if air lift pumps are used is estimated to be $5.8 million.

Section 9
Acronyms

AST	aboveground storage tank
BCA	Brownfields Cleanup Agreement
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CDM	Camp Dresser & McKee Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cps	centipoise
DCA	dichloroethane
DCE	dichloroethene
DER-10	*Draft DER-10 Technical Guidance for Site Investigation and Remediation*"
DIR	Design Investigation Report
ERH	Electrical Resistance Heating
ERM	ERM – Northeast
FID	flame ionization detector
FS	Feasibility Study
FFS	Focused Feasibility Study
FWRIA	Fish and Wildlife Resources Impact Assessment
GC	gas chromatograph
GRA	general response action
GPC	gel permeation chromotography
gpm	gallons per minute
FTIR	Infared spectroscopy
IRM	interim remedial measure
LBG	Legette, Brashears and Graham, Inc.
LNAPL	light non-aqueous phase liquid
MNA	monitor natural attenuation
MS	mass selective
NAPL	non-aqueous phase liquid
NCP	National Contingency Plan
NYCRR	New York Environmental Conservation Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
O&M	operation and maintenance
ORP	oxidation reduction potential
OSHA	Occupational Safety and Health Agency
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCE	tetrachloroethene
PEL	permissible exposure limits
PID	photo-ionization detector
PRG	preliminary remediation goals

PRP	potentially responsible party
PSA	preliminary site assessment
RAO	remedial-action objective
RI	remedial investigation
ROD	record of decision
RSCA	Recommended Soil Cleanup Objectives
SCG	standards, criteria, and guidance
SPDES	State Pollutant Discharge Elimination System
SSDS	sub-slab depressurization system
SSF	State Superfund
SVOC	semi-volatile organic compound
TCA	trichloroethane
TIC	tentatively identifiable compounds
TFR	total fluids recovery
TOC	total organic compounds
TOGS	Technical and Operational Guidance Series
TWA	time weighted average
UST	underground storage tank
VOC	volatile organic compound

Tables

Table 2-1
Former Red Devil Paint Facility
Historic Storage Tank Summary

Area	Tank No.	Tank Type	Capacity	Former Tank Contents[1]	Condition of Tank[2]	Action taken by ERM	Condition of Tank per LBG	Action Taken by LBG
A	1A	UST	1,500	alcohol	good (V)	All tanks in Area A were emptied, cleaned and removed. Soil was excavated to a depth of 6 feet where a concrete slab (tank foundation) was encountered.	Not Applicable.	Soil and groundwater sampling performed at former location of tanks.
	2A	UST	1,500	excess storage	good (V)			
	3A	UST	1,500	mineral spirits	poor (V)			
	4A	UST	1,500	methanol	good (V)			
	5A	UST	1,500	methylene chloride/isopropanol	good (V)			
	6A	UST	1,500	methylene chloride/isopropanol	good (V)			
	P[3]	UST	3,000	Original contents unknown.[3]	good (V)	Tank not included in ERM reports.	Tank had been cut open and filled with concrete slurry.	Tank was emptied of the fill, cleaned and removed. Soil and groundwater sampling performed at location of tank.
B	1	Vaulted		temporary storage for materials stored in Area A USTs; medium oil alkyd	good (V)	Tanks Nos. 1 through 8 in Area B were emptied and removed	Not Applicable.	Soil and groundwater sampling performed at former location of tanks.
	2	Vaulted		long oil alkyd/polyurethane belnd	good (V)			
	3	Vaulted		hydrocarbon resin	good (V)			
	4	Vaulted		long oil alkyd/polyurethane blend	good (V)			
	5	Vaulted		long oil alkyd/polyurethane blend	good (V)			
	6	Vaulted		methyl carbitol	good (V)			
	7	Vaulted		raw linseed oil	good (V)			
	8	Vaulted		long oil alkyd/polyurethane blend	good (V)			
	9	Vaulted		fuel oil	good (V)	Tank No. 9 was removed by the site operator, Metro Self Storage, Inc., after the May 1991 tank closure activities	Tank was in place. Used for fuel oil storage for boilers.	Emptied, cleaned and removed,
	E	UST	3500 per ERM; 3,000 per LBG	mineral spirits; methanol	good (S)	All USTs were emptied, cleaned and permanently closed in-place by filling with sand. USTs were not removed since they were located below load bearing walls.	Tanks found to be cut open, cleaned and filled with inert foam.	Emptied, cleaned and removed. Soil and groundwater sampling performed at location of tank.
	F	UST	4000 per ERM; 3,000 per LBG	acetone	good (S)			
	G	UST	3,000	medium oil alkyd	good (S)			
	H	UST	10,000	no. 6 fuel oil	good (S)		Tank was no longer on site	Soil and groundwater sampling performed at former location of tank.
C	D	UST	7500 per ERM; 4000 per LBG	polyurethane varnish	good (S)	Emptied, cleaned and permanently closed in-place by filling with sand.	Tanks found to be cut open, cleaned and filled with inert foam.	Emptied, cleaned and removed. Soil and groundwater sampling performed at location of tank.
	I per ERM, W per LBG	UST	3000 per LBG	paint sludge	good (S)		Tank found to be closed in place and filled with clean sand.	Emptied, cleaned and removed. Soil and groundwater sampling performed at location of tank.
	13	Vaulted	2,500	long oil	good (V)	All vaulted tanks in Area C were emptied and removed.	Not Applicable.	Geoprobe borings taken at location of tanks
	15	Vaulted	2,500	medium oil alkyd	good (V)			
	16	Vaulted	2,500	filtered alkyds	good (V)			
	19	Vaulted	2,500	medium oil alkyd	good (V)			
	X[3]	UST	3,000	Original contents unknown.[3]	good (V)	Tank not included in ERM reports.	Fill and vent pipes had been cut, no tank closure activities had taken place.	Emptied, cleaned and removed. Soil and groundwater sampling performed at location of tank.
	Y[3]	UST	3,000	Original contents unknown.[3]	good (V)			
	Z[3]	UST	3,000	Original contents unknown.[3]	good (V)			
D	A	UST	3,500	stormwater	good (V)	No action	Fill and vent pipes had been cut, no tank closure activities had taken place.	Emptied, cleaned and removed. Soil and groundwater sampling performed at
	B	UST	3,500	stormwater	good (V)			
	C	UST	1,500	waste oil; linseed oil	good (V)	Emptied, cleaned and removed.	Not Applicable.	Soil and groundwater sampling performed at former location of tank.
	10	UST	10,000	waste acetone/toluene; acetone/toluene	good (S)	Permanently closed with amino acid foam.	Tank found to be cut open, cleaned and filled with inert foam.	Foam was removed. Tank was emptied, cleaned and removed.
	34	UST	4,000	polyurethane varnish; mineral spirits	poor (V)	Emptied, cleaned and removed.	Not Applicable.	Soil and groundwater sampling performed at former location of tank.
	35	UST	4,000	mineral spirits; medium oil	poor (V & S)			
	36	UST	4,000	mineral spirits	good (V)			
	T[3]	UST	500	Original contents unknown. Residual contents: sludge and tank bottoms[3]	good (V)	Tank not included in ERM reports.	No tank closure activities had taken place.	Emptied, cleaned and removed. Soil and groundwater sampling performed at location of tank.
	U[3]	UST	3,000	Original contents unknown. Residual contents: hardened paint and varnish[3]	good (V)			
	V[3]	UST	275	Original contents unknown. Residual contents: sludge and tank bottoms[3]	good (V)			

1 Unless otherwise noted, tank contents information was obtained from the "Summary of Preliminary Investigation and Proposed Phase II Site Investigation, Former Red Devil Facility, Mount Vernon, New York, ERM, July 1991.
2 Tank condition determined via visual inspection of the tank (V) and/or sampling in the area of the tank (S).
3 Tank found by LBG . Tank was not included in ERM reports.

Table 3-1
Red Devil Paint
Historic ERM Delineation Well NAPL Thickness Measurements

	NAPL Thickness (ft)														
Wells	**3/31/1992**	**4/16/1992**	**1/22/1993**	**3/23/1993**	**5/25/1993**	**10/12/1993**	**9/19/1996**	**2/12/1997**	**6/24/1997**	**6/3/1998**	**9/1/1999**	**7/6/2000**	**6/7/2001**	**5/23/2002**	**7/2005**
DW-1A	0.32	0.28	0.01	0.02	0.04	0.05									0.00
DW-2A			0.03	0.00	0.00	0.00									0.00
DW-3A			0.00	0.00	0.00	0.00									0.00
DW-1C	1.25	1.30	1.12	NA	1.31	2.95	0.82	0.42	0.54		0.01	0.48	0.11	0.37	
DW-2C	1.31	1.36	1.24	NA	1.40	1.13			1.30		0.43	0.03	0.14	0.06	
DW-3C	0.05	0.10	0.06	NA	0.05	1.06		0.23							0.44
DW-4C	0.02	0.06	0.03	0.00	0.00	0.00									
DW-5C			0.34	0.51	0.45	0.16									0.04
DW-6C			1.65	1.93	1.71	2.01	0.39	0.00	0.00		0.00	0.00	0.00	0.00	0.33
DW-7C			0.02	0.00	0.00	0.05									
DW-1D	2.19	2.32	1.66	2.68	2.22	2.55	0.22	0.15		1.70					0.00
DW-2D	2.03	2.15	2.29	2.49	1.98	1.13	0.26			0.01					0.00
DW-3D	1.66	1.68	1.08	1.21	1.11	1.30				0.00					
DW-4D	1.94	1.91	NA	2.35	2.52	0.80		0.70		0.47					
DW-5D	1.35	1.53	0.46	0.70	0.62	0.59				0.00					
DW-6D	0.87	0.92	0.55	1.25	1.13	0.90									
DW-7D	0.02	0.03	0.04	0.00	0.00	0.22									
DW-8D	2.23	2.47	1.77	2.09	1.95	2.85	0.19	0.35		2.11					0.70
DW-9D	0.01	0.03	0.03	0.00	0.00	1.65									
DW-10D	3.72	3.92	3.07	3.15	2.97	3.57	0.54	1.12		0.62					
DW-11D	1.94	1.93	1.31	1.47	1.52	3.69	0.02	0.67		1.02					0.12
DW-12D	0.91	0.87	0.86	1.65	1.43	0.71		0.51		2.29					0.00
DW-13D			2.75	3.00	2.87	3.84	0.82	2.22		1.87					
DW-14D			0.02	0.15	0.11	0.16				2.31					0.66
DW-15D					0.00	0.00									0.00
DW-16D								0.00							0.00*
DW-17D							0.68	0.95							0.31*
DW-18D							0.44	0.14							0.00*
DW-19D							0.47	0.62							0.15*

Notes:
* - collected in September 2005
Well information changed dramatically after 2005, as LBG took over on site activities several wells were abandoned, new wells were installed and nomenclature changed. See Table 3-2.

Table 3-2
Red Devil Paint
Historic LBG Delineation Well NAPL Thickness Measurements

	NAPL Thickness (ft)				
	6/20/2007	3/3/2008	6/16/2008	10/14/2008	1/20/2009
DW-1A	-	-	NR	-	-
DW-2A	-	-	0.00	-	-
DW-3A	-	-	Destroyed	Destroyed	Destroyed
DW-1B	0.08	-	-	FILM	0.06
DW-20B	-	-	-	FILM	0.15
DW-21B	NI	NI	NI	-	-
DW-1C	FILM	-	-	FILM	-
DW-2C	NR	0.14	-	FILM	0.30
DW-3C	0.01	-	-	FILM	-
DW-4C	-	-	-	-	-
DW-5C	0.06	0.13	0.47	FILM	0.05
DW-6C	-	-	-	-	-
DW-7C	-	-	-	-	-
DW-18C	-	-	-	-	-
DW-19C	-	-	-	-	-
DW-1D	NR	Destroyed	Destroyed	Destroyed	Destroyed
DW-2D	NR	Destroyed	Destroyed	Destroyed	Destroyed
DW-3D	-	-	-	FILM	0.05
DW-4D	-	-	Destroyed	Destroyed	Destroyed
DW-5D	-	-	Destroyed	Destroyed	Destroyed
DW-6D	NR	-	Destroyed	Destroyed	Destroyed
DW-7D	NR	NR	NR	NR	NR
DW-8D	NR	-	Destroyed	Destroyed	Destroyed
DW-9D	NR	Destroyed	Destroyed	Destroyed	Destroyed
DW-10D	0.18	0.15	Destroyed	Destroyed	Destroyed
DW-11D	NR	Destroyed	Destroyed	Destroyed	Destroyed
DW-12D	-	-	-	-	-
DW-13D	0.65	NR	Destroyed	Destroyed	Destroyed
DW-14D	0.67	3.19	1.70	0.81	0.42
DW-15D	-	-	-	-	-
DW-16D	-	NR	-	-	-
DW-17D	-	-	-	-	-
DW-21D	0.90	0.28	-	0.08	0.20
DW-22D	-	-	-	-	-
DW-23D	-	NR	-	-	-
DW-16	-	0.00	-	-	-
DW-17	0.51	0.40	0.27	0.32	0.61
DW-18	0.49	0.79	0.59	0.20	0.77
DW-19	-	-	-	-	-

Notes:
NR - Not Recorded
NI- Not Installed
Destroyed- Well destroyed during tank closure and excavation activities
FILM - film of NAPL present in well
- no NAPL present in well

Table 3-3

Red Devil Paint

Distribution of Major Components of NAPL in On-site Wells

Well ID	DW-14D	R-4D	DW-2C
Lab ID	R0898	R0900	R0903
Sample Date	1/19/09	1/19/09	1/19/09
Distribution of Major Components of Organic Fractions			
Nonane	6%	1%	ND
1-Ethyl-4-methyl cyclohexane	ND	2%	5%
Decane and isomers	37%	32%	19%
C3-Benzene	17%	24%	ND
3-Nonyn-1-ol	ND	ND	8%
Undecane	18%	17%	24%
Cyclodecane	16%	17%	20%
Decalin	ND	ND	16%
1-Ethyl-2,3-dimethyl benzene	1%	1%	2%
2 Decalone	3%	3%	3%
Pulegone	1%	1%	2%
Dodecane and isomers	1%	2%	1%
Toluene 2,4-diisocyanate	0.90%	1.10%	0.30%
Depth to LNAPL (ft.)	13.13	15.4	13.9
Depth to Water (ft.)	13.55	16	14.2

TABLE 8-1
Red Devil Paint
Mt. Vernon, NY
Alternative 2 – Pre-Disposal

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 350,000.00	LS	$ 350,000
1b.	Workplans/Health & Safety Plan	1	$ 64,000.00	LS	$ 64,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 680,000.00	LS	$ 680,000
2. Construction Costs					
2a.	Clearing and Grubbing	1	$ 93,000.00	LS	$ 93,000
2b.	Soldier Piles and Lagging Installation	1	$ 853,500.00	LS	$ 853,500
	Soldier Piles and Lagging Materials	9500	$ 10.28	LS	$ 97,660
2c.	Secant Piling	1	$ 232,200.00	LS	$ 232,200
2d.	Excavation	1	$ 716,900.00	LS	$ 716,900
2e.	Backfilling Labor	1		LS	$ 1,001,500
	Common Fill	23000	$ 15.00	CY	$ 345,000
	Top Soil	670	$ 25.00	CY	$ 16,750
2f.	Waste Management Stockpiling/Loading (duration of clearing & excavation)	1	$ 594,000.00	LS	$ 594,000
2g.	Site Restoration	1	$ 159,000.00	LS	$ 159,000
2h.	Dewatering and Water Treatment	1	$ 595,000.00	LS	$ 595,000
2i.	Offsite Transportation and Disposal				
	Clearing and Grubbing Debris	200	$ 75	CY	$ 15,000
	Thermal Material	10400	$ 450.00	CY	$ 4,680,000
	Subtitle C Landfill	5200	$ 175.00	CY	$ 910,000
	Subtitle D Landfill	5200	$ 80.00	CY	$ 416,000
2j.	Additional Costs				
	Traffic Control	1	$ 156,600	LS	$ 156,600
	Soil Erosion and Sedimen Control Plan	1	$ 100,000.00	LS	$ 100,000
	Permits	1	$ 300,000.00	LS	$ 300,000
	Contractors Support Zone, Temporary Facilities, Bronx River Access	1	$ 1,500,000.00	LS	$ 1,500,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 13,884,110**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 4,165,233
5.	Design Engineering (20% construction plus separate gw modeling)				$ 2,836,822
6.	Contingency (20%)				$ 2,776,822
	TOTAL COSTS				**$ 23,662,987**

TABLE 8-2
Red Devil Paint
Mt. Vernon, NY
Alternative 3 – In situ Stabilization/Solidification

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 1,392,100.00	LS	$ 1,392,100
1b.	Workplans/Health & Safety Plan	1	$ 64,000.00	LS	$ 64,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 680,000.00	LS	$ 680,000
2. Construction Costs					
2a.	Clearing & Grubbing	1	$ 92,950	LS	$ 92,950
2b.	In-situ Soldification (Equipment & Labor)	1	$ 1,055,350.08	LS	$ 1,055,350
	Portland Cement	6686	$ 130.00	TONS	$ 869,180
	Portland Cement Additive	67	$ 1,025.00	TONS	$ 68,675
2b.	Barge (Equipment & Operators)	2	$ 605,950.00	LS	$ 1,211,900
2c.	Air Rotary Drill Rig (Equipment & Labor)	160	$ 2,905.00	DAYS	$ 464,800
	Decon Rig	1	$ 20,000.00	LS	$ 20,000
2d.	Waste Management Stock Piling and Loading	1	$ 151,600.00	LS	$ 151,600
2e.	Offsite Transportation and Disposal of Clearing/Grubbing Debris	1	$ 15,000.00	LS	$ 15,000
2f.	Site Restoration	1	$ 159,000.00	LS	$ 175,500
2g.	Contractors Support Zone, Temporary Facilities, Bronx River Access	1	$ 500,000.00	LS	$ 500,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 6,769,055**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 2,030,717
5.	Design Engineering (20% construction plus separate gw modeling)				$ 1,413,811
6.	Contingency (20%)				$ 1,353,811
	TOTAL COSTS				**$ 11,567,394**

TABLE 8-3
Red Devil Paint
Mt. Vernon, NY
Alternative 4 – Extraction

Extraction A - TFR with Vertical Extraction Wells

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 50,700.00	LS	$ 50,700
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 25,000.00	LS	$ 25,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
	Construction Management	1	$ 50,000.00	LS	$ 50,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Vertical Well Installation (4 wells - Including Disposal of Drill Cuttings)	1	$ 42,600.00	LS	$ 42,600
2f.	TFR Pumping System and Groundwater Treatment System	1	$ 372,900.00	LS	$ 372,900
2g.	Treatment Building	100	$ 200.00	SF	$ 20,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 676,700**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 203,010
5.	Design Engineering (20% construction plus separate gw modeling)				$ 195,340
6.	Contingency (20%)				$ 135,340
	TOTAL COSTS				**$ 1,210,390**

Extraction B - TFR with Horizontal Extraction Well

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 55,800.00	LS	$ 55,800
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 25,000.00	LS	$ 25,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 50,000.00	LS	$ 50,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Horizontal Well Installation (Including Disposal of Drill Cuttings)	1	$ 93,600.00	LS	$ 93,600
2f.	TFR Pumping System and Groundwater Treatment System	1	$ 372,900.00	LS	$ 372,900
2g.	Treatment Building	100	$ 200.00	SF	$ 20,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 732,800**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 219,840
5.	Design Engineering (20% construction plus separate gw modeling)				$ 206,560
6.	Contingency (20%)				$ 146,560
	TOTAL COSTS				**$ 1,305,760**

Extraction C - Air Lift Pumps with Vertical Extraction Wells

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 34,210.00	LS	$ 34,210
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 25,000.00	LS	$ 25,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 50,000.00	LS	$ 50,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Vertical Well Installation (4 wells - Including Disposal of Drill Cuttings)	1	$ 42,600.00	LS	$ 42,600
2f.	Groundwater Treatment System	1	$ 186,500.00	LS	$ 186,500
2g.	Air Lift Pumping System	1	$ 21,500.00	LS	$ 21,500
2h.	Treatment Building	100	$ 200.00	SF	$ 20,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 495,310**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 148,593
5.	Design Engineering (20% construction plus separate gw modeling)				$ 159,062
6.	Contingency (20%)				$ 99,062
	TOTAL COSTS				**$ 902,027**

TABLE 8-4
Red Devil Paint
Mt. Vernon, NY
Alternative 5 – Extraction and Secant Piling

Extraction and Secant Piling A- TFR with Vertical Extraction Wells

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 125,000.00	LS	$ 125,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 50,000.00	LS	$ 50,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 100,000.00	LS	$ 100,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Vertical Well Installation (4 wells - Including Disposal of Drill Cuttings)	1	$ 42,600.00	LS	$ 42,600
2f.	TFR Pumping System and Groundwater Treatment System	1	$ 372,900.00	LS	$ 372,900
2g.	Secant Piling	1	$ 2,000,000.00	LS	$ 2,000,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 2,806,000**
3. O&M Costs (not provided until results of FFS Investigation are available)					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 841,800
5.	Design Engineering (20% construction plus separate gw modeling)				$ 621,200
6.	Contingency (20%)				$ 561,200
	TOTAL COSTS				**$ 4,830,200**

Extraction and Secant Piling B- TFR with Horizontal Extraction Well

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 130,000.00	LS	$ 130,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 50,000.00	LS	$ 50,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 100,000.00	LS	$ 100,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Horizontal Well Installation (Including Disposal of Drill Cuttings)	1	$ 93,600.00	LS	$ 93,600
2f.	TFR Pumping System and Groundwater Treatment System	1	$ 372,900.00	LS	$ 372,900
2g.	Secant Piling	1	$ 2,000,000.00	LS	$ 2,000,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 2,862,000**
3. O&M Costs (not provided until results of FFS Investigation are available)					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 858,600
5.	Design Engineering (20% construction plus separate gw modeling)				$ 632,400
6.	Contingency (20%)				$ 572,400
	TOTAL COSTS				**$ 4,925,400**

Extraction and Secant Piling C - Air Lift Pumps with Vertical Wells

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 125,000.00	LS	$ 125,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 50,000.00	LS	$ 50,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 100,000.00	LS	$ 100,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Vertical Well Installation (4 wells - Including Disposal of Drill Cuttings)	1	$ 42,600.00	LS	$ 42,600
2f.	Groundwater Treatment System	1	$ 186,500.00	LS	$ 186,500
2g.	Air Lift Pumping System	1	$ 21,500.00	LS	$ 13,500
2h.	Secant Piling	1	$ 2,000,000.00	LS	$ 2,000,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 2,633,100**
3. O&M Costs (not provided until results of FFS Investigation are available)					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 789,930
5.	Design Engineering (20% construction plus separate gw modeling)				$ 586,620
6.	Contingency (20%)				$ 526,620
	TOTAL COSTS				**$ 4,536,270**

TABLE 8-5
Red Devil Paint
Mt. Vernon, NY
Alternative 6 – Extraction and Thermal Technologies

Extraction and ERH A - TFR with Vertical Extraction Wells

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 100,000.00	LS	$ 100,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 40,000.00	LS	$ 40,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 80,000.00	LS	$ 80,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Vertical Well Installation (4 wells - Including Disposal of Drill Cuttings)	1	$ 42,600.00	LS	$ 42,600
2f.	TFR Pumping System and Groundwater Treatment System	1	$ 372,900.00	LS	$ 372,900
2g.	Treatment Building	100	$ 200.00	SF	$ 20,000
2h.	ERH	1	$ 720,000.00	LS	$ 720,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 1,491,000**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 447,300
5.	Design Engineering (20% construction plus separate gw modeling)				$ 358,200
6.	Contingency (20%)				$ 298,200
	TOTAL COSTS				**$ 2,594,700**

Extraction and ERH B - TFR with Horizontal Extraction Well

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 100,000.00	LS	$ 100,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 40,000.00	LS	$ 40,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 80,000.00	LS	$ 80,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Horizontal Well Installation (Including Disposal of Drill Cuttings)	1	$ 93,600.00	LS	$ 93,600
2f.	TFR Pumping System and Groundwater Treatment System	1	$ 372,900.00	LS	$ 372,900
2g.	Treatment Building	100	$ 200.00	SF	$ 20,000
2h.	ERH	1	$ 720,000.00	LS	$ 720,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 1,542,000**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 462,600
5.	Design Engineering (20% construction plus separate gw modeling)				$ 368,400
6.	Contingency (20%)				$ 308,400
	TOTAL COSTS				**$ 2,681,400**

Extraction and ERH C - Air Lift Pumps with Vertical Extraction Wells

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 85,000.00	LS	$ 85,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 40,000.00	LS	$ 40,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 80,000.00	LS	$ 80,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Vertical Well Installation (4 wells - Including Disposal of Drill Cuttings)	1	$ 42,600.00	LS	$ 42,600
2f.	Groundwater Treatment System	1	$ 186,500.00	LS	$ 186,500
2g.	Air Lift Pumping System	1	$ 21,500.00	LS	$ 21,500
2h.	Treatment Building	100	$ 200.00	SF	$ 20,000
2i.	ERH	1	$ 720,000.00	LS	$ 720,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 1,311,100**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 393,330
5.	Design Engineering (20% construction plus separate gw modeling)				$ 322,220
6.	Contingency (20%)				$ 262,220
	TOTAL COSTS				**$ 2,288,870**

TABLE 8-6
Red Devil Paint
Mt. Vernon, NY
Alternative 7 – Extraction, Secant Piling and Thermal Technologies

Extraction, Containment and ERH A - TFR wtih Vertical Extraction Wells

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 125,000.00	LS	$ 125,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 65,000.00	LS	$ 65,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 125,000.00	LS	$ 125,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Vertical Well Installation (4 wells - Including Disposal of Drill Cuttings)	1	$ 42,600.00	LS	$ 42,600
2f.	TFR Pumping System and Groundwater Treatment System	1	$ 372,900.00	LS	$ 372,900
2g.	Treatment Building	100	$ 200.00	SF	$ 20,000
2h.	ERH	1	$ 720,000.00	LS	$ 720,000
2i.	Secant Piling	1	$ 2,000,000.00	LS	$ 2,000,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 3,586,000**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 1,075,800
5.	Design Engineering (20% construction plus separate gw modeling)				$ 777,200
6.	Contingency (20%)				$ 717,200
	TOTAL COSTS				**$ 6,156,200**

Extraction, Containment and ERH B - TFR with Horizontal Extraction Well

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 135,000.00	LS	$ 135,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 65,000.00	LS	$ 65,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 125,000.00	LS	$ 125,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Horizontal Well Installation (Including Disposal of Drill Cuttings)	1	$ 93,600.00	LS	$ 93,600
2f.	TFR Pumping System and Groundwater Treatment System	1	$ 372,900.00	LS	$ 372,900
2g.	Treatment Building	100	$ 200.00	SF	$ 20,000
2h.	ERH	1	$ 720,000.00	LS	$ 720,000
2i.	Secant Piling	1	$ 2,000,000.00	LS	$ 2,000,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 3,647,000**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 1,094,100
5.	Design Engineering (20% construction plus separate gw modeling)				$ 789,400
6.	Contingency (20%)				$ 729,400
	TOTAL COSTS				**$ 6,259,900**

Extraction, Containment and ERH C - Air Lift Pumps with Vertical Extraction Wells

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 120,000.00	LS	$ 120,000
1b.	Workplans/Health & Safety Plan	1	$ 36,000.00	LS	$ 36,000
1c.	Temporary Facilities	1	$ 65,000.00	LS	$ 65,000
1d.	Surveying	1	$ 8,000.00	LS	$ 8,000
1e.	Construction Management	1	$ 125,000.00	LS	$ 125,000
2. Construction Costs					
2a.	Erosion Control	1	$ 4,000.00	LS	$ 4,000
2b.	Site Preparation and Clearing	6000	$ 5.00	SF	$ 30,000
2c.	Dust Control & Misc. Support	1	$ 4,000.00	LS	$ 4,000
2d.	Crane Rental	1	$ 33,500.00	LS	$ 33,500
2e.	Vertical Well Installation (4 wells - Including Disposal of Drill Cuttings)	1	$ 42,600.00	LS	$ 42,600
2f.	Groundwater Treatment System	1	$ 186,500.00	LS	$ 186,500
2g.	Air Lift Pumping System	1	$ 21,500.00	LS	$ 13,500
2h.	Treatment Building	100	$ 200.00	SF	$ 20,000
2i.	ERH	1	$ 720,000.00	LS	$ 720,000
2j.	Secant Piling	1	$ 2,000,000.00	LS	$ 2,000,000
	SUBTOTAL CONSTRUCTION COSTS				**$ 3,408,100**
3. *O&M Costs (not provided until results of FFS Investigation are available)*					**$ -**
4.	General Contractor Overhead and Profit (30% construction)				$ 1,022,430
5.	Design Engineering (20% construction plus separate gw modeling)				$ 741,620
6.	Contingency (20%)				$ 681,620
	TOTAL COSTS				**$ 5,853,770**

Figures

Figure 2-1
Site Location Map
30 North West St.
Mount Vernon, NY

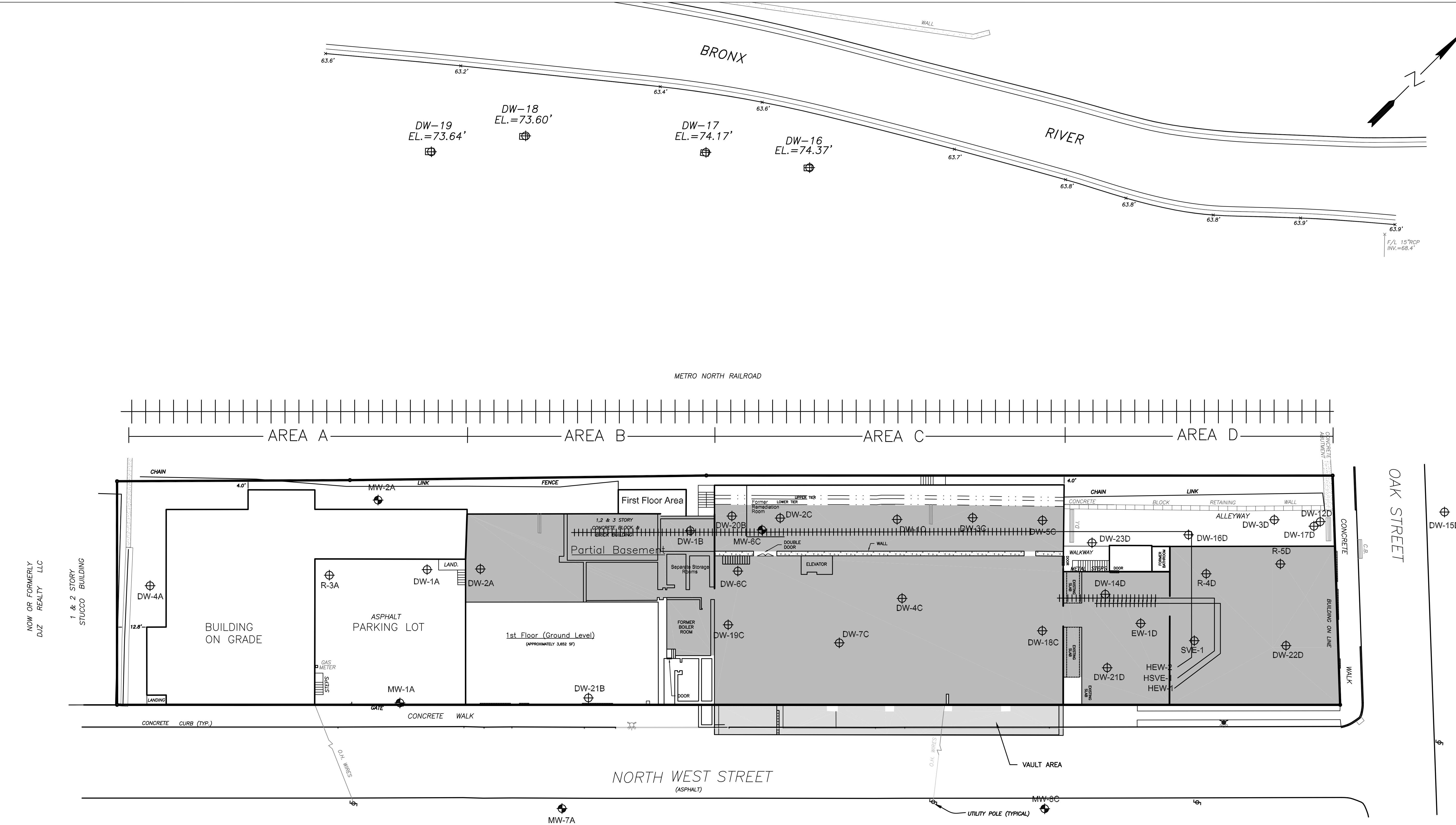


Figure adapted from Leggette, Brashears & Graham, Inc.'s Figure 16 Well Location Map 2008 from their Remedial investigation Report March 2009.

LEGEND

- PROPERTY BOUNDARY
- GROUND WATER MONITOR WELL LOCATION
- PRODUCT DELINEATION WELL LOCATION
- HORIZONTAL WELL

NOTES: BASE MAP SOURCE IS ERM–NORTHEAST
JOB # 488.004.6, PLATE 1
R–3A, R–4D AND R–5D ARE REPLACEMENT WELLS

NOTE: IT IS A VIOLATION OF ARTICLE 130 OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON TO ALTER THIS DOCUMENT IN ANY WAY WITHOUT THE EXPRESS WRITTEN VERIFICATION OR ADOPTION BY A NEW YORK STATE LICENSED LAND SURVEYOR OR ENGINEER IN ACCORDANCE WITH SECTION 7209 (2), ARTICLE 130, NEW YORK STATE EDUCATION LAW.

0 40
SCALE IN FEET

DRAFT

CDM

Figure 2-2
Site Map and Well Locations
Former Red Devil Paint Facility
Mount Vernon, New York

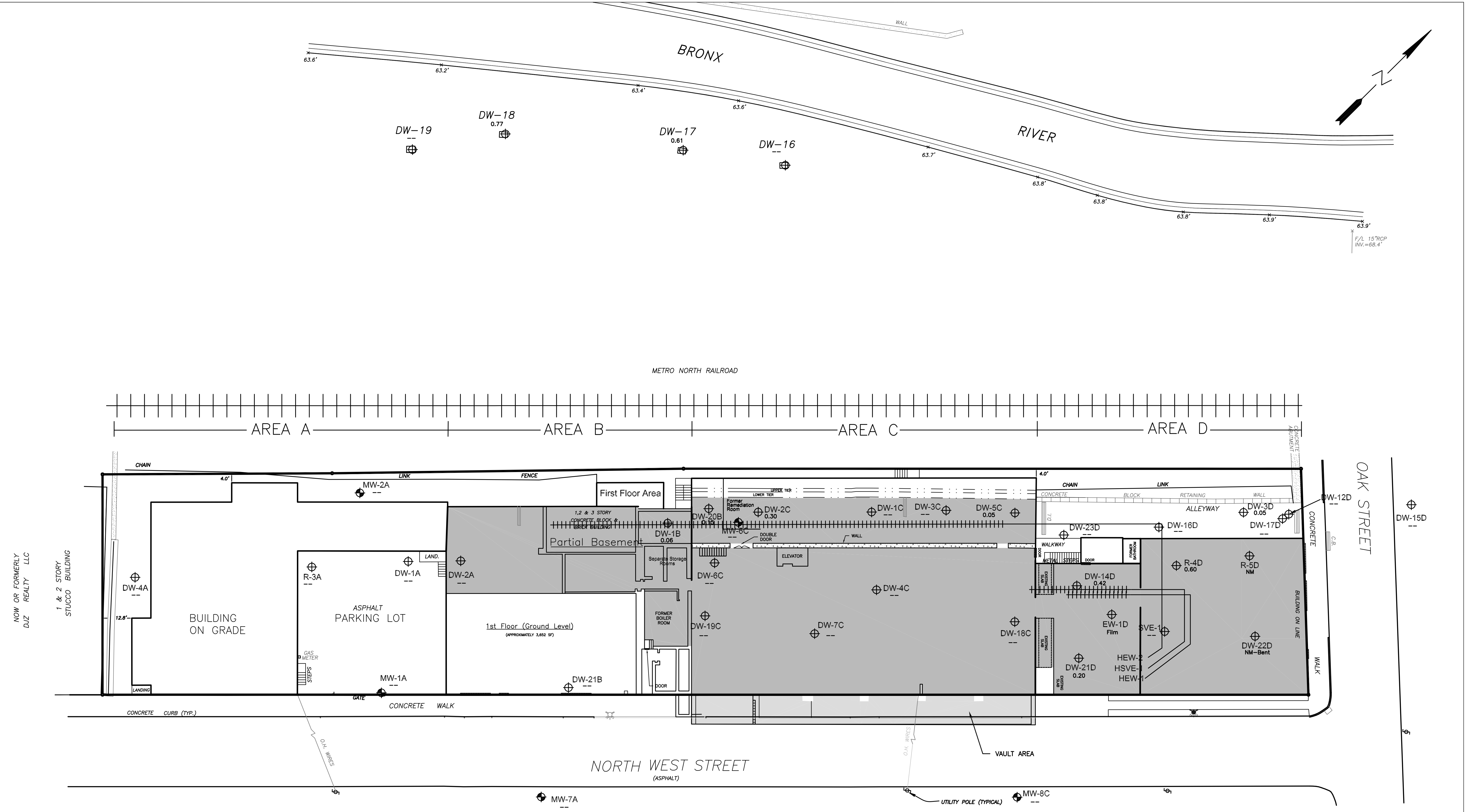


Figure adapted from Leggette, Brashears & Graham, Inc.'s Figure 58 Free-Phase Product (NAPL) Distribution January 2009 from their Remedial investigation Report March 2009.

PROPERTY BOUNDARY
GROUND WATER MONITOR WELL LOCATION
PRODUCT DELINEATION WELL LOCATION
0.30 PRODUCT THICKNESS (FEET)
NM NOT MEASURED
HORIZONTAL WELL

R-3A, R-4D AND R-5D ARE REPLACEMENT WELLS

NOTE: IT IS A VIOLATION OF ARTICLE 130 OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON TO ALTER THIS DOCUMENT IN ANY WAY WITHOUT THE EXPRESS WRITTEN VERIFICATION OR ADOPTION BY A NEW YORK STATE LICENSED LAND SURVEYOR OR ENGINEER IN ACCORDANCE WITH SECTION 7209 (2), ARTICLE 130, NEW YORK STATE EDUCATION LAW.

DRAFT

CDM

0 40 SCALE IN FEET

Figure 3-1
January 2009 LNAPL Thickness Measurements
Former Red Devil Paint Facility
Mount Vernon, New York

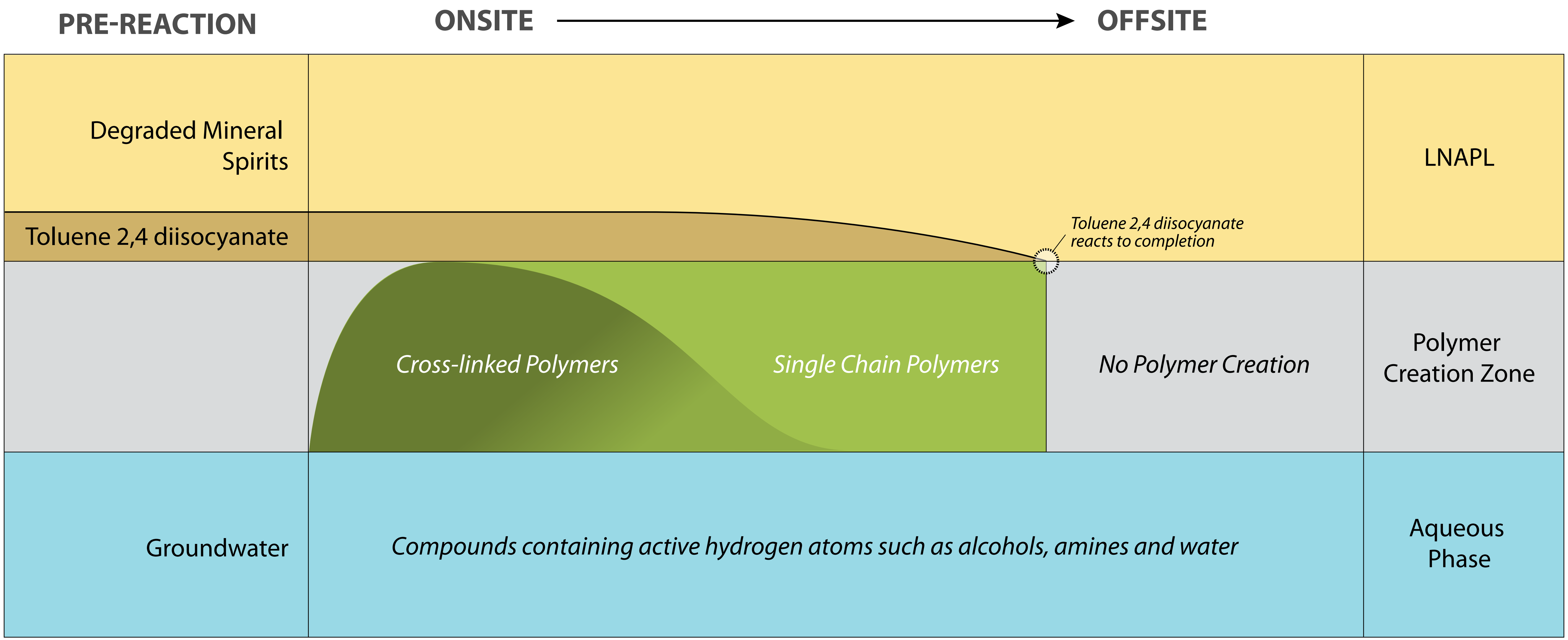
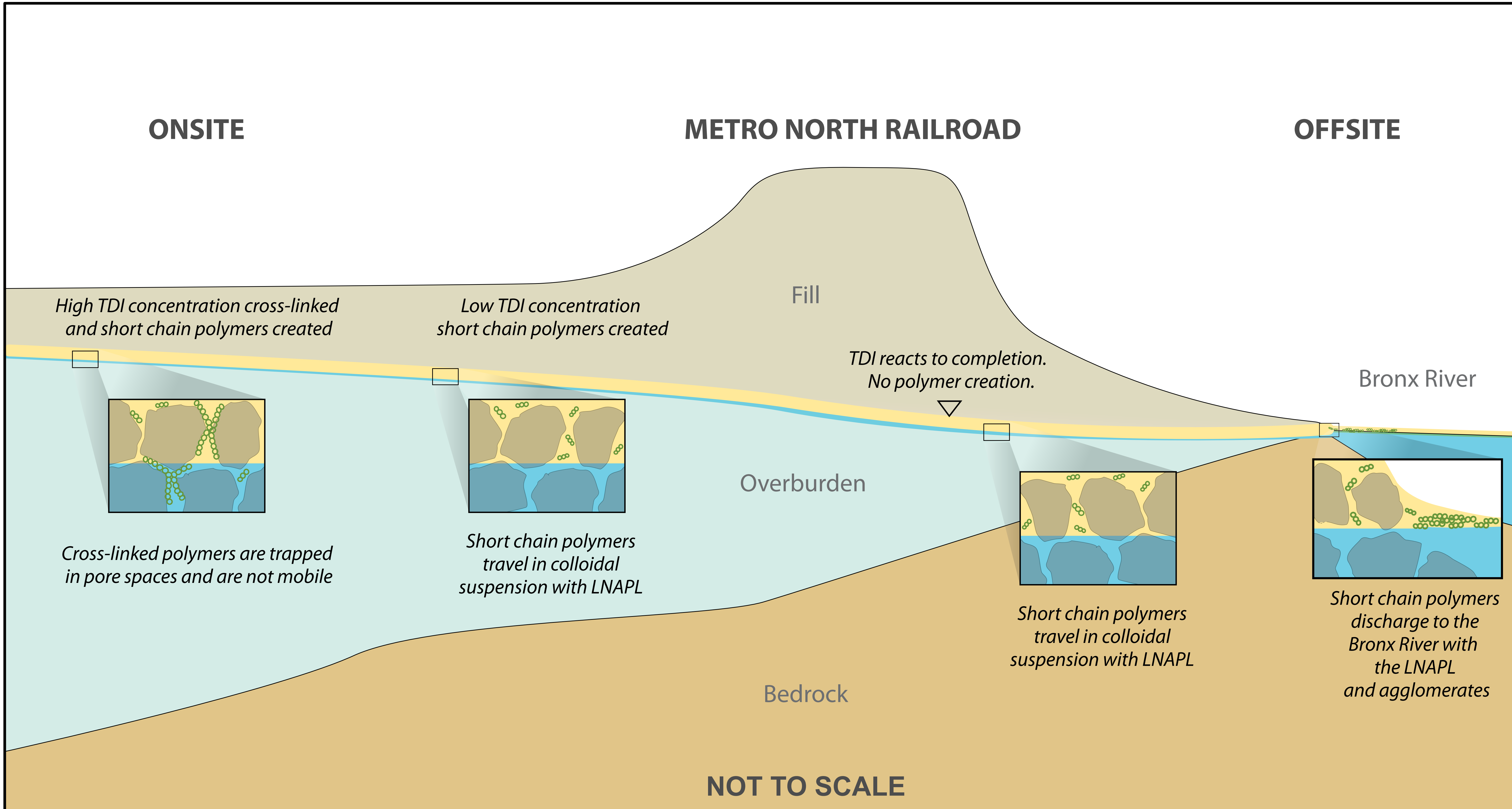


Figure 3-2
Conceptual Model of Polymer Creation
Red Devil Paint Site
Mount Vernon, NY

CDM



Legend

TDI = Toluene 2,4 diisocyanate

LNAPL = Light Non-Aqueous Phase Liquids

= Short chain polymers

= Long chain polymers

Figure 3-3
Conceptual Site Model
Red Devil Paint Site
Mount Vernon, NY

CDM

APPENDIX A
LABORATORY REPORTS

APPENDIX B
DRAFT CONCEPTUAL SITE MODEL

July 7, 2009

Ms. Kathryn Eastman
Project Manager
NYSDEC
Division of Environmental Remediation
Bureau of Program Management
625 Broadway – 11th Floor
Albany, New York 12233-7013

PROJECT: NYSDEC Standby Contract No. D006131
Work Assignment No. D006131-9 (RD/RA)

SUBJECT: Draft Conceptual Site Model
Remedial Design/Remedial Action
Red Devil Paint
Mount Vernon, Westchester County, New York
Site ID No. 3-60-031

Dear Ms. Eastman:

Camp Dresser & McKee (CDM) is pleased to present this draft conceptual site model (CSM) for the former Red Devil Paint site. This memorandum presents a summary of site background information including the site location and layout, operational history, regulatory status and previous investigations. The CSM summarizes the current understanding of contaminant fate and transport at the site, including potential contamination sources and receptors. The CSM will be updated as the additional data become available from the RI and FFS.

Site Location and Description

The former Red Devil Paint facility, referred to as the site, is located at 30 North West Street in the City of Mount Vernon, Westchester County New York. The location of the property, as seen in Figure 1, is 40 54’54” north latitude and 73 51’35” west longitude. The property is approximately 50,500 square feet (sq. ft.), of which 37,035 sq. ft. is improved with the a multi-floored facility. Due to the size and complexity of the facility, previous investigations divided the property into four areas of interest. These areas of interest were designated as Areas A, B, C and D and were determined based on the physical layout of the property and the primary operations that occurred in each portion of the facility during active manufacturing. Area A, located on the ground floor, consisted of an office area and a courtyard. Area B was located in the basement and was used for raw material storage and contained the boiler room. Area

C, which was also located in the basement, consisted of the former production area. Area D, located in the basement, contained the packing operations and a garage/storage area. The property boundaries and designated areas of interest can be seen in Figure 2.

The property is located within an industrial zoned area. The surrounding land use is urban with mixed residential and industrial/commercial developments. All of the immediate surrounding properties are industrial or commercial in nature. The property is bordered by the Metro-North Railroad to the northwest, Oak Street to the northeast, and North West Street to the southeast. The Bronx River is located approximately 115 feet northwest of the property, opposite the Metro-North Railroad tracks. Further northwest, beyond the Bronx River, the Bronx River Parkway runs adjacent to the river.

Operational History

Industrial activities have been occurring on the property for more than 80 years. The earliest Building Department records indicate that Egler and Sons Baking Company constructed a baking factory on the property in 1908. Between 1908 and 1940, the property was owned and operated by several bakeries including Shults Bread Company, Bakery Services Corporation and Continental Baking Corporation. Over this period of time, additional structures including sheds, a mill and a garage were constructed on the property. During the late forties and early fifties, Red Devil Paints and Chemicals, Inc., related to Technical Color and Chemical Works, Inc., began operations at the property.

From 1959 to 1971, Red Devil Paints & Chemicals, Inc. operated a paint facility, which blended and manufactured paints and varnishes. During the period of facility operations (1959 to 1990) materials were released from leaking USTs and ASTs and associated piping systems, resulting in soil and groundwater contamination. The following contents were identified from USTs which were abandoned: alcohol, acetone, filtered alkyds, fuel oil, hydrocarbon resin, long oil, long oil/alkyd/ polyurethane blend, medium oil alkyd, methanol, methyl carbitol, methylene chloride/isopropanol, mineral spirits, mineral spirits/medium oil, mineral spirits/ methanol, no. 6 fuel oil, paint sludge, polyurethane varnish, polyurethane varnish/mineral spirits, and raw linseed oil.

In 1971, Insilco Corporation acquired Red Devil Paint and purchased the property in 1985. Insilco sold the assets of the Red Devil Paint division to Thompson and Formby in 1989. Until 1990, Insilco continued to operate the facility under a supply agreement. Operations ceased in 1990, at which time Thompson and Formby removed a majority of the operating equipment and all of the remaining stock and transported the materials to other facilities.

Metro Self Storage Bronx, Inc. began leasing the property and the building from Insilco, until it was sold to SUSA Mt. Vernon, LLC.

Based on available records, it is believed that most of the construction on the property was completed by Red Devil Paints and Chemicals, Inc. Areas C and D, consisting of the production area, the packing and the garage areas are believed to have been built in 1915. A paint remover building, which was located in the parking lot adjacent to Area A, was built in 1956 but has since been razed to its foundation. Area B, consisting of the raw material storage, machine shop, and boiler room was constructed in 1963. The western portion of Area C, which contained the packing and mixing kettle rooms, was added as an addition to Area C in 1966. The building on the southern portion of Area A was completed in 1987 and was utilized as the final office structure.

There have been no activities of significance along the Bronx River, with the exception of remedial investigations and activities. This area has remained highly vegetated and access restricted as it is bordered by the Metro North rail line, the Mount Vernon Avenue and Oak Street Bridges and the Bronx River Parkway.

Environmental Regulatory Status

On June 29, 1992, the Red Devil Paint Company was listed on the State Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 Site (no. 360031). In April 1993, an Order of Consent requiring a Remedial Investigation/Feasibility Study (RI/FS) and an Interim Remedial Measures (IRM) program was executed by Insilco Corporation and NYSDEC. Based on the findings of the RI/FS, a Record of Decision (ROD) for Operable Unit 1 (OU-1) was issued by NYSDEC in March 1996. Two operable units, OU-1 and OU-2, were identified for the site. OU-1, would address the presence of non-aqueous phase liquid (NAPL) and paint material both on and offsite, while OU-2 would address residual groundwater and soil contamination after the NAPL has been recovered. Insilco signed a second Consent Order agreeing to implement the ROD in March 1997. However, in April 2003, Insilco stopped all remedial operations after initiating bankruptcy proceedings. In 2005, a non-Potentially Responsible Party (PRP) entered into a Brownfields Cleanup Agreement (BCA) to remediate the Red Devil site. In 2007, the portion of the Bronx River was referred to the State Superfund (SSF) program.

Previous Environmental Activities

After manufacturing operations ceased in 1990, Insilco initiated a program at the Site in order to mitigate any potential environmental damages associated with the property. These initial activities were conducted by ERM. At that time, ERM-Northeast (ERM) was hired by Insilco to implement a decommissioning program that encompassed the identification of environmental management requirements for facility deactivation. The decommissioning program aimed to identify items requiring decontamination, removal, and/or special handling in order to prepare equipment and facilities for plant closure as well as to assess areas of the site which had negatively impacted the environment through historical onsite facility activities. In June 1991, during facility decommissioning, a Spill Incident Report was made to the NYSDEC when tank releases were found to have impacted soil and groundwater beneath the facility. During the period of facility operations, materials were released from leaking USTs, ASTs and associated piping. It is unclear if material releases were a result of poor housekeeping, infiltration from the facility floor drain and sump system, which was comprised of unlined floor drains and sumps, dumping into abandoned drywells, or a result of multiple pathways.

LNAPL was observed in onsite and off-site monitoring wells and seeping from the riverbanks of the Bronx River. Soil contamination included toluene, acetone, xylenes, methanol and methylene chloride. In June 1992, the Red Devil Paint Company was listed on the State Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 Site (No 360031). Insilco, the Potentially Responsible Party (PRP), undertook to: (1) close or remove forty two (42) above-grade and underground storage tanks (ASTs and USTs), (2) remove adjacent contaminated soils and liquids, and (3) complete a preliminary site assessment (PSA).

During the period 1991-1994, the factory building was converted to its present site use as self storage. Insilco subsequently performed active site remediation starting in 1993. Insilco signed the first of two Consent Orders with the New York State Department of Environmental Conservation (NYSDEC) in April 1993 under which, Insilco contracted the design and construction of two Interim Remedial Measures (IRMs) and the completion of a Remedial Investigation/ Feasibility Study (RI/FS) in 1994. Based on the findings of the RI/FS, a Record of Decision for Operable Unit 1 (ROD OU1) was issued by NYSDEC in March 1996. The ROD (and subsequent Consent Order) defined Operable Unit 1 (OU-1) to address the NAPL and OU-2 to address residual contamination. The ROD for OU-1 mandated the installation and operation of both on-site and off-site LNAPL collection systems, and the installation of a hard boom system in the Bronx River to prevent migration of the LNAPL discharging to the Bronx River.

Insilco signed a second Consent Order agreeing to implement the ROD in March 1997. Remedial construction was completed in 1998, and the LNAPL collection systems were operated until 2003. However, there were significant operational difficulties due to differing chemical properties within the plume. LNAPL from Area C was lower in viscosity and was easier to collect, with 8500 gallons of product collected from the on-site system and 3100 gallons of product collected from the river boom system. Limited LNAPL recovery was obtained from the Area D LNAPL collection system with approximately 350 gallons of product collected from the on-site system and 450 gallons of product were collected from the off-site collection system.

However, in April 2003, Insilco stopped all remedial operations after initiating bankruptcy proceedings. In order to protect the river from the continuing influx of LNAPL, the NYSDEC took over the maintenance of the river boom system. In 2005, a non-PRP volunteer entered into a Brownfields Cleanup Agreement (BCA) to remediate the Red Devil site. In 2006, an onsite Remedial Investigation Work Plan (RIWP) was approved under the Brownfields Cleanup Program (BCP), and later a work plan for an IRM was also approved.

The volunteer has completed both the field investigation for the on-site RI and the IRM, which consisted of the removal of the remaining USTs/ASTs, and the excavation and removal of adjacent contaminated soils and source material. Significant impacts to the Bronx River are still evident as LNAPL continues to be present in onsite and offsite wells, and to seep from multiple points along the riverbank. The BCP volunteer also took over maintenance of the river boom system (from the NYSDEC) in 2006, subsequently agreeing to continue to maintain the system until the completion of an onsite remedial system to mitigate off-site LNAPL migration. A detailed discussion of site investigations and previous remedial actions will be presented in Section 2 of the Focused Feasibility Study.

Conceptual Site Model

A CSM was developed to integrate information collected during previous investigations at the former Red Devil site, including geology, hydrogeology, and the fate and transport of contamination associated with the site. The CSM will be updated as additional information is obtained during the RI and RD.

Physical Setting with Respect to Groundwater Movement

The former Red Devil site falls within the Lower Hudson River Valley of the New England physiographic province. Regional geology in this part of southern Westchester County consists of the Manhattan Schist and Hartland Formation metamorphic bedrock, overlain by a generally thin layer of unstratified glacial deposits.

Figures 3 and 4 show cross sections developed from existing hydrogeologic and groundwater quality data. These cross sections show the general site lithology where that data was available. Underlying the site is approximately 5 to 15 feet of fill material. The fill is predominantly sand, plus a mixture of coal dust, bricks, concrete rubble and boulders (construction and demolition debris). The natural sediments underlying the fill are a mixture of glacial material and recent alluvial sediments. The unconsolidated glacial material is comprised of poorly-stratified silts with lesser amounts of fine to medium sand and trace amounts of gravel. Apparent bedrock surface was encountered throughout the site at approximately 20-25 ft bgs (feet below ground surface) in Areas C and D (northern portion of the Site in the vicinity of the basement). The bedrock appears to follow the contour of site topography, which elevates to the south-southwest. Previous investigations have considered the top of bedrock to be a confining layer however, no data is available to support this conclusion.

Groundwater in the area is recharged locally by precipitation, which averages 48 inches per year. The volume of water that percolates down to the water table and recharges the groundwater is the residual of the total precipitation not returned to the atmosphere by evapotranspiration or lost by runoff to the surface water drainage systems. The depth to groundwater varied across the site from 13 feet bgs to 25 feet bgs. Groundwater appears to be flowing southwestward towards the Bronx River. The vertical groundwater flow gradient has not been defined.

The former Red Devil site is located approximately 115 feet southeast of the Bronx River. The Bronx River is classified as a Class C stream, indicating that it is fresh water suitable for fishing, fish propagation and survival, and primary and secondary contact recreation. Storm water run-off throughout the site and the surrounding area drains into drywells, percolates through the topsoil or flows into storm-water catch-basins and through the storm-water sewer, and ultimately discharges to the Bronx River. The river flows southward and discharges into the Long Island Sound, near the head of the East River. The river is 30 feet wide and 3-5 feet deep, having an average flow of 60 cubic feet per second (cfs). The river bed appears to be bedrock and the channel has been stabilized by a vertical concrete wall on the north bank and riprap material along the south bank.

Potential Contaminant Sources

As previously discussed, the former Red Devil site has been divided into 4 areas, A through D (Figure 2), for purposes of investigation and remediation. Each area has different contamination profiles based on the operations conducted within the area. Area A previously contained a paint remover building, and is currently a loading dock, parking lot and office space. There were six 1,500 gallon USTs in this area containing alcohol, mineral spirits, methanol, and methylene chloride/isopropanol. There were also three 3,000 gallon USTs with unknown contents and two USTs of unreported size or contents. There was also a dry well located in this area. Analytical results show the presence of VOCs and metals. Toluene was primary contaminant in both soil and groundwater, with concentrations generally decreasing with depth. There were also detections of arsenic, barium, chromium, lead and mercury in soils and groundwater, both at the water table and above bedrock. The groundwater plume originating in Area A seems to be primarily characterized by the presence of toluene, arsenic, barium, chromium, lead and mercury.

Area B consisted of the raw material storage, machine shop, and boiler room. Four USTs and nine vaulted ASTs were located in this area. The vaulted ASTs contained medium oil alkyd, long oil alkyd/polyurethane blend, hydrocarbon resin, methyl carbitol, raw linseed oil and fuel oil. The USTs contained mineral spirits; methanol, acetone, medium oil alkyd and no. 6 fuel oil. Contamination detected in Area B soils and groundwater included VOCs and metals, however concentrations were orders of magnitude below concentrations detected in other areas. Area B does not appear to be a significant source of groundwater contamination.

Area C was the production area and contained the packaging and mixing kettle rooms. This area contained four 2,500 gallon vaulted ASTs, which contained long oil, medium oil alkyd, filtered alkyds and medium oil alkyd, all of which are components of polyester coatings. There were also two USTs that contained paint sludge and polyurethane and three USTs with unknown contents. Contamination detected in Area C consists of VOCs, SVOCs and metals. Contaminant concentrations in both soil and groundwater generally increased with depth and contamination was detected as deep as the top of bedrock. The groundwater plume originating from Area C is primarily characterized by VOCs (toluene, ethylbenzene and trimethylbenzene (component of mineral spirits)), metals (arsenic, barium, chromium, lead and mercury) and LNAPL. This area contained the highest concentrations of mineral spirits (trimethylbenzenes), which may decrease the viscosity of the LNAPL plume.

Area D was the packaging and garage area. There were ten USTs identified in this area. Two were used to contain storm water. Five USTs were reported to have contained waste oil and linseed oil, acetone and toluene, polyurethane varnish and mineral spirits, mineral spirits and medium oil, and mineral spirits. The original contents for three USTs are unknown, but they contained sludge and hardened paint and varnish at the time of removal. Contamination detected in Area D consists of VOCs, SVOCs and metals. Contaminant concentrations in both soil and groundwater were generally consistent with depth and contamination was detected as deep as the top of bedrock. The groundwater plume originating from Area D is primarily characterized by VOCs (toluene, benzene, ethylbenzene and trimethylbenzene (component of mineral spirits)), metals (barium, chromium, lead and mercury) and LNAPL.

LNAPL has been historically reported in Areas C and D. Chemical analysis of the LNAPL performed as part of the focused feasibility study (FFS) determined the LNAPL onsite is primarily composed of cross-linked polymers and degraded mineral spirits that contain the compound toluene 2,4-diisocyanate. An in-situ chemical reaction of toluene 2,4-diisocyanate and alcohol and amines creates a cross-linked polymer such as polyurethanes, polyureas and polyesters. Higher concentrations of toluene 2,4-diisocyanate participating in the reaction at the site result in a higher degree of reaction and cross-linking during polymer formation at the site. This results in the more viscous material found on site, compared to off site.

The offsite LNAPL does not contain the toluene 2,4-diisocyanate, but rather is a mixture of degraded mineral spirits and polymers (polyurethanes, polyesthers and polyureas), with some other compounds that may be solvents used in the manufacture of polyurethanes. It is believed that the toluene 2,4-diisocyanate reacts to completion with the alcohols and amines in the aqueous phase as the plume travels, since no toluene 2,4-diisocyanate was detected offsite.

Expected Transport and Fate of Site Contaminants

Groundwater

Petroleum based oils, solvents, resins and finished coatings associated with the manufacture and distribution of paints and lacquers were released into the subsurface below the former Red Devil facility from leaking storage tanks, cesspools, drywells and poor housekeeping practices. The chemicals migrated vertically to the groundwater table where the more soluble compounds dissolved into the groundwater (VOCs, SVOCs and metals) and a portion remained as a non-aqueous phase (LNAPL). Contaminants released in Areas A, C and D created differing chemical signatures within the plume. The plume emanating from Area A is primarily characterized by the presence of toluene and metals. Areas C and D plumes are characterized by the presence of VOCs, metals and LNAPL.

Dissolved phase contamination has migrated with the groundwater, beneath the Metro North Railroad tracks and has been detected in wells located near the Bronx River. The dissolved phase plume has not been fully delineated to the southwest of the site. The dissolved phase contamination impact to the Bronx River has not been fully characterized. The top of bedrock has been assumed to be a confining layer, with no migration of dissolved phase contamination into the bedrock aquifer.

There is potential for contamination to have entered the bedrock aquifer either in the dissolved phase or from direct releases of dense non-aqueous phase liquids, (DNAPL) such as methylene chloride, which were reported stored in USTs at the site. There have been historic detections of methylene chloride, PCE and TCE in the onsite soils and groundwater, however the detected concentrations do not indicate the presence of NAPL. Additional investigation is needed to determine if the on-site bedrock aquifer is impacted by site contamination. If the on-site bedrock aquifer is contaminated, there is potential for a plume to migrate off-site and beneath the Bronx River in fractures that are not in hydraulic connection with the river.

The LNAPL plume has also migrated downgradient in the direction of groundwater flow and has been observed in wells located near the Bronx River and discharging to the river. Based on the results of the treatment system installed in 1998, the variations in viscosity of the LNAPL are also evident in the off-site plume, indicating that the low viscosity LNAPL from Area C and the high viscosity LNAPL from Area D are both migrating off-site.

Chemical analysis of the LNAPL performed during the FFS indicates the composition of the polymers in the LNAPL plume degrade from cross-linked polymers to linear, short-chain polymers. The linear polymers seen offsite appear to be the result of the decreasing concentration of toluene 2,4-diisocyanate in the LNAPL layer as it travels. As the LNAPL plume migrates downgradient toward the Bronx River, concentrations of toluene 2,4-diisocyanate diminish, resulting in reduced cross-linking and an LNAPL plume which is characterized by short-chain polymers. The LNAPL discharges to the Bronx River and agglomerates into a sheet-like material. It is expected that the VOC portion of the plume volatizes upon discharge to the River. The remaining fractions of the dissolved plume are likely attenuated by dilution.

Site contamination is not expected to impact drinking water as there are no major aquifers in southern Westchester County. Both the Manhattan Schist and the glacial sediments are capable of yielding small quantities of water to wells, but these aquifers are no longer used. Wells tapping these aquifers have been abandoned due to urbanization. All potable water in the area is supplied by a public water system which is derived principally from surface-water sources located in counties north of the site.

Soil

The onsite soils were contaminated by on-site processes, poor housekeeping practices and leaks from USTs and ASTs. VOCs, SVOCs and metals have been detected in the soils, however the concentrations do not indicate the presence of NAPL. Generally, SVOCs and metals tend to remain within the soils rather than become dissolved in groundwater. Much of the soil contamination have been characterized and remediated, however site-related contaminants have been detected below the extent of soil excavation and may continue to impact groundwater.

Air/Soil Vapor

VOCs associated with the groundwater plume have been detected in onsite soil vapor samples and may be moving downgradient dissolved in the groundwater. As such, they volatilize to the atmosphere and, in the unsaturated soil zone, to the pore spaces between soil particles. Volatile chemicals dissolved in groundwater also volatilize into the overlying unsaturated zone as a plume moves downgradient with groundwater flow. Vapors move through the unsaturated zone pore spaces, often seeking preferential flow pathways such as sandier zones with greater porosity and permeability, gravel commonly placed beneath concrete basements or pipelines that may be backfilled with sandy material. As vapors move through the unsaturated zone, they can enter structures, such as homes, and affect air quality. Vapor movement may also be affected by differential pressure gradients, either natural (e.g., caused by weather changes) or man-made (e.g., pressure differences inside and outside structures).

Surface Water/Sediment

The LNAPL migrated with the groundwater in the subsurface onto the Metro North Railroad property and was documented as seeping into the Bronx River. Hydrogeologic and water quality data indicate that the dissolved phase plume also discharges to the river. It is currently unknown if dissolved phase constituents are impacting the quality of surface water or the sediments. Contaminated surface water or sediment could result in exposure to people utilizing the river, or to ecological resources such as aquatic organisms or animals that frequent the habitat at the edge of water bodies. In addition, contaminants could enter the food chain, resulting in ecological exposure.

Figures

Figure 1
30 N West St
Mt Vernon, NY

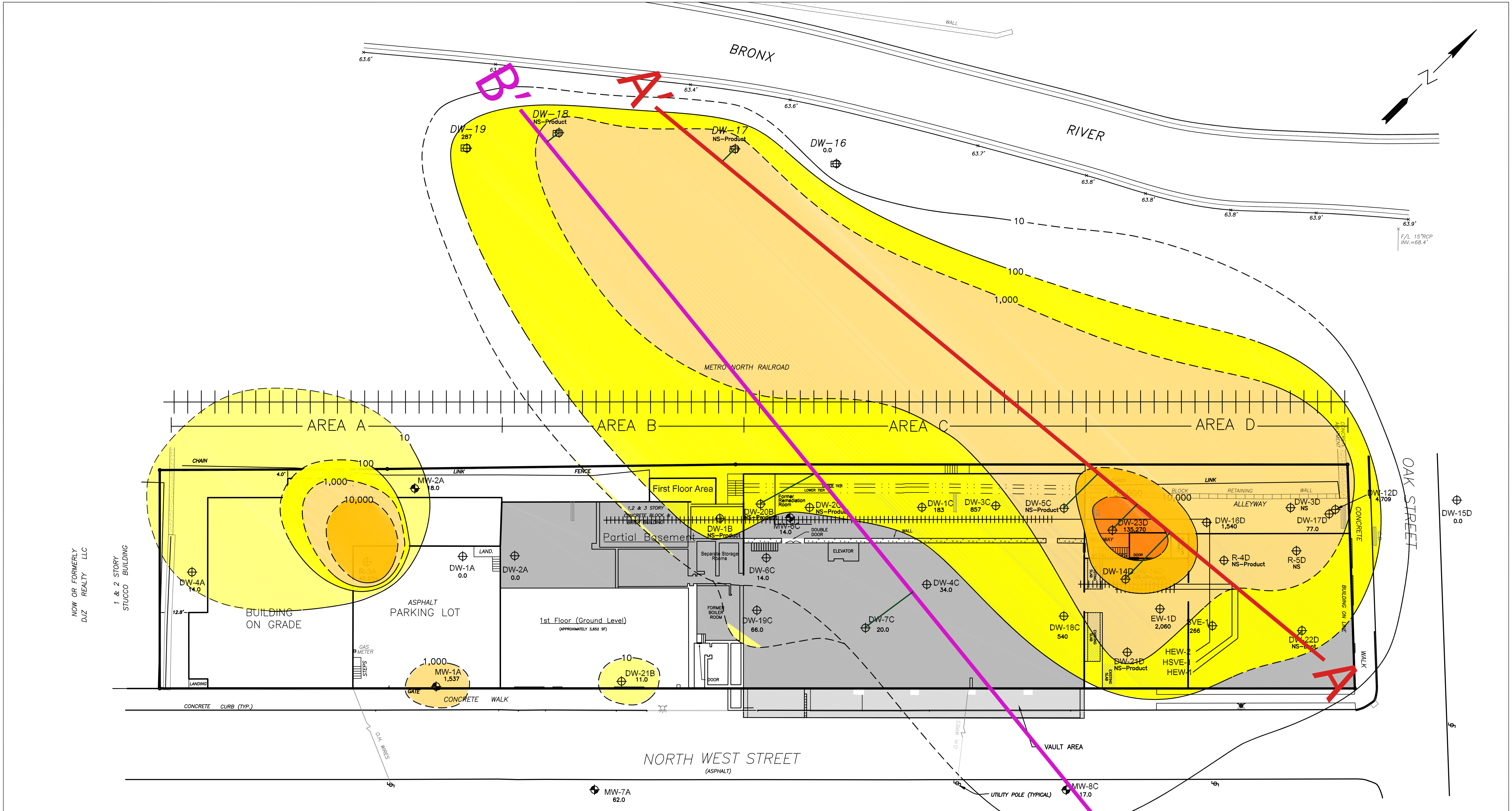


Figure adapted from Leggette, Brashears & Graham, Inc.'s Figure F Total VOC Concentrations in Groundwater January 2009 from their Remedial investigation Report March 2009.

- WELLS PROJECTED ONTO CROSS SECTIONS
- PROPERTY BOUNDARY
- GROUND WATER MONITOR WELL LOCATION
- 62.0 TOTAL VOC CONCENTRATION IN GROUNDWATER (ug/l)
- NS NOT SAMPLED
- PRODUCT DELINEATION WELL LOCATION
- HORIZONTAL WELL
- TOTAL VOC ISOCONCENTRATION LINE (DASHED WHERE INFERRED)

R-3A, R-4D AND R-5D ARE REPLACEMENT WELLS

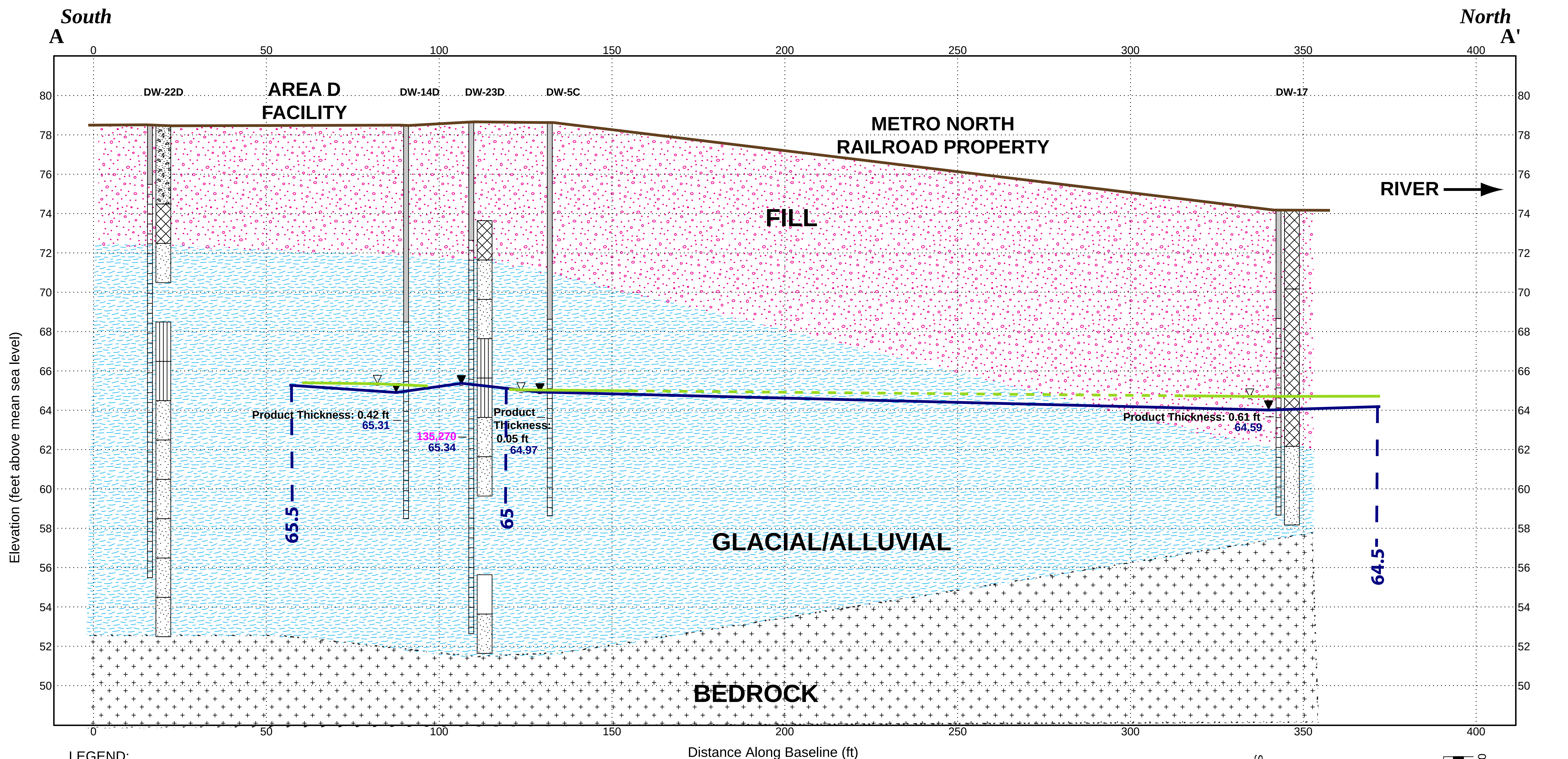
NOTE: IT IS A VIOLATION OF ARTICLE 130 OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON TO ALTER THIS DOCUMENT IN ANY WAY WITHOUT THE EXPRESS WRITTEN VERIFICATION OR ADOPTION BY A NEW YORK STATE LICENSED LAND SURVEYOR OR ENGINEER IN ACCORDANCE WITH SECTION 7209 (2), ARTICLE 130, NEW YORK STATE EDUCATION LAW.

0 40
SCALE IN FEET

DRAFT

CDM

Figure 2
Cross Section Location Map
Red Devil
Mt. Vernon, New York



LEGEND:

- Fill (made ground)
- USCS Poorly-graded Sand
- Concrete
- USCS Silt
- PVC Casing
- PVC Screen

Groundwater Sample Results (ug/L) Total VOCs

Potentiometric Surface

Potentiometric Contours 65

Top of LNAPL (dashed where inferred)

Ground Surface

Total depths and screened intervals not available for DW-13D, DW-15D, DW-1B, DW-3A, DW-5C, DW-7C, MW-7A, MW-8C. A depth of 20 ft bgs and a screened interval of 10-20 ft bgs was assigned for DW-13D, DW-15D, DW-1B, DW-3A, DW-5C, DW-7C, MW-7A, MW-8C, based on depth of other wells at site.

Water Level Elevation (feet above mean sea level) Date: 1/19/2009 — 65.31 — Screened Interval

Water Level in Shallow Well Representative of Water Table Date: 1/19/2009

Top of Product Representative of LNAPL in Well Date: 1/19/2009

Horizontal Scale (feet) 0 29

Vertical Scale (feet) 0 5

Vertical Exaggeration: 5.5x

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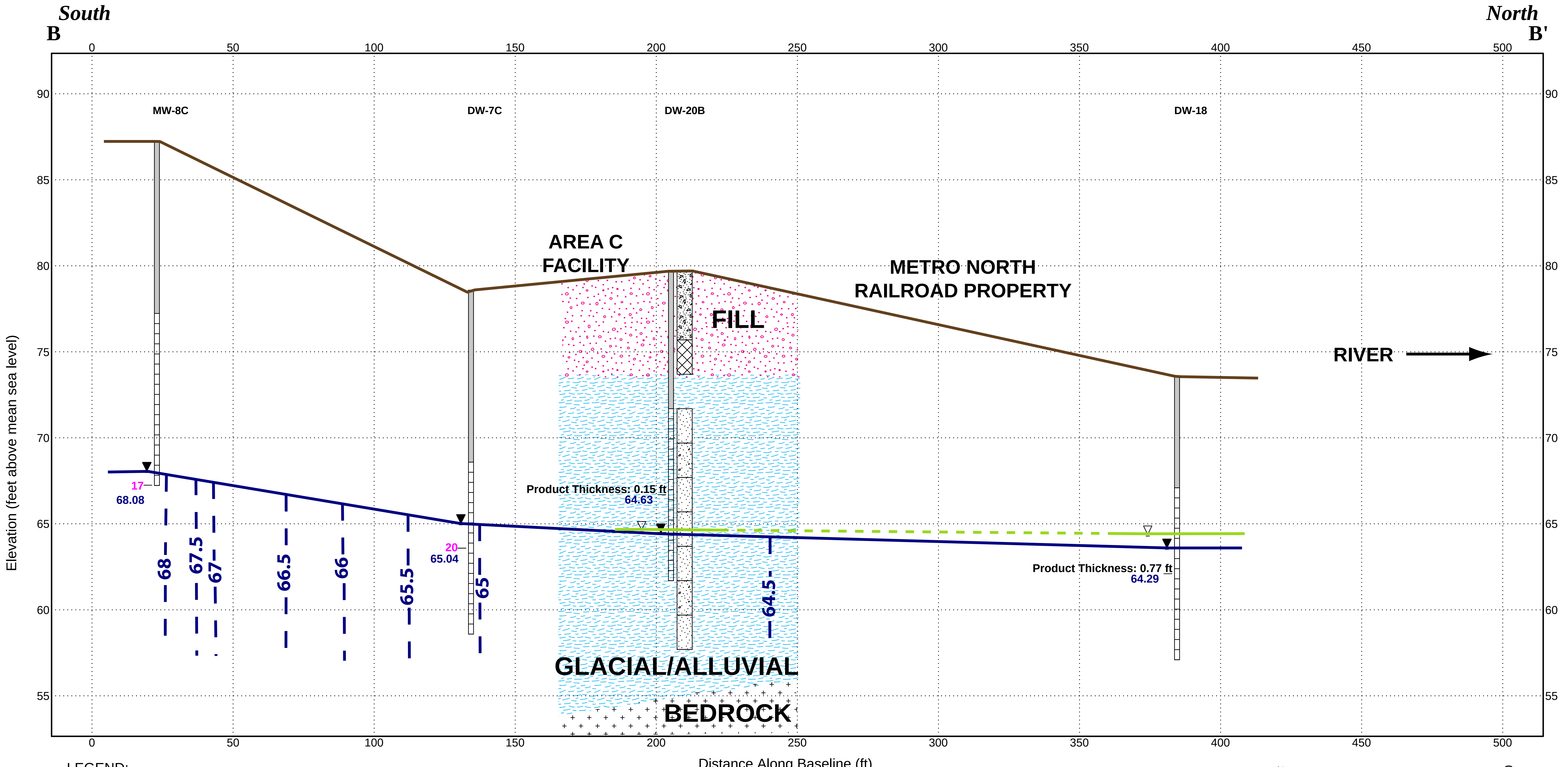
Figure 3
Area D Cross Section A-A'
Red Devil
Mt. Vernon, New York

VILLA CROSS SECTION REDDEVIL.GPJ NYSDEC.GDT 6/14/09 REV.



LEGEND:

Concrete

Fill (made ground)

USCS Poorly-graded Sand

USCS Well-graded Sand

PVC Casing

PVC Screen

Groundwater Sample Results (ug/L) Total VOCs

Potentiometric Surface

Potentiometric Contours 65

Top of LNAPL (dashed where inferred)

Ground Surface

Total depths and screened intervals not available for DW-13D, DW-15D, DW-1B, DW-3A, DW-5C, DW-7C, MW-7A, MW-8C. A depth of 20 ft bgs and a screened interval of 10-20 ft bgs was assigned for DW-13D, DW-15D, DW-1B, DW-3A, DW-5C, DW-7C, MW-7A, MW-8C, based on depth of other wells at site.

Water Level Elevation (feet above mean sea level) Date: 1/19/2009 64.29

Screened Interval

Water Level in Shallow Well Representative of Water Table Date: 1/19/2009

Top of Product Representative of LNAPL in Well Date: 1/19/2009

0 36

Horizontal Scale (feet)

0 6

Vertical Scale (feet)

Vertical Exaggeration: 6x

DRAFT

CDM

Figure 4
Area C Cross Section B-B'
Red Devil
Mt. Vernon, New York

VILLA CROSS SECTION REDDEVIL.GPJ NYSDEC.GDT 6/14/09 REV.

APPENDIX C

SURFACE WATER RESULTS

(Table 1-11 from the ERM OU1 Feasibility Study Report (1995))

Table 1-11 *Surface Water Sampling Results*
Former Red Devil Facility
Mount Vernon, New York

Sample Location Relative to the Site	Upstream of the Site			Adjacent to the Site	Downstream of the Site	Within the Boom
Sample No. / Date Collected	SW-1 6/10/93	SW-2 6/10/93	SW-10* 6/10/93	SW-3 6/10/93	SW-4 6/10/93	SW-5 6/10/93
Volatiles, ug/l						
Toluene	ND	ND	ND	ND	ND	5 J
Xylene	ND	ND	ND	ND	ND	4 J
Total TICs	24 J	17 J	19 J	27 J	33 J	93 J
Semi-Volatiles, ug/l						
2,6-Dinitrotoluene	ND	8 J	ND	ND	ND	NA
Total TICs	10 J	4 J	4 J		14 J	NA
Metals, ug/l						
Aluminum	ND	105 B	44.0 B	115 B	95.1 B	NA
Barium	68.0 B	63.6 B	69.4 B	69.4 B	69.4 B	NA
Calcium	44,600	45,400	47,300	46,300	46,400	NA
Copper	ND	10.9 B	9.1 B	9.1 B	7.3 B	NA
Iron	296	318	335	334	494	NA
Lead	ND	ND	ND	ND	4.8	NA
Magnesium	14,300	14,500	15,100	14,800	14,800	NA
Manganese	178	178	189	187	225	NA
Potassium	3,270 B	4,880 B	4,410 B	4,740 B	4,220 B	NA
Silver	ND	ND	ND	ND	ND	NA
Sodium	46,300	46,300	47,000	45,600	45,800	NA
Vanadium	ND	7.7 B	ND	ND	ND	NA
Zinc	16.1 B	14.0 B	15.4 B	12.0 B	16.8 B	NA

NOTES:
TIC: Tentatively Identified Compounds
J: an estimated value, value estimated due to data validation requirements, concentration below CRQL or compound is a TIC.
B (organics): compound detected in sample at a concentration greater than ten times the amount in the associated method blank.
B (inorganics): result is less than contract lab required detection limit, but greater than the instrument detection limit.
ND: the compound was analyzed for but not detected.
NA: the compound was not analyzed for.
D: result is from secondary dilution analysis.
** SW-10 is a field duplicate of SW-2*