FEASIBILITY STUDY REPORT

TNT-Red Star Express, Inc. Site
97 Industrial Park Drive
Town of Kirkwood, Broome County, New York
NYSDEC Site #704028

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EXECUTIVE SUMMARY

This Feasibility Study (FS) is being submitted in partial fulfillment of the requirements stipulated in the April 30, 1998 Order-On-Consent (Index # B7-97-09) between USF-Red Star, Inc. ("USF-Red Star") and the New York State Department of Environmental Conservation ("NYSDEC"). This FS Report has been prepared for the TNT-Red Star Express Site, Inc. Site Code #704028, located in Kirkwood, Broome County, New York (hereafter referred to as "the Site"). Leader Environmental, Inc. ("Leader") prepared the FS Report for USF-Red Star to identify alternatives to remediate the contaminants found beneath the Site, in general accordance with the NYSDEC-approved, November, 1998 Remedial Investigation/Feasibility Study ("RI/FS") Work Plan. Figure 1 presents a Site Location Map and Figure 2 is a Site Plan.

The RI/FS was completed in partial response to a spill of Perchloroethene ("PCE") at the loading dock of the terminal building. The spill occurred in 1991 and was cleaned-up immediately thereafter by a spill contractor. During the remediation, approximately 120 tons of asphalt, soil and cleaning materials were removed. Although the remediation was completed shortly after the spill, PCE remained in the soil and further remediation was completed using soil vapor extraction techniques. The installation of monitoring wells later showed that PCE had migrated into the uppermost groundwater zone and to the southernmost property line.

During the completion of the RI, a second contaminant plume was discovered and found to originate from the area of the waste oil tank and oil/water separator located next to the maintenance garage. This uppermost groundwater zone plume contains 1,1,1-Trichloroethane ("TCA") and PCE, and has migrated off the Site to the south.

The objectives of the FS were to identify, develop, evaluate, and select a long-term, cost-effective, environmentally-sound and comprehensive remedial action for the Site. Since the need for remediation at this Site is restricted to volatile organic compounds ("VOCs") in groundwater, alternatives have been developed accordingly. The remedial alternatives evaluated in this FS have been developed with the objective of remediating groundwater under the Site to Part 703 Class GA groundwater quality criteria levels which will be protective of both human health and the environment.

Remedial alternatives developed for the remediation of VOCs in groundwater include:

Alternative 1: No Action

- No remedial action.

Alternative 2: Limited Action

- Deed restrictions on the use of groundwater supply wells;

- Notification to the Town of Kirkwood and Broome County Department of Health ("DOH") of the location of the contaminated groundwater;

- Installation of monitoring wells; and,

- Annual groundwater monitoring of selected on and off Site wells, and reporting results to NYSDEC, New York State DOH and Broome County DOH.

Alternative 3: Air Sparging and Soil Vapor Extraction

- Install AS and SVE wells in the source areas;

- Treat source areas and monitor groundwater quality; and,

- Monitor groundwater quality biannually during the first year of remediation and then annually until remediation is complete.

Alternative 4: In-Situ Bioremediation

- Install probes for placement of nutrients and microbes in the source areas;

- Inject solutions and monitor groundwater quality quarterly during remediation; and,

- Monitor groundwater quality for VOCs one year after groundwater quality goals have been indicated by quarterly monitoring.

Alternative 5: Reaction Walls

- Excavate a trench filled with iron filings along the downgradient perimeter of the source areas;

- In-situ treatment of groundwater as it flows through the reactive iron filings; and,

- Monitor groundwater quality for VOCs in selected on-Site monitoring wells.

Alternative 6: Groundwater Pumping and Treatment

- Installation of extraction wells for the collection of groundwater in the source areas;

- Construction of a groundwater treatment system for the removal of contaminants from the groundwater;

- Operation of a groundwater pumping and treatment system; and,

- Completion of quarterly groundwater monitoring for one year and annual monitoring thereafter.

Alternative 7: In-Situ Bioremediation and Groundwater Pumping

- Install monitoring wells and probes for placement of nutrients and microbes in the source areas;
- Inject solutions and monitor groundwater quality;
- Installation of extraction wells for the collection of groundwater in the source areas;
- Construction of a groundwater treatment system for the removal of contaminants from the groundwater;
- Operation of a groundwater pumping and treatment system; and,
- Complete quarterly groundwater monitoring for one year and annual groundwater monitoring thereafter until remediation is complete.

The detailed analysis of the above alternatives indicates that Alternatives 3 through 7 are protective of human health and the environment and capable of satisfying the remedial action objectives, because they involve the following components:

- monitoring of groundwater conditions; and
- constructing an active groundwater remediation system.

The fundamental differences between these five alternatives are time and cost. Alternative 5, however, does not address the source of contamination directly, but relies on groundwater dilution to reduce contaminant levels in the source area. As a result, Alternative 5 was eliminated from further consideration. Since the contaminated medium at the Site is groundwater, there are inherent difficulties with estimating the time frame over which remediation will be completed. Thus, the estimated operation and maintenance costs and the associated total costs vary with the estimated time to achieve the cleanup levels. Because alternatives 3, 4, 6 and 7 generally satisfy the remedial action objectives and are expected to perform similarly with respect to the evaluation criterion, the present worth cost of the remedial system and the time to achieve the cleanup objectives were the principal factors in identifying the most cost-effective alternative. Alternative 7 In-Situ Bioremediation and Groundwater Pumping is recommended as the preferred remedial alternative, because it offers the most rapid projected Site cleanup, relatively low present worth cost, and more protection of human health and the environment.

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1. INTRODUCTION

This Feasibility Study (FS) is being submitted in partial fulfillment of the requirements stipulated in the April 30, 1998 Order-On-Consent (Index # B7-97-09) between USF-Red Star, Inc. ("USF-Red Star") and the New York State Department of Environmental Conservation ("NYSDEC"). This FS Report has been prepared for the TNT-Red Star Express Site, Inc. Site Code #704028, located in Kirkwood, Broome County, New York (hereafter referred to as "the Site"). Leader Environmental, Inc. ("Leader") prepared the FS Report for USF-Red Star to identify a remedial alternative to address the contaminants found beneath the Site, in general accordance with the NYSDEC-approved November 1998 Remedial Investigation/Feasibility Study ("RI/FS") Work Plan. Figure 1 presents a Site Location Map and Figure 2 is a Site Plan.

1.1 PURPOSE OF THE FS AND FS OVERVIEW

This FS report identifies general response actions, evaluates remedial technologies, and formulates and evaluates potential remedial action alternatives. The FS process involves the identification of specific response actions, where a response was deemed necessary to protect public health and the environment based on the RI. Technologies for each response action were identified and preliminarily screened on the basis of their effectiveness and technical feasibility. Additionally, the screening process was based on the USEPA guidance document entitled "Presumptive Remedies: Site Characterization and Technology Selection For CERCLA Sites With Volatile Organic Compounds In Soils, September 1993" ("Presumptive Remedies") and the NYSDEC project management team. The technologies that were retained through this initial screening process were used to develop remedial alternatives for the Site.

The FS then evaluated the remedial alternatives on the basis of effectiveness and implementability, and alternatives passing this evaluation underwent a more detailed evaluation which considered: 1) overall protection of human health and the environment; 2) compliance with New York State Standards, Criteria and Guidelines ("SCGs"); 3) long-term effectiveness and performance; 4) reduction of toxicity, mobility, and volume; 5) short-term effectiveness; 6) implementability; and 7) cost. In addition, the anticipated future use of the Site as an industrial facility was also considered. Alternatives were qualitatively compared to identify environmentally sound and cost-effective remedial actions for the Site. State and community acceptance of the results of this FS will be evaluated prior to the NYSDEC's Record of Decision ("ROD").

1.2 BASIS FOR THE FS

The FS was based on the following NYSDEC and USEPA guidance documents which include:

- 40 CFR Part 300 "National Oil and Hazardous Substances Pollution Contingency Plan (“NCP”) Final Rule;
- United States Environmental Protection Agency (“USEPA”) “Guidance for Conducting Remedial Investigation/Feasibility Studies Under CERCLA", October 1988;
- USEPA “Presumptive Remedies: Site Characterization and Technology Selection For CERCLA Sites With Volatile Organic Compounds In Soils”, September 1993.
- 6 NYCRR Part 375 “Inactive Hazardous Waste Site Regulations”;
- May 15, 1990 NYSDEC Technical and Administrative Guidance Memorandum (“TAGM”) #4030 entitled, "Selection of Remedial Actions at Inactive Hazardous Waste Sites", and subsequent revisions; and
- January 24, 1994 NYSDEC TAGM entitled, "Determination of Soil Cleanup Objectives and Cleanup Levels".

These documents are in general agreement; however, the Presumptive Remedies document specifies a select group of technologies for remediating volatile organic compounds (“VOCs”). In addition to these technologies, NYSDEC requested that other selected technologies be considered for use on the Site. As a result of the Presumptive Remedies guidance and discussions with NYSDEC, the Preliminary Screening of Technologies phase was limited for this FS Report.

1.3 REPORT ORGANIZATION

The information contained in this report is in general accordance with NYSDEC and USEPA requirements and the format is in general accordance with "USEPA Guidance for Conducting RI/FS Under CERCLA" (Table 6-5 EPA/540/G-89/004, October 1988).

The organization of this FS Report is as follows:

Section 1 Introduction;
Section 2 Selection of Remedial Technologies;
Section 3 Development and Screening of Alternatives;
Section 4 Detailed Analysis of Alternatives;
Section 5 Identification of the Recommended Alternative; and
Section 6 Limitations and Use of Report.

1.4 SUMMARY OF SITE CONDITIONS

The RI/FS was completed in partial response to a spill of Perchloroethene (“PCE”) at the loading dock of the terminal building. The spill occurred in 1991 and was cleaned-up immediately thereafter by Allwash of Syracuse, Inc. During the remediation, approximately 120 tons of asphalt, soil and cleaning materials were removed. Although the remediation was completed shortly after the spill, PCE remained in the soil and further remediation was completed using soil vapor extraction techniques. The installation of monitoring wells later showed that PCE had migrated into the uppermost groundwater zone and to the southernmost property line.

On July 31, 1998 NYSDEC and USF Red-Star entered into an Order on Consent to complete an RI/FS for the Site. Leader was retained by USF-Red Star to prepare the RI/FS Work Plan and complete the RI/FS Report. After completion of the RI fieldwork, two principal contaminants were identified on the Site: PCE and 1,1,1-Trichloroethane ("TCA"). There are two possible sources of PCE on the Site: 1) the 1991 spill and 2) the area of the oil/water separator and the waste oil tank. The area of the oil/water separator and the waste oil tank also appears to be the source of the TCA contamination. Although two sources of the contamination are suspected, additional sampling to confirm the second source area would be required. The oil/water separator and waste oil tank are the property of the Site owner, C&D Terminal Leasing, who is responsible for the maintenance of all facilities on the property.

The RI was only able to identify a small amount of soil contamination caused by the PCE and TCA releases. Soil contamination appears to be in the vicinity of the spills and has not caused further detectable soil contamination while migrating. When compared to NYSDEC soil cleanup objectives for the protection of groundwater quality, soil at the Site does not require remediation.

Groundwater contamination resulting from the PCE and TCA releases will, however, require some level of remediation and/or management. Two plumes of groundwater contamination were found during the RI, see Figures 3 and 4. The contaminated groundwater from the oil/water separator and the waste oil tank area has migrated off the Site and impacted the groundwater on the property of SARBRO Realty Corporation ("SARBRO"), located south of the Site. SARBRO owns the manufacturing property which is operated by Universal Applied Conveyor. The PCE plume from the 1991 spill appears to extend from the spill area southward to the SARBRO property, an approximate length of 400 feet. Based on the extent of contamination and the estimated velocity of groundwater, it appears unlikely that groundwater flow alone spread PCE in the groundwater. A more likely contaminant migration scenario is that some of the PCE entered into the Site's storm sewer system and was discharged from the storm sewer pipe which exits into the drainage swale that separates the Site and the SARBRO property. From the property line, groundwater flow appears to have spread PCE to the present location near monitoring wells GP-3, PW-1 and PW-9.

The PCE-TCA plume appears to have migrated in response to groundwater flow. PCE-TCA may have entered the oil/water separator and waste oil tank and been released. Waste entering the oil/water separator, outfalls in the southern-most drainage swale. The length of the PCE-TCA plume is approximately 175 to 225 feet. Unlike the 1991 PCE spill plume, there is no spill date from which a contaminant flow velocity can be calculated.

2. SELECTION OF REMEDIAL TECHNOLOGIES

This section includes the identification of the areas of concern, the goals for the remediation, and the identification of technologies to be considered in the development of remedial alternatives.

2.1 AREAS OF CONCERN

The RI Report identified two areas of the Site which have been impacted by groundwater contamination and will require remediation or monitoring. Those areas of concern include:

- The 1991 PCE Spill Area; and
- The oil/water separator and the waste oil tank.

2.1.1 1991 PCE Spill Area

Within the 1991 PCE Spill Area there are three potential issues: soil contamination; dense non-aqueous phase liquids ("DNAPL"); and groundwater.

2.1.1.1 Soil Contamination

Soil contamination in the 1991 PCE Spill Area is not a concern because the soil has been successfully remediated. Immediately after the spill, the impacted soil was excavated and disposed of off the Site. To remove smaller, residual amounts of PCE from soil and groundwater, the soil was further treated using vapor extraction techniques. To verify that significant amounts of contamination had not migrated from the spill area, Leader completed two soil borings (soil boring B-1 and B-4) where the soil was sampled continuously to a lower impermeable layer. The sampling found only low levels of PCE. These levels are below TAGM recommended soil cleanup values for the protection of groundwater.

2.1.1.2 DNAPL

During the remedial investigation, Leader completed a number of tasks to evaluate the Site for the presence of DNAPLs. Tasks completed included: 1) reviewing soil and groundwater data for PCE levels that reach 10 percent of the PCE solubility in water (contaminant levels approaching the solubility concentration is an indicator of a DNAPL, PCE has a very low solubility); 2) evaluating the soil headspace samples (elevated headspace results would suggest higher concentrations of contaminants); 3) visual evaluation of soil and groundwater samples for liquid products (since PCE is heavier than water, PCE DNAPL may accumulate at the interface of impermeable layers and at the bottom of the monitoring wells). This process failed to identify any soil or groundwater areas as potentially containing DNAPL.

2.1.1.3 Groundwater

The installation and sampling of monitoring wells found that the Site's groundwater has been impacted by contaminants associated with 1991 PCE spill. Groundwater impacted from the 1991 PCE spill has migrated from the monitoring well MW-3 area southward to monitoring well MW-2 and MW-4. Minor off-site contamination has also occurred from this source area.

2.1.2 Oil/Water Separator and Waste Oil Tank Area

Within the oil/water separator and waste oil tank area there has not been a reported release like that associated with the 1991 PCE spill area, but there has been substantial contamination found in the immediate area. Contaminants found in the area of the oil/water separator and waste oil tank include: TCA, 1,1-Dichloroethane, 1,1-Dichloroethene, Acetone, and n-Butylbenzene. Like the 1991 PCE Spill Area, there are three potential issues: soil contamination; DNAPL; and groundwater.

2.1.2.1 Soil Contamination

Soil contamination in the oil/water separator and waste oil tank area is not a concern because the soil borings (PW-4 and B-5) completed in this area found only trace amounts of Acetone, Carbon Disulfide, 1,1-Dichloroethane, Toluene, and TCA. These levels, however, are below TAGM recommended soil cleanup values for the protection of groundwater.

2.1.2.2 DNAPL

During the remedial investigation, Leader completed a number of tasks to evaluate the Site for the presence of DNAPLs. Tasks completed included: 1) reviewing soil and groundwater data for PCE and TCA levels that reach 10 percent of the PCE or TCA contaminant solubility in water (contaminant levels approaching the solubility concentration is an indicator of a DNAPL, PCE and TCA have very low solubilities); 2) evaluating the soil headspace samples (elevated headspace results would suggest higher concentrations of contaminants); 3) visual evaluation of soil and groundwater samples for liquid products (since PCE and TCA are heavier than water, DNAPLs of these compounds may accumulate at the interface of impermeable layers and at the bottom of the monitoring wells). This process failed to identify any soil or groundwater areas as potentially containing DNAPL.

2.1.2.3 Groundwater

The installation and sampling of monitoring wells found that the Site's groundwater has been impacted by contaminants associated with PCE and TCA. Groundwater in the oil/water separator and waste oil tank area have been impacted with Acetone, n-Butylbenzene, Chloroform, 1,1,-Dichloroethane, 1,1-Dichloroethene, PCE, TCA, and Xylene. All of these substances may have originated from either the separator or the tank, but a source (i.e., spill or leaking tank) can not definitively be determined at this time.

These contaminants have migrated from the PW-4 area to at least GP-2 on the southern property line. Minor off-site contamination has also occurred from this suspected source area.

2.1.3 Approach

The suspected source areas share similar subsurface characteristics and contaminants; as a result, the areas will be lumped into a single operable unit to facilitate the discussion of remedial alternatives.

2.2 REMEDIAL ACTION GOALS AND OBJECTIVES

The overall goals and objectives of the remedial program is to meet all SCGs and be protective of human health and the environment. At a minimum, the remedy selected must eliminate or mitigate all significant threats to public health and/or the environment presented by hazardous substances spilled at the Site through proper application of scientific and engineering principles. The site-specific goals should include:

- Eliminate, to the extent practicable, off-Site migration of groundwater that does not attain NYSDEC Class GA Ambient Water Quality Criteria and NYSDOH drinking water standards.

- Eliminate, to the extent practicable, future direct contact with the contaminated groundwater.

- Reduce, to the extent practicable, the level of groundwater contamination on the Site, particularly the designated source areas.

The goals and objectives of the FS are to identify, develop, evaluate, and select long-term, cost-effective, environmentally sound and comprehensive remedial action for the Site. Since the need for remediation at the Site is limited to VOCs in groundwater, alternatives were developed accordingly. The technologies evaluated in this FS were designed to remediate groundwater on the Site to Part 703 GA groundwater quality criteria levels which will be protective of both human health and the environment.

2.3 IDENTIFICATION OF APPLICABLE REMEDIAL TECHNOLOGIES

The USEPA guidance document “Presumptive Remedies” identifies several remedial technologies suitable for remediating soil contaminated with VOCs. Some of these technologies can also be used in the remediation of groundwater. These pre-approved technologies include:

- Soil Vapor Extraction;
- Thermal Desorption; and

- Incineration.

In addition to these three technologies, NYSDEC also requested that the following technologies also be considered during the FS:

- Air sparging;
- Steam Injection;
- Reaction Walls (including Fenton's Reagent); and
- Groundwater Pumping and Treatment.

Since there is also evidence that bioremediation is taking place on the Site, we have also included bioremediation as another feasible technology. In addition to these technologies, monitoring with natural attenuation and deed restrictions was also considered.

2.4 SCREENING OF TECHNOLOGIES

The technologies were screened on the basis of effectiveness and implementability. A summary of the evaluation criteria is presented below and results of the screening are included on Table 1.

Effectiveness

Effectiveness refers to the degree that a technology achieves the remedial action objectives. As this evaluation pertains to technologies rather than overall remedial alternatives, a technology need not achieve the remedial objective in its entirety to be considered effective. Effective technologies may be combined with other complementary technologies, if required, to form effective alternatives to achieve the remedial objectives. Thus, this evaluation is based upon the effectiveness of each technology in its intended site-specific function.

Implementability

Implementability encompasses both the technical and administrative feasibility of implementing a technological process. Technical implementability is used to initially screen technologies and to eliminate those that are clearly ineffective or unworkable at a Site. Subsequently, technologies are evaluated based on the institutional aspects of implementability, such as the ability to obtain the necessary permits for off-Site actions and the availability of necessary equipment and skilled workers to implement the technology.

Table 1 presents the results of the screening analysis. Based on this evaluation, soil vapor extraction, steam injection, thermal desorption, and incineration were eliminated from further consideration, as stand-alone technologies, because they are primarily used for soil remediation. However, soil vapor extraction was retained to be evaluated with the air-sparging alternative because off-gas from the sparging of the contaminated groundwater will need to be collected and vented or else there is a potential for VOCs to be re-absorbed by clean soil.

2.5 SCREENING EVALUATION RESULTS

Based on the screening and evaluation of technologies completed in Section 2.4, the following remedial technologies have been retained for further consideration:

1. Air Sparging and Soil Vapor Extraction;
2. Bioremediation;
3. Reaction Walls; and
4. Groundwater Pumping and Treatment.

Additionally, No Action and Limited Action (i.e., monitoring with natural attenuation and deed restrictions) were retained for further consideration.

3. DEVELOPMENT AND SCREENING OF ALTERNATIVES

Screening and evaluation of potentially applicable technologies were addressed in Section 2.0. Based on the remedial technologies that have passed this initial screening process, Section 3.0 addresses the development and screening of alternatives and the identification of the most cost-effective remedial alternatives for the Site.

3.1 DEVELOPMENT OF ALTERNATIVES

The following seven remedial alternatives include technologies that could potentially achieve the appropriate levels of remediation, as defined by the remedial action objectives for the Site.

1. No Action;
2. Limited Action (Groundwater Monitoring, Natural Attenuation, Supply Well Restriction);
3. Air Sparging and Soil Vapor Extraction;
4. In-Situ Bioremediation;
5. Reaction Walls;
6. Groundwater Pumping and Treatment; and
7. In-Situ Bioremediation and Groundwater Pumping.

Each of the seven (7) alternatives are presented on Table 2 and described below.

Alternative 1: No Action

The No Action alternative for groundwater would involve leaving the Site in its present condition and allowing the contaminants to continue to migrate off of the Site. The No Action alternative is presented here as a baseline against which to evaluate other alternatives.

Alternative 2: Limited Action

The Limited Action alternative for groundwater would involve leaving the Site in its present condition and monitoring the groundwater contaminant levels on an annual basis. Additionally, deed restrictions would be placed on the Site until the natural attenuation process, which appears to be occurring at the Site, satisfies the remedial action objectives. The use of this alternative is practical and a cost-effective solution in this setting for the following reasons:

- There are no users of the groundwater in the vicinity of the Site and future potential use could be restricted though administrative controls, e.g., deed restrictions.

- The concentration of VOCs potentially released as vapor by the groundwater contaminants is very low and would not represent a health risk to workers in this industrial setting. Based on an optimum conversion of contaminants from liquid to gas, the maximum concentrations of PCE and TCA are not anticipated to reach levels which would be a concern to workers. The maximum concentration of PCE off the Site was found at a concentration of 15 micrograms per liter, this converts to 10 milligrams per cubic meter (“mg/m^3”) or 1.5 parts per million (“ppm”) in air. OSHA’s time-weighted-average (“TWA”) for workers is 100 mg/m^3. The maximum concentration of TCA off the Site was found at a concentration of 26 micrograms per liter, this converts to 33 mg/m^3 in air. OSHA’s TWA for workers is 1910 mg/m^3.

- There is already a significant amount of natural attenuation occurring once the contaminants are off the Site through dilution and natural bio-degradation.

Limited Action is a reasonable, cost-effective alternative that ensures that the existing contamination does not represent a risk to human health or the environment.

Alternative 3: Air Sparging/Soil Vapor Extraction

This alternative would involve the placement of air sparging (“AS”) wells and soil vapor extraction (“SVE”) wells or trenches for the removal of VOCs from the groundwater. When used in combination, AS and SVE are proven technologies for the removal of VOCs from groundwater. The AS system will pump air into the groundwater, via sparging wells, to create a curtain of air bubbles. As groundwater flows through the air bubble curtain, the VOCs are stripped from the groundwater. For more recalcitrant compounds, the temperature of the air can be increased which will facilitate the removal of VOC’s by transferring heat into the groundwater. In general, the volatility of most compounds (as measured by Henry’s Law Constants) increases when the temperature of the liquid is increased.

The off-gas from the sparging process is then collected by the SVE system. SVE is a process which creates airflow through the soil by applying a vacuum on collection intakes. Intakes can be in the form of horizontally laid perforated pipe or vertical wells. The collection of the AS off-gas is sometimes important so that VOCs are not absorbed on to clean soil or allowed to migrate into buildings. As necessary, the SVE off-gas is treated prior to discharge to the atmosphere. The discharge of off-gas will require an air permit from NYSDEC and periodic monitoring.

The installation of the AS wells and a SVE collection system requires only conventional construction equipment. The mechanical parts of the AS/SVE system are readily available. Prior to designing such a system, a pilot test will be required for proper sizing and placement of AS wells and the SVE collection intakes.

Alternative 4: In-Situ Bioremediation

In-situ Bioremediation involves treatment of the soil and groundwater by injecting nutrients and microbes. Site groundwater conditions appear to be suitable for bioremediation, especially in the vicinity of the oil/water separator and the waste oil tank, where there are indications that bioremediation is already taking place. The appearance of TCA daughter products, including 1,1-DCA and DCE, suggests biological breakdown of TCA. Since the conditions appear favorable for bioremediation by existing microbes, the addition of nutrients to assist in VOC metabolism or mineralization will expedite the degradation of the VOCs. A Site-specific pilot scale test would be needed to evaluate and design the in-situ bioremediation treatment.

Monitoring of the groundwater will be required during the remediation to ensure that chlorinated compounds are being removed and no further off-Site migration is occurring. Because the groundwater flow velocity is 0.02 feet per day, if bioremediation is not treating the VOCs at an acceptable rate, then an additional technology such as groundwater pumping can be used to assist in the flow of groundwater through the treatment area.

Alternative 5: Reaction Walls

Reaction walls are a generic name for a remedial system that uses chemical compounds (synthetic or natural products) to treat contaminants as they flow through the material. In most cases, the materials used for treatment are placed into a trench excavated into the groundwater zone, but they can also be placed using drilling techniques or injection wells. For this Site, NYSDEC requested the evaluation of Fenton's Reagent (iron and hydrogen peroxide). A preliminary review of the technology indicates that treatability studies are required and careful maintenance is needed to keep the system in chemical balance with the environment. It also appears that treatment of the chlorinated hydrocarbons could be achieved by placing a wall of iron filings into the groundwater. The benefit of this technology is that there is no introduction of dangerous chemicals (hydrogen peroxide) into the groundwater. In addition, the iron filing technology has been used in New York by the Army Corps of Engineers with some success.

The use of this technology is complicated and would require completion of a treatability study prior to design; however, the implementation of the technology is straightforward requiring only conventional construction equipment or drilling equipment. A benefit of the technology would be the absence of secondary discharges or waste. There are no off-gases to collect or treat, or liquids to manage and treat.

Alternative 6: Groundwater Pumping and Treatment

Groundwater pumping and treatment uses conventional groundwater extraction wells or infiltration trenches to remove contaminated groundwater for treatment. The continuous operation of pumping systems flushes the contaminated source areas and will over time remove contaminants from the groundwater and soil. Contaminants with high organic partitioning coefficients, like the VOCs on Site, are typically more difficult to remove because they absorb onto soil particles and continue to leach into the groundwater even after numerous flushings of the contaminated zone.

Treatment of the contaminated groundwater can be achieved using many different technologies. The treatments considered for this FS include: 1) air stripping, 2) carbon treatment, 3) on-Site biological treatment, and 4) discharge to the Binghamton-Johnson City Joint Sewer Authority.

Alternative 7: In-Situ Bioremediation and Groundwater Pumping

In-Situ Bioremediation and Groundwater Pumping involves treatment of the soil and groundwater by injecting nutrients and microbes in addition to groundwater pumping to accelerate the migration of microbes through the subsurface. Site groundwater conditions appear to be suitable for bioremediation, especially in the vicinity of the oil/water separator and the waste oil tank, where there are indications that bioremediation is already taking place. The appearance of TCA daughter products, including 1,1-DCA and DCE, suggest biological breakdown of TCA. Since the conditions appear favorable for bioremediation by existing microbes, the addition of nutrients to assist in VOC metabolism or mineralization will expedite the degradation of VOCs. A site-specific pilot scale test would be needed to evaluate and design the in-situ bioremedation treatment system

Monitoring of the groundwater will be required during the remediation to ensure that chlorinated compounds are being removed and no further off-site migration is occurring. Because the groundwater flow velocity is approximately 0.02 feet per day, groundwater pumping will be used to accelerate groundwater flow, and accelerate Site remediation. Groundwater treatment would be achieved utilizing a bioreactor. The bioreactor will use the same microbes as injected into the groundwater. A portion of the treated groundwater will be re-injected to assist in the remediation. Monitoring of groundwater conditions will be required to ensure sufficient treatment is occurring.

3.2 SCREENING OF ALTERNATIVES

In this section, remedial alternatives discussed in Section 3.1 for the Site are screened on the basis of effectiveness and implementability. The objective of the screening is to narrow the list of potential remedial alternatives.

Alternative 1: No Action

The No Action alternative is being reviewed to provide a baseline condition against which other alternatives can be compared. As the title states, this alternative involves no remedial action and would leave the Site in its present condition. The No Action alternative does not meet the remedial action objectives for the Site. Impacts to the environment may be limited based on the low off-Site VOC concentrations in the groundwater. It appears the contaminants are attenuating to below groundwater SCGs further downgradient of the Site.

Effectiveness

"No Action" is not considered to be effective, because contaminant concentrations in at least the original PCE Spill Area do not appear to be diluting or degrading as rapidly as near the oil/water separator and waste oil tank. As a result, there would be some level of risk to workers on the Site if excavations encountered groundwater. Although these risks appear to be relatively low at present, off-Site environmental and public health risks would not be alleviated by this alternative. The magnitude of risks would remain the same and any reduction in risk would be due solely to dilution or natural attenuation.

Implementability

There would be no technical difficulty associated with the implementation of this alternative.

Alternative 2: Limited Action

The Limited Action alternative is being reviewed to provide an option that monitors and manages the off-Site migration of contaminants. The Limited Action alternative does not immediately meet the remedial action objectives for the Site to reduce the level of contamination, but it is protective of human health and the environment by active monitoring and managing contaminant migration. Potential impacts to the environment would be limited because off-Site VOC levels are near groundwater quality levels as a result of natural attenuation processes. Monitoring well sample data from the RI indicates that groundwater quality concentrations are already achieved in the vicinity of monitoring wells PW-1, GP-3 and PW-9, see Figures 3 and 4. Monitoring will assess whether the contaminant plumes are at a steady-state condition (i.e., where the plume edge is being attenuated as fast as it is migrating).

Effectiveness

The Limited Action alternative is considered to be effective, because contaminant migration appears to be at a steady-state condition in the vicinity of monitoring wells PW-1, GP-3 and PW-9. Additional monitoring, as proposed under the Limited Action scenario, would verify whether this condition is occurring. Since groundwater is moving slowly off the Site (approximately 0.02 feet per day), monitoring will provide sufficient lead-time to supplement this alternative with an active remedial technology. As a result of implementing this alternative, there is a limited risk to workers off the Site if contaminated groundwater is encountered. This risk could be managed through administrative controls on groundwater supply well usage and the issuance of construction permits and utility clearances.

Implementability

There would be no technical difficulty associated with the implementation of this alternative.

Alternative 3: Air Sparging and Soil Vapor Extraction

This alternative involves the placement of AS wells and the placement of either horizontal or vertical SVE extraction wells. The alternative would remove contaminants from the groundwater and contaminants present in the vadose zone above the groundwater.

Effectiveness

This alternative would be effective in removing contaminants from the groundwater zone based on the characteristics of the VOCs present. In addition, the slow movement of the groundwater across the Site is a benefit to the alternative, because it allows the use of lower air volumes to strip the contaminants. The slow movement of groundwater is also a benefit during compliance monitoring, because adjustments to the system could be implemented before high levels of VOCs migrate off-Site. In the event of insufficient removal, additional air could be injected, the AS could be cycled (on and off) to create a turbulent flow of the bubble curtain, or additional injection points could be added.

Implementability

The implementation of this alternative is straightforward and the technologies to be applied are reliable. The use of the technology should not interfere with the use of the Site. A small shed will be required to house the mechanical systems. Implementation of the alternative will require local building permits and NYSDEC permits to operate an air emission point.

Alternative 4: In-Situ Bioremediation

This alternative involves the installation of monitoring wells or injection points for the injection of nutrients or microbes ("additives") into the groundwater zone. The additives can also be placed using geoprobe or hollow stem augering techniques. The alternative treats (i.e, biodegrades) the contaminants in the groundwater and possibly contaminants present in the vadose zone above the groundwater. Unlike other alternatives, this alternative does not transfer the contaminants from the groundwater to the air.

Effectiveness

This alternative treats contaminants in the groundwater zone as a result of microbes metabolizing or mineralizing the contaminants. The byproducts of the process are carbon dioxide and water. The slow movement of the groundwater across the Site is both a benefit and detriment to bioremediation. The slow movement of groundwater allows for monitoring to identify problems in the remediation process and to quickly respond to correct the problem. However, the slow movement of the groundwater will require the use of multiple points to inject additives to ensure coverage of the contaminated area. To increase effectiveness of the remedial alternative, groundwater pumping can be used to expedite cleanup by directing groundwater through treatment zones and to control contaminant migration.

Implementability

The implementation of this alternative is straightforward and the technologies to be applied are reliable, although there are only a few contractors who have the expertise to complete the project. The use of the technology should not interfere with the use of the Site. If groundwater pumping is used with the technology, a temporary shed may be used to protect pumps and groundwater treatment unit(s).

Alternative 5: Reaction Walls

This alternative involves the placement of iron filings into the groundwater for the treatment of contaminants. The placement of iron filings requires either the excavation of a trench or the use of drilling techniques to penetrate the groundwater zone. The alternative would treat contaminants in the groundwater, but would have no affect on contaminants in the vadose zone above the groundwater.

Effectiveness

This alternative treats the contaminants using a chemical de-chlorination process, in contrast to bioremediation techniques that use microbes. The byproducts of the process are carbon dioxide and water. Like bioremediation, there is no transfer of contaminants from the groundwater to the air, so there is a complete reduction of contaminant mass and mobility. The slow movement of the groundwater across the Site decreases the effectiveness of this alternative, because the alternative relies on the movement of groundwater to bring contaminants to the treatment zone. The slow movement of groundwater allows for monitoring to identify and correct problems in the remediation process. However, if a problem was to develop, there would be a high cost to modify this alternative.

Implementability

This alternative includes technologies that are reliable, although there are only a few contractors who have the expertise to implement the technology. In addition, if trenching was considered a means of placing the iron, groundwater saturated waste soil would be generated which will likely require on-Site treatment or off-Site disposal. Additionally, specialized equipment, available only from contractor’s located in North Dakota and Michigan, may be required to complete the trenching without generating as much waste soil as conventional trenching techniques. The use of the technology should not interfere with the use of the Site.

Alternative 6: Groundwater Pumping and Treatment

This alternative involves the installation of groundwater extraction wells or trenches for the collection of contaminated groundwater. The collected groundwater will be treated to remove contaminants from the groundwater prior to discharge of the effluent.

Effectiveness

This alternative removes contaminants from groundwater at the Site through continuous flushing of the contaminated areas. This flushing of the contaminated areas will eventually remove contaminants until the remedial action objectives are satisfied. The fine grain nature of the Site soil, which limits the amount of water that can be pumped, may limit the effectiveness of groundwater pumping to remediate the contaminated groundwater zone.

Implementability

The implementation of this alternative is straightforward, requiring only conventional drilling and construction equipment. Treatment technologies are also straightforward and have been used for many years. The equipment typically used in this type of alternative is readily available and reliable.

Alternative 7: In-Situ Bioremediation and Groundwater Pumping

This alternative involves the installation of monitoring wells or injection points for the injection of nutrients or microbes ("additives") into the groundwater zone, and the installation of wells to pump groundwater. The additives can also be placed using Geoprobe or hollow-stem auguring techniques. The alternative treats (i.e., biodegrades) the contaminants in the groundwater and possibly contaminants potentially present in the vadose zone above the groundwater table. Unlike other alternatives, this alternative does not transfer the contaminants from the groundwater to the air. Groundwater removed through pumping will be biologically treated and a portion of the treated groundwater will be re-injection into the ground to help accelerate treatment and replenish additives.

Effectiveness

This alternative treats contaminants in the groundwater zone as a result of microbes metabolizing or mineralizing the contaminants. The byproducts of the process are carbon dioxide and water. The slow movement of the groundwater across the Site is accelerated by groundwater pumping. Accelerating the flow of groundwater through the contaminant zone will shorten remediation time and assist the movement of additives.

Implementability

The implementation of this alternative is straightforward and the technologies to be applied are reliable, although there are only a few contractors who have the expertise to complete the biological portion of the project. The use of the technology should not interfere with the use of the Site. Groundwater pumping will require the use of temporary shed to protect pumps and groundwater treatment units(s).

3.3 SUMMARY OF SCREENING

Remedial alternatives retained for further consideration are based on the evaluation process, as discussed above. These comprehensive remedial alternatives are summarized below and are further evaluated during the Detailed Analysis of Alternatives (Section 4.0). Reaction Walls, Alternative 5, has been eliminated from further consideration, because the method of installation generates a considerable volume of waste soil for treatment/off-Site disposal or requires specialized equipment to minimize the amount of waste and product used. The use of this specialized equipment is limited to approximately two contractors which may make scheduling use of the equipment difficult.

Alternative 1: No Action

- No remedial action.

Alternative 2: Limited Action

- Deed restrictions on the use of groundwater supply wells;
- Notification to the Town of Kirkwood and Broome County Department of Health ("DOH") of the location of the contaminated groundwater.
- Installation of monitoring wells.
- Annual groundwater monitoring of selected on and off-Site wells, and reporting results to NYSDEC, New York State DOH and Broome County DOH.

Alternative 3: Air Sparging and Soil Vapor Extraction

- Install AS and SVE wells in the source areas;
- Treat source areas and monitor groundwater quality; and
- Monitor groundwater quality biannually during the first year of remediation and annually until remediation is completed.

Alternative 4: In-Situ Bioremediation

- Install monitoring wells or injection points for placement of nutrients and microbes in the source areas;
- Inject solutions and monitor groundwater quality quarterly during remediation; and
- Completion of one round of groundwater monitoring for VOCs one year after groundwater quality goals have been achieved.

Alternative 6: Groundwater Pumping and Treatment

- Installation of extraction wells for the collection of groundwater in the source areas;
- Construction of a groundwater treatment system for the removal of contaminants from the groundwater;
- Operation of a groundwater pumping and treatment system; and
- Completion of quarterly groundwater monitoring for one year with annual monitoring thereafter.

Alternative 7: In-Situ Bioremediation and Groundwater Pumping

- Install monitoring wells and injection points for placement of nutrients and microbes in the source areas;
- Inject solutions and monitor groundwater quality;
- Installation of extraction wells for the collection of groundwater in the source areas;
- Construction of a groundwater treatment system for the removal of contaminants from the groundwater;
- Operation of groundwater pumping and treatment system; and
- Complete quarterly groundwater monitoring for one year and annual monitoring until remediation is completed.

4. DETAILED ANALYSIS OF ALTERNATIVES

The remedial alternatives developed for the Site were summarized in Section 3.3. Consistent with the NCP and NYSDEC guidance documents, these remedial alternatives undergo a more detailed evaluation in this section. The Detailed Analysis of Alternatives includes an individual and comparative analysis of the alternatives relative to criteria described in USEPA 540/6-89/004.

4.1 CRITERIA FOR ANALYSIS OF ALTERNATIVES

The remedial alternatives developed for the Site represent a range of groundwater treatment strategies that satisfy the SCGs for the Site. Although the selected alternative for the Site will be further refined as necessary during the design phase, these alternatives reflect the fundamental components of the various contaminant removal approaches being considered for the Site. These alternatives are evaluated with respect to seven (7) of the nine (9) criteria recommended in USEPA 540/G-89/004. The seven (7) criteria are summarized in the following paragraphs. State acceptance and community acceptance, the remaining two criteria, are not considered herein, but will be addressed in the Record of Decision ("ROD"), upon receipt of comments for the FS Report.

1) **Overall Protection of Human Health and the Environment -** The evaluation of each alternative with respect to the overall protection of human health and the environment provides a summary of how the alternative reduces the risk from potential exposure pathways through treatment, engineering or institutional controls. This criterion also evaluates whether alternatives pose unacceptable short-term or cross-media impacts. The risks associated with each alternative were evaluated qualitatively as opposed to a quantitative evaluation.

2) **Compliance with SCGs -** The applicable or relevant and appropriate SCGs are applied to each alternative; a table of SCGs is provided as Table 3. The ability of each alternative to meet the SCGs or the need to justify a waiver is noted for each. The most significant of the SCGs will be the ability for the alternative to satisfy NYSDEC Part 703 class GA groundwater quality criteria. By satisfying this criteria, the human and environmental health will be protected. In addition, where appropriate, other SCGs may be relevant; for example, clean air standards for the discharge of contaminants from an SVE system or requirements for surface water or publicly owned treatment works ("POTW") discharge of the treated effluent.

3) **Long-term Effectiveness and Permanence -** Long-term effectiveness and permanence are evaluated with respect to the magnitude of the residual risk and the adequacy and the reliability of controls used to manage remaining waste (i.e., untreated waste and treatment residuals) over the long-term. Alternatives that have the highest degree of long-term effectiveness and permanence are those that leave little or no waste remaining

at the Site, such that long-term maintenance and monitoring are unnecessary and reliance on institutional controls is limited.

4) **Reduction of Toxicity, Mobility, or Volume Through Treatment -** Evaluation of reduction of toxicity, mobility, or volume through treatment addresses the anticipated performance of the treatment technologies. This evaluation relates to the statutory preference for selecting a remedial action that uses treatment to reduce the toxicity, mobility, or volume of hazardous substances. Aspects of this criteria include: 1) the amount of waste treated or destroyed; 2) the reduction of toxicity, mobility, or volume; 3) the irreversibility of the treatment process; and 4) the type and quantity of residuals resulting from any treatment process.

5) **Short-term Effectiveness -** Evaluation of alternatives with respect to short-term effectiveness takes into account: 1) protection of workers and the community during the remedial action; 2) environmental impacts from implementing the action; and 3) the time required to achieve the cleanup goals.

6) **Implementability -** Implementability deals with the administrative and technical feasibility of implementing the alternatives as well as the availability of necessary goods and services. This evaluation includes such items as: 1) the ability to obtain services, capacities, and equipment; 2) the ability to construct and operate components of the alternative; 3) the ability to monitor the performance and the effectiveness of the technologies; and 4) the ability to obtain the necessary approvals and permits from other agencies.

7) **Costs -** Costs are divided into capital and operation and maintenance (O&M) costs. Capital costs include those expenditures required to implement a remedial action (i.e., both direct and indirect costs are considered). Direct capital costs include construction costs or expenditures for equipment, labor, and materials required to implement a remedial action. Indirect capital costs include those associated with engineering, permitting, construction management, and other services necessary to carry-out a remedial action. Annual O&M costs include labor, maintenance materials, energy, and purchased services. The O&M costs include costs incurred even after the initial remedial activity is complete. The year 2000 present worth costs were estimated using a 5 percent discount factor per year for the time period associated with implementation of the specific alternative, not to exceed 30 years.

The cost estimates presented herein are order-of-magnitude estimates and are based on vendor information, conventional cost estimating guides, generic unit costs and/or prior experience. The FS cost estimates have been prepared for guidance in project evaluation and are based on the available information at the time of the estimate. The real costs of the project at the time of implementation will depend on real labor and material costs, Site conditions, competitive market conditions, final project scope, the implementation schedule, and other variable factors both anticipated and unforeseen. An uncertainty that would affect the cost is actual volumes of contaminated groundwater pumped and waste requiring off Site disposal. The accuracy of these estimated costs are expected to be in the range of +50 percent to -30 percent based on the anticipated Site conditions and other variables as mentioned above.

4.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

In this section, each of the alternatives for the Site are evaluated with respect to each of the seven evaluation criteria.

4.2.1 Alternative 1 - No Action

The no action alternative is included in the FS to measure the potential environmental risks posed by the Site if no remedial actions were implemented. All groundwater contaminants would continue to migrate off the Site at a velocity of 0.02 feet per day or less.

1. *Overall Protection of Human Health and the Environment* - Since no remedial actions would be conducted as part of this alternative, the risk to human health and the environment from potential pathways would not be reduced, except through dilution of contaminants in the groundwater or natural degradation of the contaminants.

2. *Compliance with SCGs* - This alternative would not meet the applicable SCGs since no steps would be taken to address the contaminants.

3. *Long-term Effectiveness and Permanence* - The selection of this alternative could result in a long-term or permanent solution since the dilution and natural degradation of contaminants would occur; however, the time-frame over which this would take place would likely be over 10 years.

4. *Reduction of Toxicity, Mobility, or Volume Through Treatment* - Since there are no activities performed during this alternative, the only reduction in toxicity, mobility or volume of the contaminants would be through dilution or natural degradation.

5. *Short-term Effectiveness* - The lack of any activity conducted under this alternative would eliminate the short-term risks encountered by workers on-Site.

6. *Implementability* - Since there are no activities which will be performed under this alternative, it is considered to be the most implementable.

7. *Cost* - There would be no costs associated with this alternative because no activities are planned.

4.2.2 Alternative 2 - Limited Action

The Limited Action alternative is included in the FS as a cost-effective means to manage the potential environmental risks posed by the groundwater contamination. Groundwater contaminants would continue to migrate off the Site at a theoretical velocity of approximately 0.0006 feet per day ("ft./day") for PCE and 0.0014 ft./day for TCA. A more conservative estimate of the groundwater flow rate is 0.02 ft./day. Notwithstanding, the contaminants are migrating slowly and can be monitored to ensure that potential risks are managed.

Since experimental data is available for TCA, we can estimate how far a given mass of TCA will travel before it reaches SCGs levels. Based on the RI Site data, TCA is migrating in the groundwater at a velocity ranging from 0.0014 ft./day to 0.02 ft./day. Experimental data suggest that TCA's half-life (including biodegradation and dilution) in groundwater is 231 days. From a theoretical standpoint, TCA, in the groundwater at a concentration of 2,200 micrograms per liter (the concentration at monitoring well GP-2), migrating through the groundwater zone will achieve SCG levels in approximately 1617 days, or a distance of approximately 32 feet (using a flow rate of 0.02 ft./day). These calculations, using non-Site specific degradation rates, indicate that the plume should reach SCG levels approximately half way between monitoring well GP-2 and PW-9. The RI data appear to suggest that SCG concentration levels are present slightly beyond monitoring well PW-9. The apparent agreement between the theoretical degradation of TCA and the attenuation revealed by the data, suggests the natural processes have brought the plume to a steady-state condition (where the plume is no longer advancing). If the plume is no longer migrating, then monitoring the plume would be an effective remedial technique.

1. *Overall Protection of Human Health and the Environment* - The risk to human health and the environment from potential pathways would not be reduced, except through dilution of contaminants in the groundwater or natural degradation of the contaminants. However, the risks can be effectively managed through monitoring, construction restrictions and deed restrictions to require use of municipal water instead of groundwater as a source of drinking or industrial supply.

2. *Compliance with SCGs* - This alternative would not immediately meet the applicable SCGs, but over time natural attenuation processes could reduce the concentration of contaminants to SCG levels.

3. *Long-term Effectiveness and Permanence* - The selection of this alternative could result in a long-term or permanent solution since the dilution and natural attenuation of contaminants would occur; however, the time frame over which this would take place would be greater than Alternative 3 through 6.

4. *Reduction of Toxicity, Mobility, or Volume Through Treatment* - Since there are no activities performed during this alternative, the only reduction in toxicity, mobility or volume of the contaminants is dilution or natural attenuation.

5. *Short-term Effectiveness* - The lack of any construction activity conducted under this alternative would eliminate the short-term risks encountered by workers on-Site.

6. *Implementability* - Since there are no construction activities which will be performed under this alternative, it is considered to be the most implementable.

7. *Cost* - The present worth cost of this alternative has been calculated for 10 years of monitoring and is presented on Table 4.

4.2.3 Alternative 3 - Air Sparging and Soil Vapor Extraction

This alternative consists of installing AS wells and SVE intakes in two areas of the Site, 1) in the vicinity of the 1991 PCE Spill Area; and 2) in the oil/water separator-waste oil tank area. The alternative will remove contaminants from the groundwater and discharge them to the atmosphere. At this time it does not appear that off-gas treatment will be required, but this will be determined during the design phase of the project. The specifications and the sequence of work required to implement this alternative are described below.

<u>1991 PCE Spill Area</u>

The 1991 PCE spill source area covers approximately 2,500 square-feet centered around monitoring well MW-3, see Figure 3. Air sparging wells will be placed in a grid covering the area. Pilot testing will have to be completed to determine the correct spacing for both the AS wells and the SVE intakes. Published data from other locations suggest that a 30-foot diameter of influence might be realized when sparging at a depth of 10 feet below the groundwater surface. A depth of 10 feet below the groundwater surface is approximately 20 feet below the ground surface. Based on the depth below the groundwater surface and the grain size of the sediment, the working pressure of the AS system is estimated to be approximately 6 pounds per square inch.

The amount of air required to strip contaminants from the groundwater is a function of contaminant concentration, Henry's Law Constant, the size of the treatment zone, and the groundwater velocity. The estimated amount of air needed per well is approximately 0.15 cubic feet per minute. This air flow rate is based on 100-percent coverage of the treatment zone. Based on this air flow and the use of four wells, the total air flow needed is approximately 0.6 cubic feet per minute to remove the contaminants from the groundwater. Depending on the efficiency of the bubble curtain to strip contaminants from the groundwater and saturated soil, cleanup of this area could be completed in less than 4 years.

Oil/Water Separator-Waste Oil Tank Area

The oil/water separator-waste oil tank source area contamination covers approximately 2,500 square-feet with its origin at the oil/water separator and waste oil tank, see Figure 4. Air sparging wells would be placed in a grid covering the area. Pilot testing will need to be completed to determine the correct spacing for both the AS wells and the SVE intakes. Published data from other locations suggest that a 24 foot diameter of influence might be realized when sparging at a depth of 7 feet below the water surface. A depth of 7 feet below the groundwater surface is approximately 18 feet below the ground surface. Based on the depth below the groundwater surface and the grain size of the sediment, the working pressure of the AS system will be approximately 4 pounds per square-inch.

The amount of air required to strip contaminants from the groundwater is a function of contaminant concentration, Henry's Law Constant, the size of the treatment zone, and the groundwater velocity. Based on these parameters, the amount of air needed per well is approximately 0.6 cubic-feet per minute. This air flow rate is based on 100-percent coverage of the treatment zone. Based on this air flow, 4 wells will be needed with a total air flow of approximately 2.4 cubic-feet per minute to remove the contaminants from the groundwater. Depending on the efficiency of the bubble curtain to strip contaminants from the groundwater and saturated soil, cleanup of this area could be completed in less than 3.5 years.

The SVE system would be used to remove contaminants stripped from the groundwater by the AS system. As a result, SVE will need to evacuate only the air injected into the groundwater and operate at a vacuum that will not raise the height of the water table. The specifications for the SVE system will include a vacuum of less 48 inches of water column and a flow rate of less than 50 cubic feet per minute.

1. *Overall Protection of Human Health and the Environment* - This alternative would be protective of human health and the environment by removing contaminants from the groundwater zone to satisfy the SCGs.

2. *Compliance with SCGs* - The removal of contaminants from the groundwater zone beneath the Site would meet SCGs on a long-term basis.

3. *Long-term Effectiveness and Permanence* - This alternative would be effective over the long term because the contaminants will be removed. However, since the bubble curtain will take the path of least resistance, monitoring after remediation will be needed to assess whether contaminants desorbed from the soil to re-contaminant the groundwater.

4. *Reduction of Toxicity, Mobility, or Volume Through Treatment* - This alternative will reduce the volume of the contaminants in the groundwater. However, contaminants would be transferred from the soil and groundwater to another media. There will be a

reduction of the toxicity and mobility of the contaminants on the Site. The alternative will have no effect on the contaminants which have already migrated off the Site.

5. *Short-term Effectiveness* - This alternative will have little effect on the environment or human health during the implementation phase. Small amounts of contaminated soil and groundwater will be handled during the implementation phase, but these materials will be managed in closed or covered containers until removed or treated on-Site. Workers and the community will be protected with Site specific health, safety and contingency plans. Implementation time for the construction of the remedial systems is approximately three to six weeks.

6. *Implementability* - Implementation of this alternative is straightforward requiring conventional construction equipment. The remedial equipment is used in general industry and easily obtained. Administratively, it is anticipated that local building permits will be required, as well as air permits for the SVE discharge.

7. *Costs* - The present worth cost of this Alternative has been calculated for a 4-year remediation schedule. The costs are presented on Table 4.

4.2.4 Alternative 4 - In-Situ Bioremediation

This alternative consists of installing monitoring wells and injection points to introduce nutrients and/or microbes into the groundwater for in-situ treatment of the contaminants. Contaminants will be biodegraded in place by the microbes digesting or mineralizing the contaminants as a part of their food source. Waste products from this microbial process will include carbon dioxide and water. In the oil/water separator and waste oil tank area of the Site, there is evidence that microbial digestion is already occurring because the daughter products of TCA are present.

Introducing nutrients and microbes into the groundwater will require monitoring during the treatment phase to evaluate the progress of the treatment and to make chemical adjustments. The specifications and the sequence of work required to implement this alternative are described below, but will require a brief treatability study which will be completed during the design phase of the project.

The project will be implemented by the injection of nutrients and/or microbes into the groundwater using a grid pattern. The gird spacing is determined based on the contaminant mass and the amount of the additives needed to de-chlorinate the contaminants. At this time both source areas can be constructed in identical fashion with thirty boreholes and a grid spacing estimated to be 10 feet by 10 feet. Each borehole will require approximately 60 pounds of a proprietary additive. Monitoring of the system will be completed weekly for approximately the first month of treatment, then once a month thereafter. The remediation is estimated to take from 1.5 to 3 years to complete.

1. *Overall Protection of Human Health and the Environment* - This alternative would be protective of human health and the environment by reducing contaminant levels in groundwater zone to meet the SCGs. The alternative does not transfer contaminants from one media to another.

2. *Compliance with SCGs* - The removal of contaminants from the soil below the water table and groundwater beneath the Site results in satisfying the SCGs on a long-term basis.

3. *Long-term Effectiveness and Permanence* - This alternative will have long-term effectiveness because the contaminants will be eliminated.

4. *Reduction of Toxicity, Mobility, or Volume Through Treatment* - This alternative will remove the contaminants from the soil below the water table and the groundwater thereby eliminating the toxicity and mobility concerns.

5. *Short-term Effectiveness* - This alternative has a minimal impact on the environment and human health during the implementation phase. Small amounts of contaminated soil and groundwater will be handled during the implementation phase, but these materials will be managed in closed or covered containers until removed or treated on-Site. Workers and the community will be protected with Site-specific health, safety and contingency plans. Implementation time for construction of this alternative is approximately one to two weeks.

6. *Implementability* - The technical and administrative feasibility is straightforward; there will be no need for local inspections or permits.

7. *Costs* - The present worth cost of this Alternative has been calculated for a 3-year remediation schedule. The costs are presented on Table 4.

4.2.5 Alternative 6 - Groundwater Pumping and Treatment

This alternative consists of installing extraction wells to collect contaminated groundwater in the vicinity of the 1991 PCE spill area and the oil/water separator-waste oil tank area. Groundwater collected by the extraction system will be treated to remove contaminants from the groundwater prior to discharge to the ground surface under the permit conditions of a State Pollution Discharge Elimination System ("SPDES") permit or to the sanitary sewer system under a permit from the POTW. The specifications and the sequence of work required to implement this alternative are described below.

<u>1991 PCE Spill Area</u>

The 1991 PCE Spill Area covers approximately 2,500 square-feet and is centered around monitoring well MW-3, see Figure 3. Groundwater collection will be completed using extraction wells. Based on hydraulic conductivity data (0.0008 feet per minute), estimated from RI data, two extraction wells will be used in the spill area, each pumping at a rate of approximately 0.4 gallons per minute ("gpm"). Based on the types of contaminants present and the initial concentration, it will take approximately 184 pore volume flushes to reduce the contaminant concentrations to SCG levels. This equates to approximately 9.5 million gallons of water to be pumped and treated. With the pumping system removing 0.8 gpm, pumping will take approximately 22 years to remediate the groundwater assuming ideal conditions. This time-frame estimate is based on ideal hydraulic flow conditions. Note that groundwater pumping and treatment scenarios do not typically remove contaminants according to theoretical equations.

Oil/Water Separator-Waste Oil Tank Area

The oil/water separator-waste oil tank source area covers approximately 2,500 square-feet with the origin of the contamination in the vicinity of the oil/water separator and the waste oil tank, as shown on Figure 4. Groundwater collection will be completed using extraction wells placed in the source area. Based on hydraulic conductivity data (0.0008 feet per minute), estimated from RI data, two extraction wells will be used in the spill area, each pumping at a rate of approximately 0.26 gallons per minute ("gpm"). Based on the types of contaminants present and the initial concentration, it will take approximately 98 pore volume flushes to reduce the contaminant concentrations to SCG levels. This equates to approximately 7 million gallons of water to be pumped and treated at a flow rate of approximately 0.5 gallons per minute. Based on this flow rate it will take approximately 26 years to remediate this area. NYSDEC has indicated that it may be possible to terminate groundwater pumping in as little as 5 years. This time-frame estimate is based on ideal hydraulic flow conditions. Note that groundwater pumping and treatment remediation scenarios do not typically remove contaminants according to theoretical equations.

An air stripping water treatment system will be used to remove contaminants from the groundwater with discharge of the effluent to surface water under SPDES permit or to the sanitary sewer under a POTW permit. This alternative is evaluated below.

1. *Overall Protection of Human Health and the Environment* - This alternative would be protective of human health and the environment by reducing contaminants in the groundwater to satisfy the SCGs. The alternative would also be able to capture a small amount of the contaminants that have migrated off the Site.

2. *Compliance with SCGs* - The removal of contaminants from the groundwater beneath the Site results in meeting the SCGs on a long-term basis.

3. *Long-term Effectiveness and Permanence* - This alternative will have long-term effectiveness, because the contaminants will be removed; however, since groundwater flow will take the path of least resistance, monitoring after remediation will be needed to assess whether any remaining contaminants desorb from the soil or remain in

untreated soil pores to re-contaminant the groundwater. The presence of these sources of contaminant mass can significantly extend the remediation time.

4. *Reduction of Toxicity, Mobility, or Volume Through Treatment* - This alternative will significantly reduce the volume of the contaminants in the groundwater; there will be a reduction of the toxicity, mobility of the contaminants on the Site.

5. *Short-term Effectiveness* - This alternative should have little effect on the environment or human health during the construction phase. Using conventional drilling and well installation techniques will generate approximately 12 drums of soil waste and approximately 250 to 500 gallons of development water. These wastes will be managed in closed or covered containers until disposed of off-Site. Workers and the community will be protected with Site-specific health, safety and contingency plans. The construction time for this alternative is approximately one to two months.

6. *Implementability* - The technical and administrative feasibility is straightforward requiring conventional construction equipment and tools to install. The equipment, although designed for this use, is used in general industry and easily obtained. Administratively, it is anticipated that local building permits will be required, operational permits for the air stripper and a SPDES or POTW discharge, and construction inspections.

7. *Costs* - The present worth cost of this Alternative is presented on Table 4. NYSDEC has indicated that it is probable that groundwater pumping could be completed in approximately 5 years and as a result, our present worth remedial cost estimate has only been extended for a 5-year period.

4.2.6 Alternative 7 - In-Situ Bioremediation and Groundwater Pumping

This alternative consists of installing wells and injection points to introduce nutrients and/or microbes into the groundwater (in the source areas) for in-situ treatment of the contaminants. The source areas where nutrients and microbes are being released will be referred hereafter as treatment zones. Groundwater pumping will also be used to expedite the flow of groundwater through the treatment zones and through the remaining contaminated source areas. Groundwater extraction wells will be placed in each source area to increase the groundwater velocity through the treatment zones and the contaminated areas. In addition to improving groundwater velocity through the contaminated areas, pumping will also capture contaminated groundwater which exceeds a total concentration of 1 ppm of VOCs. To capture this amount of groundwater may require multiple pumping wells with each source area, but based on data from the RI one pumping well may be sufficient. Additional testing of the groundwater zone will be completed during the design phase to finalize the number, location, and pumping rate of the pumping wells.

Extracted groundwater will be treated using a biological reactor using the same microbes introduced into groundwater zone. A portion of the treated groundwater will be reintroduced into the groundwater zone. Treated groundwater will carry nutrients and microbes to facilitate contaminant destruction in the source areas. Treated groundwater will meet SPDES permit levels and SCGs prior to discharge.

Contaminants will be biodegraded in place by the microbes digesting the contaminants as part of their food source. Waste products from the microbe digestion process will include carbon dioxide and water.

Introducing nutrients and microbes into the groundwater will require monitoring during the treatment phase to access the treatment progress and the need for additional amendments. The specifications and the sequence of work required to implement this alternative are described below, but will require a brief treatability study which will be completed during the design phase of this project.

1991 PCE Spill Area

The 1991 PCE Spill Area covers approximately 2,500 square-feet and is centered around monitoring well MW-3, see Figure 3. Groundwater collection will be completed using a single extraction well. Based on the conductivity data (0.0008 feet per minute), estimated From the RI data, one extraction well will be used in the spill area pumping at a rate of approximately 0.4 gpm. The estimate drawdown using this pumping rate is 5 feet. Maintaining this drawdown, the hydraulic capture zone radius could range from 10 feet to more than 50 feet. As a result of the variability of the estimated capture zone radii, two wells may be required to capture all of the groundwater contaminated with total VOCs greater than 1 ppm. Pumping at a rate of 0.4 gpm, one flush of the source area (51,630 gallons) can be accomplished in approximately 90 days. Pumping groundwater from the center of the source area will assist in the spread of microbes into the contaminated zone and assist in shortening the remediation schedule. Microbes and nutrients will be added to the groundwater from two injections wells located on the upgradient perimeter of the source area. Pumping under these drawdown and withdrawal conditions, groundwater at the edge of the source area would travel to the extraction well at an estimated rate of 0.77 feet per day or 32 days to travel the half the width of the source area (25 feet). A portion of the treated effluent will be injected into a single well located south of the extraction well, near the downgradient limit of the spill area. The injection of the effluent, containing microbes and nutrients, will assist in the treatment of groundwater on the downgradient side of the pumping well and contaminants migrating away from source area. The remaining effluent will be discharged to the ground surface under a State Pollution Discharge Elimination System ("SPDES") permit. Figure 5 shows the configuration of the pumping well and the injection wells in the spill area.

The maximum contaminant concentration in the source area is estimated to be 1.5 milligrams per liter and a source area contaminant mass of approximately 390,000 milligrams of PCE. Under ideal conditions, microbes can degrade approximately 10,800 milligrams per day. Based on these estimates, and using modeled microbe degradation rates, the contaminant mass could theoretically be eliminated in approximately 36 days.

Pumping of a single extraction well increases the groundwater velocity from approximately 0.02 feet per day to 0.77 feet per day. Increasing the groundwater velocity and introducing microbes into the groundwater zone will assist in the rapid removal of contaminants, perhaps in less than one year. This remedial schedule is more rapid than just pumping and treating the groundwater, because the microbes will degrade contaminants that fix onto the soil matrix and are difficult to remove by simple dilution in groundwater. However, because of the limited hydraulic data currently available, the cleanup is conservatively estimated to be complete in approximately 2 years.

Oil/Water Separator - Waste Oil Tank Area

The source area surrounding the oil/water separator - waste oil tank area covers approximately 2,500 square-feet and appears to originate in the vicinity of the oil/water separator - waste oil tank area (see Figure 4). The injection of microbes and nutrients into the upgradient side of the source area will be spread through the source area as a result of pumping from one to two groundwater extraction wells. The extraction well(s) will be placed in the approximate center of the source area.

Based on the hydraulic conductivity data (0.0008 feet per minute), estimated from RI data, one extraction well will be used in this area pumping at a rate of approximately 0.26 gpm. The estimated drawdown using this rate is 3.5 feet. Maintaining this drawdown, a hydraulic capture zone radius could range from 7 feet to more than 50 feet. As a result of the variability of the estimated capture zone radii, two wells may be required to capture all of the groundwater contaminated with total VOCs greater than 1 ppm. Pumping at a rate of 0.26 gpm, one flush of the source area (71,428 gallons) can be accomplished in approximately 190 days. Pumping under these drawdown and withdrawal conditions, groundwater at the edge of the source area, would travel to the extraction well, at an estimated rate of 0.54 feet per day or 46 days to travel half the width of the source are (25 feet). One injection well for microbes and nutrients will be located on the upgradient and the downgradient sides of the source area. The pumping well is to be located approximately 25 feet from the oil/water separator. The injection of at least a portion of the effluent (containing microbes and nutrients) will assist in the treatment of groundwater migrating away from the source area. This injection well will be placed on the property line, near monitoring well GP-2. The remaining effluent, if any, will be discharged to the ground surface under a SPDES permit. If needed, a third well for the injection of microbes can be installed, between the pumping well and the effluent injection well, to assist in the removal of contaminants. Figure 6 shows the configuration of the extraction well and the injection wells in the spill area.

The maximum containment concentration in the source area is estimated to be 3.5 milligrams per liter and a source area containment mass of approximately 1,250,000 milligrams of TCA. Under ideal conditions, microbes can degrade approximately 10,8000 milligrams per day. Based on these estimates and using modeled microbe degradation rates, the contaminant mass could theoretically be eliminated in approximately 116 days.

Pumping of a single extraction well increases the groundwater velocity from approximately 0.02 feet per day to 0.54 feet per day. Increasing the groundwater velocity and introducing microbes into the groundwater zone will assist in the rapid removal of contaminants, perhaps in less than one year. This remedial schedule is more rapid than just pumping and treating the groundwater because the microbes will degrade contaminants that fix onto the soil matrix and are difficult to remove by simple dilution in groundwater. However, because of the limited hydraulic data currently available, the cleanup is conservatively estimated to be complete in approximately 2 years.

This alternative also favorably addresses the evaluation criteria, which includes:

1. *Overall Protection of Human Health and the Environment* - This alternative would be protective of human health and the environment by treating contaminants from in the groundwater zone to satisfy the SCGs. The alternative does not transfer contaminants from one media to another.

2. *Compliance with SCGs* - The removal of contaminants from the groundwater zone beneath the Site results in meeting the SCGs on a long-term basis.

3. *Long-term Effectiveness and Permanence* - This alternative will have long-term effectiveness, since the contaminants will be eliminated.

4. *Reduction of Toxicity, Mobility, or Volume Through Treatment* - This alternative will completely remove the contaminants from the groundwater zone thereby eliminating the toxicity and mobility concerns. Groundwater pumping will also control the migration of contaminants off the Site and may, to a limited extent, reduce the contamination off the Site.

5. *Short-term Effectiveness* - This alternative has little effect on the environment or human health during the construction phase. Contaminated soil and groundwater will be handled during the construction phase, but these waste materials will be managed in closed or covered containers until removed or treated on-Site. Workers and the community will be protected with Site-specific health, safety and contingency plans. Implementation time for construction of this alternative is approximately one to two months.

6. *Implementability* - The technical and administrative feasibility is straightforward; there will be a need for permits to handle the groundwater effluent. Local inspections or permits may be required for the temporary treatment system.

7. *Costs* - The present worth cost of this Alternative has been calculated for a 2-year remediation schedule. The costs are presented on Table 4.

4.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

A comparative analysis of the alternatives indicates that alternatives 3, 4, 6 and 7 are capable of reaching the Site SCGs and being protective of human health and the environment. All of the alternatives can be implemented using convention construction equipment and mechanical systems. Fundamentally, the issues that separate Alternatives 3, 4, 6, and 7 are time (i.e., how fast remediation can be completed), and the cost of construction and operating the alternative.

Alternative 2 is a limited action alternative that uses deed restrictions and notifications to the Town of Kirkwood and Broome County Health Department to restrict activities which might encounter or change the path of contamination. By accepting this alternative the groundwater conditions would be monitored to ensure there is no increased risk to human health or the environment. Although the alternative is protective of human health and the environment it relies on natural processes to assimilate the contamination to SCG levels which may not occur for an extensive period of time (i.e., possibly over 30 years).

The alternative with the highest cost, Alternative 3 - AS and SVE, is a feasible remedy for the Site and can satisfy SCGs relatively quickly, but its capital and yearly operation and maintenance costs are the highest of the alternatives reviewed. The use of AS to remediate the groundwater will limit the concurrent use of other techniques, because the groundwater will become more oxygenated which would hinder bioremediation of the chlorinated compounds present. In addition, the contaminants are not destroyed, but transferred from the groundwater to another media, such as activated carbon or discharged directly into the atmosphere. In summary, AS and SVE can complete the remediation in approximately 3.5 to 4 years, but does this at a relatively high cost and only transfers contaminants from the groundwater to another media.

Alternative 4, In-Situ Bioremediation, involves injection of proprietary compounds into the groundwater to stimulate microbiological activity and microbial degradation of the contaminants. The technology is well known and capable of achieving SCG levels within a 3-year period of time. Use of the technology will require a treatability study prior to use to determine the correct mixtures to stimulate biological activity. The capital and yearly operational cost of bioremediation are low compared to the other alternatives, but since at least one additional application of proprietary compounds may be required, the contingency costs are the highest of the alternatives reviewed.

Alternative 6, Groundwater Pumping, has one of the lowest initial capital investment of the Alternatives evaluated. Alternative 5 involves installing extraction wells to remove contaminated groundwater from the groundwater zone. The alternative relies on the contaminant's ability to dissolve in groundwater so it can be removed. Contaminated groundwater will be treated using an air stripper prior to discharge of the effluent under a SPDES pr POTW permit. This alternative has a low initial capital cost; however, because remediation may take longer, possibly 5 to 26 years, the present worth of the alternative's operational costs is larger than many of the alternatives considered.

Alternative 7, In-Situ Bioremediation and Groundwater Pumping, should satisfy the remedial action objectives in 3 months to 2 years. Thus, Alternative 7 requires the shortest remediation period and is protective of human health and environment. Unlike Alternative 4 where in-situ bioremediation relies on the natural groundwater flow velocity to drive remediation, this alternative proposes to install groundwater extraction wells to increase the rate of groundwater flow and accelerate remediation. The extracted groundwater would be treated in a bioreactor then pumped back into the groundwater. The treated effluent used for injection into the groundwater would meet SCGs, but also carry microbes to enhance in-situ bioremediation. Groundwater treatment for metals is not anticipated since the contaminants of concern are VOCs. Microbes will initially by introduced into the groundwater in newly installed passive injection wells. The initial and yearly operational costs are more than Alternative 4.

5. INDENTIFICATION OF THE RECOMMENDED ALTERNATIVE

The detailed analysis of the alternatives indicates that Alternatives 3 through 7 are protective of human health and the environment and capable of meeting the remedial action objectives because the involve the following components:

- monitoring of groundwater conditions; and
- constructing an active remediation system.

The fundamental differences between these five alternatives are the estimated remediation time and cost. Alternative 5, however, does not address the source of contamination directly, but relies on groundwater dilution to reduce contaminant levels in the source area. As a result, Alternative 5 was eliminated from further consideration.

Since the contaminated medium at the Site is groundwater, there are inherent difficulties with estimating the time frame over which remediation will be completed. Thus, the estimated operation and maintenance costs and the associated total costs vary with the time to achieve the cleanup levels. Because alternatives 3, 4, and 6 generally satisfy the remedial action objectives and are expected to perform similarly with respect to the evaluation criterion, the present worth cost of the remedial system and the time to achieve the cleanup objectives were the principal factors in identifying the most cost-effective alternative. Alternative 7 In-Situ Bioremediation and Groundwater Pumping is recommended as the preferred remedial alternative, because it offers the most rapid projected Site cleanup, relatively low present worth cost, and protection of human health and the environment.

6. LIMITATIONS AND USE OF THIS REPORT

This Feasibility Study was prepared by Leader Environmental, Inc. in accordance with generally accepted practices of other consultants preparing similar reports, and we observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. The analyses and conclusions submitted in this report are based, in part, upon data and information, provided by others and are contingent upon their validity. Cost and volume estimates included herein should be considered approximate.

The FS Report was prepared exclusively for USF Red-Star for specific application to the TNT-Red Star Express, Inc. Site in accordance with generally accepted engineering practice. No other warranty, expressed or implied is made.

TABLE 1

SCREENING ANALYSIS OF TECHNOLOGIES

General Response Action	Remedial Technology	Description	Screening Comments
No Action	None	No Action	Required for consideration by National Contingency Plan
Limited Action	Monitoring with Natural Attenuation and Deed Restrictions	The groundwater quality will be monitored to ensure contaminant concentrations do not increase. Deed restrictions would be placed to ensure groundwater is not used for drinking water proposes.	Monitoring of the groundwater will help ensure that off Site risks to human health and the environment do not increase. The contaminant plumes appear to be a steady state conditions and as such should naturally attenuate without further environmental damage, but the time required for SCGs to be met is greater than significant.
On - Site Treatment	Soil Vapor Extraction	Removal of contaminants using vacuum technologies. Vacuum increases the evaporation rate of contaminants from the impacted media.	Technology is useful for unsaturated soil or contaminants that are floating on the groundwater surface. Limited success on the removal of contaminants in solution. Technique is not appropriate in this setting.
	Thermal Desorption	Removal of contaminants by exposing to increased temperatures and evaporating contaminants.	Technology is useful for unsaturated soil. Injection of hot air or heating of soil using electro-magnetic or heating coils is not usually practical for groundwater cleanup. Heating of air injected through sparging points may enhance contaminant removal. Technology by itself is not effective.
	Incineration	Removal of contaminants by exposing waste to open or enclosed flame in a combustion chamber.	Technology is not appropriate for liquids with dilute contaminant concentrations or low BTU value.
	Air sparging	Removal of contaminants by introducing a stream of air bubbles into the groundwater and air stripping contaminants out of the groundwater.	Technology is an effective groundwater treatment method, but may have limited application in low porosity soils or with contaminants with low Henry's Law Constants.
	Steam Injection	Removal of contaminants by introducing steam into the soil or groundwater. Hot vapor rising from the soil and groundwater can be collected for contaminant removal.	Technology is effective groundwater treatment method, but may have limited application in low porosity soils. Technology can be evaluated as an air sparging enhancement.
	Bio-Remediation	Destruction of contaminants in place or in bioreactors using engineered microbes or enhancing site conditions using nutrients for native microbes to being destruction process.	Technology can be effective in remediating contaminants on site. Technology may be limited by natural chemical and geologic conditions, but can be enhanced with other remedial options.
	Reaction Walls	Treatment of groundwater contaminants using Fenton's Reagent, iron filings, or biological matrixes.	Technology is effective in removing groundwater contaminants, but is dependent on groundwater flow to bring contaminants to the treatment zone. The technology is not necessarily appropriate for source removal.
	Groundwater pumping and treatment	Removal of groundwater contaminants by pumping water through the contaminant source. Treatment of extracted groundwater followed by discharge of effluent.	Technology has limited effectiveness as a source removal technique in low permeability soil or when contaminants have low solubilities. Implementable and effective at this Site.

TABLE 2

REMEDIAL ALTERNATIVE SUMMARY

Remedial Alternative	Description
1. No Action	No Action, site is left in its existing condition.
2. Limited Action	Monitoring groundwater quality and the placement of deed restrictions on groundwater use.
3. Air Sparging and Soil Vapor Extraction	Air sparging is used to remove contaminants from the groundwater and soil vapor extraction is used to remove contaminants from the subsurface and treated, if required.
4. In-Situ Bioremediation	Nutrients and engineered microbes are injected into groundwater to treat contaminants in place.
5. Reaction Walls	Iron filings are used to treat groundwater migrating off of the Site and to treat groundwater in contaminant source areas.
6. Groundwater Pumping and Treatment	Groundwater is pumped to remove contaminants and to induce groundwater flow through contaminant source areas, expediting cleanup by dissolution of contaminants from saturated soil.
7. Groundwater Pumping and Treatment	Nutrients and microbes are injected into groundwater to treat contaminants in place. Groundwater pumping is used to expedite cleanup of the Site and to control contaminant migration during remediation.

TABLE 4

SUMMARY OF ALTERNATIVE COSTS

Alternative	Total Capital Cost	Total Yearly Operation and Maintenance	Total Indirect Costs	Number of Years of Remediation	Total Present Worth
1. No Action	$0	$0	$0	N/A	$0
2. Limited Action	$7,780.00	$2,010.00	$292.00	10	$25,602.00
3. Air Sparging and Soil Vapor Extraction	$64,183.00	$25,980.00	$17,590.00	4	$169,135.00
4. In-Situ Bioremediation	$47,963.00	$8,540.00	$35,360.00	3	$98,446.00
6. Groundwater Pumping and Treatment	$48,418.00	$18,888.00	$13,025.00	5	$123,576.00
7. In-situ Bioremediation and Groundwater Pumping	$65,491.00	$19,388.00	$18,897.00	2	$120,437.00

Notes:

Total Capital Costs: Capital costs based on vendor quotations or catalog suggested prices.

Total Indirect Costs: Cost includes 15% contingency on the equipment and construction costs, and a 15% contingency for engineering design on all capital costs. In-Situ bioremediation also includes a 60% contingency for a second application of nutrients, if needed.

Total Present Worth Costs: Cost includes operating or monitoring the remedial system for the number of years shown and the costs having a 5% discount rate.

APPENDICES

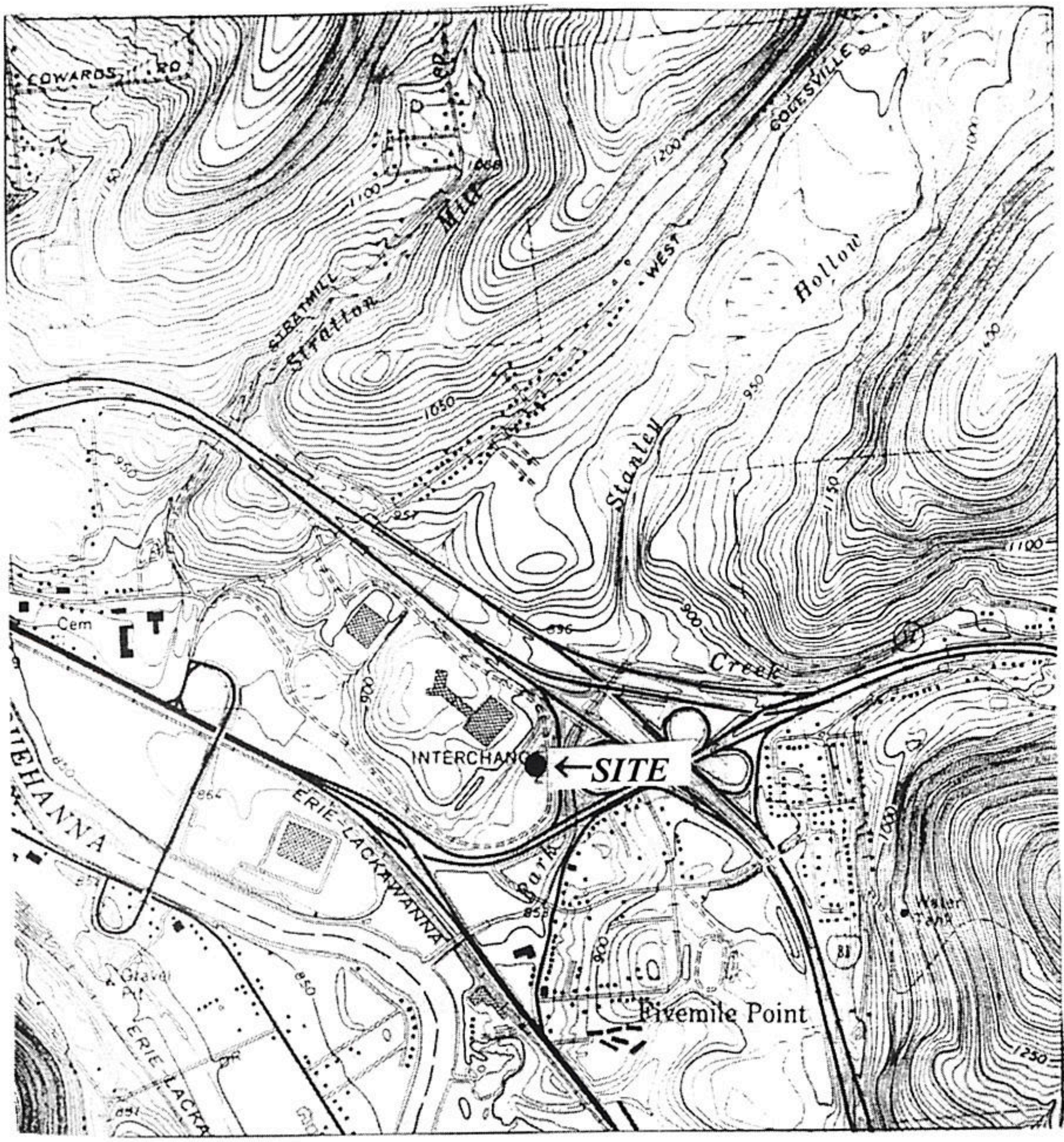
APPENDIX A

REMEDIAL ALTERNATIVE COST SUMMARIES

APPENDIX B

REFERENCES

COST TABLES



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TNT-Red Star Express Site
Kirkwood, New York

Prepared For: USF Red Star
Newark, New Jersey

LEADER
Leader Environmental, Inc
640 Kreag Road-Suite 300
Pittsford, New York 14534
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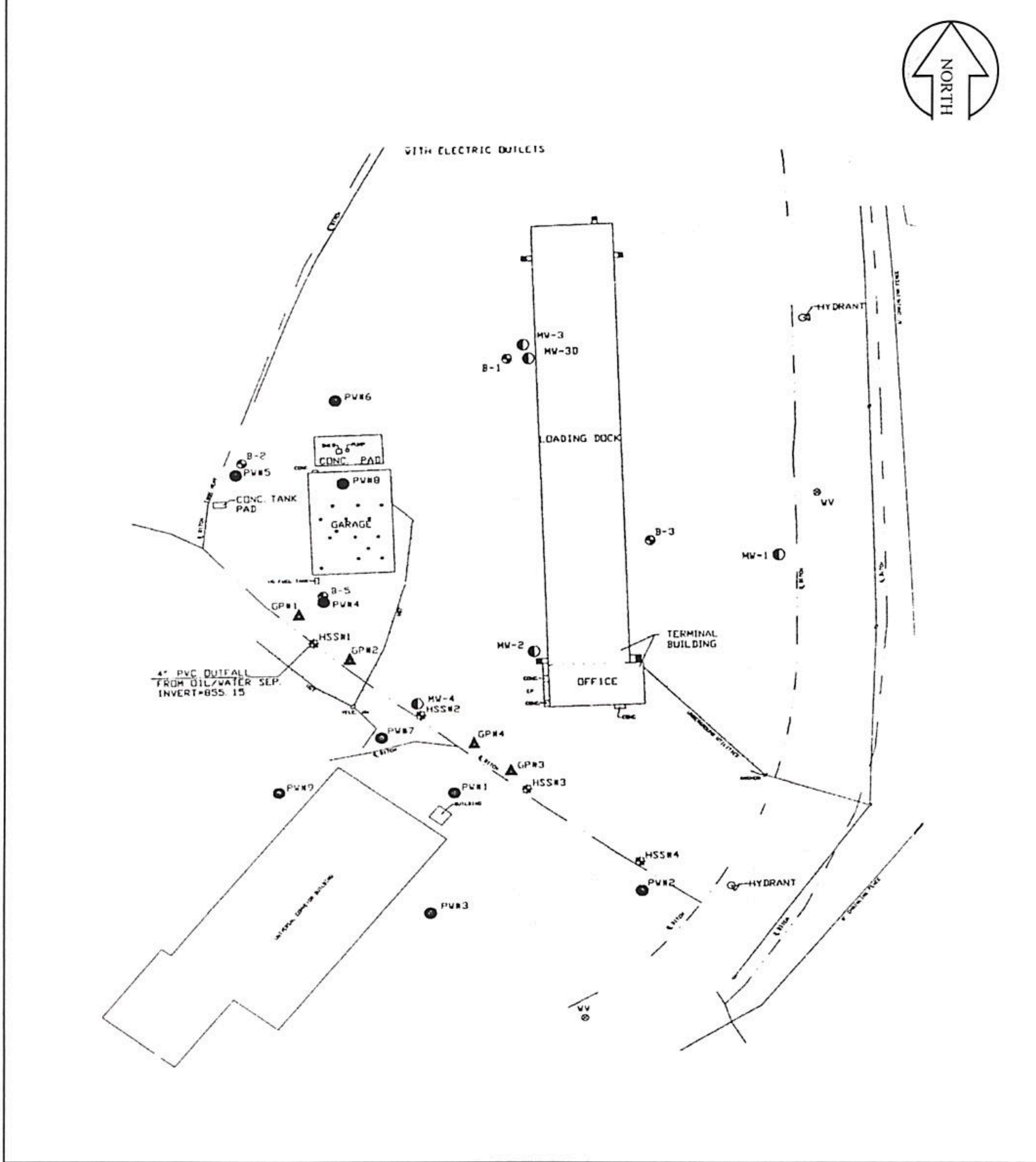
Project: 250.001
Date: 1-7-00
Scale: 1" = 2,000'

Drawn: PVS
Checked: MPR
File Name:

Figure 1



Title: Site Map
TNT-Red Star Express Site
Kirkwood, New York

Prepared For: USF Red Star
Newark, New Jersey

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Project: 250.001
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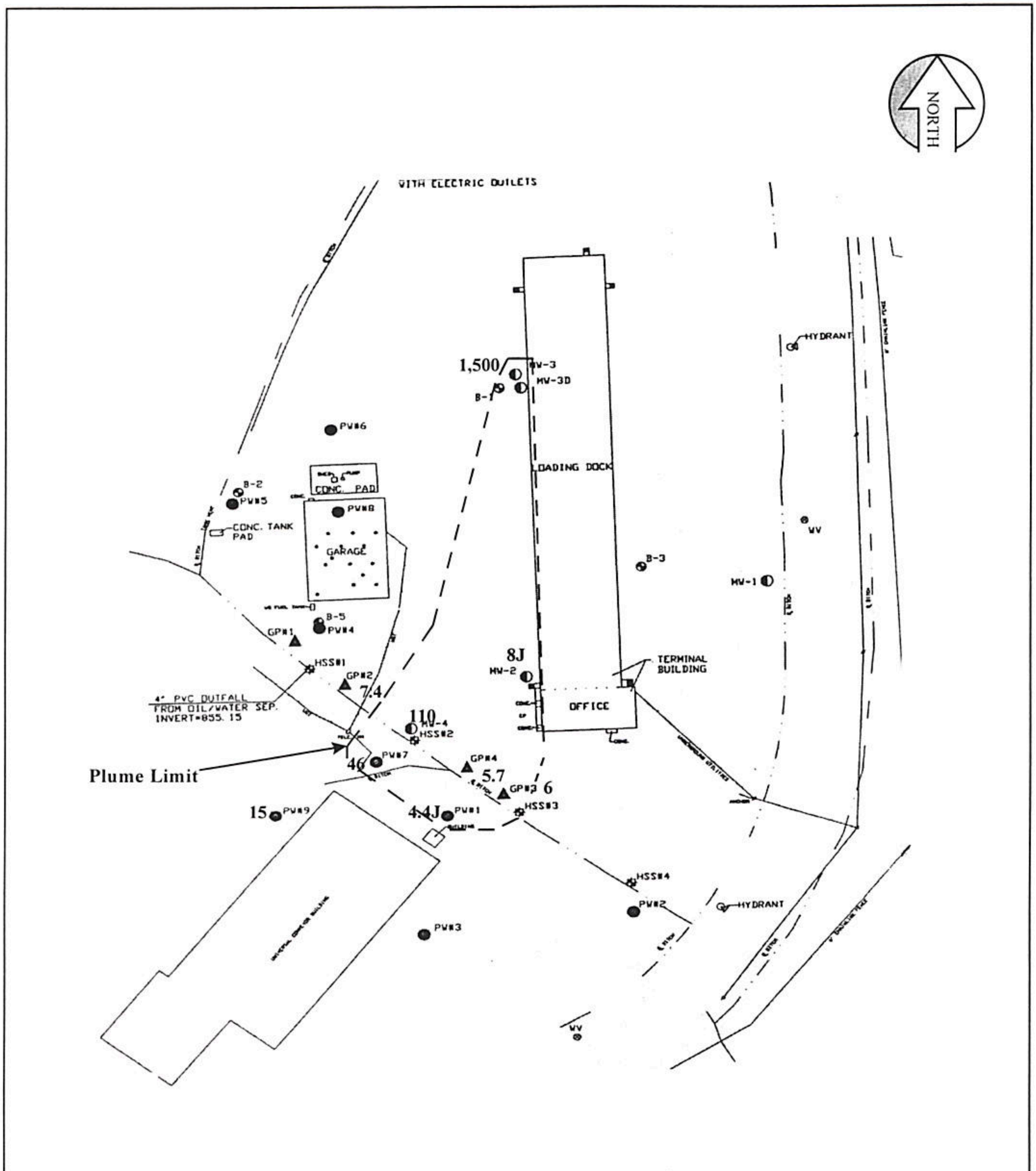
Figure 2



Title	1991 PCE Spill Plume TNT-Red Star Express Site Kirkwood, New York
Prepared For	USF Red Star Newark, New Jersey

LEADER

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Project	250.001
Date	1-7-00
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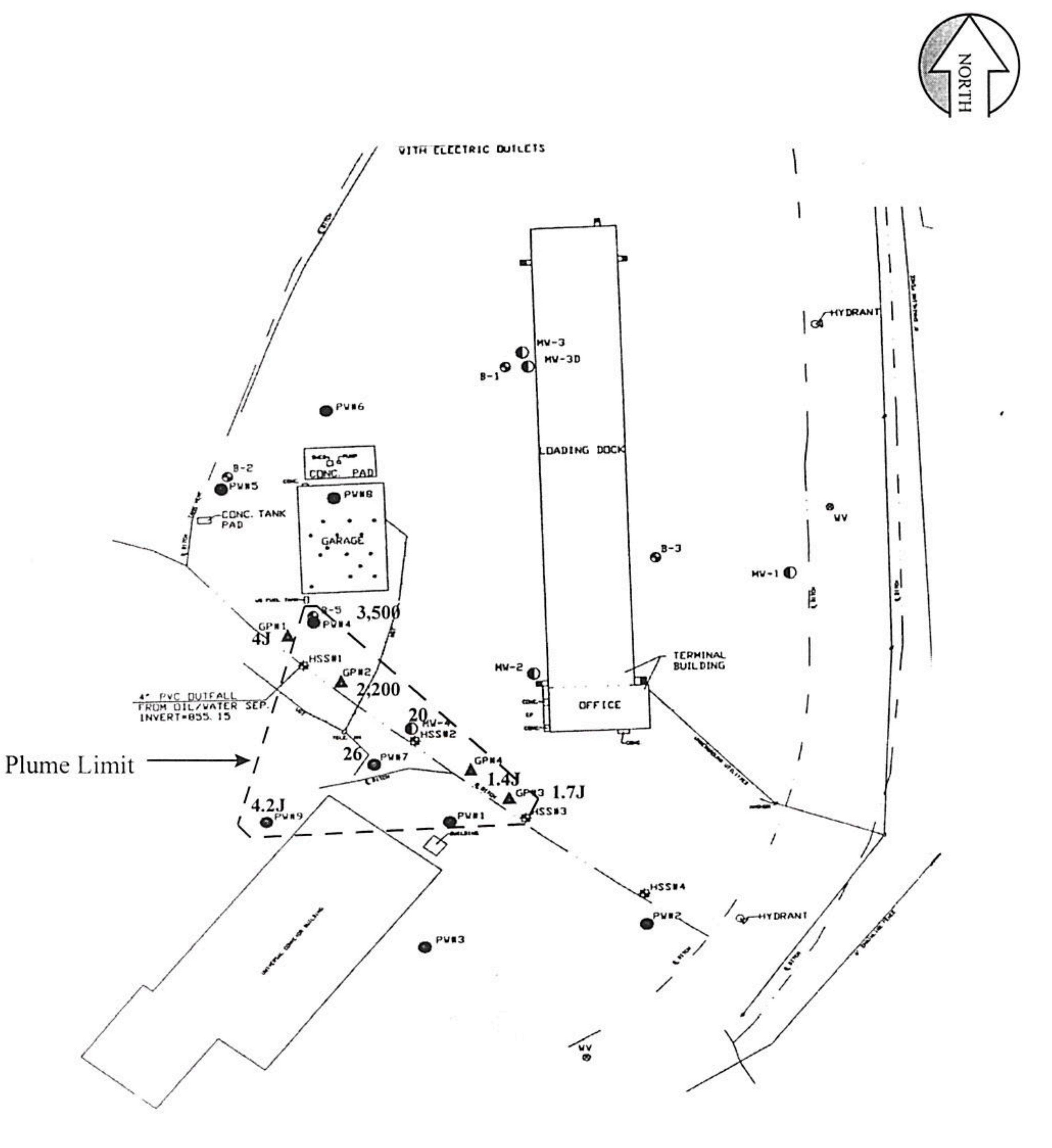
Figure	3



Title Oil/Water Separator-Waste Oil Tank Plume
TNT-Red Star Express Site
Kirkwood, New York

Prepared For
USF Red Star
Newark, New Jersey

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Project	250.001
Date	1-7-00
Scale	1" = 100'
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Figure	4

ESTIMATE OF COSTS FOR ALTERNATIVE No. 2
LIMITED ACTION

ALTERNATIVE 2 LIMITED ACTION							
DIRECT COSTS							
ITEM	**DESCRIPTION**	**QUANTITY**	**UNIT**	**UNIT COST [1]**	**CAPITAL**	**YEARLY O&M**	**TOTAL PRESENT WORTH [2,3]**
1	**GROUNDWATER MANAGEMENT**						
	Replace Temporary Wells	4	ea	$1,945.00	$7,780.00		$7,780.00
	Annual Monitoring - 10 Years	1	Year	$2,010.00	$0.00	$2,010.00	$17,530.69
TOTAL DIRECT COSTS (TDC)					**$7,780**	**$2,010**	**$25,311**
INDIRECT COSTS							
	Contingency - 15% of TDC (Capital Cost)	1	LS	$1,945	$292	$0.00	$292
TOTAL INDIRECT COSTS					**$292**	**$0**	**$292**
TOTAL COSTS					**$8,072**	**$2,010**	**$25,602**

NOTES:

1 Unit costs based on vendor qoutes or catalog suggested prices.

2 Total Present Worth based on a 5% discount rate.

3 Total Present Worth based on a remediation time frame of 10 years.

ESTIMATE OF COSTS FOR ALTERNATIVE No. 3
AIR SPARGING AND SOIL VAPOR EXTRACTION REMEDIATION

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST [1]	CAPITAL	YEARLY O&M	TOTAL PRESENT WORTH [2,3]
DIRECT COSTS							
1	**AIR SPARGING AND SVE PILOT TESTING**						
	Pilot Test						
	Equipment Rental	3	day	$1,500.00	$4,500.00		$4,500.00
	Test Wells Installed	1	day	$3,100.00	$3,100.00		$3,100.00
	Testing and Reporting	1	LS	$3,500.00	$3,500.00		$3,500.00
2	**IMPLEMENTATION**						
	Wells						
	Sparge Well Installation	8	ea.	$980.00	$7,840.00		$7,840.00
	AS/SVE Installation of Headers						
	AS Headers and Supply Lines	750	LF	$10.50	$7,875.00		$7,875.00
	SVE Headers and Intake (Share Trenching with AS Supply)	600	LF	$12.00	$7,200.00		$7,200.00
	Pavement Restoration	1,500	sq.ft.	$1.50	$2,250.00		$2,250.00
	AS/SVE Mechanical Systems						
	SVE 100 CFM @ 50 WC vac. 3 H.P. Motor	1	LS	$3,500.00	$3,500.00		$3,500.00
	AS 18 CFM @ 15 psi 2 H. P. Motor	1	LS	$2,100.00	$2,100.00		$2,100.00
	System Control Panel	1	LS	$3,000.00	$3,000.00		$3,000.00
	8 X 10 ft. Shed and Concrete Slab with Lights and Heat	1	LS	$3,800.00	$3,800.00		$3,800.00
	Delivery of Remedial System	1	LS	$1,000.00	$1,000.00		$1,000.00
	Remedial System Assembly						
	Taking Delivery of System and Set Up						
	Electrical and Mechanical Connections to Shed	1	LS	$5,560.00	$5,560.00		$5,560.00
	Waste Disposal						
	Analysis, Transportation, & Disposal	8	Drum	$560.00	$4,480.00		$4,480.00
3	**MAINTENANCE, OPERATION & MONITORING**						
	GC Management	0.075	LS	$59,705.00	$4,477.88	$0.00	$4,477.88
	Maintenance	52	Week	$140.00	$0.00	$7,280.00	$25,814.52
	Filters, oil, grease	12	Month	$1,060.00	$0.00	$12,720.00	$45,104.49
	Electric 5 H.P. Rate of $0.06 KWH	32,662	KWH	$0.06	$0.00	$1,959.72	$6,949.07
	Groundwater Monitoring - 6 Wells - 1st. Year	2	Events	$2,010.00	$0.00	$4,020.00	$4,020.00
	Groundwater Monitoring - 6 Wells - 2, 3, 4th. Years	1	Event	$2,010.00	$0.00	$0.00	$5,473.73
TOTAL DIRECT COSTS (TDC)					**$64,183**	**$25,980**	**$151,545**
INDIRECT COSTS							
	Contingency - 15% of TDC (Equipment and Construction)	1	LS	$7,962	$7,962		$7,962
	Engineering Design - 15% of TDC (All Capital Costs)	1	LS	$9,627	$9,627		$9,627
TOTAL INDIRECT COSTS					**$17,590**	**$0**	**$17,590**
TOTAL COSTS					**$81,773**	**$25,980**	**$169,135**

NOTES

1 Unit costs based on vendor qoutes or catalog suggested prices.

2 Total Present Worth based on a 5% discount rate.

3 Total Present Worth based on a remediation time frame of 4 years.

ESTIMATE OF COSTS FOR ALTERNATIVE No. 4
BIOREMEDIATION

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST[1]	CAPITAL	YEARLY O&M	TOTAL PRESENT WORTH (2,3)
DIRECT COSTS							
1	**TREATABILITY TESTING**						
	Treatability Testing	1	LS	$5,000.00	$5,000.00		$5,000.00
2	**IMPLEMENTATION**						
	Geoprobe	5	day	$2,000.00	$10,000.00		$10,000.00
	Regenesis HRC	3,600	lb	$6.48	$23,328.00		$23,328.00
	Additional Monitoring Wells	2	ea	$2,000.00	$4,000.00		$4,000.00
	Process Monitoring	4	ea	$690.00	$2,760.00		$2,760.00
3	**MANAGEMENT**						
	GC Management	0.075	LS	$38,328.00	$2,874.60		$2,874.60
	Qtrly Monitoring - 3 Years - 6 Wells	1	Year	$8,540.00	$0.00	$8,540.00	$15,123.20
TOTAL DIRECT COSTS (TDC)					**$47,963**	**$8,540**	**$63,086**
INDIRECT COSTS							
	Contingency - 15% of TDC (Equipment and Construction) [4]	1	LS	$28,166	$28,166		$28,166
	Engineering Design- 15% of TDC	1	LS	$7,194	$7,194		$7,194
TOTAL INDIRECT COSTS					**$35,360**	**$0**	**$35,360**
TOTAL COSTS					**$83,323**	**$8,540**	**$98,446**

NOTES:

1. Unit costs based on vendor qoutes or catalog suggested prices.
2. Total Present Worth based on a 5% discount rate.
3. Total Present Worth based on a remediation time frame of 3 years.
4. Contingency also includes 60% of HRC treatment cost for 2nd application.

ESTIMATE OF COSTS FOR ALTERNATIVE No. 5
GROUNDWATER PUMPING AND TREATMENT REMEDIATION

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST[1]	CAPITAL	YEARLY O&M	TOTAL PRESENT WORTH [(2,3)]
DIRECT COSTS							
1	**IMPLEMENTATION**						
	Pumping Well						
	Drilling	4	Days	$2,500.00	$10,000.00		$10,000.00
	6-inch PVC Well	80	LF	$50.00	$4,000.00		$4,000.00
	Pump, Controller, and Switches	4	ea.	$1,500.00	$6,000.00		$6,000.00
	Pump Installer	3	Day	$480.00	$1,440.00		$1,440.00
	Electrician	3	Day	$480.00	$1,440.00		$1,440.00
	Laborer	3	Day	$280.00	$840.00		$840.00
	Treatment Option 1						
	Air Stripper	1	ea.	$6,300.00	$6,300.00		$6,300.00
	Shed, with Electric Heater, Light, Insulation	1	LS	$1,500.00	$1,500.00		$1,500.00
	Plumber	2	Day	$480.00	$960.00		$960.00
	Electrician	2	Day	$480.00	$960.00		$960.00
	Electric Supplies	1	LS	$500.00	$500.00		$500.00
	Utility Trenches						
	Backhoe	2	Days	$600.00	$1,200.00		$1,200.00
	Laborer	2	Day	$280.00	$560.00		$560.00
	Plumber	2	Day	$480.00	$960.00		$960.00
	Supplies, Manholes, pipe, connections	1	LS	$1,500.00	$1,500.00		$1,500.00
	Pavement Restoration	1,600	sq.ft.	$1.50	$2,400.00		$2,400.00
	Waste Disposal						
	Analysis, Transportation, & Disposal	8	Drum	$560.00	$4,480.00		$4,480.00
2	**MAINTENANCE, OPERATION & MONITORING**						
	GC Management	0.075	LS	$45,040.00	$3,378.00	$0.00	$3,378.00
	Maintenance	52	Week	$140.00	$0.00	$7,280.00	$31,518.59
	SPDES Monitoring	4	Qtr.	$500.00	$0.00	$2,000.00	$8,658.95
	Electric 4 H.P. Rate of .10 KWH	26,129	KWH	$0.06	$0.00	$1,567.74	$6,787.49
	Groundwater Monitoring-6 Wells- 1st. Year	4	Events	$2,010.00	$0.00	$8,040.00	$8,040.00
	Groundwater Monitoring-6 Wells-2,3,4,5th. Years	1	Event	$2,010.00	$0.00	$0.00	$7,127.36
TOTAL DIRECT COSTS (TDC)					**$48,418**	**$18,888**	**$110,550**
INDIRECT COSTS							
	Contingency - 15% of TDC (Equipment and Construction C	1	LS	$5,763	$5,763		$5,763
	Engineering Design - 15% of TDC (All Capital Costs)	1	LS	$7,263	$7,263		$7,263
TOTAL INDIRECT COSTS					**$13,025**	**$0**	**$13,025**
TOTAL COSTS					**$61,443**	**$18,888**	**$123,576**

NOTES:

1 Unit costs based on vendor qoutes or catalog suggested prices.

2 Total Present Worth based on a 5% discount rate.

3 Total Present Worth based on a remediation time frame of 5 years.

ESTIMATE OF COSTS FOR ALTERNATIVE No. 6
BIOREMEDIATION AND PUMPING REMEDIATION

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST[1]	CAPITAL	YEARLY O&M	TOTAL PRESENT WORTH [2,3]
DIRECT COSTS							
1	**TREATABILITY TESTING**						
	Treatability Testing	1	LS	$5,000.00	$5,000.00		$5,000.00
2	**IMPLEMENTATION**						
	Pumping Well						
	Drilling	4	Days	$2,500.00	$10,000.00		$10,000.00
	6-inch PVC Well	80	LF	$40.00	$3,200.00		$3,200.00
	4-inch PVC Well	80	LF	$20.00	$1,600.00		$1,600.00
	Header	500	lf	$7.00	$3,500.00		$3,500.00
	Pump	2	ea.	$1,500.00	$3,000.00		$3,000.00
	Electrician	2	Day	$960.00	$1,920.00		$1,920.00
	Treatment						
	Bioreactor	1	LS	$8,000.00	$8,000.00		$8,000.00
	Shed, with Electric Heater, Light, Insulation	1	LS	$3,000.00	$3,000.00		$3,000.00
	Plumber	2	Day	$480.00	$960.00		$960.00
	Electrician	2	Day	$480.00	$960.00		$960.00
	Electric Supplies	1	LS	$500.00	$500.00		$500.00
	Utility Trenches						
	Backhoe	2	Days	$600.00	$1,200.00		$1,200.00
	Laborer	2	Day	$280.00	$560.00		$560.00
	Plumber	2	Day	$480.00	$960.00		$960.00
	Pavement Restoration	1,600	sq.ft.	$1.50	$2,400.00		$2,400.00
	Waste Disposal						
	Analysis, Transportation, & Disposal	8	Drum	$560	$4,480		$4,480
3	**MAINTENANCE, OPERATION & MONITORING**						
	GC Management 0.075 of project	43,400	LS	$0.08	$3,255.00		
	Maintenance - Two Years	26	Days	$280.00	$0.00	$7,280.00	$13,536.51
	Electric 2 H.P. Rate of .06 KWH	13,065	KWH	$0.06	$0.00	$783.90	$1,457.59
	SPDES Monitoring	4	Qtr.	$500.00	$0.00	$2,000.00	$3,718.82
	Groundwater Monitoring	4	Qtr.	$2,135.00	$0.00	$8,540.00	$15,879.37
TOTAL DIRECT COSTS (TDC)					$54,495	$18,604	$85,832
INDIRECT COSTS							
	Contingency - 15% of TDC (Equipment and Construction Cost)	1	LS	$7,424	$7,424		$7,424
	Engineering Design - 15% of TDC (All Capital Cost)	1	LS	$8,174	$8,174		$8,174
TOTAL INDIRECT COSTS					$15,599	$0	$15,599
TOTAL COSTS					$70,094	$18,604	$101,431

NOTES:

1 Unit costs based on vendor qoutes or catalog suggested prices.

2 Total Present Worth based on a 5% discount rate.

3 Total Present Worth based on a remediation time frame of 2 years.

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REFERENCES

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