Oser Avenue DEC Feasibility Study Comments

SUBSTANTIVE COMMENTS

1. Section 1.2.6 – This section discusses risk-based concentrations (RBCs) derived from guidance by US Environmental Protection Agency (USEPA) Region III to determine chemicals of potential concern. However, the New York State Standards, Criteria, and Guidance (SCGs) values (mentioned in 6NYCRR Part 375) were not discussed in this section and are equally important. Part 375 Standards and Criteria are the New York State equivalent to the Federal applicable or relevant and appropriate requirements (ARARs). New York's SCGs are often more stringent than the RBCs from the EPA. Please add the above-mentioned references and include a discussion in this section. The appropriate cleanup objectives should also be added to the tables and text appropriately. Otherwise, this section does not match very well with the detailed analysis where the SCGs are used to compare each alternative.

   Risk-based concentrations are not necessarily the same as SCGs. Specifically, the TAGM soil values were developed based on a variety of endpoints, including not only direct contact (risk) considerations, but leaching to groundwater and state-wide background. In the case of chlorinated organics, the TAGM numbers are all leaching based. Therefore, they are not relevant to risk.

   As discussed in the RI, the groundwater screening was performed using the New York State Department of Health Maximum Contaminant Limits (MCLs), not the NYS Part 703 Groundwater Standards. The MCLs are specifically designed to be health-based and apply to all drinking water resources. All the groundwater COPCs (1,1-DCE, 1,2-DCE, PCE , TCE, and 1,1,1-TCA) are regulated under Part 703 as Principal Organic Constituents (POCs), as derived from the MCLs. Citing both statutes is redundant, the NYSDOH standards are the appropriate original health-based values.

   The purpose of the exposure assessment (EA) is not to provide a comparison with all potentially relevant standards and criteria. Rather the EA identifies the exposure pathways that are complete based on site use and conditions and the screening evaluation compares the concentrations in media that could be contacted with reference values specially based on the exposure mechanism. Excess risk may be present even when SCGs are met, and, conversely, presence of contamination above an SCG does not necessarily indicate a health impact. For this reason, the FS process requires that overall protectiveness and compliance with SCGs be handled as two separate evaluation criteria. The information developed in the EA is used to perform the protectiveness evaluation. In the sense, the screening levels use in the EA to determine the potential for unacceptable exposures may (and typically should) differ from the SCGs evaluated in the SCG criterion that follows.

2. Section 1.2.6.1, Soil – A reference should be made to the NYSDEC Division of Environmental Remediation's Technical and Administrative Guidance Memorandum (TAGM) 4046 in addition to the EPA's RBCs. TAGM 4046 discusses recommended soil cleanup objectives of contaminants in soil. Please add the appropriate references to the

groundwater discussion as well. Part 703 should also be referenced pertaining to groundwater cleanup standards.

See above Comment #1.

3. Section 3.1.1.4, In-Situ Treatment – HRC, ORC, and permanganate were mentioned as possibilities for in-situ chemical oxidation, but ozone was not included or described. Ozone has been used to treat chlorinated VOCs in the soil and groundwater. Ozone was initially going to be considered as part of a soil vapor extraction system for better efficiency, but ozone has also been used for soil and groundwater remediation alone. A description for initial comparison purposes would make this section more complete and may also be carried through the feasibility study analysis.

The following text will be added.

Ozonation: Ozonation involves injection of water saturated with ozone into an aquifer contaminated with chlorinated compounds. Ozone (O_3) is a strong oxidant, which upon contact breaks down chlorinated compounds into carbon dioxide (CO_2), chloride (Cl) and water (H_2O). The advantage of O_3 is that it is 12 times more soluble than oxygen, therefore, it can be transferred into the aqueous phase much more rapidly. High solubility is beneficial for achieving O_3 saturation in a contaminated aquifer.

Effectiveness: Ozonation can be very effective in destruction of the chlorinated volatile organic compounds in the aquifer, if the ozone is in direct contact with the contaminant. Site-specific constraints must be first considered, because oxidation is dependent on achieving adequate contact between oxidants and contaminants. Subsurface heterogeneities, preferential flow paths and poor mixing in the subsurface can result in pockets of untreated contaminants. Further, the reagents can be consumed by other oxidizable substrates (e.g., natural organic compounds or dissolved iron), reducing, but not limiting, the efficiency of the in-situ treatment. The short half-life of O_3 limits its ability to migrate through soil or groundwater over large distances.

Implementability: Although the chemistry involved in ozonation is relatively simple, the technology is not a simple one to implement. The subsurface environment can be difficult to control, and it can be difficult to get adequate distribution of the oxidants within the subsurface. The technology has been commercially applied for the last 5 to 6 years but it is still considered an emerging technology and strides are being made to better understand its limitations and overcome them. Safety and handling issues need to be addressed for ozone generation.

Cost: Ozone generation system requires a relatively large capital investment.

Conclusion:

Although ozonation is potentially effective remediation technique for chlorinated VOCs, it is difficult to implement in the subsurface applications. This remediation method is not retained for further evaluation.

4. Section 5 – The cost differences for the groundwater alternatives indicate that less permanganate would be used in the combination alternative. Please explain the reason for these differences.

   The combination alternative would only use permanganate to treat the source rather than the entire plume, thereby reducing the quantity of permanganate used.

5. Section 5 – The chemical permanganate for the in-site chemical oxidation is mentioned as being readily available. However, are there any proprietary concerns regarding the delivery system or any part of the in-situ chemical oxidation process? If so, this should be mentioned in the FS.

   This technology has not been patented.

6. Section 5.2 – The permanganate alternatives for soil and groundwater involve different types of permanganate, namely sodium versus potassium salts. Please describe in more detail why sodium permanganate is more appropriate for the soil remedy in the correct section. Some literature has described that potassium permanganate is a preferred oxidizer based on its effectiveness in treating both dissolved phase and separate phase in both the vadose and the saturated zones. Please explain the benefits to using sodium permanganate versus potassium permanganate.

   Sodium permanganate is more soluble and can be injected at a much stronger solution. It is also more viscous when it's at a stronger concentration which will slow it's travel time and increase it's residency time allowing more time for the reaction to occur.

7. Section 5.2.2.5 – How do we know that the time for the pump and treat alternative will take so long? The descriptions for time periods are also missing from the other remedies. Please include the assumptions and reasoning for the remedial time frames for every remedial alternative. Appropriate time estimates for each of the alternatives will help in the comparison of the alternatives.

   Groundwater modeling results will be presented in the Appendix.

8. Section 5.2.7 – For details about injecting sodium permanganate to remediate the soil contamination, the delivery process is not described (i.e. gravity feed or pressure injection). Five injection locations that can be included, such as the figures for a possible SVE system?

   As discussed, through both dry wells and infiltration gallery. Potential for point injection through piezometers during a subsequent injection should monitoring data warrant it.

9. Section 5.2.7 – The text discusses the lateral dispersion being the main design consideration for soil remediation via permanganate. What happens when the solution doesn't come into contact with the contamination or follow the same pathways in the void spaces as the PCE has taken? Isn't this going to leave PCE in the soil?

The potential for residual PCE to remain is a possibility. However, when permanganate is combined with an alternative technology, such as SVE, it is a cost effective solution.

10. Section 5.2.10.7 – The last sentence mentions the pump and treat system. Isn't this section meant to describe the soil vapor extraction rather than the pump and treat for groundwater? Please adjust the text.

    Adjusted accordingly.

11. Section 5 – For the permanganate alternatives for soil and groundwater, additional costs should be added to the estimates for continued monitoring of the contaminated media. Monitoring may occur for a few years after remediation to ensure that the remedy was effective.

    Cost will be added.

12. Section 5 – Why are the capital costs for the sodium permanganate soil alternative higher than the combination of permanganate and soil vapor extraction? Would less permanganate be used for the combination alternative? If so, this should be stated in the description.

    Yes, it is correct that less permanganate will would be used in the combination remedial action. And, existing SVE system would be used once mass was decreased.

13. Section 7.3 – Recommendations should be excluded from the conclusions section. If necessary, the conclusions section may be removed from the Feasibility Study.

    The conclusion section has been removed.

14. Appendix A – The text summary for the oxidant demand test was helpful, but it did not explain why there was a chlorine type odor during the source test. According to the chemistry literature for permanganate remediation, chloride ions are produced, but this would not produce a chlorine type odor. One possible explanation for possible chlorine odors may be the formation of chlorine gas due to high redox conditions. Chlorine gas in the groundwater will convert to hypochlorous acid and then may possible form chloromethanes. The possibility of this scenario should be discussed in the chemistry of the permanganate description in the text.

    The resulting end products from the oxidation of PCE are somewhat dependent on the pH of the aquifer at the time of the reaction. Chlorine gas can be generated only when the pH of the treatment zone drops to acidic conditions. Only when a pH of 3.5 or lower is achieved and under high redox conditions, (above Eh of approx. 1.4 volts) should any levels of chlorine rather than chloride be generated. The natural buffer capacity of the local soils should prevent chlorine gas from becoming a significant by-product during the in-site remediation.

15. The western drywells at the source area on the 100 Oser Avenue property were not discussed in the Feasibility Study other than being a general treatment location for the

soil and groundwater alternatives and being the source area. How would the presence of the drywells interfere or be beneficial to the alternatives discussed? Possible alternatives for the drywells include excavation and disposal or in-situ abandonment, as well as re-routing storm water by installing additional drywells. A brief description should be included in the text to say that the presence of the drywells will be considered in each of the alternatives, especially since they are part of the source area and are still contributing to the site's contamination.

> Drainage should be re-routed to prevent further contribution to the groundwater plume. Dry wells should not be abandoned as they may be used as part of the final remedy. Re-routing of the drainage system will be incorporated into each remedial alternative.

16. The evidence of perched water at the drywells was not discussed and how this and the presence of organics might affect the delivery of sodium permanganate to the contaminated soil around and below the drywells. Has there been any experience (i.e. case studies) with using sodium permanganate in the vadose zone to treat contamination?

> IT does not currently have any case studies for this type of application.

17. If the potassium permanganate alternative is chosen and due to similar case studies, a pilot test for the groundwater remediation may not be necessary.

> Yes, the DEC site National Heatset, also located in Suffolk County, may be applicable to the site.

18. How is the elevated concentration of manganese in groundwater going to affect the precipitation of manganese after a possible permanganate remedy? Also, will the elevated concentrations of manganese already in the groundwater affect the injection of permanganate? What is the maximum concentration of manganese that would still permit the appropriate use of permanganate as a remedial alternative?

> Dissolved Manganese will be add to the overall oxidation of consumption rate or total oxidant demand for the aquifer. We have treated an aquifer, with great success, in Texas that had manganese levels of 100 ppm and iron levels of 200 ppm. These are much greater concentrations than are anticipated at Oser Ave. It should be noted that at the end of in-site permanganate treatment, the dissolved manganese concentration will be reduced due to manganese precipitation.

19. Does the estimate for a pilot test of permanganate in soil include oxidation/reduction potential, the pH of the soil, the dissolved oxygen, or moisture content?

> These parameters will be monitored.

GENERAL COMMENTS:

20. Section 1.2.2, Last Paragraph – The paragraph mentions the lack of seasonal gauging data. Even though the additional work of groundwater gauging may not be completed in

time for the final FS, the paragraph could mention that work is currently being done to examine the potential seasonal fluctuations.

Text added as follows:

Additional work is currently being conducted to examine the potential for seasonal groundwater flucuations.

21. Section 1.2.6.2, Exposure Assessment – For the section regarding on-site and off-site workers, the second paragraph mentions that the maximum concentration is 2,900 ppm of PCE in soil. According to other text in this report and the figures, the maximum concentration of PCE is 9,400 ppm in the soil at approximately 35 feet below ground surface. Please correct the text. Also, Figure 1-4 containing the cross section of the soil work in the Phase II investigation incorrectly lists the concentration of 9,400 ppm as 9,990.

    The exposure assessment is based on the RI data. At that time the maximum soil concentration was 2,900 ppm. However, Figure 1-4 will be corrected.

22. Section 1.2.6.2, Paragraph 3 – It's not clear that both the 100 and the 110 buildings had concentrations of PCE in the indoor air that previously exceeded the NYSDOH's guidance value of 100 µg/m^3. Please adjust the text to include mention of both buildings.

    The text will be adjusted accordingly.

23. Figure 1-14 – The figure has the locations of the groundwater sample points, but the concentrations of contaminants are not included at any of the wells. Only the contour lines indicate the concentrations of the PCE plume.

    Concentrations will be added to Figure 1-4.

24. Appendix B, Cost Estimates – Table 5-2 Addendum is included twice for Groundwater Alternative 2, Pump and Treat. However, the table with two pages seems to belong to Alternative 1, No Action. Please correct the title to prevent confusion about the tables.

    The Table titles will be corrected.

25. Table 5-3 – The text indicates that the capital cost is different than the cost in the table. Please input the correct cost to the appropriate section.

    The text will be corrected.

26. Table 5-8 – This table does not have an addendum table for the PVA calculations.

    This table will be updated.

The comments above must be addressed before the Feasibility Study is approvable. A few spelling and grammatical errors were found in the text.

Oser Avenue DOH Feasibility Study Comments

SUBSTANTIVE COMMENTS

1. The document as a whole is thorough and well written. The introductory section and the associated tables and figures provide an excellent summary of the results of the remedial investigation at OU1.

   Comment noted.

2. In the final version of the FS, the parenthetic note in the second paragraph of Section 1.2.5.1 (Indoor Air) should be updated to mention that PCE was detected in the indoor Air at 110 Oser avenue at concentrations up to 3,160 ug/m^3 in May 2001. Simply acknowledging the results will be sufficient; there is no need to change the rest of the text in that section.

   Text changed to acknowledge new data.

   (Note: A sampling event on March 27, 2001 found PCE at concentrations in the 110 Oser Ave building in exceedance of NYSDOH Action levels. These results were confirmed in a subsequent sampling event (May 2001). The maximum concentration detected was 3,160 ug/m3. However, for the purposes of completing the FS, air quality is assumed to be as monitored prior to the March and May 2001 sampling events.)

3. Section 1.2.5.2 Soil Gas- The references to a NYSDOH Action Level for soil gas contamination in the first two paragraphs of this section should be omitted. The NYSDOH guidance to which this section refers applies to indoor and outdoor ambient air; it does no apply directly to soil gas. It is also not accurate to suggest that PCE is the only compound in the soil gas that represents a significant risk. Other VOCs were detected in some of the soil gas samples at concentrations that on their own would at least raise concerns about potential indoor air quality impacts; we have not focused on them because PCE was detected at much higher concentrations in all of those samples.

   Text will be changed that under DEC direction the soil gas plume was delineated based on indoor air concerns for PCE.

   Section 1.2.5.2 Paragraph 1 last sentence will now read.

   In accordance to requests from the NYSDOH and NYSDEC, soil gas analytical results were compared to the NYSDOH PCE Action Level of 1,000 ug/m3 for indoor air as a means of delineating the soil gas plume.

   Paragraph 2 second sentence will be deleted.

4. I understand that the exposure assessment discussed in Section 1.2 6 considered indoor air sampling data only thorough June 2000 and I see no benefit to modifying the exposure assessment at this time. The increased PCE concentrations in indoor air at 110 Oser Avenue (from a maximum of 900 ug/m^3 in June 200 to a maximum of 3,160 ug/m^3 in May 2001) have made it more urgent that the indoor air contamination be addressed, but the approach to addressing it will probably remain the same.

Comment noted.

5. In Section 1.2.5.4, on Page 13, the statement is made that SVOCs, metals, PCBs, and pesticides are contaminants of concern at the site. This statement should probably be modified to state that these classes of contaminants are not COCs at the site. Otherwise these compounds should be discussed further.

   Noted text has been removed.

6. One Page 16, the last compound in the bulleted list should be 1,1,1-TCA (not TCE).

   Text has been corrected.

7. Section 3.1.1.4 (Page 36) does not clearly explain that Hydrogen Release Compound (HRC) and Oxygen Release Compound (ORC) treatment are methods from enhancing bioremediation. I suggest that the section be reworked slightly to clearly distinguish between the two categories of in-situ treatment that are being considered: bioremediation (including HRC and ORC treatment) and chemical oxidation (permanganate, ozone, and peroxide, etc.).

   Text has been revised to distinguish between enhanced bioremediation and in-situ chemical oxidation.

8. I would be interested to know more about the trials of permanganate oxidation cited in Section 3.1.1.4 (Page 38). In particular, I am curious why only about 60% of chlorinated ethenes were oxidized in some cases, and what technologies would be appropriate to address residual contamination in that event. I would appreciate receiving copes of any information IT Corporation provides you on this subject.

   In several pilot tests, destruction results were less than anticipated due to higher contamination or higher oxidant than originally anticipated. This was addressed in the final design by increasing the oxidant dosage.

   In some instances, a lower oxidant dosage than what was required was used because of sensitive receptors in the area. In these instances, small doses and lower application rates were used to control exposure and migration.

   In some cases, due to geological or physical restraints, it is not possible to reach all contamination with permanganate. In these cases, permanganate may be teamed with another technology, such as SVE, or the contamination is left to naturally attenuate.

9. Section 3.1.1.4 (page 39) should explain why the subsurface environment at this site is thought to be aerobic (e.g. dissolved oxygen data, scarcity of anaerobic PCE biodegradation products).

   The following text will be added.

   The subsurface environment at Oser Ave is believed to be aerobic due to the classification of the aquifer and existing site data. The Oser Ave surficial aquifer is unconfined, and as such is in contact with the surface environment. This allows it to respond to atmospheric changes (i.e. barometric pressure) and tidal changes, thereby creating an aerobic environment. Existing site data confirms this belief, as the groundwater monitoring data generally indicates that anaerobic degradation products are not present.

10. Section 3.1.2.4 (page 44) should explain in greater detail why source excavation is infeasible at this site (e.g. proximity of buildings, depth of contamination).

    Section 3.1.2.4 now reads:

    Due to the location of the source (at depths greater than 30 ft bgs) and it's proximity to building 100's foundation and the retaining wall between building 100 and 110, the associated costs.....

11. In describing the chemical oxidation alternatives for soil and groundwater, it would be helpful to include figures that depict potential locations of injection points and monitoring points.

    A permanganate injection well location map will be included.

12. At the top of Page 56, there are two references to potassium permanganate treatment of soils. I understand that sodium permanganate ($NaMnO_4$) was evaluated for soil treatment because of its greater solubility. These references should be changed.

    Text has been corrected.

13. I understand that because of the availability of pilot test data from nearby sites, NYSDEC may not require a pilot test of potassium permanganate in groundwater at the 100 Oser Avenue site. I would appreciate the opportunity to review both the work plan and the results of the pilot test(s) that might be considered to apply to the 100 Oser Avenue site.

    IT will provide NYSDOH a copy of the work plan from National Heatset if this site is chosen as the pilot test for Oser Ave.

14. The Cost section on Page 60 is probably suppose to read, "…accurate to *–30% to +50%*."

    Text will be corrected.

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A Member of The IT Group

FEASIBILITY REPORT
OPERABLE UNIT NO. 1
100 OSER AVENUE
HAUPPAUGE, NEW YORK

IT Corporation Project 781882

October 10, 2001

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LIST OF ACRONYMS

Anorad	Anorad Corporation
ARARS	Applicable or Relevant and Appropriate Requirements
ASP	Analytical Services Protocol
AST	Aboveground Storage Tank
bgs	Below Ground Surface
Caputo	M. Caputo & Associates, Inc.
cm/day	Centimeters per Day
COCs	Constituents of Concern
Consent Order	Order on Consent
COPC	Chemicals of Potential Concern
CVOCs	Chlorinated Volatile Organic Compounds
1,1-DCE	1,1-Dichloroethene
1,2-DCE	Total 1,2-Dichloroethene
DNAPL	Dense Non-Aqueous Phase Liquid
DUSR	Data Usability Summary Report
EA	Exposure Assessment
EDR	Environmental Data Resources
EDV	Environmental Data Validation, Inc.
EPA	Environmental Protection Agency
ERAGs	Ecological Risk Assessment Guidance
FPM	Fanning, Phillips, and Molnar
FS	Feasibility Study
FWIA	Fish and Wildlife Impact Assessment
GRA	General Response Action
HVAC	Heating, Ventilation, and Air Conditioning
IDW	Investigation Derived Waste
IP	Interface Probe
IRIS	Integrated Risk Information System
IRM	Interim Remedial Measure
IT Corporation	IT Corporation, Inc.
$\mu g/L$	Micrograms per Liter
$\mu g/m^3$	Micrograms per Cubic Meter
m/s	Meters per Second
m^2/s	Square Meters per Second
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MIBK	Methyl Isobutyl Ketone
MSL	Mean Sea Level
NCP	National Contingency Plan
NDW	North Dry Well
NSD	North Storm Drain
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbon

PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PGC	Portable Gas Chromatograph
PID	Photoionization Detector
PQL	Practical Quantitation Limit
PRP	Potentially Responsible Party
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RA	Risk Assessment
RAGs	Risk Assessment Guidance
RAOs	Remedial Action Objectives
RBC	Risk Based Concentrations
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RSCOs	Recommended Soil Cleanup Objectives
Sands	Sands Textile Corporation
SCDHS	Suffolk County Department of Health Services
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
SVE	Soil Vapor Extraction
SVOCs	Semivolatile Organic Compounds
TAGM	Technical and Administrative Guidance Memorandum
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leachate Procedure
TF	Toxicity Factors
TOC	Total Organic Compounds
1,1,1-TCA	1,1,1-Trichloroethene
USDOT	United States Department of Transportation
UST	Underground Storage Tank
Vanderbilt	Vanderbilt Associates
VOCs	Volatile Organic Compounds
WMH	Western Manhole (Overflow Dry Well)
WSD	Western Storm Drain (Catch Basin Dry Well)

1.0 INTRODUCTION

This Feasibility Study (FS) has been prepared by IT Corporation, Inc. (IT) on behalf of the New York State Department of Environmental Conservation (NYSDEC) for the 100 Oser Avenue, Hauppauge, New York State Superfund Site.

The submittal of this Feasibility Study represents the completion of activities set forth in the Remedial Investigation Feasibility Study (RI/FS) Work Plan for the 100 Oser Ave dated August 5, 1999 (IT Corporation, 1999). The conclusions and recommendations presented within this FS are based on the characterization of the site as presented in the Oser Avenue Remedial Investigation (RI) Report dated October 5, 2000 (IT Corporation, 2000), and the Draft Phase II Remedial Investigation Report (IT Corporation) dated January 17, 2001.

1.1 Purpose and Organization of Report

On September 25, 1998, the NYSDEC issued Consent Order D1-0023-98-09 for the implementation of an investigatory and remedial program for the 100 Oser Avenue, Hauppauge, New York property. This FS has been prepared pursuant to this Order.

The purpose of this FS is to develop and evaluate alternatives for appropriate remedial response actions that may be needed to prevent or mitigate the effects of volatile organic contamination at the 100 Oser Avenue Site and surrounding sites (90 Oser Avenue and 110 Oser Avenue). This FS is divided into the following Sections:

Section 1 presents a general summary of the remedial investigation and exposure assessment. This section includes information describing the study area, its history (including previous investigations), the nature and extent of contamination, exposure assessment, and the interim remedial measures taken at the site.

Section 2 presents a summary of the applicable or relevant and appropriate requirements (ARARs) and remedial action objects (RAOs), and presents the general response actions (GRAs) for the 100 Oser Avenue Site.

Section 3 presents an identification and screening of technologies. It proceeds to identify technologies and process options for each GRA.

Section 4 presents the development of alternatives to meet the remedial action objectives for the Site. Narratives discussing the elements of each alternative and the remedial action objectives that they address are presented as well.

Section 5 presents a detailed analysis of the alternatives developed in **Section 4**. A detailed analysis of each retained alternative in accordance with the National Contingency Plan (NCP) is presented.

Section 6 presents the summary of the detailed analysis discussed in **Section 5**.

1.2 Background Summary

1.2.1 Site Description

The Oser Avenue Site (Operable Unit 1) is situated in the Heartland Industrial Park located in the Town of Hauppauge, Suffolk County, New York at an approximate surface elevation of 120 feet above sea level. A Site Location Map is included as **Figure 1-1**. The Site consists of the industrial properties located at 90, 100, and 110 Oser Avenue. The properties located at 100 and 110 Oser Avenue are currently occupied by Anorad Corporation. The property located at 90 Oser Avenue is currently occupied by Tiffen Manufacturing, Inc. A Site Map illustrating these propertied is included as **Figure 1-2**.

The 100 Oser Avenue property was the original property under investigation pursuant to the Order of Consent. The 2.5 acre property is developed with a one-floor masonry building, roughly 24,000 square feet in area, located at the southern end of the property along Oser Avenue. The ground surface changes approximately five feet, sloping from west to east. Approximately 0.6 acres at the north end is wooded and undeveloped, with the majority of the remaining acreage covered by asphalt or the masonry building. A grassy area covers the southern end and accounts for less than ten percent of the surface area. To the north, the property is bounded by residential property along Holiday Park Drive. The 90 and 110 Oser Avenue properties each have one-floor masonry buildings. The surface characteristics of each of these properties are similar to those of 100 Oser Avenue.

All utilities are brought to the properties through underground connections. Active sanitary dry wells are located throughout the Site properties. Two dry wells located on the western side of the 100 Oser Avenue property have been identified as the source of the contamination encountered at the Site. One of these dry wells receives water from the surface through a flush mounted grate. This dry well has previously been referred to in historical reports as the catch basin dry well. A secondary overflow dry well, located adjacent to the catch basin dry well, receives overflow water from the catch basin dry well through an underground 6-inch diameter polyvinyl chloride (PVC) pipe. This dry well has previously been referred to as the overflow dry well. Another catch basin is located approximately 50 feet south of the catch basin dry well which drains directly to the catch basin dry well. This dry well system receives all surface drainage from the western side of the 100 Oser Avenue building. Two half-inch diameter copper pipes are present leading into the catch basin dry well. Historical reports prepared by Fanning, Philips, and Molnar (FPM) indicate that these pipes previously served as a boiler outfall for the previous tenant (Sands Textile Corporation).

Two aboveground storage tanks (ASTs) used for tetrachloroethylene (PCE), of unknown capacity, were historically located on-site at the northwest corner of the 100 Oser Avenue building. These ASTs were removed prior to the initiation of the RI at the 100 Oser Avenue property.

An RI was performed at the Site during 1999 and 2000 and is summarized in the Remedial Investigation Report, dated October 5, 2000, and the Draft Phase II Remedial Investigation Report, dated January 17, 2001. Prior to the submittal of the Phase II RI Report, the NYSDEC determined that future investigative and remedial efforts would be simplified if the contaminated area was divided into two operable units (OU). OU1 encompasses the 90, 100, and 110 Oser Avenue properties, while OU2 is comprised of the remainder of the contaminated area. This FS is aimed to determine the preferred remedial alternatives for the OU1 properties.

1.2.2 Site History

This section describes details of previous investigations, as well as historical usage and ownership. The following was taken from an historical Work Plan prepared by FPM (January 1998).

Aerial photographs show that the property was undeveloped and wooded in 1968. The next available photographs indicate that by 1976 the Site was developed to include the present building. The building was first owned by Vanderbilt Associates (Vanderbilt), who leased the building to Sands Textile Corporation (Sands) during the 1980s. Sands was reportedly a textile manufacturer utilizing PCE to dry clean finished products. Vanderbilt sold the property in September 1985. At some point after this, Anwar Chitayat began operations at the Site and became the new owner of the property. Mr. Chitayat is the current owner of the property and majority interest owner of Anorad Corporation (Anorad), a Rockwell Automation business, which presently conducts manufacturing of precision positioning equipment at the Site. The FPM January 1998 report states that Anorad has never utilized PCE at the 100 Oser Avenue Site. Several investigations conducted at the subject property and neighboring properties during the late 1980s and early 1990s have found that PCE is the major contaminant at 100 Oser Avenue. The source of the contamination is alleged to be related to discharges of PCE and other solvents to former interior floor and sink drains connected to the on-site septic system, and discharges along the western side of the building in the area of sumps and drain pools during use of the facility by Sands.

Several other manufacturing facilities located to the south of the property (regionally upgradient) have been listed as Class 2 sites on the State's Registry of Inactive Hazardous Waste Disposal Sites and are either being investigated or remediated. Chemicals of interest at these upgradient sites also include Volatile Organic Compounds (VOCs), chlorinated VOCs (CVOCs) and metals. Following is a chronological summary of the investigations conducted at the Site.

Phase I Investigation of potential Sources of Contamination, FPM, July 1990

This report was prepared for Anorad and presents the chain of ownership of the property and the results of shallow soil sampling conducted on the west side of the property. The report also presents the results of groundwater samples collected from four monitoring wells installed along the western side of the property in the area of the sumps and ASTs. Results from upgradient monitoring wells are also presented demonstrating that contamination is coming to the Site from upgradient sources, as well as specific on-site discharges of CVOCs.

Follow-Up Soil Investigation, FPM, November 1990

This report documents the results of a soil gas survey and soil sampling conducted as follow-up to the previous work. Samples were collected from shallow and deep borings, indicating high levels of impacts of VOCs in shallow soils on the west side and northwest corner of the building associated with the sumps and ASTs. Shallow soils in the eastern portion of the Site were not impacted. Deep soil samples were impacted to a much lesser degree, indicating that soil impacts at this depth are associated by contact with the contaminated water table. The deep soil borings were converted to soil vapor extraction wells in anticipation of remediation at the Site. The report recommended an engineering study to determine the applicability of soil vapor extraction technology at the Site, and to pursue other potentially responsible parties for investigation and remediation activities.

Investigation of Potentially Responsible Parties, FPM, January 1992

This investigation was conducted for Anorad to identify potentially responsible parties within the vicinity of the Site. Pall RAI, Inc., United Guardian, inc., Color Pak, Time Electronics, Computer Circuits Corporation, EMR Circuits and Standard Microsystems Corporation were investigated since they were located in an apparent upgradient direction from the 100 Oser Avenue Site. Pall RAI, Inc was identified as the most probable source of contaminated groundwater at the Site. The report recommended additional groundwater sampling at the Site to clarify the contribution of contaminants from upgradient sources.

In-situ Vapor Extraction, FPM, 1992

This report evaluated remediation options for the Site, recommending soil extraction, natural soil venting and capping as remedial options.

Remedial Investigation Report, FPM, October 1992

This report was prepared at the request of Anorad to determine if contamination on-site was caused by on-site or upgradient sources. The work included the installation of five borings in a straight line trending northwest to southeast across the middle of the property behind the building. Groundwater was sampled from three discrete zones in the borings (zero to five, 25 to 30, and 45 to 50 feet below the water table), finding total VOCs ranging from 13 to 51 milligrams per liter (mg/L). The greatest single analyte detected was PCE at concentrations ranging from 12 to 44 mg/L. The report concluded that upgradient sources comprise a portion of the on-site plume, and that the contamination is limited to the upper 100 feet of the aquifer.

Remedial Investigation Report, IT Corporation, October 2000

This report was prepared at the request of the NYSDEC to determine the nature and extent of the contamination previously observed at the 100 Oser Avenue property and to assess any current and potential health risks posed to residents and workers in the area. The primary contaminant found on the Site was PCE. PCE was found at concentrations exceeding various regulatory standards and/or guidelines in soil, groundwater, soil gas, and indoor air. PCE concentrations in soil, in excess of NYSDEC soil standards, were isolated to the area immediately surrounding the overflow and catch basin dry wells located on the west side of the 100 Oser Avenue building. These dry wells were identified as the only known source of contamination on the property. Impacts to groundwater were found to encompass a majority of the 90, 100, and 110 Oser Avenue properties. The highest concentrations of PCE in groundwater were found in the vicinity of the aforementioned dry wells. Impacts to soil gas were found in excess of the NYSDOH guidance value of 100 micrograms per cubic meter ($\mu g/m^3$) across the Site. Concentrations of PCE were found above the NYSDOH guidance value in ambient air within the 100 and 110 Oser Avenue buildings prompting the NYSDOH to recommend adjustments to the heating, ventilation, and air conditioning units within these buildings. The RI Report recommended the installation of a soil vapor extraction system as an interim remedial measure at 100 Oser Avenue building for the source area. Additional investigation of soil, groundwater, and soil gas was recommended at the Site in order to delineate the extent of contamination up- and down-gradient of the 100 Oser Avenue property.

Phase II Remedial Investigation Report, IT Corporation, April 2001

This report was prepared at the request of the NYSDEC to present findings of the additional investigative work performed subsequent to the submittal of the RI Report. Prior to the submission of this report to the NYSDEC, the 90, 100, and 110 Oser Avenue properties were defined as OU 1, and the remaining impacted areas were defined as OU 2. Subsequent soil sampling in the vicinity of the overflow and catch basin dry wells confirmed them as a primary source area. Concentrations of PCE in soil were found up to 9,400 milligrams per kilograms (mg/kg). Additional monitoring wells were installed on the northeast corner of 90 Oser Avenue, the northwest corner and southern side of 110 Oser Avenue, and two on the Pall RAI properties located south of the OU1 Site. The wells installed on the Pall RAI properties (225 Marcus Boulevard and 95 Oser Avenue) and the southern side of the 110 Oser Avenue property were intended to provide data on the hydrogeologic flow regime as well as the contribution from upgradient sources. The wells confirmed a predominantly northeast trending groundwater flow direction. The presence or absence of a groundwater flow divide or reversal was not confirmed due to the lack of seasonal gauging data. Additional work is currently being conducted to examine the potential for seasonal groundwater fluctuations. Concentrations of PCE in groundwater exceeding NYSDEC standards were found in each of these three monitoring wells. The groundwater sample collected from the monitoring well located on the northwest corner of the 110 Oser Avenue property did not contain concentrations of VOCs above the laboratory reporting limits. Additional indoor air and soil gas sampling was also conducted. The limits of the 1,000 $\mu g/m^3$ soil gas plume was not completely defined. However, it was concluded that the data was sufficient for the characterization of the OU1 Site. Additional indoor air sampling was conducted within the 90, 95, 100, and 110 Oser Avenue buildings. Indoor air samples collected from within the 90, 95, and 100 Oser Avenue buildings did not contain concentrations of PCE above the NYSDOH guidance value of 100 $\mu g/m^3$. Indoor air samples collected from within the 110 Oser Avenue building continued to contain concentrations of PCE in excess of the NYSDOH guidance value. Additional engineering controls were recommended to Anorad by the NYSDEC to control these detected concentrations.

1.2.3 Geologic and Hydrogeologic Characteristics

1.2.3.1 Regional Geology

The regional geology is composed of approximately 1,000 to 1,500 feet of unconsolidated sediment (D. Cadwell, "Surficial Geologic Map of New York, Lower Hudson Sheet", 1989). The most recent deposit is from the Wisconsin Continental Glacier in the Pleistocene Era. This deposit is known as the Ronkonkoma Terminal Moraine and is composed of sand, gravel, and boulders with occasional silt and clay lenses. The thickness of the glacial deposit varies across the island. Below the Upper Pleistocene Glacial Deposit is an Upper Cretaceous coastal deposit of gray and white, fine to medium silty sand and gravel with lenses of coarse sand and clay known as the Magothy Formation. Below the Magothy Formation are the Raritan Clay Member and the Lloyd Sand Member, respectively, with increasing depth. Below the unconsolidated sediment is an erosional bedrock surface.

1.2.3.2 Site Geology

The RI investigation conducted at 100 Oser Avenue encountered sediments ranging in depth from surface to approximately 242 feet below ground surface (bgs). Approximately the top one foot of sediments was fill material consisting of non-native sand, gravel, brick fragments, and miscellaneous debris. Pleistocene Glacial Deposits were present beneath the fill material to depths of approximately 200 feet bgs. These deposits consisted primarily of poorly sorted sand and gravel. Localized lenses of fine sand, silt, and/or clay were also encountered at several locations throughout the site. A layer of clay was found between the glacial deposits and the Magothy formation. The extent of this layer has not been adequately defined. Six soil samples were collected from the Pleistocene Glacial deposits for analysis for total organic carbon (TOC), pH, and grain size distribution. Values for pH ranged from 7 to 7.3. TOC ranged from below the laboratory reporting limit to 4 percent. Grain size distribution results showed the vast majority of each sample to consist of sand grains greater than 0.4 millimeters (mm) (62.78% to 78.34%). Laboratory analytical results are summarized in **Table 1-1**. The deepest boring advanced at the site extended approximately 55 feet into the Magothy Formation (ITHP-3). The sediments encountered within the Magothy Formation consisted primarily of silty sands with isolated lenses of clay and organic material. Site wide cross sections are included on **Figure 1-3**. A detailed cross section at the source area is included on **Figure 1-4**.

1.2.3.3 Surface Water

The town of Smithtown, New York operates a groundwater recharge basin east of the 90 Oser Avenue property. The recharge basin accepts surface and roof water drainage from various properties throughout the Heartland Industrial Park. The Central Islip 7.5 minute United States Geological Survey topographic map indicates the presence of a surface water feature located approximately 2,600 feet northeast of the 100 Oser Avenue property. A wetland area associated with New Mill Pond is located approximately 4,000 feet northeast of OU1. No surface water features are present within the confines of the Oser Avenue OU1 Site.

1.2.4 Hydrogeology

1.2.4.1 Regional Hydrogeology

There are two primary aquifers in the region. One is the Upper Pleistocene and the other is the deeper Magothy Aquifer. The Upper Pleistocene formation is a glacial deposit consisting of sand, gravel, and boulders, while the Magothy Formation is a coastal deposit consisting primarily of a silty sand. Farther northeast, the Smithtown Clay creates a permeability barrier between the Upper Glacial Aquifer and the Magothy. A clay layer was encountered in several of the deep borings at the site occurring between the Magothy and the Pleistocene deposits. This clay layer may represent the outer fringe of the Smithtown Clay.

The Ronkonkoma terminal moraine creates the groundwater divide on Long Island. The groundwater divide traverses east to west across the north central part of the island.

1.2.4.2 Site Hydrogeology

The following hydrogeologic data have been collected to date:

- Four gauging events (dates) have been performed to ascertain the direction and gradient of groundwater flow; and
- Slug tests were performed on monitoring wells ITMW-1S, ITMW-3S, and ITMW-3D in order to calculate the hydraulic conductivity of the Pleistocene glacial deposits.

The following subsections present and discuss the data obtained as listed above:

Shallow Groundwater (Water Table Conditions)

Water level data for the monitoring wells installed with screens intersecting or close to the water table were collected on January 31, 2000; March 13, 2000; November 1, 2000; and February 27, 2001. The results are summarized in **Table 1-2**. Water table elevation maps were created from data obtained during each of these gauging events and are included as **Figures 1-5** through **1-8**. An occasional mounding of the water table has been historically observed in the vicinity of the dry wells on the west side of the 100 Oser Avenue building. Data collected during the March 13, 2000 gauging event indicated that the mounding could have created a small-scale reversal of the direction of groundwater flow. This potential reversal has not been observed since then, however, significant fluctuations of the flow pattern in the vicinity of the 100 Oser Avenue building have been observed. A regular gauging and sampling routine is being developed to verify the potential presence of seasonal fluctuations. A majority of the Site and the Site vicinity is paved and therefore restricts uniform recharge of storm water to the subsurface. Recharge at and in the vicinity of the Site is predominantly accomplished through water infiltrating through dry wells and/or septic leach fields. Several dry wells and a leach field are present on the western and southern sides of the Site. These features are likely causing the fluctuation of the water table observed at the Site. Based upon research into the regional groundwater flow regime, as well as observations of changes in water table elevations from the southern to the northern portions of the Site, it is apparent that the predominant groundwater flow direction across the Site is to the northeast.

The hydraulic gradients of the water table were calculated for the gauging events conducted on January 31, 2000, March 13, 2000, November 1, 2000, and February 27, 2001. The following equation was used for the calculation:

$$I = \frac{H_1 - H_2}{D}$$

Where:

H_1 = the water elevation at point H_1 (upgradient
H_2 = the water elevation at point H_2 (downgradient)
D = the distance between points H_1 and H_2
I = the hydraulic gradient

The calculated gradients range from 0.13 percent to 0.093 percent with an average value of 0.1 percent.

Deep Groundwater

Water level data from monitoring wells installed with screens at depths significantly deeper than the water table was collected on January 31, 2000, March 13, 2000, November 1, 2000, and February 27, 2001. The results are summarized in **Table 1-2**. The data from the March 13, 2000 gauging event was used to create the potentiometric map included as **Figure 1-9**. Screened depths range from approximately 158 to 231 feet bgs. The deep monitoring wells, which are installed at greater depths, are screened within the Magothy formation while those at shallower depths are within the Pleistocene glacial deposits. The potentiometric map created with the March 13, 2000 gauging date is not intended to illustrate isolated flow regimes within specific depths of these units. It is intended to illustrate the general flow regime at depths significantly below the water table. The data illustrates a predominant groundwater flow direction to the northeast. The hydraulic gradient of the deep well potentiometric surface on March 13, 2000 was calculated using the same equation as the shallow wells. A gradient of 0.13 percent was calculated using data from monitoring wells ITMW-4D and ITMW-9D.

Vertical Flow

Four clusters of deep and shallow monitoring wells are present at the Site. The water level data for each of these clusters was evaluated in order to ascertain the vertical flow regime at the Site. Three of the four clusters consistently indicated a downward flow while one consistently indicated an upward flow. Most of the data, however, is not valid for a determination of vertical flow. In order to accurately determine vertical flow conditions in an unconfined aquifer, monitoring wells must be installed in close vicinity and at different depths. Furthermore, these monitoring wells must be installed with identical screen lengths within homogenous materials (similar lithology). The deep monitoring well from the cluster which exhibited and apparent upward flow (monitoring wells ITMW-1S and ITMW-1D) was installed in a portion of the aquifer which had thin clay lenses. These lenses likely created localized areas within the aquifer which are under increased hydrostatic pressure. This could indicate that upward flow is occurring in isolated portions of the aquifer but would not influence the predominant flow direction. Two other clusters (monitoring wells ITMW-3S and ITMW-3D, and ITMW-9S and ITMW-9D) had screens of different lengths (20 feet in the shallow monitoring wells versus 10 feet in the deep monitoring wells). These two clusters indicated a downward flow. The fact that the screens were of different lengths technically invalidates the data, but it still indicates downward flow. Monitoring wells ITMW-5S and ITMW-5D were both installed with identical screen lengths which are located in homogenous material. Data from the four gauging events conducted at the site indicated a downward flow direction in this cluster. This data further suggests that the Site is located in a hydrogeologic recharge area.

Hydraulic Conductivities and Flow Velocity

Hydraulic conductivity was evaluated at the site by performing a series of slug tests in several monitoring wells. Comparison of the data to published data, as well as through consultation with the Suffolk County Department of Health Services, indicated that the conductivity values obtained for the site were significantly lower than what is expected in similar formations. Therefore, an average conductivity value for Suffolk County, as directed by the Suffolk County Department of Health Services, of 250 feet per day will be used for subsequent discussions and calculations. A discussion of the slug tests and subsequent analysis are included in the RI Report.

Horizontal groundwater velocity was calculated using the following parameters: hydraulic conductivity of 250 feet per day, an assumed porosity of 0.25, and a uniform constant aquifer with a continuous formation thickness of 130 feet from ITMW-3S to ITMW-7S. Groundwater gauging data collected on February 27, 2001 at ITMW-3S (H_1) and ITMW-7S (H_2) were used to determine the head at each location. Using the following equation:

$$q^1 = \frac{K(h_1^2 - h_2^2)}{2L}$$

Where

h_1 is the head at the origin
h_2 is the head at L
K is the hydraulic conductivity
L is the distance from the origin at the point where h_2 is measured
q^1 is the flow per unit width

Using the above parameters, a q^1 of 42.46 square feet per day was calculated. Then letting h_1 represent the thickness of the aquifer, V was calculated using the following formula:

$$V = \frac{q^1}{n_{eff} h_1}$$

Where

V is the horizontal groundwater velocity
n_{eff} is the effective porosity

Using the above parameters, a horizontal velocity of 1.09 feet per day was calculated.

1.2.5 Nature and Extent of Contamination

This section is organized by environmental media and summarizes the extensive information presented in the RI and the Phase II RI. Media discussed in this section include indoor (ambient) air, soil gas, soil, and groundwater.

1.2.5.1 Indoor Air

Indoor air quality was investigated inside the 110, 100, and 90 Oser Avenue buildings located on the OU1 Site, as well as within the 95 Oser Avenue building and several residential properties located within the OU2 Site. The OU2 indoor air results are being included in this discussion for reference purposes only as the nature of these results are inextricably linked to the OU1 site. The results of several sampling events in all the buildings were compared to NYSDOH Guidelines of 100 $\mu g/m^3$ as a Guideline Value and 1,000 $\mu g/m^3$ as an Action Level.

The initial indoor air sampling event was conducted concurrently by IT Corporation and the Suffolk County Department of Health Services. Samples were analyzed for VOCs. Several samples contained concentrations of PCE, methanol, and methyl isobutyl ketone at levels exceeding the NYSDOH Guideline Value. Subsequent samples collected within the remaining buildings were analyzed for PCE only due the results of the subsurface investigation. All samples collected and analyzed for PCE only on the OU1 and OU2 sites were below the 1,000 $\mu g/m^3$ Action Level. [Note: A sampling event on March 27, 2001 found PCE at concentrations in the 110 Oser Avenue building in exceedance of NYSDOH Action Levels. These results were confirmed in a subsequent sampling event (May 2001). The maximum concentration detected was 3,160 $\mu g/m^3$. However, for the purposes of completing the FS, air quality is assumed to be as monitored prior to the March and May 2001 sampling events.] Several indoor air samples within the 100 and 110 Oser Avenue buildings were above the 100 $\mu g/m^3$ Guideline Value. Per the NYSDOH recommendations, modifications to the heating, ventilation, and air conditioning (HVAC) system within the 100 Oser Avenue building reduced the concentrations of PCE to below the NYSDOH Guideline Value, as determined during subsequent monitoring events. Similar modifications were made to the HVAC system within the 110 Oser Avenue site building. Indoor air samples collected subsequent to the modifications indicated that the concentrations remained above the NYSDOH Guideline Value for PCE.

Indoor air is considered an impacted media to be addressed by the FS. The indoor air found within the properties located on the OU2 site will not be specifically addressed in this FS. However, the recommendations for treating the soil and soil gas may indirectly affect the quality of the indoor air found within these properties. Indoor air analytical results are summarized in **Tables 1-3** and **1-4**. Sampling locations are illustrated on **Figure 1-10**.

1.2.5.2 Soil Gas

Soil gas was investigated within the boundaries of the OU1 site as well as at several locations at the OU2 site. The OU2 soil gas results are being included in this discussion for reference purposes only as the nature of these results are inextricably linked to the OU1 site. In accordance to requests from the NYSDOH and NYSDEC, soil gas analytical results were compared to the NYSDOH PCE Action Level of 1,000 $\mu g/m^3$ for indoor air as a means of delineating the soil gas plume.

Soil gas samples were analyzed for VOCs. PCE concentrations ranged from below the laboratory detection limit in two of the samples collected within the residential area north of OU1 to 150,000,000 $\mu g/m^3$ in a sample collected from beneath the 100 Oser Avenue building.

The NYSDOH requested to the NYSDEC that IT Corporation attempt to define the extent of soil gas impacts where PCE concentrations exceeded 1,000 $\mu g/m^3$. The investigation found that the soil gas beneath a majority of the OU1 site is impacted at concentrations in excess of 1,000 $\mu g/m^3$. The extent of the area exhibiting soil gas concentrations in excess of 1,000 $\mu g/m^3$ was not adequately defined to the south and west, extending to the OU2 site.

Soil gas is considered an impacted media to be addressed by the FS. The soil gas found within the properties located on the OU2 site will not be specifically addressed in this FS. However, the recommendations for treating the soil and soil gas may indirectly affect the quality of the soil gas found within these properties. Soil gas analytical results are summarized in **Table 1-5**. The soil gas sample analytical results are illustrated on **Figure 1-11**.

1.2.5.3 Soil

Soil samples were collected from several borings throughout the OU1 site. Sampling depths ranged from 4 to 242 feet bgs. Soil sample analytical results were compared to the Recommended Soil Cleanup Objectives (RSCO) found in TAGM 4046. SVOCs, inorganic compounds, and PCBs were either not detected at or above the respective laboratory reporting limit or were detected below the RSCO. Adsorbed-phase compounds in these categories are not considered potential constituents of concern at the site. 1,1,1-trichloroethane (1,1,1-TCA), methylene chloride, toluene, ethylbenzene, and xylenes were detected in select soil samples at concentrations significantly lower than their respective soil standards. Trichloroethene (TCE) was detected above the RSCO in one HydroPunch soil sample at less than ten feet below grade, but was qualified by the laboratory as an estimated concentration. PCE was the only other VOC detected at the site, and was detected at concentrations significantly higher than the TAGM 4046 RSCO of 1.4 mg/kg. Therefore, PCE is the only adsorbed-phase constituent which is a concern at the subject property. The soil samples exhibiting PCE concentrations above the RSCO were found only in soils on the west side of the property.

Soil is considered an impacted media to be addressed by the FS. **Tables 1-6, 1-7,** and **1-8** summarize the VOC soil sample analytical results. Soil sample analytical results from the source area soil borings are illustrated on **Figure 1-4**. Remaining boring locations are illustrated on **Figure 1-2**.

1.2.5.4 Groundwater

Groundwater samples were collected from several borings throughout the OU1 site. Sampling methods included depth-discrete HydroPunch samples and standard monitoring well sampling methods. Analytical results from the HydroPunch groundwater samples exhibited strong correlation to the samples collected from the monitoring wells. Groundwater sample analytical results were compared to the NYSDEC TOGS Water Quality Standards. Groundwater samples were analyzed for VOCs, semi-volatile organic compounds (SVOCs), Metals, PCBs, and Pesticides. VOCs detected at concentrations exceeding water quality standards included PCE, TCE, DCE, toluene, 1,1,1-trichloroethane, 1,1-dichloroethene (1,1-DCE), acetone, methylene chloride, chloroform, and 1,1,2-trichloro-1,2,2-trifluoroethane. Chloroform and acetone are common laboratory artifacts. Chloroform is likely originated in the decontamination fluids (commonly found in drinking water). PCE was found to be the primary constituent found at the site. Concentrations ranged from below the laboratory detection limit to 100,000 μg/L. TCE and DCE are breakdown products from PCE. Concentrations of these chlorinated ethenes are found throughout the OU1 site to depths up to 222 feet bgs. A majority of the contaminant load is isolated to the upper 20 feet of the aquifer. A majority of the remaining compounds are found at deeper depths and appear to be migrating to the site from off-site sources. Sources for these compounds have not been identified on the OU1 site.
Groundwater is considered an impacted media to be addressed by the FS. **Tables 1-9** and **1-10** summarize the VOC groundwater sample analytical results. **Figures 1-12, 1-13,** and **1-14** illustrate the dissolved PCE concentrations found in shallow groundwater in February and November 2000 and February 2001. **Figure 1-15** illustrates the dissolved PCE concentrations found in deep groundwater in February 2000.

1.2.6 Exposure Assessment

The qualitative exposure assessment (EA) was used to determine the current and potential future exposure pathways associated with baseline (that is, current or unremediated) site conditions. The EA identified chemicals of potential concern (COPCs) and complete exposure pathways (mechanisms by which receptors may come into contact with site-related contaminants). The risk to receptors via complete pathways were then assessed based on comparison to risk-based screening levels in the context of current and reasonably foreseeable site exposures. The role of completed, ongoing and proposed remedial activities at the site in mitigating exposures was addressed where appropriate. The EA used data from the RI prepared by IT Corporation, dated October 5, 2000.

The human health exposure assessment process was derived from the guidance set forth in the United States Environmental Protection Agency's Risk Assessment Guidance for Superfund (RAGS; 1989, 1991). The ecological evaluation was based on Step IIA (Pathway Analysis) of the Contaminant-Specific Assessment detailed in NYSDEC's Fish and Wildlife Impact Assessment for Hazardous Waste Sites (1994), with additional input from EPA's Ecological Risk Assessment Guidance for Superfund (ERAGS; 1999).

1.2.6.1 Chemicals of Potential Concern (COPCs)

To select COPCs, the analytical results for air, soil, soil gas, and groundwater were compared to risk-based screening levels to determine whether levels measured are likely to present unacceptable exposures. The screening levels used are the risk-based concentrations (RBCs) developed by USEPA Region III (USEPA, 2000b) and the NYSDOH guideline for PCE (1999c). The RBCs are calculated using the Standard RAGS formulas for established exposure scenarios (residential and industrial). They do not necessarily characterize actual exposure in any site-specific situation. However, they do represent measures of safe concentrations using a series of conservative assumptions. Therefore, chemicals with concentrations below screening levels can generally be omitted as COPCs.

The RBCs are based on toxicity factors (TFs) developed by USEPA. The TFs are carcinogenic potency factors (for cancer-causing endpoints) and reference doses for safe exposure based on noncarcinogenic toxicity. The RBCs therefore incorporate the available information on the toxicity of the associated constituents. Additional toxic effect-specific information can be found in EPA's Integrated Risk Information System (IRIS) database (USEPA, 2000a).

AIR

The USEPA has calculated an RBC for PCE in air of 3.1 $\mu g/m^3$. This is a risk assessment screening value that corresponds to an excess lifetime cancer risk of one in one million, or 10^{-6}. This value is similar to the concentrations of PCE typically found in indoor air. The RBC is lower than the NYSDOH guideline value of 100 $\mu g/m^3$. The NYSDOH's October 1997

Tetrachloroethene Ambient Air Criteria Document, which provides the basis for the 100 μg/m^3 guideline, discusses this discrepancy as follows:

"The purpose of the (NYSDOH criteria) document is to provide qualitative and quantitative criteria for use in risk assessments to evaluate the health risks of exposure to tetrachloroethene in ambient air. Using the recommended unit risk estimate derived from animal studies, the lifetime excess cancer risk at the criterion for non-carcinogenic effects (0.1 mg/m^3 [100 μg/m^3]) is about one in ten thousand. In general, there is consensus among the scientific and regulatory community about what actions may or may not be needed depending on the level of estimated lifetime excess cancer risk. An increased lifetime cancer risk of one in one million or less is generally not considered a significant public health concern. Increased lifetime cancer risks greater than one in ten thousand usually trigger actions to lower exposure. Other considerations in evaluating risks include, but are not limited to, the conservativeness of the assumptions used to estimate risk, the scientific strength of the epidemiological and toxicological databases, and the potential for chronic or lifetime exposure. Based on these factors, the 1991 DOH recommendation that the average ambient air level for tetrachloroethene in a residential community should not exceed 0.1 mg/m^3 is believed to be protective of public health".

Table 1-3 presents the initial indoor air samples collected in September 1999 by IT Corporation and the SCDHS. The following constituents were consistently above RBCs:

- Methylene chloride
- 1,2,4-Trimethylbenzene
- MIBK
- PCE
- Toluene

The ambient air results measured by the NYSDOH confirm the presence of PCE above the USEPA RBC in various locations on-site, as well as at three residences on Holiday Park Drive. The detection limit for the NYSDOH analyses is reported as 5 μg/m^3, whereas the RBC for PCE is 3.1 μg/m^3. The database cannot therefore confirm that PCE is not present at concentrations between the RBC and the 5 μg/m^3 detection limit in areas where no detections were reported. None of the off-site ambient air results are over the NYSDOH PCE guideline of 100 μg/m^3. The detected concentrations did not differ significantly from values that are typically detected in indoor air samples.

SOIL

Tables 1-11 and **1-12** present the soil analytical results from the soil boring and HydroPunch investigations, respectively. The industrial soil RBC is listed for comparison. The only location with an exceedance of an RBC was ITSB-05, on the western side of the building, in which all samples had PCE over the RBC. None of the HydroPunch samples contained any soil constituents (including PCE) above the RBCs.

GROUNDWATER

A summary of groundwater data (from the HydroPunch, monitoring well and public water supply samples) appears in **Table 1-13**. The screening levels used are the New York State Maximum Contaminant Limits (MCLs), the actual drinking water Standards for protection of human health. These differ only slightly from the groundwater Standards, which are also primarily risk-based. The following constituents were detected above MCLs in on-site groundwater:

- 1,1-Dichloroethene
- 1,2- Dichloroethene
- PCE
- Trichloroethylene
- 1,1,1-TCA

Semivolatile organic compound (SVOC) detections in the monitoring wells were limited to traces of 4-methylphenol (MW-01D) and several polynuclear aromatic hydrocarbons (PAHs; MW-9). The PAHs are likely due to soil particles (turbidity) in the well. On this basis, no SVOCs warrant inclusion as COPCs.

Inorganic analytes in monitoring wells above groundwater Standards were primarily limited to the common earth elements iron and manganese, with isolated exceedances for antimony (below reporting limit), arsenic, chromium and sodium. Given that the samples were not collected using low-flow techniques, it is likely that much of the inorganic presence observed is related to well turbidity. No pattern emerges with respect to depth, gradient or co-occurrence. Overall, inorganic contamination of groundwater associated with the site is not apparent, and therefore inorganics will not be included as COPCs.

In summary, the COPCs at the site are VOCs, primarily PCE and its chlorinated degradation products. **Table 1-14** summarizes the COPCs and relevant media.

1.2.6.2 Exposure Assessment

The potential contact media at the site are ambient air, soil and downgradient groundwater. The two groups of receptors at risk of exposure are on-site facility/construction workers and residents downgradient of the site who use the groundwater as a water supply.

On-Site and Off-Site Workers

On-site workers and off-site workers (at adjacent facilities or involved in utility and construction activities) may be exposed to COPCs in site media via the following mechanisms:

- Incidental ingestion
- Dermal contact
- Inhalation of constituents volatilized from soil
- Inhalation of VOCs in indoor air

As discussed above, soil contamination above risk-based levels was only observed in one location, and most were within an order of magnitude of the RBC. Furthermore, the RBC is based on a "work week" daily exposure (250 days/year) rate. In fact, the area of soil contamination (ITSB-05) is covered with pavement, and the only occasion for exposing it would be during transient excavation or construction activities such as utility or parking lot repair. Concentrations at levels of potential concern do exist within the depth range of utility repair activities, although the maximum concentration (2,900 ppm) is 14-16 feet deep, below the depth at which these activities would likely occur. However, contact would be intermittent and transient. Overall, therefore, the level of direct contact with soils would not pose an unacceptable exposure under current or foreseeable site use conditions. Mitigation measures to control exposures during excavation activities would further reduce exposures.

PCE could volatilize out of soils during excavation. Given that the location is outdoors, natural ventilation would prevent accumulation of volatilized PCE to levels of health concern.
Several VOCs exceed EPA RBCs in indoor air measured in the facility. PCE concentrations were also over the NYSDOH guideline of 100 $\mu g/m^3$. In the samples collected by NYSDOH, PCE was detected at levels ranging from 266 to 585 $\mu g/m^3$ throughout both buildings. In correspondence to the site owner dated November 1999, the NYSDOH indicated that although health effects are not expected to be observed in individuals exposed to the levels measured in the building, it would be prudent to reduce the levels of PCE in both buildings.

NYSDOH noted that the indoor air samples also contained elevated levels of methanol and methyl isobutyl ketone (MIBK), solvents that are likely related to alcohols and ketones used during on-site activities. Other than the primary contaminants noted above, most compounds and concentrations detected were similar to those frequently detected in indoor air. This includes the petroleum related compounds benzene, toluene, ethylbenzene, xylenes, trimethylbenzenes, styrene, naphthalene, and 2,2,4-trimethylpentane. Other compounds detected at typical concentrations include trichloroethene, methylene chloride, trichlorofluoromethane (Freon 11) and 2-butanone. These chemicals are used primarily as basic ingredients in chemical production, as cleaning solvents, degreasers, and/or refrigerants. Dichlorofluoromethane (Freon 12) was detected at levels somewhat higher than typically found at background levels. This chemical is commonly used as a refrigerant. Other common compounds detected in the samples include aldehydes, which may be associated with diesel fuel emissions, fragrances/odorizers and construction materials.

NYSDOH concluded that the analytical results, coupled with information from other recent investigations indicating significant soil and soil vapor contamination around the building foundation, suggest that the PCE in the building may be due to subsurface vapors associated with past disposal practices at 100 Oser Avenue.

Downgradient Residents

Residential receptors living downgradient of the site may be exposed by:

- Inhalation of VOCs from indoor air
- Water Consumption
- Inhalation of VOCs from groundwater while showering
- Dermal contact with VOCs in water

AIR

Indoor air analytical results for PCE, presented in **Table 1-14,** indicate levels ranging from nondetected to over 11 $\mu g/m^3$. The NYSDOH (2000) has stated the following regarding residential exposures:

“When evaluating concentrations of PCE in air, NYSDOH uses its Guideline Value of 100 $\mu g/m^3$ for PCE. The guideline is not a line between air levels that cause health effects and those that do not. The health effects of PCE depend on the level and duration of exposure. NYSDOH is particularly concerned about residential exposure where individuals may be exposed for many hours per day on a prolonged basis. For residential scenarios, NYSDOH also compares air testing results to levels typically found in indoor air to evaluate whether the levels are above background ranges. The levels of PCE detected in sampled residences near 100 Oser Avenue are not significantly different than typical background air levels.

“At a minimum, the goal of remedial activities should be to reduce perc concentrations to below the 100 µg/m^3 guideline. In all cases the NYSDOH recommends that simple, common sense actions to reduce exposure should be taken even if an air level is below 100 µg/m^3. Therefore, remedial actions that serve to further reduce exposure, including measures that reduce indoor air concentrations of contaminants to typical or background ranges, should be implemented. Concentrations of PCE in affected structures will continue to be monitored as remedial activities progress to determine the effectiveness of these activities at reducing PCE concentrations."

WATER

Water well concentrations have been detected above MCLs for several constituents, with laboratory detection limits above MCLs (which makes it impossible to confirm the absence of elevated levels in samples with undetected results). A contaminated water supply will lead to exposure via ingestion, dermal contact and inhalation, particularly while showering. According to the local water utility, water from the impacted downgradient well field at Felcon Drive is treated and tested prior to distribution.

In the September 1999 Responsiveness Summary, NYSDOH concluded the following regarding residential water supply exposures:

"Exposures to low levels (up to about 20 micrograms per liter, (µg/L)) of volatile organic chemicals (VOCs) probably occurred in the past via use of contaminated drinking water from public supply wells near Oser Avenue. The concentrations of contaminants, not necessarily related to 100 Oser Avenue, in the drinking water did not exceed the NYSDOH guideline in effect at that time (50 µg/L for each VOC not to exceed 100 µg/L for total VOCs). The risks due to the past exposures are not definitively known; however, conservative estimates suggest that a low cancer risk exists. Public water supplied from these wells is now treated to remove VOCs from the water. The treated water meets the more stringent NYSDOH drinking water standards currently in effect (5 µg/L for each of the VOCs of concern at the well field). Routine monitoring of the treated water for VOCs will continue. This monitoring serves as a check on the effectiveness of the treatment systems.

"The earliest VOC samples (1977 through 1980) from one of the two Falcon Drive water supply wells, Well #14326, contained some 1,1,1-trichloroethane (TCA), some trichloroethene (TCE), and some PCE at concentrations near or below the current drinking water standard of 5 micrograms per liter (µg/L) for each of these chemicals. The contaminants were not detected during 1981 and 1982; TCA reappeared in 1983, PCE in 1984, and TCE in 1986. Freon also began to appear in the well in 1986. The well was removed from service early in 1987 and returned to service with VOC treatment in 1990. During the ten-year period from when the contaminants were first detected until the well was taken out of service, none of the VOC concentrations exceeded the guideline of 50 µg/L that was in effect at that time.

"The earliest samples from the other well, Well # 44774, did not contain these chemicals; TCA and PCE were detected in that well (at relatively low concentrations) in 1985. Freon began appearing in 1986. Concentrations of these three contaminants in the well have remained near or below the current drinking water standard of 5 micrograms per liter (µg/L). The well water has been treated for VOC removal since 1990."

1.2.6.3 Environmental Evaluation

Step II of NYSDEC's Fish and Wildlife Impact Assessment (FWIA), "Contaminant-Specific Impact Analysis," requires a review of exposure mechanisms (Step IIA, "Pathway Analysis"), followed, if necessary, by a Criteria-Specific Analysis (Step IIB). Step IIB, which involves a comparison to ecological-based toxicity screening levels, is only required if complete pathways of significance are identified.

Receptors

The OU1 site is located in a highly developed area. Most of the land is either paved or covered with structures. There is a small wooded area (less than one acre) on the northern end of the 100 Oser Avenue property that could potentially serve as limited habitat for small suburban species, such as rabbits and squirrels. There are no aquatic resources within the site area. The nearest wetland is approximately three-quarters of a mile to the northeast. The possibility of the presence of sensitive or endangered species is highly remote. Flora and fauna present would be hardy, adaptive species.

Contaminated media at the site consist of groundwater and subsurface soils in the immediate vicinity of the building. Groundwater is about 60 feet below ground surface and does not discharge to the surface within the site area. No data are available for surficial soil quality in the wooded area; however, based on available site information, there have been no contaminant release pathways associated with surface run-off that present a potential for contaminants to have been transported to this area. Furthermore, the COPCs at the site are all VOCs, which would have a very short half life in surficial materials even if they were discharged. Therefore, the wooded area is assumed to be unimpacted.

The nearest wetland is hydraulically downgradient of the site. Even assuming that groundwater discharges to the wetland, there have been no evaluations to measure or predict transport of COPCs to this area.

Pathways

Small terrestrial animals or plants in the wooded area could not encounter any contaminated site media. Groundwater is too deep to present a contact potential, and other areas where subsurface contamination exists or could exist are covered with pavement or buildings, preventing burrowing.

Based on the detection of PCE in ambient air on-site and in the residential area across from the site, it is possible that there is PCE present in the wooded area. The concentrations of PCE, if any, are unknown. However, no PCE was detected on-site in outdoor air, so PCE presence cannot be confirmed. If there are low-level VOCs in the breathing zone in the northern area of the site, they are unlikely to be at a level that would present a threat to flora and fauna present. Overall, there are no apparent ecological impacts associated with the site. No further evaluation is recommended.

1.2.6.4 Risk Summary

The human health pathways associated with potentially unacceptable exposure are inhalation of VOCs by full-time on-site workers, inhalation of ambient air in the residential neighborhood along Holiday Park Drive, and possibly those involving use of the Falcon Street well water as a water supply (depending on the effectiveness of current treatment and monitoring). These pathways and exposures are presented in **Table 1-15**.

There are no apparent risks to ecological receptors.

This qualitative exposure assessment is for screening purposes only. Actual exposures would require a quantification of exposure based onsite-specific use, occupancy and duration information.

1.2.7 Interim Remedial Measure

During the Remedial Investigation of OU1, high levels of PCE vapor were found within the site building which prompted the NYSDEC to require an Interim Remedial Measure. In September 2000, IT Corporation, on the behalf of the NYSDEC implemented an Interim Remedial Measure (IRM) at 100 Oser Avenue. The primary purpose of the IRM was to take immediate steps to reduce concentrations of halogenated volatile organic compounds in the unsaturated (vadose) zone of the source of the vapors. Two dry wells proximate to the 100 Oser Avenue building's western exterior have been identified as the primary source of the PCE vapors at the Site.

The IRM consisted of two stages. The initial stage (Stage I) modified the existing HVAC configuration at the Site to increase fresh airflow and produced a positive pressure within the building. Based on subsequent laboratory data, this new configuration has reduced indoor air concentrations of PCE to below New York State Department of Health guidelines. The second stage (Stage II) of the IRM included a limited soil vapor extraction system (SVE) designed to reduce VOC soil vapor concentrations at the source. This SVE system includes a catalytic oxidation unit to destroy VOCs in the soil vapor effluent stream. This system has been in continuous operation since September 2000, with the exception of March 2001, when the system was down for repairs.

2.0 REMEDIAL ACTION OBJECTIVES

2.1 Introduction

The purpose of this FS is to develop and evaluate alternatives for remedial response actions that are potentially applicable for the reduction of potential risks to human health and the environment at the 100 Oser Avenue Site. This section of the FS describes the development of the Remedial Action Objectives (RAOs) for impacted media detected during the RI, and how the RAOs will be used to evaluate potentially applicable remedial alternatives within this FS. The general requirements for this work are described in the Order on Consent #D1-0023-98-09 (NYSDEC September 25, 1998) and relevant guidance documents, including the NYSDEC TAGM 4030 (NYSDEC, 1990) and USEPA guidance for developing remedial actions (USEPA, 1988).

The RAOs consist of medium-specific (i.e. soil, groundwater, soil gas/indoor air) goals for protecting human health and the environment. They are developed by determining COPCs, exposure routes, and determination of qualitative and quantitative goals for cleanup in each medium that may require cleanup, including preliminary remediation goals (PRGs).

In accordance to USEPA guidance (USEPA, 1988), RAOs for protecting human receptors should express a remediation goal for COPCs in association with an exposure route, as protection may be achieved by reducing exposure (such as capping an area, limiting access, or providing an alternate water supply), as well as reducing COPC levels. In **Section 2.2**, the COPCs identified at the Site during the RI Report are discussed with respect to each medium along with the qualitative and quantitative goals for COPC response actions.

General Response Actions (GRAs) are media-specific actions that will satisfy the RAOs, Standards, Criteria, and Guidelines (SCGs), and ARARs. The process used to generate the Site's GRAs is consistent with the NCP under CERCLA and NYSDEC guidance documents. GRAs for each medium of concern at the Site are listed in **Section 2.** Each GRA and relevant technology applications will be screened to select the most applicable technologies to meet the RAO for each medium of concern. Representative process options will be identified for each medium of concern in **Section 3.0**.

2.2 Remedial Action Objectives

The remedial action objectives for this site are determined by specific media. Each media was evaluated with respect to COPCs; SCGs; ARARs; and RAOs. The three media that are of concern are groundwater, soil, and soil gas/indoor air. For the purposes of the remedial action objectives and screening of technologies, soil gas and indoor air have been combined.

Extensive chemical and physical data collected at the Site were screened during the exposure assessment (discussed in **Section 1.2.5**) to identify COPCs from among the chemical constituents detected in the various media sampled. To select COPCs, the analytical results for air, soil, and groundwater were compared to risk-based screening levels to determine whether levels measured are likely to present unacceptable exposures. The screening levels used are the risk-based concentrations (RBCs) developed by USEPA Region III (USEPA, 2000b) and the NYSDOH guideline for PCE (1999c). The RBCs were calculated using the Standard RAGS formulas for established exposure scenarios (residential and industrial). They do not necessarily characterize actual exposure in any site-specific situation. However they represent measures of safe concentrations using a series of conservative assumptions. Therefore, chemicals with concentrations below the screening levels can generally be omitted as COPCs.

SCGs and ARARs are integral to RAO development and are included in each to determine qualitative and quantitative cleanup goals. In addition, there are general ARARs that are applicable to the entire process. Some of these include RCRA (Resource Conservation and Recovery Act) and EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA EPA/540/G-89/004.

NYSDEC SCGs and Federal ARARs for inactive hazardous waste sites interpret applications of other SCGs and ARARs. Regulations and guidance for New York State's *Inactive Hazardous Waste Disposal Site Remedial Program*, 6 NYCRR Part 375 (NYSDEC, 1992) were promulgated to promote the orderly and efficient administration of Article 27, Title 13 of the Environmental Conservation Law (ECL). The scope, nature, and content of an inactive hazardous waste site remedial program performed in accordance with this statute are to be determined on a site-specific basis. Specifically, Part 375 pertains to the development and implementation of remedial programs under authority of ECL Article 27. Furthermore, subpart 375-1.10(c)(1) states that "due consideration" must be given to "standards, criteria and guidelines" (SCGs) when evaluating remedial alternatives for Class 2 inactive hazardous waste disposal sites. The regulation states that such "consideration" should be given to guidance "determined, after the exercise of engineering judgement, to be applicable on a case-specific basis" (6 NYCRR 375.1-10(c)(1)(ii)).

These SCGs include both New York State's criteria applicable to cleanup of contaminated media and Federal ARARs that may be more stringent than the State's criteria. As part of this FS, SCGs were evaluated for site applicability in order to develop the medium-specific RAOs. SCGs can be chemical-specific or site-specific guidelines. Most of the requirements outlined in this document are chemical-specific guidelines listed in tables for the different media involved. Site location-specific requirements for clean-up come into play when specific site characteristics impact or restrict the actions taken in that particular area. These will be addressed as needed.

2.2.1 Groundwater

Chemicals of Potential Concern

Analysis of the groundwater data shows that the chemicals of potential concern in this media are:

- 1,1-Dichloroethene (1,1-DCE),
- 1,2-Dichloroethene (1,2-DCE),
- 1,1,1-TCA,
- PCE, and
- TCE.

SCGs and ARARs

Both NYS and Federal ARARs and SCGs, along with RBCs discussed in the exposure assessment, have been evaluated to determine the preliminary remediation goals for the contaminated groundwater. The preliminary remediation goals for the COPCs in groundwater are listed in **Table 2-1**.

Table 2-1 presents the differences between:

- New York State Water Quality Standards for Surface Waters and Groundwater,
- US EPA Water Quality Standards in terms of Primary and Secondary MCLs (maximum contaminant levels as part of the Safe Drinking Water Act),
- National Academy of Sciences Drinking Water and Health standards for SNARLs (suggested no adverse response levels), and

- US Environmental Protection Agency (EPA), Office of Water, Drinking Water Regulations and Health Advisories for EPA SNARLs.

The Safe Drinking Water Act MCLs provide standards for the treatment of groundwater and surface water for public potable water supplies and the New York State Water Quality Regulations (6 NYCRR Part 703.5) are used to protect human health and the environment. The NYS Water Quality Standards are the most stringent, and therefore, will be used as the groundwater PRGs.

Remedial Action Objectives

There are two remedial objectives for the on-site groundwater:

1) Mitigate further downstream contamination of groundwater to the extent practical.
2) Remediate on-site groundwater to requirements of NYS Water Quality standards as presented in **Table 2-1**.

2.2.2 Soil

Chemicals of Potential Concern

The only chemical of potential concern in the soil is tetrachloroethene (PCE). No other chemicals were found to exceed the RBCs.

SCGs and ARARs

The applicable SCGs and ARARs for PCE cleanup requirements for soil contamination are listed in **Table 2-2**.

The primary guidance for soil clean-up values under Part 375 remedial actions is derived in the Technical and Administrative Guidance Memorandum on Determination of Soil Clean-up Objectives and Clean-up Levels HWR-94-4046 (TAGM 4046). TAGM provides a basis for determining generic soil cleanup values that essentially ensure that all significant threats to human health and/or the environment posed by an inactive hazardous waste site are eliminated. The TAGM's health based levels for cancer risks are contained in USEPA's Health Effects Assessment Summary Tables (HEASTs). TAGM's health based levels for systemic toxicants are calculated from RfDs (reference doses) also contained in the HEASTs. Both of these values are compiled and updated quarterly by the NYSDEC's Division of Hazardous Substances Regulation. An additional guidance document is the Suffolk County Department of Health Services Standard Operating Procedure for the Administration of Article 12 of the Suffolk County Sanitary Code (Article 12 – SOP No. 9-95). This lists specific goals for a number of chemicals of concern to the Suffolk County area. As is demonstrated by **Table 2-2** the Suffolk County criteria for PCE is the same as the TAGM cleanup objective. The two health based values for carcinogens and toxicants by the EPA show that cleanup to the TAGM objective would be well below the acceptable limits for even carcinogenic compounds. Therefore, the PRG for PCE in soil is 1.4 mg/kg as per TAGM 4046, as well as the Suffolk County Sanitary Code.

Remedial Action Objectives

There are two RAOs for the Site soil:

1) Mitigate continued contact with and degradation of the groundwater by contaminated soil by treating the impacted soil to the established PRG.

2) Mitigate further contamination of soil gas and indoor air by treating the impacted soil to the established PRG.

2.2.3 Soil Gas/Indoor Air

Contaminants of Potential Concern

Indoor air sampling and analysis reported five compounds that were above the RBCs. The soil gas/indoor air COPCs are:

- Methylene chloride,
- 1,2,4-Trimethylbenzene,
- MIBK,
- PCE, and
- Toluene.

SCGs and ARARs

New York State and Federal regulations have been considered as SCGs and ARARs for the soil gas/indoor air contaminants. These criteria to be considered are listed in **Table 2-3**.

Table 2-3 presents the New York State Department of Health Tetrachloroethylene Ambient Air Criteria Document guidance value and USEPA Region III risk-based concentrations for indoor air. The USEPA Region III RBCs, calculated using the Standard Risk Assessment Guidance for Superfund (RAGs, 1989, 1991), are discussed in the exposure assessment presented in **Section 1.2.5.** For all compounds, with the exception of PCE, the USEPA Region III RBCs will be used as the site soil gas/indoor air PRGs. In accordance with NYSDEC and NYSDOH recommendations, the NYSDOH PCE Guidance Value will be used as the site PCE soil gas/indoor air PRG for the following rationale:

"The purpose of the (NYSDOH criteria) document is to provide qualitative and quantitative criteria for use in risk assessments to evaluate the health risks of exposure to tetrachloroethene in ambient air. Using the recommended unit risk estimate derived from animal studies, the lifetime excess cancer risk at the criterion for non-carcinogenic effects (0.1 mg/m^3 [100 $\mu g/m^3$]) is about one in ten thousand. In general, there is consensus among the scientific and regulatory community about what actions may or may not be needed depending on the level of estimated lifetime excess cancer risk. An increased lifetime cancer risk of one in one million or less is generally not considered a significant public health concern. Increased lifetime cancer risks greater than one in ten thousand usually trigger actions to lower exposure. Other considerations in evaluating risks include, but are not limited to, the conservativeness of the assumptions used to estimate risk, the scientific strength of the epidemiological and toxicological databases, and the potential for chronic or lifetime exposure. Based on these factors, the 1991 DOH recommendation that the average ambient air level for tetrachloroethene in a residential community should not exceed 0.1 mg/m^3 is believed to be protective of public health". (NYSDOH, October, 1997)

Remedial Action Objectives

There are two remedial action objectives for the on-site soil gas/indoor air:

1) Reduce risk of exposure in indoor facilities to contaminated soil gas, and

2) Mitigate further migration of contaminated soil gas.

2.2.4 Extracted Groundwater

Groundwater extraction may be a potential alternative for the contaminated groundwater. Based on this assumption the chemicals of concern in this media are:

- 1,1-DCE,

- 1,2-DCE,
- 1,1,1-TCA,
- PCE, and
- TCE.

SCGs and ARARs

Under New York State law, to discharge the extracted groundwater to a surface water or back to groundwater a State Pollutant Discharge Elimination System (SPDES) permit must be obtained. The preliminary remediation goals for the COPCs in groundwater as listed in **Table 2-1** will also meet the SPDES requirements.

2.2.5 Off-gases

Contaminants of Potential Concern

Off-gases from potential treatment alternatives are:

- Hydrochloric acid
- 1,1-DCE,
- 1,2-DCE,
- 1,1,1-TCA,
- PCE, and
- TCE.

SCGs and ARARs

New York State Department of Environment Conservation Division of Air Resources DAR-1 provides the requirements and standards for air discharge permits. DAR-1 Annual Guideline Concentrations (AGCs) and Short-Term Guideline Concentrations (SCGs), as updated in July 2000, will be used as the off-gas discharge requirements. **Table 2-4** presents these requirements.

2.3 General Response Actions

General Response Actions are media-specific actions that satisfy the remedial action objectives. The process used to develop the General Response Actions is in compliance with the National

Contingency Plan (NCP) under CERCLA (USEPA, 1988) and NYSDEC (NYSDEC, 1990). This process ensures that a wide range of potential responses is considered during the development of the remedial alternatives for the Site.

Figure 2-1 presents a matrix of General Response Actions for each media at the Site. The general response actions included in this figure are:

- No Further Action,
- Institutional Controls,
- Removal/Disposal,
- *Ex-situ* Treatment and Disposal,
- *In-situ* Treatment, and
- *In-situ/Ex-situ* Treatment.

General Response Actions available for contaminated groundwater include:

- No Further Action,
- Institutional Controls,
- Containment,
- *In-situ* Treatment,
- *In-situ/Ex-situ* Treatment, and
- *Ex-situ* Treatment and Disposal.

General Response Actions Available for contaminated soil include:

- No Further Action,
- Institutional Controls,
- Containment,
- Removal and Disposal,
- *In-situ* Treatment; and
- *In-situ/Ex-situ* Treatment.

General Response Actions available for contaminated soil gas/indoor air include:

- No Further Action,
- Containment, and
- *In-situ/Ex-situ* Treatment

Each of the general response actions is discussed below.

No Further Action

The "No Further Action" alternative has been included as a baseline general response against which all other actions can be measured. This alternative assumes that no further actions will be implemented at the site. However, it should be noted that even if no further action were to be implemented, there is an interim remedial measure which has already been implemented. (See **Section 1.2.6**)

Further screening of this alternative is not required. It is retained as a general option for the later assembly of alternatives (**Section 4.0**) and for the comparative purpose in the detailed analysis (**Section 5.0**).

Institutional Controls

Under this response category, measures would be taken to restrict access to contaminated areas and/or control specified activities in the contaminated areas. Both physical and legal means could be utilized to restrict and control access. Physical controls include access restrictions such as fencing, postings, warning signs, and other barriers. Legal controls include zoning and deed restrictions.

Containment

This General Response Action refers to the use of natural or engineered barriers on-site to minimize potential direct contact with, or migration of, contaminated media. Technologies within this response category include contact barriers, capping, vertical barriers, and surface controls (e.g., drainage/grading).

Removal and Disposal

This general response refers to those activities in which the impacted media is removed from the environment and disposed of at an appropriate facility.

Ex-situ Treatment and Disposal

This general response refers to those activities in which the impacted media is removed from the environment and treated by an appropriate technology. Once treated, the media is disposed of appropriately.

In-Situ Treatment

This general response refers to technologies which would accomplish treatment in place without a removal phase.

In-Situ/Ex-Situ Treatment

This general response refers to technologies which would accomplish much of the treatment *in-situ*, but may require at least one phase to be removed and treated prior to disposal.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section identifies and describes potentially applicable technologies and process options for each General Response Action and presents a screening of each technology and process option. The technologies are grouped by media (groundwater, soil, and soil gas/indoor air). To help expedite the screening process, a preliminary evaluation of each technology and process option was performed to determine which technologies are applicable for the given media, based on COPCs, RAOs, SCGs, and ARARs discussed in **Section 2**. **Table 3-1** presents the media-specific general response actions, remedial technologies and process options, and preliminary evaluation results.

3.1 Screening of Technologies

The remedial action technologies presented in **Table 3-1** that passed the preliminary evaluation have been screened to limit the number of technologies and options that may be subsequently used to formulate remedial action alternatives. The formulation of alternatives is discussed in **Section 4.0** and the detailed analysis of each alternative is discussed in **Section 5.0**. During the preliminary evaluation, technologies that required additional treatability studies were identified. The results of the subsequent study are presented in **Appendix A**.

The screening process of the technologies, presented in **Table 3-1**, was based on how the following three criteria are applicable to the study area conditions:

- Effectiveness,
- Implementability, and
- Cost.

Effectiveness: The technologies are evaluated on their effectiveness relative to other technologies, considering:

- how effective the technology is in achieving remedial action objectives; and
- how proven and reliable the process is in addressing the contaminants of concern.

Implementability: Process options are evaluated for institutional and technical implementability. The technical feasibility is used to eliminate certain process options that are ineffective and clearly not applicable to the site conditions. The deciding factors for this issue are:

- difficulty in constructing and operating the process option,
- potentially adverse health and environmental impacts created during the implementation,
- potential material handling difficulties, and
- adverse effects of the chemicals and other materials used by the technologies.

Cost: Cost plays a limited role at this stage of the screening process. Relative unitized costs are used in the analysis. Technologies that are an order of magnitude or greater in unitized cost were screened out if the option did not offer any greater effectiveness, reliability, or environmental protection than other options. The cost comparison is generally limited to process options, under a particular technology type. Costs are only discussed where they affect the screening process.

The various technologies and options by media are presented in the following sections.

3.1.1 Screening of Groundwater Technologies

3.1.1.1 No Further Action

The "No Further Action" alternative has been included as a baseline general response against which all other actions can be measured. This alternative assumes that no further actions will be implemented at the site. However, it should be noted that even if no further action were implemented, there is an interim remedial measure which has already been implemented. (See **Section 1.2.6**)

Further screening of this alternative is not required. It is retained as a general option for the later assembly of alternatives (**Section 4.0**) and for comparative purposes the detailed analysis (**Section 5.0**).

3.1.1.2 Institutional Controls

Institutional controls are physical or legal measures taken to prevent direct exposure to impacted media. Institutional controls are not technologies; however, they can be used to enhance long-term effectiveness and permanence of a remedial action. Potentially implementable measures that could be taken include access restrictions, zoning restrictions, and deed restrictions. The remedial technology types which could be utilized to implement institutional controls are identified in **Table 3-1** and include access restrictions, deed restrictions, and zoning restrictions.

Access Restrictions: Access restrictions could include fencing, alarm systems, security gates and patrols, and other physical barriers that would restrict access to the selected Site areas. Other measures to control specific activities could be employed as dictated by future land use. Workers engaged in activities potentially exposing them to impacted media would require Occupational Safety and Health Administration (OSHA) training and certification (29 CFR 1910.120), medical fitness testing, and other appropriate documentation, including an approved Health and Safety Plan. These plans would stipulate appropriate protective measures to prevent worker exposures during the completion of work on-site.

Effectiveness: This option effectively minimizes the potential of direct contact exposure scenarios for groundwater.

Implementability: The nature of this technology warrants no discussion of technical considerations. This technology is readily implementable.

Cost: Cost for access restrictions is minimal.

Conclusions: This option is potentially applicable and is retained for further consideration.

Deed and Zoning Restrictions: Deed and zoning restrictions can be used to limit exposure risks by regulating future site activities. These types of institutional controls may include prohibiting the use of the property for residential, grammar school, recreational, and/or food growing purposes for as long as contamination is present at the site.

Effectiveness: These actions would effectively minimize exposure risks at the Site.

Implementability: Deed restrictions are typically more readily implementable than zoning restrictions due to the local government approval process required to create special zoning districts.

Cost: The cost to implement either a deed or zoning restriction cannot be accurately assessed this time; however, they are considered to be reasonable.

Conclusion: These options are potentially applicable and are retained for further consideration.

3.1.1.3 Containment

The containment of groundwater contamination encompasses both containing the source contributing to the groundwater contamination and preventing the evasive movement of contaminated groundwater.

The primary remedial technologies for the containment of groundwater include capping, vertical barriers, and hydraulic control. As discussed in **Table 3-1**, capping and vertical barriers are not applicable to the site and have not been retained for further consideration. Because OU1 is bordered by OU2, which is currently under investigation and will include groundwater remediation, complete containment of groundwater in OU1 is not necessary.

Hydraulic Control: Groundwater can be contained using hydraulic control measures. These measures include the extraction of and or injection of groundwater in the subsurface. Extraction and injection can be accomplished using a system of wells, subsurface drains, and interceptor wells.

Plume Control Using Wells

Extraction of groundwater through wells is used to contain or remove the plume of contaminated water. The selection of well types depends upon the depth of contamination and the hydrogeological properties of the aquifer.

Effectiveness: The effectiveness of an extraction system depends on proper design and selection of the extraction wells.

Implementability: The implementation of an extraction system would be influenced by subsurface features. Based on known geological conditions, groundwater extraction is implementable at the site.

Cost: Cost for plume control using wells is moderate.

Conclusion: This process option has been retained for further consideration.

Subsurface Drains and Interceptor Trenches

Subsurface drains and interceptor trenches include any type of buried conduit or trench used to intercept and collect groundwater upgradient of the interceptor system. These subsurface drains and trenches essentially function like an infinite line of extraction wells. They create a zone of influence in which groundwater flows toward the drain.

Effectiveness: Subsurface drains are effective at a shallow depth. Since the groundwater at the Site is deep, this process option is not effective for the site.
Implementability: Implementation of this technology would be difficult and costly due to the depth to groundwater at the site.

Cost: Cost for subsurface drains is moderate.

Conclusion: This process option has not been retained.

3.1.1.4 In-Situ Treatment

In-situ treatment refers to technologies which would accomplish treatment in place without a removal phase. *In-situ* technologies that were retained after the preliminary evaluation include enhanced bioremediation (HRC Treatment, and ORC Treatment), chemical oxidation (Permanganate and ozonation Treatment), and bioremediation.

HRC: HRC Treatment, an enhanced bioremediation technology, uses hydrogen releasing compounds (HRC) to chemically alter the COPC, producing non-toxic end products. HRC is composed of a polyactate ester that releases lactic acid upon hydration. When placed in a contaminated aquifer, HRC compounds generate hydrogen gas that stimulates a multi-step dechlorination process, which results in the production of non-toxic end products such as ethene gas. The advantages of HRC are:

- Low cost – as an *in-situ* treatment there are no significant capital or O&M costs.
- Rapid – the hydrogen released in the aquifer serves as an electron donor increasing the rate of contaminant degradation an order of magnitude or faster than natural attenuation rates.
- Simple to install – HRC is added to the aquifer through borings or wells.
- Cuts off plume migration – HRC applied at the downgradient perimeter of a plume prevents further migration of the plume. This barrier can be applied at a fraction of the cost of a reactive iron wall or sparging system.
- Time release action – by providing continuous hydrogen gas release, repeated or continuous injections are generally not required.

The use of HRC compounds for groundwater remediation offers a comparatively simple and cost effective alternative to more traditional technologies.

Effectiveness: Use of HRC compounds is a promising technology starting to come into use for remediation of chlorinated compound impacts to groundwater. These compounds can be used for source area reduction or in combination with other technologies to control or limit the magnitude of the migration of the groundwater plume.

Implementability: HRC compounds have been shown to be effective and are easily installed with normal geoprobe or well drilling equipment. This passive approach requires no O&M activity. Periodic well sampling is conducted to monitor the effectiveness of the treatment and to determine if subsequent additional applications are necessary. This is new technology and there is not a significant database of previous applications at sites similar to Oser Avenue.

Cost: The initial cost for HRC remediation is usually higher initially compared to *ex-situ* treatment methods, but because there are no continuing O&M costs, the total project cost may ultimately be less depending upon project duration.

Conclusion: Although the use of HRC compounds is an effective remediation of chlorinated VOCs impacts to groundwater, it is not proven at sites similar to Oser. This method is not retained for further evaluation

ORC: ORC, an enhanced bioremediation technology, uses oxygen releasing compounds (ORC) to promote biological degradation of contamination. Oxygen releasing compounds, which are variations of magnesium peroxides, are designed to provide timed release of oxygen upon hydration. These ORCs are widely used in the remediation industry to increase dissolved oxygen levels in groundwater. Higher dissolved oxygen levels in groundwater provide electron acceptors to support the aerobic biodegradation of hydrocarbon compounds. Petroleum-based hydrocarbons including select chlorinated compounds such as dichloroethenes or vinyl chloride can be degraded.

Effectiveness: These compounds have not been shown to be effective for chlorinated compounds such as PCE. Use of ORC compounds is not appropriate for the site-specific contaminants in this case.

Implementability: ORC compounds are easily installed with normal geoprobe or well drilling equipment. However, their use is not technically effective for this site-specific evaluation.

Cost: The use is not appropriate for this site-specific evaluation.

Conclusion: This method is eliminated from further evaluation.

Permanganate Injection: Permanganate Injection, a chemical oxidation technology, uses the permanganate ion to oxidize organic contaminants in the subsurface to non-toxic compounds. Permanganate, delivered either as potassium ($KMnO_4$) or sodium salts ($NaMnO_4$) is a common oxidant widely used in the water treatment industry to remove and precipitate dissolved metals, and in the sewage treatment industry to treat sulfide odors. MnO_4^- ions will react with and oxidize a wide range of common organic compounds, relatively quickly and completely. In particular, MnO_4^- ions react rapidly with the non-conjugated (i.e., nonaromatic) double bonds in chlorinated ethenes such as PCE, TCE, DCE isomers, and vinyl chloride.

Recent research at the University of Waterloo has demonstrated that injection of $KMnO_4$-solutions into soils contaminated with chlorinated ethenes results in substantial *in situ* destruction of the VOCs. IT Corporation has completed numerous successful field trials of permanganate injection with the percent reduction of chlorinated ethenes ranging from >60% to >99%.

Permanganate oxidizes the chlorinated ethenes to CO_2 and chloride ions. The balanced chemical equation for potassium permanganate oxidation of PCE (for example) is:

PCE: $4KMnO_4 + 3C_2Cl_4 + 4H_2O \text{--->} 6CO_2 + 4MnO_2 + 4K^+ + 12Cl^- + 8H^+$

Sodium permanganate ($NaMnO_4$) may also be used and has the advantage of being available as a 40% liquid solution. $NaMnO_4$ oxidation of PCE follows the same reaction pathways as $KMnO_4$, except that the reaction forms Na^+ ions rather than the K^+ ions:

PCE : $4NaMnO_4 + 3C_2Cl_4 + 4H_2O \text{--->} 6CO_2 + 4MnO_2 + 4Na^+ + 12Cl^- + 8H^+$

A disadvantage of sodium permanganate is its higher cost compared to the potassium form.

In situ oxidation is a chemical reaction. The effectiveness of treatment depends on the following three factors:

- the kinetics of the reaction between the permanganate and the contaminant compounds,
- the contact between the oxidant and the contaminants, and
- competitive reactions of permanganate with other reduced/oxidizable species.

If the contaminant being targeted for *in situ* chemical oxidation is reactive (i.e., chlorinated ethenes), and sufficient oxidant has been added to overcome the demand from other reduced species, the limiting factor to the successful application of *in situ* oxidation is the transport of the oxidant to the areas where contaminants are present, not the reaction itself between the permanganate and the contaminants. The oxidation of contaminants by permanganate is an essentially instantaneous reaction. If the permanganate contacts the contaminant, it will react. Significant oxidation can be observed in as little as a few hours after addition. By contrast, travel times for the permanganate to migrate away from the injecting point may be on the order of a day to weeks, depending on the rate of groundwater flow.

The primary limitation to permanganate treatment is the ability to apply the permanganate *in situ* and to maintain efficient contact between the permanganate and the contaminants. Low permeability soils and highly heterogeneous soils present a challenge to apply permanganate to the target location.

Effectiveness: This is a viable option for the treatment of the chemical compounds present in groundwater at the site. A pilot test at the site would be required to determine the site-specific chemical transport properties of the aquifer.

Implementability: This option would require the necessary injection permits from the applicable state and local agencies. Permanganate injection has been performed at several sites nationwide. Delivery systems include storage tanks and pressure pumps. The required equipment and staff are readily available to implement the treatment.

Cost: The initial cost of permanganate treatment is usually higher compared to *ex-situ* treatment methods, but because there are no continuing O&M costs, the total project cost may ultimately be less depending upon project duration.

Conclusion: This option is retained for further evaluation.

Ozonation: Ozonation, a chemical oxidation technology, involves injection of water saturated with ozone into an aquifer contaminated with chlorinated compounds. Ozone (O_3) is a strong oxidant, which upon contact breaks down chlorinated compounds into carbon dioxide (CO_2), chloride (Cl) and water H_2O). The advantage of O_3 is that it is 12 times more soluble than oxygen, therefore, it can be transferred into the aqueous phase much more rapidly. High solubility is beneficial for achieving O_3 saturation in a contaminated aquifer.

Effectiveness: Ozonation can be very effective in destruction of the chlorinated volatile organic compounds in the aquifer, if the ozone is in direct contact with the contaminant. Site-specific constraints must be first considered, because oxidation is dependent on achieving adequate contact between oxidants and contaminants. Subsurface heterogeneities, preferential flow paths and poor mixing in the subsurface can result in pockets of untreated contaminants. Further, the reagents can be consumed by other oxidizable substrates (e.g., natural organic compounds or dissolved iron), reducing, but not limiting, the efficiency of the in-situ treatment. The short half-life of O_3 limits its ability to migrate through soil or groundwater over large distances.

Implementability: Although the chemistry involved in ozonation is relatively simple, the technology is not a simple one to implement. The subsurface environment can be difficult to control, and it can be difficult to get adequate distribution of the oxidants within the subsurface. The technology has been commercially applied for the last 5 to 6 years but it is still considered an emerging technology and strides are being made to better understand its limitations and overcome them. Safety and handling issues need to be addressed for ozone generation.

Cost: Ozone generation system requires a relatively large capital investment.

Conclusion: Although ozonation is potentially effective remediation technique for chlorinated VOCs, it is difficult to implement in the subsurface applications. This remediation method is not retained for further evaluation.

***In-Situ* Bioremediation:** *In-situ* bioremediation uses indigenous microorganisms to biodegrade organic compounds in the groundwater by stimulating the natural system to favorable conditions for biodegradation. In general, bioremediation stimulates the indigenous microcosm by adding nutrients to the subsurface that are necessary for the metabolisms of organic contaminants. Nutrient requirements and optimum conditions for biodegradation are determined by laboratory simulation of existing conditions.

To accomplish *in-situ* bioremediation, nutrients are added to the subsurface by injection through wells or infiltration galleries. The method of injection is subject to site conditions. To more efficiently biodegrade chlorinated hydrocarbons, anaerobic conditions are required. In general bioremediation systems promote an aerobic condition with the nutrients they add, creating an anaerobic environment where it does not exist, is difficult. The subsurface environment at Oser Ave is believed to be aerobic due to the classification of the aquifer and the existing site data. The Oser Ave surficial aquifer is unconfined, and as such is in contact with the surface environment. This allows it to respond to atmospheric changes (ie. Barometric pressure) and tidal changes, thereby creating an aerobic environment. Existing site data confirms this belief, as the groundwater monitoring data generally indicates that anaerobic degradation products are not present.

Effectiveness: Biodegradation has not been routinely demonstrated for chlorinated compounds such as PCE.

Implementability: Nutrients are easily delivered with normal geoprobe or well drilling equipment. However, the establishment of an anaerobic environment is not technically effective for this site-specific evaluation.

Cost: The use is not appropriate for this site-specific evaluation.

Conclusion: This technology is eliminated from further evaluation.

3.1.1.5 In-Situ/Ex-Situ Treatment

*In-situ/ex-*situ treatment refers to technologies which would accomplish much of the treatment *in-situ*, but may require one phase to be removed and treated prior to disposal. Air sparging/soil vapor extraction is one such technology.

Air Sparging/Soil Vapor Extraction: Air sparging is a method of removing dissolved phase contaminant removal from groundwater. This process uses air as a carrier fluid for the transfer of the COPCs. Pressurized air is injected into the saturated and contaminated aquifer where the air forms bubbles which rise up through the aquifer coming into contact with dissolved phase and immiscible phase contaminants. The pressurized air is generated using a compressor or blower and applied within the aquifer, below the contamination, via air sparging wells, which are constructed specifically for this purpose and installed with conventional well installation equipment. The contaminants volatilize into the rising air stream and are carried out of the aquifer in gaseous form (*in-situ* air stripping). Typically, the gaseous emissions are collected from the vadose zone with a complementary soil vapor extraction system and the extracted vapors containing the contaminant are processed through an air treatment system.

Effectiveness: Air sparging/SVE is a proven technology and is widely used to remediate contaminated groundwater. Used alone or in combination with other technologies, air sparging/soil vapor extraction can be used for source area removals or for plume control and reduction of chlorinated solvents.

Implementability: The air sparge wells and processing equipment are commercially available and installed using conventional methods. Once installed and operating, the O&M requirements are generally lower than groundwater pump and treat systems, because it is generally less expensive to move and treat air rather than groundwater.

Cost: The cost for air sparging is generally moderate and may be more effective than pump and treat in site-specific cases.

Conclusion: Use of air sparging technology is an appropriate technology for this site-specific use. This method is retained for further evaluation.

3.1.1.6 Ex-Situ Treatment and Disposal

Based on previous discussion in this section, groundwater can be extracted by several means. The removal of groundwater would be preformed primarily to remove the source of continuing groundwater contamination downgradient. The removed groundwater requires treatment prior to disposal.

Pump and Treat: A pump and treat system will provide source removal, hydraulic control, and containment of the site contamination. This process option is a combination of many different technologies. A typical pump and treat system consists of recovery wells with pumps and a treatment system for removal of the VOCs and heavy metals from the contaminated groundwater. A conventional groundwater treatment comprises the following unit operations and equipment:

- equalization tank for collection of groundwater from different wells and attenuation of contaminant levels prior to treatment;
- metals removal equipment consisting of an inclined plate clarifier (IPC), chemical feed systems (sodium hydroxide and polymer) and sludge pump for removal of precipitated metal hydroxides;
- IPC effluent collection tank with a transfer pump
- Filtration consisting of a set of bag filters (minimum) for removal of suspended solids carried over from the IPC;
- Air stripper with a blower and an effluent sump pump

- Liquid and vapor phase granular activated carbon systems for polishing of the air stripper effluent and removal of VOCs from air stripper off-gas, respectively;
- Discharge system

Effectiveness: Pump and treat is one of the most widely used options for treatment of groundwater contaminated with VOCs at CERCLA sites and elsewhere. Based on the available information, including groundwater modeling, it is estimated that properly located extraction wells will be able to capture sufficient groundwater flow to restrict off-site migration of contamination. This technology would recover and treat contaminated groundwater from the Site.

Implementability: The recovery wells, process equipment and discharge system comprising the pump and treat option is commercially available and installed using conventional methods. Based on the specific equipment, the treatment process is typically enclosed within a building or suitable structure.

Cost: The capital cost for pump and treat at the Site is moderate, when compared to No Action or short-term remedial alternatives. However, the total cost of the pump and treat system is relatively expensive due to long-term O&M costs, when compared to other appropriate technologies.

Conclusion: Pump and treat systems are an effective and reliable technology for remediation of groundwater contaminated with VOCs and is retained for further consideration as a stand alone technology or in combination with other technologies for development of remedial alternatives.

3.1.2 Screening of Soil Technologies

3.1.2.1 No Further Action

The "No Further Action" alternative has been included as a baseline general response against which all other actions can be measured. This alternative assumes that no further actions will be implemented at the site. However, it should be noted that even if no further action were implemented, there is an interim remedial measure which has already been implemented. (See **Section 1.2.6**)

Further screening of this alternative is not required. It is retained as a general option for the later assembly of alternatives (**Section 4.0**) and for comparative purposes in the detailed analysis (**Section 5.0**).

3.1.2.2 Institutional Controls

Institutional controls are physical or legal measures taken to prevent direct exposure to impacted media. Institutional controls are not technologies; however, they can be used to enhance long-term effectiveness and permanence of a remedial action. The remedial technology types which could be utilized to implement institutional controls are identified in **Table 3-1** and include access restrictions, deed restrictions, and zoning restrictions.

Access Restrictions: Access restrictions could include fencing, alarm systems, security gates and patrols, and other physical barriers that would restrict access to the selected site areas. Other measures to control specific activities could be employed as dictated by future land use. Workers engaged in activities potentially exposing them to impacted media would require Occupational Safety and Health Administration (OSHA) training and certification (29 CFR 1910.120), medical fitness testing, and other appropriate documentation, including an approved Health and Safety Plan. These plans would stipulate appropriate protective measures to prevent worker exposures during the completion of work on-site.

Effectiveness: This option effectively minimizes the potential of direct contact exposure scenarios for soil.

Implementability: The nature of this technology warrants no discussion of technical considerations.

Cost: Cost for access restrictions is minimal.

Conclusions: This option is potentially applicable and is retained for further consideration.

Deed and Zoning Restrictions: Deed and zoning restrictions can be used to limit exposure risks by regulating future site activities. These types of institutional controls may include prohibiting the use of the property for residential, grammar school, recreational, and/or food growing purposes for as long as contamination is present at the site.

Effectiveness: These actions would effectively minimize exposure risks at the Site.

Implementability: Deed restrictions are typically more readily implementable than zoning restrictions, due to the local government approval process required create special zoning districts.

Cost: The costs to implement either a deed or zoning restriction cannot be accurately assessed at this time; however, they are considered to be reasonable.

Conclusion: These options are potentially applicable and are retained for further consideration.

3.1.2.3 Containment

The containment of soil contamination provides protection from direct contact of contamination with potential receptors and prevents contamination migration. Soil contamination may migrate through the soil column to the groundwater due to precipitation leaching though the soil, or the flushing of stormdrains/dryewells on-site. Capping is the only containment technology identified for soil contamination.

Capping: Containment can be accomplished through the use of a capping system that reduces the amount of precipitation that infiltrates and percolates into and out of impacted soils. Impermeable capping systems are typically constructed using synthetic liners and compacted clay. Low permeability caps can also be constructed using dense-grade or hydraulic-grade asphalt. Ninety-percent of the Site is currently covered with asphaltic pavement. Although this asphalt pavement is not specifically designed to act as a low permeability barrier it does limit the amount of direct infiltration.

Effectiveness: Construction of a low permeability barrier at the Site would provide little to no additional benefit in reducing infiltration; therefore, this technology will not be retained for further consideration.

Implementability: This technology is easily implemented. However, if would provide little or no additional benefit.

Cost: This option has marginal cost.

Conclusions: This option is not appropriate for this site, and will not be retained.

3.1.2.4 Removal and Disposal

Removal and disposal refers to those activities which remove impacted soil from the environment and dispose of it at an appropriate facility. Due to the location of the source (at depths greater than 30 feet) its proximity to Building 100's foundation and the retaining between Building 100 and 110, the associated costs, implementability, and technical feasibility of the source removal each is prohibitive; thus this technology is no longer under consideration.

3.1.2.5 In-Situ Treatment

In-situ treatment refers to technologies which would accomplish the treatment in place without a removal phase. *In-situ* technology that was retained after the preliminary evaluation is permanganate treatment.

Permanganate Treatment: The background and chemistry for treatment of dissolved phase chlorinated VOCs with permanganate was described in **Section 3.1.1.4**. The reactions and theory behind the treatment of adsorbed-phase chlorinated VOCs with permanganate is virtually identical. The significant difference is the method of delivery to impacted media. The driving force behind the delivery of permanganate to dissolved phase compounds is the movement of groundwater. When treating adsorbed phase compounds, the driving force becomes the ability of the vadose zone soils to laterally disperse the permanganate to impacted soils. The injection must be designed such that the injection points are placed in a cluster which is dense enough to deliver the permanganate to the entire volume of impacted sediment.

Effectiveness: This is a viable option for the treatment of the chemical compounds present in soil at the site. However, permanganate is a non-selective oxidant; therefore, organics in the soil (which are not COPCs) will also react with the permanganate.

Implementability: This option would require the necessary injection permits from the applicable state and local agencies. Permanganate injection has been performed at several sites nationwide. The required equipment and staff are readily available to implement the treatment.
Cost: The initial cost of permanganate treatment usually higher compared to *ex-situ* treatment methods, but because there are no continuing O&M costs, the total project cost may ultimately be less depending upon project duration and soil chemistry.

Conclusion: This option is retained for further evaluation.

3.1.2.6 In-Situ/Ex-Situ Technologies

In-situ/ex-situ treatment refers to technologies which would accomplish much of the treatment *in-situ*, but may require one phase to be removed and treated prior to disposal. Soil vapor extraction is one such technology.

Soil Vapor Extraction: Soil vapor extraction (SVE) is an *in-situ* process where adsorbed VOC contaminants are removed from the vadose zone soils by mechanically applying a vacuum to the subsurface. The applied vacuum creates air movement in the subsurface and contaminants are volatilized and extracted with the air that moves through the soil pore spaces. These vapors are drawn through the extraction system, and process pump or blower that vents either directly to the atmosphere or through a vapor abatement system if required. The vacuum is applied to the subsurface either through shallow trenches or vertical wells installed by conventional means.

Effectiveness: SVE is one of the most widely used and effective process options for treatment of the vadose zone soils contaminated with the VOCs at CERCLA sites and elsewhere. Based on the available information, it is estimated that properly located SVE extraction wells will be able to capture sufficient contaminant mass at the source area soils to minimize contaminant flux into the groundwater. This technology would recover and treat contaminated soil vapors from the dry well source area at the Site.

Implementability: The recovery wells, process equipment and discharge system are commercially available and installed using conventional methods. Based on the required equipment, the treatment process is typically enclosed within a building or suitable structure. SVE technology has been installed and operated at numerous sites since the early 1990's.

Cost: The capital cost for a source area remediation system at Oser Avenue is moderate, when compared to No Action or short-term remedial alternatives. However, the total cost of the SVE remediation is moderately expensive due to long-term O&M costs and vapor treatment maintenance which are dependent upon the project duration.

Conclusion: An SVE system is an effective and reliable technology for remediation of the source area soils contained within the vadose zone. This technology is retained for further consideration as a stand-alone technology or in combination with other technologies for development of remedial alternatives.

Soil Vapor Extraction/ Recirculation: This option uses a standard soil vapor extraction system but increases the efficiency by recirculating the heat generated from the vapor abatement system through the vadose zone. The rate of efficiency is increased by increasing the rate of volatilization due to the temperature increase. This option would also use a blower (similar to an air sparging blower) to introduce hot air into the subsurface. All other aspects of the process option will be similar to a standard SVE System.

Effectiveness: This option is more efficient than a traditional SVE design, due to the increased rate of volatilization. Based on the available information, it is estimated that properly located SVE extraction wells will be able to capture sufficient contaminant mass at the source area soils to minimize contaminant flux in to the groundwater plume. This technology would recover and treat contaminated soil vapors from the dry well source area at the Site.

Implementability: The recovery wells, process equipment and discharge system are commercially available and installed using conventional methods. Additional equipment is needed to create and apply the heat to the subsurface. The application of heat is best applied if there is a significant, existing waste heat source on site (such as a thermal or catalytic oxidizer).

Cost: If heat energy needs to be created specifically for this application, then project costs would escalate to the point where the additional performance efficiency of the recovery is not economically warranted. Based on the scope of equipment, the treatment process (except the waste heat source) is typically enclosed within a building or suitable structure. The capital cost for a source area SVE/heat remediation system at Oser Avenue is high. Additional O&M costs are also incurred to maintain the heat generating equipment.

Conclusion: Due to the small size of the impacted vadose zone area and the relative ease for volatilization of PCE at natural soil temperatures, SVE/heat is not a viable option.

Hence, an SVE/heat recirculation system is not an effective and reliable technology for remediation of the source area soils contained within the vadose zone at this site. This technology is eliminated from further consideration as a stand-alone technology or in combination with other technologies for development of remedial alternatives.

3.1.3 Screening of Soil Gas/Indoor Air Technologies

3.1.3.1 No Further Action

The "No Further Action" alternative has been included as a baseline general response against which all other actions can be measured. This alternative assumes that no further actions will be implemented at the site. However, it should be noted that even if no further action were implemented, there is an interim remedial measure which has already been implemented. (See **Section 1.2.6**)

Further screening of this alternative is not required. It is retained as a general option for the later assembly of alternatives (**Section 4.0**) and for comparative analysis the detailed analysis (**Section 5.0**).

3.1.3.2 Containment

The containment of soil gas contamination provides protection from direct contact of contamination with potential receptors and prevents contamination migration. Soil gas contamination may migrate through the soil column to the ambient air or into buildings.

Passive Capping: Passive capping systems can be used to control emissions of soil gas. These caps are typically constructed using synthetic liners or compacted clay. Capping systems are typically used in conjunction with an active soil gas venting system. In these situations, existing asphaltic or concrete pavement and slabs on grade can function as a cap.

Effectiveness: As a stand-alone technology, passive capping systems are not effective, because soil gas is already migrating through existing pavement and building slabs. However, as part of an active soil venting system, the existing pavements and building slabs will be considered for further consideration.

Implementability: This technology is easily implemented.

Cost: This option has marginal cost.

Conclusions: This option has been retained.

3.1.3.3 In-Situ Treatment

In-situ treatment refers to technologies which would accomplish treatment in place without a removal phase. *In-situ* technologies that were retained after the preliminary evaluation are soil vapor extraction and soil vapor extraction with heat recirculation.

Soil Vapor Extraction: Soil vapor extraction can be used adjacent to buildings to influence the natural pressure gradient between the structure and the underlying soils. By applying a vacuum to wells or trenches located adjacent to the structure, or placed below the structure, or both, soil gases can be collected before they impact indoor air quality. Soil vapor extraction (SVE) is an *in-situ* process where adsorbed VOC contaminants and contaminated soil vapors are removed from the vadose zone soils by physically applying a vacuum to the subsurface. The applied vacuum creates air movement in the subsurface and contaminants are volatilized and extracted with the air that exists and moves through the soil pore spaces away from the structures of concern. These vapors are drawn through the extraction system and process pump or blower and vented either directly to the atmosphere or processed through a vapor abatement system. The vacuum is applied to the subsurface either through shallow trenches or vertical wells installed by conventional means.

> Effectiveness: SVE is one of the most widely used and effective process options for treatment of the vadose zone soils contaminated with the VOCs at CERCLA sites and elsewhere. SVE is especially effective at preventing the migration of contaminated vapor in to buildings and other structures. Based on the available information, it is estimated that properly located SVE extraction wells will be able to capture sufficient contaminants from below the building to minimize contaminant flux into the structure. This technology would recover and treat contaminated soil vapors from the area below the building at the Site.
>
> Implementability: The recovery wells, process equipment and discharge system are commercially available and installed using conventional methods. Based on the scope of equipment, the treatment process could be combined with the SVE effort at the source area on the western side of the building as one implementation.
>
> Cost: The capital cost to include vapor extraction adjacent to the building to be included in the source area treatment system at Oser Avenue is low. This option is retained for further analysis.
>
> Conclusion: An SVE system is an effective and reliable technology for remediation of the soils underlying the building area. This technology is retained for further

consideration as a stand-alone technology or in combination with other technologies for development of remedial alternatives.

Soil Vapor Extraction/Heat Recirculation: This option will use soil vapor extraction adjacent to buildings in order to influence the natural pressure gradient between the structure and the underlying soils. System efficiency is increased by recirculating heat from the vapor abatement system though the vadose zone. The efficiency of this process is improved by heating the soils in the area of remediation, because heat increases the rate of volatilization. This representative process option would also use a blower (similar to an air sparging blower) to introduce hot air into the subsurface. All of the other aspects of this process option are similar to those of SVE.

Effectiveness: This options has a greater efficiency than a traditional SVE system, because the addition of heat recirculation increases the rate of VOC volatilization in the subsurface. Based on the available information, it is estimated that properly located SVE extraction wells will be able to capture sufficient soil gas at the building location to minimize contaminant flux into the structure. This technology would recover and treat contaminated soil vapors from the dry well source area at the Site.

Implementability: The recovery wells, process equipment and discharge system are commercially available and installed using conventional methods. Additional equipment is needed to create and apply the heat to the subsurface. The application of heat is best applied when there is an existing waste heat source on site (such as a thermal or catalytic oxidizer).

Cost: If heat energy needs to be created specifically for this application then project costs may quickly escalate to the point where the additional efficiency of the recovery is not warranted by the increased costs. The capital cost for a SVE/heat recirculation system at the building location is low to moderate because of the additional O&M costs incurred to maintain the heat generating equipment.

Conclusion: Due to the small size of the impacted vadose zone area and the relative ease for volatilization of PCE at natural soil temperatures, SVE/heat is not a viable option.

Hence, an SVE/heat recirculation system is not an effective and reliable technology for remediation of the soil vapors below the building. This technology is eliminated from further consideration as a stand-alone technology or in combination with other technologies for development of remedial alternatives.

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

4.1 Development of Alternatives

The technologies retained in **Section 3.0** are assembled into remedial alternatives designed to achieve the RAOs discussed in **Section 2.0**. The RAOs are goals developed to protected human health and the environment. The remedial alternatives are assembled to address the three media of concern at the Site: groundwater, soil, and soil gas/indoor air.

The range of alternatives for the 100 Oser Avenue Site have been developed within the framework of the regulatory guidelines outlined in the RI/FS Guidance Document (EPA 1988). The alternatives address both site-specific source control and management of groundwater migration concerns.

A brief discussion of the alternatives developed for each media and the rationale behind their development is presented in the following sections. The detailed evaluation of the retained alternatives is then presented in **Section 5.0**.

4.1.1 Development of Groundwater Alternatives

Alternative 1: No Action

The No Action alternative has been included in order to provide a baseline by which to compare other alternatives. Under this alternative groundwater will not be treated and the site conditions would remain the same. Groundwater monitoring would continue for 60 years.

Alternative 2: Pump and Treat

In this treatment alternative, the groundwater is extracted from the contaminated aquifer at approximately 150 gallons per minute through five (5) recovery wells, pumped to a treatment system and then discharged into a local discharge basin. A representative groundwater treatment system consists of an equalization tank and transfer pump, a set of bag filters for removal of suspended solids, a low-profile air stripper with a sump and a sump pump, liquid phase granular activated carbon (GAC) vessels for polishing the liquid stream prior to discharge to a discharge basin, and GAC vessels for removal of VOCs from the air stripper off-gas prior to discharge to the atmosphere.

Pump and treat is an effective means to actively control groundwater flow in the subsurface. This is especially relevant in regards to the control of migrating dissolved phase plumes. Pump and treat systems can be designed to control and recover plumes to prevent further migration.

> Effectiveness: This is a viable option for the treatment of the chemical compounds present in groundwater at the Site. A pilot test at the site would be required to determine the site-specific chemical and physical transport properties of the aquifer for the groundwater extraction system design.
>
> Implementability: This option would require the necessary water discharge permits from the applicable state and local agencies. Pump and treat technology is widely used, well understood, and readily available.
>
> Cost: Initial design and set-up costs are relatively low compared to *in-situ* treatment methods; however, long-term system operation and maintenance increases the overall costs of this remedial alternative.
>
> Conclusion: This remedial alternative is retained for further evaluation.

Alternative 3: *In-Situ* Treatment Using KMnO4

Prior to the initiation of a full-scale injection of permanganate for treatment of the dissolved phase plume, a pilot-scale injection would be needed. Potassium permanganate would be mixed on-site and injected into one monitoring well in the vicinity of the dry wells on the west side of 100 Oser Avenue building. Several monitoring wells would be field tested for various parameters prior to injection, and then on a daily basis following injection. Groundwater samples would be collected for analysis from these monitoring wells on a weekly basis. The pilot-scale test would provide the level of data needed for the accurate design of full-scale injection.

The full-scale injection would be designed to treat the entire onsite saturated thickness of the dissolved phase contaminant plume encountered on the OU1 Site. A representative process option consists of potassium permanganate mixed on-site and then injected into eight shallow monitoring wells and four deep monitoring wells. Additional deep and shallow monitoring wells would need to be installed for post-injection performance monitoring.

Effectiveness: This is a viable option for the treatment of the chemical compounds present in groundwater at the site. A pilot test at the site would be required to determine the site-specific chemical transport properties of the aquifer.

Implementability: This option would require the necessary injection permits from the applicable state and local agencies. Permanganate injection has been performed at several sites nationwide. The required equipment and staff are readily available to implement the treatment.

Cost: The initial cost for permanganate remediation is usually higher compared to *ex-situ* treatment methods, but because there are no continuing O&M costs, the total project cost depends upon whether additional injections are required to reduce contaminants to closure levels.

Conclusion: This remedial alternative is retained for further evaluation.

Alternative 4: *In-Situ* Source Area Treatment Using KMnO4 with a Pump and Treat Downgradient Barrier

The pump and treat option is very effective at controlling off site migration of the dissolved phase plume but requires a long period of time to effect complete remediation as a stand alone technology. This is primarily due to the time required for the contaminants in the aquifer to move naturally with groundwater flow into the area influenced by the recovery system where the contaminants are extracted. A representative process option combines technologies that address different areas of the Site (source area and downgradient plume) can potentially provide a more timely and cost effective alternative than either technology by itself. Addressing the source area with a chemical oxidation approach would be immediately effective in decreasing the contaminant mass introduced into the plume. Addressing the source area separately from the entire extent of the saturated impacted area would also lessen the project scope and resultant cost for the permanganate injection. The remainder of the dissolved phase plume would be remediated with a downgradient pump and treat system which would also prevent additional off site migration of contaminants. The pump and treat portion of the combined remedy would not be required for as long a period of time (compared to just pump and treat) because the immediate removal of source mass would shorten the time required for recovery of the remaining contaminant mass in the body of the plume. Additionally, should the permanganate not be completely effective with the primary injection volume then the pump and treat portion would still control additional offsite impact while a second permanganate injection event is performed.

Effectiveness: This is a viable option for the treatment of the chemical compounds present in groundwater at the Site. A pilot test at the Site would be required to determine the site-specific chemical and physical transport properties of the aquifer for the permanganate injection and the groundwater extraction system design.

Implementability: This option would require the necessary injection and water discharge permits from the applicable state and local agencies. Permanganate injection has been performed at several sites nationwide. The required equipment and staff are readily available to implement the treatment. Pump and treat technology is widely used, well understood, and readily available.

Cost: The cost for permanganate source area remediation combined with a plume control pump and treat process option is higher initially compared to standard *ex-situ* treatment methods, but, because the pump and treat portion of the remedy will be terminated sooner than as a stand alone technology, the total project cost may ultimately be less depending upon whether additional permanganate injections are required to reduce contaminants to closure levels in the source area.

Conclusion: This remedial alternative is retained for further evaluation.

4.1.2 Development of Soil Alternatives

Alternative 1: No Action

The No Action alternative has been included in order to provide a baseline by which to compare other alternatives. Under this alternative, soil will not be treated and the Site conditions would remain the same.

Alternative 2: SVE

Soil vapor extraction (SVE) is an *in-situ* process where adsorbed VOC contaminants are removed from the vadose zone soils by physically applying a vacuum to the subsurface. The applied vacuum creates an air movement in the subsurface and contaminants are volatilized and extracted with the air that moves through the soil pore spaces. These vapors are drawn through the extraction system and process pump/blower that vents either directly to the atmosphere or through a vapor abatement system if required. The vacuum is applied to the subsurface either through shallow trenches or vertical wells installed by conventional means.

Effectiveness: SVE is one of the most widely used and effective process options for treatment of the vadose zone soils contaminated with VOCs at CERCLA sites and elsewhere. Based on the available information, it is estimated that properly located SVE extraction wells will be able to capture sufficient contaminant mass at the source area soils to minimize contaminant flux into the groundwater. This technology would recover and treat contaminated soil vapors from the dry well source area at the Site.

Implementability: The recovery wells, process equipment and discharge system are commercially available and installed using conventional methods. Based on the required equipment, the treatment process may be enclosed within a building or suitable structure. SVE technology has been installed and operated at numerous sites since the early 1990's.

Cost: The capital cost for an SVE process option at Oser Avenue is moderate, when compared to No Action or other short-term remedial alternatives. However, the total cost of the SVE remediation is moderately expensive due to long-term O&M costs and vapor treatment system maintenance, which is dependent upon the project duration.

Conclusions: An SVE system is an effective and reliable technology for remediation of the source area soils contained within the vadose zone. This remedial alternative is retained for further consideration.

Alternative 3: *In-Situ* Treatment of Source Area with NaMnO4

In this treatment alternative, several shallow wells would be constructed within the vadose zone in the vicinity of the dry wells on the west side of the 100 Oser Avenue building. Sodium permanganate would be injected into these wells for the treatment of the PCE impacted soils. The permanganate would treat the impacted soils as it infiltrates the source area.

Effectiveness: This is a viable option for the treatment of the chemical compounds present in the vadose zone at the Site depending on the infiltration extent and rate. A pilot test at the site would be required to determine the site-specific chemical transport properties.

Implementability: This option would require the necessary injection permits from the applicable state and local agencies. Permanganate injection has been performed at several sites nationwide. The required equipment and staff are readily available to implement the treatment.

Cost:: The cost for permanganate remediation is usually higher initially compared to *ex-situ* treatment methods, but, because there are no continuing O&M costs, the total project cost may ultimately be less depending upon whether additional injections are required to reduce contaminants to closure levels.

Conclusions: This remedial alternative is retained for detailed analysis.

Alternative 4: *In-Situ* Treatment of Source Area with NaMnO4 and SVE

In this combined treatment technology alternative, several shallow wells would be constructed within the vadose zone in the vicinity of the dry wells on the west side of the 100 Oser Avenue building. Sodium permanganate would be injected into these wells for the treatment of the PCE impacted soils. The permanganate would treat the impacted soils as it infiltrates the source area. This would immediately reduce the mass of contaminants in the source area soils. SVE would then be applied to the remaining soil mass exhibiting lower contaminant levels. This would reduce the size, complexity, air treatment requirement, and cost of the SVE design. It would also shorten the duration of the SVE extraction system operational period. The reduced capacity SVE system design would be more easily integrated with the SVE design proposed for the soil gas / indoor air control system.

Effectiveness: Direct chemical oxidation of the site contaminants is a highly effective method to immediately reduce source area contamination. Soils that do not come into contact with the oxidant would be remediated with an SVE system. SVE is one of the most widely used and effective process options for treatment of the vadose zone soils contaminated with the VOCs at CERCLA sites and elsewhere. Based on the available information, it is estimated that properly located SVE extraction wells will be able to capture the remaining contaminant mass at the source area soils to minimize contaminant flux into the groundwater plume. This technology would recover and treat contaminated soil vapors from the dry well source area at 100 Oser Avenue.

Implementability: The recovery and injection wells, process equipment and discharge system are commercially available and installed using conventional methods. Based on the required equipment, the SVE treatment process may be enclosed within a building or suitable structure. SVE technology has been installed and operated at numerous sites since the early 1990's. Equipment and staff are readily available to implement this remedial alternative.

Cost: The capital cost for a combined $NaMnO_4$ and SVE process option at Oser Avenue is moderate, when compared to No Action or short-term remedial alternatives. However, the total cost of this remedial alternative is moderately expensive due to long-term O&M costs and vapor treatment maintenance which are dependent upon the project duration.

Conclusions: An SVE – $NaMnO_4$ and SVE process option is an effective and reliable technology for remediation of the source area soils contained within the vadose zone. This remedial alternative is retained for further consideration.

4.1.3 Development of Soil Gas/Indoor Air Alternatives

Alternative 1: No Action

The No Action alternative has been included in order to provide a baseline by which to compare other alternatives. Under this alternative the affected media will not be treated and the site conditions would remain the same.

Alternative 2: SVE

Soil vapor extraction can be used adjacent to buildings to influence the natural pressure gradient between the structure and the underlying soils. SVE is an *in-situ* process where adsorbed VOC contaminants and contaminated soil vapors are removed from the vadose zone soils by physically applying a vacuum to the subsurface. By applying a vacuum to wells or trenches located adjacent to the structure, or placed below the structure, or both, soil gases can be collected before they impact indoor air quality. The applied vacuum creates air movement in the subsurface and contaminants are volatilized and extracted with the air that exists and moves through the soil pore spaces away from the impacted structures. These vapors are drawn through the extraction system and process pump or blower and vented either directly to the atmosphere or processed through a vapor abatement system. The vacuum is applied to the subsurface either through shallow trenches or vertical wells installed by conventional means.

Effectiveness: SVE is one of the most widely used and effective process options for treatment of the vadose zone soils contaminated with the VOCs at CERCLA sites and elsewhere. SVE is especially effective at preventing the migration of contaminated vapor into buildings and other structures. Based on the available information, it is estimated that properly located SVE extraction wells will be able to capture sufficient contaminants from below the building to minimize contaminant flux into the structure. This technology would recover and treat contaminated soil vapors from the area below the building at 100 Oser Avenue and below the building at 110 Oser Avenue.

Implementability: The recovery wells, process equipment and discharge system are commercially available and installed using conventional methods. Based on the scope of equipment, the treatment process could be combined with the SVE effort at the source area on the western side of the building as one implementation.

Cost: The capital cost to include vapor extraction adjacent to the building to be included in the source area treatment system at Oser Avenue is low and the O&M costs would be low to moderate, depending upon the project duration.

Conclusions: An SVE system is an effective and reliable technology for remediation of the soils underlying the building area. This remedial alternative is retained for further consideration.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 Introduction

In this section, remedial action alternatives developed and retained for further consideration in **Section 4.0** are described and evaluated in detail. The detailed evaluation of alternatives provides information to facilitate the comparison of alternatives and the selection of a final remedy. In accordance with the guidance documents, the seven CERCLA screening criteria are used in the detailed analysis:

1) Overall Protection of Human Health and Environment
2) Compliance with SCGs, ARARs, and Other Regulations
3) Short-Term Effectiveness
4) Long-Term Effectiveness
5) Reduction in Mobility, Toxicity, and Volume
6) Implementability
7) Cost

The analysis of alternatives is two-tiered. The first tier is comprised of threshold factors 1) overall protection of human health and the environment, and 2) compliance with SCGs, ARARs, and other previously referenced applicable regulations. Any selected remedy must result in overall protection of human health and the environment. Similarly, the SCGs, ARARs, and other regulations must be complied with unless there is an overriding reason why compliance is not possible. The second tier is comprised of the remaining five criteria. The relative merits and problems associated with meeting these factors must be balanced in arriving at a remedy. The issues associated with each of these seven criteria are briefly described below.

Overall Protection of Human Health and Environment

This criterion addresses the overall protection of human health and the environment by eliminating, reducing or controlling site risks posed through the exposure pathways. This includes direct contact risks and potential risks to ecosystems.

Compliance with SCGs, ARARs, and Other Regulations

This criterion evaluates how each alternative complies with SCGs, ARARs and other regulations. The three regulatory categories of ARARs that will be considered are chemical-specific, location-specific, and action-specific. Additionally, the need for waivers will be addressed, if appropriate.

Short-Term Effectiveness

The effectiveness of an alternative in protecting human health and the environment during construction and implementation is assessed under short-term effectiveness. This criterion encompasses concerns about short-term impacts, as well as the length of time required to implement the alternative. Factors such as cross media impacts, the need to transport contaminated material through populated areas, current site operations, and the potential disruption of neighborhoods and ecosystems may be pertinent.

A site-specific health and safety plan would be prepared, which would include the potential impacts of a particular remediation activity and contain measures to address the concerns.

Long-Term Effectiveness

The evaluation of an alternative under this criterion addresses the results of remedial action, in terms of residual risk and residual mass of VOCs remaining in a particular media after the completion of the alternative.

Reduction in Mobility, Toxicity, and Volume

This criterion involves the following factors:

- Degree of expected reduction of VOC contamination, in terms of concentration and mass, and
- The mass of VOCs or the volume of impacted media that will be destroyed or contained.

This criterion also addresses changes in risks due to changes in contaminant mobility, toxicity, or volume.

Implementability

This criterion involves an evaluation of the alternative with respect to performance, reliability, and implementability. Performance and reliability focus on the ability of the alternative to meet specific goals or clean-up levels. The implementability of an alternative addresses construction and operation in regards to the site-specific conditions. Implementability also addresses the difficulties or impediments of implementing a particular treatment option at the site. It also focuses on the time and effort required obtaining appropriate approvals, and addressing other administrative issues.

Cost

Capital and operation order-of-magnitude maintenance costs are evaluated for each alternative under each scenario. These costs include design and construction costs, remedial action operating costs, other capital and short-term costs, costs associated with maintenance, and costs of performance evaluations, including monitoring. All costs are calculated on a present worth basis and are accurate to –30% to +50%. The EPA 2000 Guidance document was used to establish costs and uniform comparison between remedial alternatives. Detailed costs estimates are provided in **Appendix B**.

5.2 Detailed Analysis of Individual Alternatives

Alternatives formulated in **Section 4.0** for detailed analysis are grouped by medium in this section as follows:

Groundwater Alternative 1: No Action
Groundwater Alternative 2: Pump and Treat
Groundwater Alternative 3: KMnO4 Injection
Groundwater Alternative 4: KMnO4 Injection and Pump and Treat

Soil Alternative 1: No Action
Soil Alternative 2: SVE
Soil Alternative 3: NaMnO4 Injection
Soil Alternative 4: SVE and NaMnO4 Injection

Soil/Gas Indoor Air Alternative 1: No Action
Soil/Gas Indoor Air Alternative 2: SVE

5.2.1 Groundwater Alternative 1: No Action

The No Action alternative represents a baseline against which other applicable alternatives are measured. Under this alternative no remedial action would be taken to address the VOC contamination in the groundwater. The only activity that will be performed at the site would be

60 year groundwater monitoring during the natural attenuation of the contaminants in the aquifer.

5.2.1.1 Overall Protection of Human Health and Environment

This alternative would not reduce potential risks to human health or the environment.

5.2.1.2 Compliance with SCGs, ARARs, and Other Regulations

This alternative would not comply with SCGs, ARARs, and other regulations related to the VOCs in the groundwater at the site.

5.2.1.3 Short-Term Effectiveness

No short-term adverse impacts would result from implementing this alternative because there are no construction activities associated with it.

5.2.1.4 Long-Term Effectiveness

This alternative would result in a slow gradual reduction of the VOCs in both levels and toxicity as natural attenuation processes continue to occur. Residual theoretical upperbound risks would decline correspondingly from the existing theoretical risk levels.

5.2.1.5 Reduction in Mobility, Toxicity and Volume

The No Action alternative does not reduce mobility, toxicity or volume of the contaminants. Contaminants continue to migrate (volume expansion) throughout the environment and their toxicity remains relatively the same, with a possibility of natural attenuation having a minimal effect on the concentration levels of individual contaminants.

5.2.1.6 Implementability

Since no action is taken to implement this alternative, technical feasibility and performance are not an issue.

5.2.1.7 Cost

There are no capital or maintenance costs associated with this alternative. The only cost associated with this alternative would be for periodic groundwater monitoring. Assuming that groundwater monitoring will extend for 60 years, the total net present worth cost for this activity, as outlined in **Table 5-1** in **Appendix B**, is estimated to be $157,252.

5.2.2 Groundwater Alternative 2: Pump and Treat

This remedial alternative consists of the installation of five (5) groundwater extraction wells within the plume and a pump and treat system to treat the contaminated groundwater **(Figure 5-1).**

Groundwater would be extracted using standard recovery wells and transferred to a treatment system. The treatment system will include an air stripper with liquid and vapor phase activated carbon. The system will be designed to comply with the air and surface water discharge criteria.

The implementation of this alternative includes design, construction, operation and maintenance of the groundwater recovery wells and pump and treat system.

Groundwater extracted from the on-site wells would be transferred via an underground force main (header) to the treatment system, which will be located at the rear of 100 Oser Avenue. Groundwater collected from the recovery system will be collected in an equalization tank to regulate flow and settle larger suspended solids. An air stripper and liquid phase granular activated carbon (GAC) unit will remove VOCs. The VOCs in the air stripper off-gas will be removed in vapor phase GAC prior to discharge to the atmosphere. Treated water will be pumped into a retention basin located behind 80 Oser Avenue using a transfer pump and buried discharge pipe.

Based on the groundwater modeling, the pump and treat system will operate for approximately 35 years to reduce the VOC concentrations to the compliance levels.

5.2.2.1 Overall Protection of Human Health and Environment

This alternative will be protective of human health and the environment because on-site VOC impacted groundwater will be captured, treated, and prevented from further migration.

This alternative reduces the concentrations of VOCs in the aquifer to below MCLs within 35 years, reduces the amount of plume growth and migration, and therefore meets the RAOs presented in this FS Report.

5.2.2.2 Compliance with SCGs, ARARs, and Other Regulations

Implementation of this alternative will achieve chemical-specific ARARs on-site in approximately 35 years. This alternative will provide for significant reductions of contaminants in the groundwater and reduce further migration of the contaminated groundwater. Therefore, the goal of the removal action, to minimize exposure and contaminant migration, and restoration of the aquifer, will be met by this alternative.

This alternative will also comply with action-specific and chemical-specific ARARs related to the discharge of the groundwater and the air discharge. Compliance with action-specific ARARs will be met through proper design and sizing of the remedial equipment. System effluent sampling and reporting for the treatment system will document compliance with all discharge standards. Compliance with ARARs for air emissions will be met by complying with the technical requirements of the appropriate air permitting and utilizing off-gas treatment prior to discharge. This alternative will be designed and operated to comply with applicable ARARs governing air emissions to minimize adverse impacts to human health and the environment.

5.2.2.3 Short-Term Effectiveness

Potential short-term risks to construction workers and the community may exist during the installation of the remediation system components specified within this alternative. During the installation of the extraction wells and foundation for the treatment building, exposure to contaminated media will be minimized through the use of personal protective equipment such as gloves and protective clothing. Implementing a site-specific health and safety program will minimize other short-term risks.

5.2.2.4 Long-Term Effectiveness

This alternative would provide an effective long-term remedy for COPCs present in groundwater at the Site. VOC contaminated groundwater will be removed and treated in an on-site treatment system. The pump and treat system will permanently capture, remove and contain existing VOC concentrations within the defined hot-spot area and mitigate migration of VOCs to beyond the existing plume boundaries.

The recovery wells will permanently remove the contaminants of concern from the aquifer and will provide a reduction of total contaminant mass and prevent downgradient VOC migration. Because each well will operate independently, certain wells may be turned off once clean-up goals are achieved while maintaining long-term effectiveness. Routine operations and maintenance of the pump and treat system will ensure proper system performance.

5.2.2.5 Reduction in Mobility, Toxicity and Volume

This alternative will reduce the overall volume of toxic contaminants present in the aquifer, provide a permanent remedy for reduction of contaminant toxicity, mobility and volume through treatment, and meet the USEPA statutory preference for treatment as a principal element. Implementation of this alternative does provide for moderate to high reductions in the risk of exposure from additional groundwater migration. Groundwater impacted by VOC concentrations greater than MCLs, not captured by this system, will be naturally attenuated. Groundwater modeling simulations indicate that the pump and treat system reduces VOC plume concentrations, mobility, and volume significantly. Based on groundwater modeling simulations, VOCs within the aquifer will be remediated down to MCLs within 35 years.

5.2.2.6 Implementability

This alternative is implementable at the Site. Pump and treat systems are commonly used for remediation of contaminated aquifers. Recovery wells can be installed at the required depths. Construction of a treatment system and renovation of the existing detention basin is a relatively straightforward task. Prior to discharging treated effluent, a discharge permit will need to be obtained.

5.2.2.7 Cost

Capital costs associated with this alternative include: the installation of on-site recovery wells, on-site pump and treat system and facility, and the implementation of a groundwater monitoring program. The capital cost for this alternative is approximately $1,141,808.

The present worth cost also takes into consideration the following:

- Operating and maintaining the on-site extraction wells and pump and treat system for approximately 35 years.
- Quarterly sampling of four wells for the first 10 years, and semi-annual groundwater sampling for the following 25 years
- Reporting function for the duration of operation.

The total net present worth cost for the pump and treat system, as outlined in **Table 5-2** in **Appendix B** is estimated to be $6,023,037.

5.2.3 Groundwater Alternative 3: $KMnO_4$ Injection

This remedial alternative consists of the injection of a solution of potassium permanganate to treat the entire saturated thickness of the contaminant plume. The effectiveness of treatment depends on three factors: the kinetics of the reaction between the permanganate and the contaminant compounds; the contact between the oxidant and the contaminants; and competitive reactions of permanganate with other reduced/oxidizable species. If the contaminant being targeted for *in-situ* chemical oxidation is reactive (i.e., chlorinated ethenes), and sufficient oxidant has been added to overcome the demand from other reduced species, the limiting factor to the successful application of *in-situ* oxidation is the transport of the oxidant to the areas where contaminants are present, not the reaction itself between the permanganate and the contaminants. The oxidation of contaminants by permanganate is essentially an instantaneous reaction. By contrast, travel times for the permanganate to migrate away from the addition point may be on the order of a day to weeks, depending on the rate of groundwater flow.

The primary limitation to permanganate treatment is the ability to apply the permanganate *in-situ* and to maintain efficient contact between the permanganate and the contaminants. Despite the data obtained during the RI, accurate site-specific groundwater flow characteristics have not been determined to the degree necessary to assure the successful and safe application of permanganate. Therefore, a pilot test will need to be conducted. The pilot test will have the following objectives:

- **Evaluate the Rate of Reaction.** The migration of permanganate, the amount consumed, and the area affected will be monitored to determine the overall effectiveness of this treatment method.

- **Evaluate Mass Destruction.** The mass of VOCs destroyed in the reaction will be estimated using the amount of chloride measured, results of field parameter tests, and the concentrations of VOCs detected during subsequent groundwater sampling events.

- **Evaluate Direction and Time of Travel.** Field measurements for conductivity and sample analysis for field parameters will be conducted to estimate the travel time of permanganate. This information will also be used to demonstrate the effectiveness of this treatment method.

The pilot-scale test will be used to determine the design of the treatment volume and application spacing for the representative process option full-scale injection. For costing purposes, the following assumptions apply:

5.2.3.1 *Overall Protection of Human Health and the Environment*

This alternative will be protective of human health and the environment by destroying dissolved VOC contaminants and preventing further plume migration. This alternative will reduce the concentrations of VOCs in groundwater to below cleanup levels and therefore meets the RAOs presented in this FS Report.

5.2.3.2 *Compliance with SCGs, ARARs, and Other Regulations*

Implementation of this alternative will achieve chemical-specific ARARs on-site in approximately one year. This includes the completion of the pilot-scale test, design and implementation of the full-scale injection, and post-injection monitoring. This alternative will provide for significant reductions of contaminants in the groundwater and reduce further migration of the contaminated groundwater. Therefore, the goal of the removal action, to minimize exposure and contaminant migration, and restoration of the aquifer, will be met by this alternative. However, this assumes the prior removal of any continuing source of VOC contamination.

5.2.3.3 *Short-Term Effectiveness*

Potential short-term risks to construction workers and the community might exist during activities involving the installation of monitoring wells, collection of groundwater data, and mixing and injection of permanganate. Exposure to contaminated media, during the installation of the monitoring wells, will be minimized through the use of personal protective equipment such as gloves and protective clothing. Applicable protective gear and a spill response plan will also be used during the handling, mixing, and injection of the permanganate solution. Similar protocols will be implemented for all associated groundwater gauging and sampling activities. Additionally, short-term effects during the installation of this alternative can be minimized by implementing an effective site-specific health and safety program, and through the use of institutional controls.

5.2.3.4 *Long-Term Effectiveness*

This alternative would provide an effective long-term remedy for VOCs present in the groundwater at the Site. This alternative's long-term effectiveness will permanently destroy existing dissolved phase VOC concentrations on the OU1 site as well as prevent the continued off-site migration of VOCs. The alternative will provide a reduction of the total contaminant mass and prevent downgradient VOC migration.

This alternative would be greatly inhibited by the presence of a continued source of VOC contaminants. Long-term effectiveness would be enhanced by the treatment of the source area prior to the final permanganate injection. Otherwise, subsequent permanganate injection(s) may be required. Groundwater monitoring data will help determine the overall effectiveness of this alternative.

5.2.3.5 Reduction in Mobility, Toxicity and Volume

This alternative will reduce the overall volume of toxic contaminants present in the saturated zone; provide a permanent remedy for reduction of contaminant toxicity, mobility, and volume through treatment; and meet the USEPA statutory preference for treatment as a principal element. Effectiveness of this technology will be determined through the successful completion of the field pilot test. Successful treatment will be dependent on the determination of groundwater transport and mass balance for full-scale treatment to concentrations meeting cleanup objectives. Groundwater impacted with VOCs not reached or affected by permanganate will be naturally attenuated.

5.2.3.6 Implementability

Permanganate is a food-grade oxidizing chemical ideal for the application to groundwater for the treatment of a variety of VOCs, specifically chlorinated ethenes. Permanganate has been used at sites throughout the country, in a variety of geologic settings for the destruction of the compounds found at the Oser Avenue site. Injection of permanganate is accomplished through injection wells constructed in an identical manner to existing monitoring wells. The structures existing on-site present the only restriction to successful implementation of a permanganate injection. However, the pilot test will allow for the successful design of an application scenario that will ensure the migration of the permanganate to locations underneath the buildings.

5.2.3.7 Cost

- Collection of baseline data including field sampling and fixed-base laboratory sampling will be completed prior to full scale injection.
- Permanganate will be injected into eight new shallow monitoring wells and four existing deep monitoring wells.

- Field data will be collected weekly for the first 12 weeks and biweekly for the subsequent 24 weeks.
- Groundwater samples will be collected one and three months after injection.

Capital costs associated with the estimated scope of the full scale injection, based on data obtained during the RI, includes the pilot test, baseline monitoring, preparation and injection of potassium permanganate, the post injection monitoring program, and any necessary reporting. The capital cost for this alternative is approximately $1,733,280 with a total estimated net present worth, as outlined in **Table 5-3** in **Appendix B**, of $1,910,881. This cost estimate may be altered substantially based upon the results of the pilot study.

The total net present worth for potassium permanganate injection, including the field pilot test and full-scale injections is estimated to be $1,910,881.

5.2.4 Groundwater Alternative 4: $KMnO_4$ Injection and Pump and Treat

This remedial alternative option consists of two separate technologies to separately and effectively deal with the two parts of the plume, the source area of the plume and the downgradient portion of the plume. The injection of a solution of potassium permanganate would be used to treat the entire saturated thickness of the source area of the plume. The effectiveness of treatment depends on three factors: the kinetics of the reaction between the permanganate and the contaminant compounds; the contact between the oxidant and the contaminants; and competitive reactions of permanganate with other reduced/oxidizable species. The oxidation of contaminants by permanganate is an essentially instantaneous reaction. By contrast, travel times for the permanganate to migrate away from the addition point to the entire source area may be on the order of a day to weeks, depending on the rate of groundwater flow. A field pilot test would be necessary to determine site-specific groundwater flow characteristics necessary to assure the successful and safe application of permanganate. This approach would quickly remove a large portion of the contaminant mass in the saturated zone.

The second part of this remedial alternative consists of the installation of five (5) groundwater extraction wells within the plume and pump and treat system to treat the contaminated groundwater as a means of mass removal and control of the migration of the plume offsite. The groundwater will be extracted using standard recovery wells, transferred via buried pipe onsite and treated via an air stripper and liquid and vapor phase activated carbon to comply with the air and surface water discharge criteria, respectively. The implementation of this alternative includes design, construction, operation, and maintenance of the groundwater recovery wells and pump and treat system.

The groundwater extracted from the on-site wells will be transferred via underground force main (header) to a treatment system, which will be located at the rear of 100 Oser Avenue. Groundwater collected from the recovery system will be collected in an equalization tank to regulate flow and settle some larger suspended solids. An air stripper and liquid phase granular activated carbon (GAC) unit will remove VOCs. The VOCs in the air stripper off-gas will be removed in vapor phase GAC prior to discharge to the atmosphere. Treated water will be pumped into a detention basin located behind 80 Oser Avenue using a transfer pump and discharge pipe.

Based on the groundwater modeling, the pump and treat system will operate for a period of 15 years to reduce the VOC concentrations to compliance levels. This is because the permanganate representative process option will achieve quick source removal, hence the initial VOC concentrations in the groundwater will be lower, reducing the treatment time needed for the pump and treat alternative.

5.2.4.1 Overall Protection of Human Health and Environment

This alternative will be protective of human health and the environment because on-site VOC impacted groundwater will be captured, destroyed or treated, and prevented from further migration.

5.2.4.2 Compliance with SCGs, ARARs, and Other Regulations

Implementation of this alternative will achieve chemical-specific ARARs on-site in approximately 15 years. This alternative will provide for significant reductions of contaminants in the groundwater and reduce further migration of the contaminated groundwater. Therefore, the goal of the removal action, to minimize exposure and contaminant migration, and restoration of the aquifer, will be met by this alternative.

This alternative will also comply with action-specific and chemical-specific ARARs related to the discharge of the groundwater and the air discharge from the treatment system. Compliance with action-specific ARARs will be met through proper design and sizing of the permanganate injections and the remedial equipment. System effluent sampling and reporting for the treatment system will document compliance with all discharge standards. Compliance with ARARs for air emissions will be met by complying with the technical requirements of the appropriate air permitting and by utilizing off-gas treatment prior to discharge. This alternative will be designed and operated to comply with applicable ARARs governing air emissions to minimize adverse impacts to human health and the environment.

5.2.4.3 Short-Term Effectiveness

Potential short-term risks to construction workers and the community might exist during the installation of the remediation system components specified within this alternative. Exposure to contaminated media will be minimized during the installation of the extraction wells and foundation for the treatment building through the use of personal protective equipment such as gloves and protective clothing. Personal protective gear for workers during sampling will help minimize similar associated risks. Additionally, implementing an effective site-specific health and safety program, and institutional controls can minimize short-term effects during the installation of this alternative. Applicable protective gear and a spill response plan will also be used during the handling, mixing, and injection of the permanganate solution.

This remedial alternative will be designed and operated to comply with applicable ARARs governing treated water discharge and air emissions to minimize adverse impacts to human health and the environment.

5.2.4.4 Long-Term Effectiveness

This alternative would provide an effective long-term remedy for VOCs present in groundwater at the Site by reducing source are VOCs with permanganate and by capturing VOCs in the groundwater plume with on-site recovery wells.

The permanganate injection and groundwater recovery will permanently remove the contaminants of concern from the aquifer and will provide a reduction of total contaminant mass and prevent downgradient VOC migration. Since each well will operate independently, certain wells may be turned off once clean-up goals are achieved while maintaining long-term effectiveness. Routine operations and maintenance of the pump and treat system will ensure proper system performance.

5.2.4.5 Reduction in Mobility, Toxicity and Volume

This alternative will reduce the overall volume of toxic contaminants present in the aquifer, especially at the source area, halting further deterioration of aquifer quality. The pump and treat portion will provide a continuous and permanent remedy for reduction of contaminant toxicity, mobility and volume through treatment, and will meet the USEPA statutory preference for treatment as a principal element. Implementation of this alternative does provide for moderate to high reductions in the risk of exposure from additional groundwater migration. Groundwater impacted by VOC concentrations greater than MCLs, not captured by this system, will be naturally attenuated. Groundwater modeling simulations indicate that the pump and treat system reduces VOC plume concentrations, mobility, and volume significantly. Based on the removal of the source area and continued operation of the pump and treat system for plume control, based on groundwater modeling simulations, VOCs within the aquifer will be remediated down to MCLs within 15 years.

5.2.4.6 Implementability

This alternative is implementable at the Site. Pump and treat systems are commonly used for remediation of contaminated aquifers. Recovery wells can be installed at the required depths. Construction of a treatment system and renovation of the existing detention basin is a relatively straightforward task. Prior to discharging treated effluent, a discharge permit will need to be obtained.

Permanganate is a food grade oxidizing chemical ideal for the application to groundwater for the treatment of a variety of VOCs, specifically chlorinated ethenes. Permanganate has been used at sites throughout the country, in a variety of geologic settings for the treatment of the compounds found at the Oser Avenue site. Injection of permanganate is accomplished through injection wells constructed in an identical manner to existing monitoring wells. The structures existing on-site present the only restriction to successful implementation of a permanganate injection. However, the pilot test will allow for the successful design of an application scenario that will ensure the migration of the permanganate to locations underneath the buildings.

5.2.4.7 Cost

Capital costs associated with this alternative include: application of permanganate oxidant, the installation of on-site recovery wells, on-site pump and treat system and facility, and the implementation of a groundwater monitoring program. The capital cost for this alternative is approximately $2,449,358 as outlined in **Table 5-4** in **Appendix B**.

The present worth cost also takes into consideration the following:

- Operating and maintaining the on-site extraction wells and pump and treat system for approximately 15 years.
- Quarterly sampling of 4 wells for the first 10 years, and semi-annual groundwater sampling for the following 5 years
- Reporting function for the duration of operation.

The total net present worth cost for the pump and treat and $KMnO_4$ injection system, as outlined in **Table 5-4** in **Appendix B** is estimated to be $5,847,145.

5.2.5 Soil Alternative 1: No Action

The No Action alternative represents a baseline against which other alternatives are measured. Under this alternative no remedial action would be taken to address the VOC contamination in the vadose zone source area. The only activity that will be performed at the site would be indefinite groundwater monitoring as the contaminants leach into the groundwater and undergo natural attenuation of the contaminants in the aquifer.

5.2.5.1 Overall Protection of Human Health and Environment

This alternative would not reduce potential risks to human health of the environment.

5.2.5.2 Compliance with SCGs, ARARs, and Other Regulations

This alternative would not comply with SCGs, ARARs, and other regulations related to the VOCs found in the soils at the Site.

5.2.5.3 Short-Term Effectiveness

No short-term adverse impacts would result from implementing this alternative since there are no construction activities associated with it.

5.2.5.4 Long-Term Effects

This alternative would result in a gradual reduction of the VOCs in both levels and toxicity as natural attenuation processes continue to occur. Residual theoretical upper bound risks would decline correspondingly from the existing theoretical risk levels.

5.2.5.5 Reduction in Mobility, Toxicity and Volume

The No Action alternative does not reduce mobility, toxicity or volume of the contaminants. Contaminants continue to migrate (volume expansion) throughout the environment and their toxicity remains relatively the same, with a possibility of gradual natural attenuation having a minimal effect on the concentration levels of individual contaminants over time.

5.2.5.6 Implementability

Since no action is taken to implement this alternative, technical feasibility and performance are not an issue.

5.2.5.7 Cost

There are no capital or maintenance costs associated with this alternative. The only cost associated with this alternative would be for groundwater monitoring. Assuming that groundwater monitoring will extend for 60 years, the total net present worth cost for this activity, as outlined in **Table 5-1** in **Appendix B**, is estimated to be $157,252.

5.2.6 Soil Alternative 2: SVE

This remedial alternative consists of the installation of two (2) soil vapor extraction wells within the drywell source area to remove the PCE contaminant.

The soil vapor will be extracted using standard extraction wells and transferred to a treatment system via subsurface pipe. The onsite treatment system will consist of an existing catalytic oxidizer and acid gas scrubber designed to comply with the appropriate air discharge criteria and a vapor abatement system. The system will be located on the northern side of Building 100.

The implementation of this alternative includes design, construction, operation and maintenance of the soil vapor extraction and treatment system.

5.2.6.1 Overall Protection of Human Health and Environment

This alternative will be protective of human health and the environment because on-site VOC impacted soils will be treated and destroyed, thus preventing further migration of PCE.

This alternative will reduce the concentrations of VOCs in the vadose zone to below cleanup levels and reduce the amount of plume growth and migration; therefore, this alternative meets the RAOs presented in this FS Report.

5.2.6.2 Compliance with ARARs

Implementation of this alternative will achieve chemical-specific ARARs on-site in approximately five years. This alternative will provide for significant reductions of contaminants in the groundwater and reduce further migration of the contaminated groundwater. Therefore, the goal of the removal action, to minimize exposure and contaminant migration, and restoration of the aquifer, will be met by this alternative.

This alternative will also comply with action-specific and chemical-specific ARARs related to the discharge of the groundwater and the air discharge. Compliance with action-specific ARARs will be met through proper design and sizing of the remedial equipment. System effluent sampling and reporting for the treatment system will document compliance with all discharge standards. Compliance with ARARs for air emissions will be met by complying with the technical requirements of the appropriate air permitting and utilizing off-gas treatment prior to discharge. This alternative will be designed and operated to comply with applicable ARARs governing air emissions to minimize adverse impacts to human health and the environment.

5.2.6.3 Short-Term Effectiveness

Potential short-term risks to construction workers and the community may exist during activities involving the installation of the remedial components specified within this alternative. During the installation of the extraction wells and foundation for the treatment building, exposure to contaminated media will be minimized through the use of personal protective equipment such as gloves and protective clothing. Personal protective gear for workers during sampling will help minimize similar associated risks. Additionally, implementing an effective site-specific health and safety program, and institutional controls can minimize short-term effects during the installation of this alternative.

This remedial alternative will be designed and operated to comply with applicable ARARs governing treated air discharge and to minimize adverse impacts to human health and the environment.

5.2.6.4 Long-Term Effectiveness

This alternative would provide an effective long-term remedy for COPCs present in the vadose zone at the Site. The vacuum extraction system will capture and remove the existing VOC contamination located within the defined source area and prevent further migration of VOCs to the aquifer.

The recovery wells will permanently remove the contaminants of concern from the vadose zone and will provide a reduction of total contaminant mass and prevent downward VOC migration. A long-term on-site management strategy that incorporates controlling contaminated soil exposure pathways will effectively minimize the risks associated with the VOC contaminated source area. Routine operations and maintenance of the extraction system will ensure proper system performance. A monitoring program will be established to measure the contaminant levels present in the effluent stream prior to discharge. In addition, pressure drop will be monitored across the vacuum pump to monitor potential fouling conditions, which may impact treatment efficiency. An air monitoring program will be established to measure contaminant levels within the emissions from the air treatment unit prior to discharge. Groundwater monitoring data will help determine the overall effectiveness of this alternative. Routine operations and maintenance of the remediation system will ensure proper system performance.

5.2.6.5 Reduction in Mobility, Toxicity and Volume

This alternative will reduce the overall volume of toxic contaminants present in the vadose zone, provide a permanent remedy for reduction of contaminant toxicity, mobility and volume through treatment and destruction, and meet the USEPA statutory preference for treatment as a principal element. Implementation of this alternative does provide for moderate to high reductions in the risk of exposure from additional contamination of the groundwater. Soils impacted by VOC concentrations greater than cleanup limits, not captured by this system, will be naturally attenuated.

5.2.6.6 Implementability

This alternative is implementable at the Site. The soil vapor extraction process is commonly used in the remediation of VOC-contaminated vadose zone soils. The system is reliable and can achieve the specified performance criteria for removal of the organic compounds. Wells can be drilled to the depths required and discharge of the treated air stream will need to be permitted.

5.2.6.7 Cost

Capital costs associated with this alternative include: the installation of two (2) on-site recovery wells, an on-site extraction system and facility, and the implementation of a groundwater monitoring program. The capital cost for this alternative is approximately $595,800 as outlined in **Table 5-5** in **Appendix B**.

The total net present worth cost for the SVE alternative, as outlined in **Table 5-5** in **Appendix B** is estimated to be $2,172,153.

5.2.7 Soil Alternative 3: $NaMnO_4$ Injection

This remedial option consists of the injection of a sodium permanganate solution into the area surrounding the dry wells located on the western side of the 100 Oser Avenue building. Sodium permanganate would be used rather than potassium permanganate previously discussed as a groundwater alternative due to the increased solubility of sodium permanganate. The higher mass of PCE found in the source area would require the use of a higher concentration permanganate solution due to the lower injection contact time and higher contaminant mass volume.

The effectiveness of this remedial strategy is the ability of the permanganate to be applied such that the entire contaminated volume of soil comes into contact with a sufficient mass of permanganate to overcome the oxidant demand from the soils. The primary consideration for the design of an injection strategy is the ability of the sediments to spread the permanganate laterally. Soil investigations in the vicinity of the dry wells have shown little variation in the grain size of sediments that would facilitate the lateral dispersion of fluids infiltrating into the vadose zone. Thin lenses of fine-grained sand and occasional silty layers were encountered; however, observations and chemical analysis of soil samples, indicates that this lateral dispersion is minimal.

An injection strategy would consist of the installation of five injection wells screened in the contaminated area of the vadose zone (**Figure 5-2**). Mass calculations and oxidant demand testing has estimated the total mass of permanganate necessary to treat the source area to be approximately 376,200 pounds. This would be equally distributed between the five injection wells in order to ensure application to the entire impacted area.

5.2.7.1 Overall Protection of Human Health and Environment

This alternative will be protective of human health and the environment by destroying adsorbed phase VOCs in the source area soils, thus preventing leaching to groundwater. This alternative will reduce the concentrations of VOCs in soil to below cleanup levels and therefore meets the RAOs presented in this FS report.

5.2.7.2 Compliance with ARARs

Implementation of this alternative will achieve chemical specific ARARs on site in approximately 1 year. This includes the design and implementation of the permanganate injection event and post injection monitoring. This alternative will provide for the significant reduction of contaminants in the source area soils and prevent future migration of contaminants to groundwater.

5.2.7.3 Short-Term Effectiveness

Potential short-term risks to construction workers and the community may exist during activities involving the installation of injection wells, collection of baseline data, and the mixing and injection of permanganate. During the installation of monitor wells, exposure to contaminated media will be minimized through the use of personal protective equipment such as gloves and protective clothing. Applicable protective gear and a spill response plan will also be used during the handling, mixing, and injection of the permanganate solution. Similar protocols will be implemented for all associated soil and groundwater sampling activities. Additionally, short-term risks during the application of this alternative can be minimized by implementing an effective site-specific health and safety program and institutional controls.

5.2.7.4 Long-Term Effectiveness

This alternative would provide an effective long-term remedy for VOCs present in the vadose zone at the Site. This alternative will permanently destroy some, if not all, of the existing adsorbed phase VOC concentrations found in the vicinity of the dry wells located on the western side of the 100 Oser Avenue building. This will also reduce, if not eliminate, this area as a continued source of groundwater contamination, thereby presenting a reduction in the transport of contaminants to off-site properties.

Long-term exposure risks associated with periodic sampling activities will be minimized through the implementation of a site-specific health and safety plan and institutional controls. Soil and groundwater monitoring data will be used to determine the overall effectiveness of this alternative.

5.2.7.5 Reduction in Mobility, Toxicity and Volume

This alternative would effectively reduce the overall volume of vadose zone contaminants in the vicinity of the dry wells located on the western side of the 100 Oser Avenue building. Mass balance calculations indicate that the mass of permanganate proposed for treatment is more than sufficient to completely oxidize the contaminant mass found in this area. VOC impacted soil in this area that cannot be reached by permanganate will be naturally attenuated or treated by another remedial option.

5.2.7.6 Implementability

Permanganate is a food-grade oxidizing chemical ideal for the application to soil for the treatment of a variety of VOCs, specifically chlorinated ethenes. Permanganate has been used at sites throughout the country, in a variety of geologic settings for the treatment of the compounds found at the Oser Avenue site. Injection of permanganate is accomplished through monitoring wells that could be easily installed. There are no conditions at the site that would limit the ability to implement this remedial option. The applications anticipated are several times greater than the stoichiometric demand for permanganate to ensure performance and reliability.

5.2.7.7 Cost

Capital costs associated with the field pilot study are not included in the source area permanganate injection. It is assumed that the pilot study data obtained from the Groundwater Remedy will be sufficient. This will result in a cost savings of approximately $160,000.

Capital costs associated with the estimated scope of the full scale injection, according to the data obtained during the RI, includes the baseline monitoring, preparation and injection of sodium permanganate, the post injection monitoring program and any necessary reporting. The capital costs for this alternative are approximately $2,155,148, with a total estimated present worth as outlined in **Table 5-6** of $2,202,068. This cost estimate may be altered substantially based upon the results of the field pilot study.

5.2.8 Soil Alternative 4: $NaMnO_4$ and SVE

This remedial alternative consists of the injection of a sodium permanganate solution into the area surrounding the dry wells located on the western side of the 100 Oser Avenue building. Sodium permanganate would be used rather than potassium permanganate (previously discussed as a groundwater alternative) due to the increased solubility of sodium permanganate. The higher mass of PCE found in the source area would require the use of a higher concentration permanganate solution due to the lower injection contact time and higher contaminant mass volume. After sufficient time for the contact and chemical reaction of the contaminants and the oxident, the SVE system would be started to recover the remaining contaminants. The soil vapor will be extracted using standard extraction wells and transferred via subsurface pipe to an onsite carbon adsorption treatment system. The treatment system will be designed to comply with the air discharge criteria.

The effectiveness of this remedial strategy is the ability of the permanganate to be applied such that the entire contaminated volume of soil comes into contact with a sufficient mass of permanganate to overcome the oxidant demand. The primary consideration for the design of an injection strategy is the ability of the sediments to spread the permanganate laterally. Soil investigations in the vicinity of the dry wells have shown little variation in the grain size of sediments that would facilitate the lateral dispersion of fluids infiltrating into the vadose zone. Thin lenses of fine-grained sand and occasional silty layers were encountered; however, observations and chemical analysis of soils samples, indicates that this dispersion is minimal. Those soils not contacted by the permanganate will be remediated by the SVE process. The implementation of this alternative includes design, construction, injection, and operation and maintenance of the soil vapor extraction and treatment system. The operational cost of the SVE system will be substantially reduced (as compared to just using SVE as an alternative) due to the lower initial starting concentrations of soil contaminants after the permanganate injection.

The remedial strategy would consist of the installation of two SVE wells and five permanganate injection wells screened in the contaminated area of the vadose zone. Well locations are illustrated on **Figure 5-3**. Mass calculations and oxidant demand testing has estimated the total mass of permanganate necessary to treat the source area to be approximately 376,228 pounds. This would be equally distributed between the five injection wells in order to ensure application to the entire impacted area. The SVE system would then be used as a follow up technology to ensure that all contaminants are recovered or destroyed *in-situ*.

5.2.8.1 Overall Protection of Human Health and Environment

This alternative will be protective of human health and the environment by destroying adsorbed phase VOCs in the source area soils, thus preventing leaching to groundwater. This alternative will reduce the concentrations of VOCs in soil to below cleanup levels and therefore meets the RAOs presented in this FS report.

5.2.8.2 Compliance with SCGs, ARARs, and Other Regulations

Implementation of this alternative will achieve chemical specific ARARs on site in approximately one year. This includes the design and implementation of the permanganate injection and post injection monitoring. This alternative will provide for significant reductions of contaminants in the source area soils and prevent future migration of contaminants to groundwater.

5.2.8.3 Short-Term Effectiveness

Potential short-term risks to construction workers and the community may exist during activities involving the installation of injection and recovery wells, collection of baseline data, the mixing and injection of permanganate, and the maintenance of the SVE system. During the installation of extraction and injection wells, exposure to contaminated media will be minimized through the use of personal protective equipment such as gloves and protective clothing. Applicable protective gear and a spill response plan will also be used during the handling, mixing, and injection of the permanganate solution. Similar protocols will be implemented for all associated soil and groundwater sampling activities. Additionally, short-term risks during the application of this alternative can be minimized by implementing an effective site-specific health and safety program and institutional controls.

5.2.8.4 Long-Term Effectiveness

This alternative would provide an effective long-term remedy for VOCs present in the vadose zone at the Site. The injection of permanganate will permanently destroy some, if not all, of the existing adsorbed phase VOC concentrations found in the vicinity of the dry wells located on the western side of the OSER Avenue building. The remaining contaminants will be recovered with the SVE system. This alternative will eliminate this area as a continued source of groundwater contamination, thereby presenting a reduction in the transport of contaminants to off site properties.

Long-term exposure risks associated with periodic sampling activities will be minimized through the implementation of a site-specific health and safety plan and institutional controls. Soil and groundwater monitoring data will be used to determine the overall effectiveness of this alternative.

5.2.8.5 Reduction in Mobility, Toxicity and Volume

This alternative would effectively reduce the overall volume of vadose zone contaminants in the vicinity of the dry wells located on the western side of the 100 Oser Avenue building. Mass balance calculations indicate that the mass of permanganate proposed for treatment is sufficient to completely oxidize the contaminant mass found in this area. However, should soils in this area impacted with VOCs not be reached by permanganate, they will be recovered and treated by the SVE system.

5.2.8.6 Implementability

Permanganate is a food-grade oxidizing chemical ideal for the application to soil for the treatment of a variety of VOCs, specifically chlorinated ethenes. Permanganate has been used at sites throughout the country, in a variety of geologic settings for the treatment of the compounds found at the Oser Avenue site. SVE technology is well understood and very successful in the recovery of the Site-specific compounds. Injection of permanganate is accomplished through monitoring wells that could be easily installed in the locations indicated on **Figure 5-3**. There are no conditions at the site that would limit the ability to implement this injection design. The SVE component uses standard wells and technology and can be combined with the SVE soil gas / indoor air remedy to create a cost effective SVE design that will accomplish both objectives.

5.2.8.7 Cost

Capital costs associated with this alternative include: application of permanganate oxidant, the installation of vapor extraction wells, and the on-site soil vapor extraction system. The capital cost for this alternative is approximately $1,978,411. The total net present worth cost for the permanganate injection and SVE system, as outlined in **Table 5-7** in **Appendix B**, is approximately $3,071,937.

5.2.9 Indoor Air Alternative 1: No Action

The No Action alternative represents a baseline against which other alternatives are measured. Under this alternative no remedial action would be taken to specifically address the VOC-impacted air inside the buildings at 100 and 110 Oser Avenue or the contaminated soils located beneath the buildings. The only activity that will be performed at the site would be indefinite air monitoring in the building. Contaminants would continue to migrate into the buildings and leach into the groundwater as they undergo the natural attenuation of the contaminants in the aquifer.

5.2.9.1 Overall Protection of Human Health and Environment

This alternative would not reduce potential risks to human health or the environment.

5.2.9.2 Compliance with SCGs, ARARs, and Other Regulations

This alternative would not comply with the specified ARARs for the volatile organic compounds detected in the indoor air at the site.

5.2.9.3 Short-Term Effectiveness

No short-term adverse impacts would result from implementing this alternative since there are no construction activities associated with it.

5.2.9.4 Long-Term Effects

This alternative would result in a gradual reduction of the VOCs in both levels and toxicity as gradual natural attenuation processes continue to occur. Residual theoretical upperbound risks would decline correspondingly from the existing theoretical risk levels.

5.2.9.5 Reduction in Mobility, Toxicity and Volume

The No Action alternative will not reduce mobility, toxicity or volume of the contaminants. Contaminants continue to migrate (volume expansion) throughout the environment and their toxicity remains relatively the same, with a possibility of natural attenuation having a minimal effect on the concentration levels of individual contaminants.

5.2.9.6 Implementability

Since no action is taken to implement this alternative, technical feasibility and performance are not an issue.

5.2.9.7 Cost

There are no capital or maintenance costs associated with this alternative. The only cost associated with this alternative would be for air monitoring. Assuming that air monitoring will extend for 30 years, the total net present worth cost for this activity, as outlined in **Table 5-1** of **Appendix B**, is estimated to be $157,252.

5.2.10 Indoor Air Alternative 2: Vapor Extraction

This remedial alternative consists of the installation of sixteen (16) vapor extraction wells adjacent to and inside the buildings at 100 and 110 Oser Avenue (**Figure 5-4**) to remove the PCE-impacted gas vapors in the building atmospheres and prevent further migration of vapors into the buildings.

The gas vapors will be extracted using standard extraction wells and transferred to an onsite treatment system. The treatment system will consist of vapor phase carbon or a catalytic oxidizer unit designed to comply with the appropriate air discharge criteria.

The implementation of this alternative includes design, construction, operation and maintenance of the vapor extraction and treatment system.

5.2.10.1 Overall Protection of Human Health and Environment

This alternative will be protective of human health and the environment because on-site VOC impacted vapors will be captured, treated, and prevented from further migration into the buildings.

This alternative will reduce the concentrations of VOCs in the vapor beneath and within the buildings at the Site to levels below the cleanup goals; therefore, this alternative meets the RAOs presented in this FS Report for indoor air quality.

5.2.10.2 Compliance with SCGs, ARARs, and Other Regulations

Implementation of this alternative will achieve chemical-specific ARARs on-site in approximately 2 years. This alternative will provide for significant reductions of contaminants in the indoor air and soil gas beneath the buildings, and minimize the source area contribution to the groundwater. The goal of reducing indoor air contaminants to acceptable levels will be achieved by this remedial alternative.

This alternative will also comply with action-specific and chemical-specific ARARs related to the discharge of the groundwater and the air discharge. Compliance with action-specific ARARs will be met through proper design and sizing of the remedial equipment. System effluent sampling and reporting for the treatment system will document compliance with all discharge standards. Compliance with ARARs for air emissions will be met by complying with the technical requirements of the appropriate air permitting and utilizing off-gas treatment prior to discharge. This alternative will be designed and operated to comply with applicable ARARs governing air emissions to minimize adverse impacts to human health and the environment.

5.2.10.3 Short-Term Effectiveness

Potential short-term risks to construction workers and the community may exist during activities involving the installation of the remedial components specified within this alternative. During the installation of the extraction wells and foundation for the treatment building, exposure to contaminated media will be minimized through the use of personal protective equipment such as gloves and protective clothing. Personal protective gear for workers during sampling will help minimize similar associated risks. Additionally, implementing an effective site-specific health and safety program, and institutional controls can minimize short-term effects during the installation of this alternative.

This remedial alternative will be designed and operated to comply with applicable ARARs governing treated air discharge and to minimize adverse impacts to human health and the environment.

5.2.10.4 Long-Term Effectiveness

This alternative's long-term effectiveness of a vacuum extraction system will permanently capture, remove and contain existing VOC contaminated vapors located beneath the buildings. The recovery wells will permanently remove contaminants form beneath the buildings and prevent further migration of vapors into the buildings.

A long-term on-site management strategy that incorporates controlling the migration of contaminated vapors into the buildings will effectively minimize the risks associated with the VOC-laden indoor air. Routine operations and maintenance of the extraction system will ensure proper system performance. A monitoring program will be established to measure the contaminant levels present in the effluent stream prior to discharge. In addition, pressure drop will be monitored across the vacuum pump to monitor potential fouling conditions, which may impact treatment efficiency.

An air monitoring program will be established to measure contaminant levels at the Site from the air treatment unit prior to discharge. Air monitoring data from within the building will help to determine the overall effectiveness of this alternative. Routine operations and maintenance of the remediation system will ensure proper system performance.

5.2.10.5 Reduction in Mobility, Toxicity and Volume

This alternative will reduce the overall volume of toxic contaminants present in the buildings, provide a permanent remedy for reduction of contaminant toxicity, mobility and volume through treatment, and meet the USEPA statutory preference for treatment as a principal element. Implementation of this alternative does provide for moderate to high reductions in the risk of exposure from soil gas vapors entering the building.

5.2.10.6 Implementability

The vapor extraction process option is commonly used in the remediation of VOC-contaminated vadose zone soils and venting of building foundations. The system is reliable and can achieve the specified performance criteria for removal of the organic compounds. Since the SVE is widely used for remediation of contaminated soils, there are no specific difficulties in implementing this technology at the site. Wells can be drilled to the depths required and discharge of the treated air stream will need to be permitted.

5.2.10.7 Cost

Capital costs associates with this alternative include: the installation of on-site vapor extraction wells, connection to the on-site vapor extraction system and facility, and the implementation of an air monitoring program. The capital cost for this alternative is approximately $300,141.

The total net present worth cost for the vapor extraction system, as outlined in **Table 5-8** in **Appendix B** is estimated to be $451,269.

6.0 COMPARATIVE ANALYSIS

This section compares, by media, the relative performance of each of the remedial alternatives retained for further detailed analysis using the specific evaluation criteria presented in **Section 5.0**. Comparisons are presented in a qualitative manner in order to identify substantive differences between the alternatives. As with the detailed evaluation, the following criteria were used for the comparative analysis:

1) Overall Protection of Human Health and the Environment
2) Compliance with SCGs, ARARs, and Other Regulations
3) Short-Term Effectiveness
4) Long-Term Effectiveness
5) Reduction in Mobility, Toxicity, and Volume
6) Implementability
7) Cost

The qualitative comparison is outlined in the following sections.

6.1 Comparative Analysis of Groundwater Remedial Alternatives

The Groundwater Remedial Alternatives are:

Alternative 1 – No Action
Alternative 2 – Pump and Treat
Alternative 3 – $KMnO_4$ Injection
Alternative 4 – $KMnO_4$ Injection and Pump and Treat

6.1.1 Overall Protection of Human Health and the Environment

The comparative evaluation of overall protection of human health and the environment evaluates attainment of PRGs, as well as the analysis of other criteria evaluated for each alternative (specifically, short- and long-term effectiveness). The evaluation of this criteria focuses on such factors as the manner in which the remedial alternatives achieve protection over time, the degree to which site risks would be reduced, and the manner in which each source of COPCs would be eliminated, reduced, or controlled.

Alternative 1 (No Action) is not protective of human health and the environment. Alternative 2 (Pump and Treat) and Alternative 3 ($KMnO_4$ Injection) are protective of human health and the environment. Alternative 2 would effectively reduce potential human health exposure to the groundwater exceeding the PRGs by capturing, treating, and preventing further migration of VOC impacted groundwater. Alternative 3 would effectively reduce potential human health exposure to the groundwater exceeding PRGs by oxidizing (destroying) the VOCs into inert compounds. Alternative 4 ($KMnO_4$ Injection and Pump and Treat) effectively reduces the potential of human health exposure to the VOC laden groundwater by oxidizing (destroying) the VOCs into inert compounds, any VOC not oxidized will be captured and treated, thereby preventing further migration of VOC impacted groundwater.

Short-term impacts to both human health and the environment during the implementation of Alternatives 2, 3, and 4 are minimal and easily managed. Alternatives 2, 3, and 4 would all be considered effective measures to protect against potential long-term human health risks and environmental impacts.

6.1.2 Compliance with SCG, and ARARs

The comparative evaluation of the compliance of each Alternative focuses on the following criteria:

- Published NYSDEC Standards, Criteria, and Guidance (SCGs)
- Other applicable federal relevant and appropriate requirements (ARARs)

Alternative 1 (No Action) does not comply with the SCGs and ARARs related to the VOCs in groundwater. Alternatives 2, 3, and 4 would comply with the SCGs and ARARs by either capturing, treating and preventing further migration of VOC contaminated groundwater and/or by oxidizing the VOCs in the groundwater to inert compounds. All remedial actions would be completed in a manner compliant with action-specific standards (i.e., NYS SPDES , DAR-1, and other applicable criteria).

6.1.3 Short-Term Effectiveness

The short-term effectiveness comparison includes the evaluation of the relative potential for impacts to the nearby communities, site worker exposures, environmental impacts, and the time frame for implementation of the alternatives.

The implementation of Alternative 1 (No Action) would result in the least short-term impact, because no action would be taken to disturb the impacted groundwater or other media at the site. Of the alternatives that will achieve the PRGs, Alternative 3 ($KMnO_4$ Injection) is anticipated to have the greatest short-term effectiveness. Alternative 3 presents controllable risk to the nearby communities, site workers, and the environment. Any risks associated with implementing Alternative 3 are easily managed. The time required to achieve short-term protection is significantly shorter than any other alternative. It is anticipated that Alternative 3 will reach the groundwater PRGs in one year. However, due to the uncertainties associated with the Site conditions, the estimated number of permanganate doses and treatment time may increase. The field pilot test will reduce these uncertainties.

Alternative 2 (Pump and Treat) and Alternative 4 ($KMnO_4$ Injection and Pump and Treat) would result in minimal short-term impacts that could be easily managed. It is estimated that Alternative 2 will take 35 years to reach the groundwater PRGs, while Alternative 4 will take 15 years to reach the PRGs.

6.1.4 Long-Term Effectiveness

The comparative evaluation of long-term effectiveness focuses on the reduction of residual risk and adequacy and reliability of controls provided by each alternative.

Alternative 2 (Pump and Treat) and Alternative 4 ($KMnO_4$ Injection and Pump and Treat) are anticipated to have the greatest long-term effectiveness. Alternative 2 will permanently capture, remove, and contain existing VOC concentrations within the groundwater and prevent migration of VOCs downgradient. Alternative 4 will use $KMnO_4$ to oxidize VOCs to inert compounds and use a pump and treat system to remove, treat and contain any residual VOCs remaining within the groundwater. Both alternatives will achieve the groundwater PRGs.

Alternative 3 ($KMnO_4$ Injection) will provide an effective long-term remedy for VOCs present in the groundwater. Alternative 3 will permanently destroy VOCs in the groundwater by oxidation, thereby, reducing the VOC mass in groundwater and preventing off-site migration. This alternative is greatly inhibited by the presence of a continuing source of VOCs. If there is a continuing source to groundwater, subsequent injections may be required.

Alternative 1 (No Action) will have a minimal long-term effectiveness. Implementation of Alternative 1 will result in a gradual reduction of VOCs in the groundwater as the natural attenuation processes continue to occur.

6.1.5 Reduction in Mobility, Toxicity, and Volume

The comparative evaluation of the reduction of mobility, toxicity, and volume focuses on the ability of the alternative to address the impacted material on-site, the mass of material destroyed or treated, the irreversibility of the process employed, and the nature of the impacted materials after implementation of the alternative.

Alternative 1 would rely on natural attenuation and degradation to reduce the volume and toxicity of VOCs in the groundwater. Contaminants would continue to migrate (volume expansion) throughout the environment and their toxicity would remain relatively the same, with natural attenuation having a minimal effect on the concentration levels of VOCs.

Alternative 2 (Pump and Treat), Alternative 3 ($KMnO_4$ Injection) and Alternative 4 ($KMnO_4$ Injection and Pump and Treat) will reduce the overall volume of toxic contaminants present in the aquifer, provide a permanent remedy for the reduction of contaminant toxicity, mobility, and volume through treatment, and meet the USEPA statutory preference for treatment as a principal element. Alternatives 3 and 4 are destructive technologies, while Alternative 2 transfers the COPCs from one media to another for disposal.

6.1.6 Implementability

The comparative evaluation of implementability focuses on the feasibility of construction and operation of each alternative, the administrative feasibility, the availability or required disposal facilities, technical and service personnel, and contractors.

Alternative 1 (No Action) is readily implementable. No construction would be required to implement this alternative. Subsequently, technical feasibility and performance are not an issue.

Alternative 2 (Pump and Treat), Alternative 3 ($KMnO_4$ Injection), and Alternative 4 ($KMnO_4$ Injection and Pump and Treat) are all readily implementable. The pump and treat systems are commonly used for remediation of contaminated aquifers. Recovery wells can be installed at the required depths. Permanganate has been used at sites throughout the country, in a variety of geologic settings for the treatment of the compounds found at the Oser Avenue site. Due to the uncertainties associated with site conditions, the estimated time of completion and the number of permanganate doses may increase. The structures existing on-site present the only restriction to successful implementation of a permanganate injection. However, the pilot test will allow for the successful design of an application scenario and will ensure the migration of the permanganate to locations underneath the buildings.

6.1.7 Cost

The comparative evaluation of the cost of remediation is based on the net present worth of each alternative. The total capital, annual O&M, periodic, and present worth costs for all Alternatives are presented in **Appendix B**. The costs associated with Alternative 1 are approximately \$157,252. The costs associated with Alternative 2 are approximately \$6,023,037. The costs associated with Alternative 3 are approximately \$1,910,881. Alternative 4 would cost approximately \$5,847,145.

6.1.8 Summary

Each alternative was qualitatively evaluated by each of the criteria described above. Alternative 3 was selected as the preferred remedy because it was determined to be more protective of human health and the environment during the implementation of the remedy. Alternative 3 is technically and administratively feasible to implement. Short-term risks are controllable and long-term effectiveness is considered to be high. Even with the uncertainties associated with the time of implementation and the number of permanganate doses, Alternative 3 is the most cost effective alternative. Although, Alternative 2 also offers a high degree of protection to human health and the environment, its 15-year implementation time and higher present worth cost, make it a less desirable alternative.

6.2 Comparative Analysis of Soil Remedial Alternatives

The Soil Remedial Alternatives are:

Alternative 1 – No Action
Alternative 2 – SVE
Alternative 3 – $NaMnO_4$ Injection
Alternative 4 – SVE and $NaMnO_4$ Injection

6.2.1 Overall Protection of Human Health and the Environment

The comparative evaluation of overall protection of human health and the environment evaluates attainment of PRGs, as well as the analysis of other criteria evaluated for each alternative (specifically, short- and long-term effectiveness). The evaluation of this criteria focuses on such factors as the manner in which the remedial alternatives achieve protection over time, the degree to which site risks would be reduced, and the manner in which each source of COPCs would be eliminated, reduced, or controlled.

Alternative 1 (No Action) is not protective of human health and the environment. Alternative 2 (SVE), Alternative 3 ($NaMnO_4$ Injection) and Alternative 4 ($NaMnO_4$ Injection and SVE) are protective of human health and the environment. Alternative 2 will effectively reduce the concentrations below the PRGs and reduce the amount of plume growth from soil contamination migration, by extracting and treating VOC vapors. Alternative 3 will effectively reduce potential human health exposure to the VOC contaminated soil by oxidizing the VOCs into inert compounds. Alternative 4 effectively reduces potential human health exposure to VOC contaminated soil by oxidizing the VOCs into inert compounds. Any VOC not oxidized, will be extracted and treated using the SVE system.

Short-term impacts to both human health and the environment during the implementation of Alternatives 2, 3, and 4 are minimal and easily managed. Alternatives 2, 3, and 4 would all be considered effective measures to protect against potential long-term human health risks and environmental impacts.

6.2.2 Compliance with SCGs, and ARARs

The comparative evaluation of the compliance of each Alternative focuses on the following criteria:

- Published NYSDEC Standards, Criteria, and Guidance (SCGs)
- Other applicable federal relevant and appropriate requirements (ARARs)

Alternative 1 (No Action) does not comply with the SCGs and ARARs related to the VOCs in soil. Alternatives 2, 3, and 4 would comply with the SCGs and ARARs by either extracting, treating and preventing further migration of VOC contamination to the groundwater and/or by oxidizing the VOCs in the soil to inert compounds. All remedial actions would be completed in a manner compliant with action-specific standards (i.e., NYS SPDES , DAR-1, and other applicable criteria).

6.2.3 Short-Term Effectiveness

The short-term effectiveness comparison includes the evaluation of the relative potential for impacts to the nearby communities, site worker exposures, environmental impacts, and the time frame for implementation of the alternatives.

The implementation of Alternative 1 (No Action) would result in the least short-term impact, since no action would be taken to disturb the impacted soil or other media at the site. Of the

alternatives that will achieve the PRGs, Alternative 3 (NaMnO4 Injection) is anticipated to have the greatest short-term effectiveness. Alternative 3 presents controllable risk to the nearby communities, site workers, and the environment. Any risks associated with implementing Alternative 3 are easily managed. The time required to achieve short-term protection is significantly shorter than any other alternative. It is anticipated that Alternative 3 will reach the soil PRGs in one year. However, due to the uncertainties associated with the Site conditions, the estimated number of permanganate doses and treatment time may increase. The field pilot test, as described **Section 5.2.2,** will reduce these uncertainties.
Alternative 2 (SVE) and Alternative 4 ($NaMnO_4$ Injection and SVE) would result in minimal short-term impacts that could be easily managed. It is estimated that Alternative 2 will take 5 years to reach the soil PRGs, while Alternative 4 will take 3 years to reach the PRGs.

6.2.4 Long-Term Effectiveness

The comparative evaluation of long-term effectiveness focuses on the reduction of residual risk and adequacy and reliability of controls provided by each alternative.

Alternative 2 (SVE) and Alternative 4 ($NaMnO_4$ Injection and SVE) are anticipated to have the greatest long-term effectiveness. Alternative 2 will permanently capture, remove, and contain existing VOC concentrations within the soil and prevent migration of VOCs to groundwater. Alternative 4 will use $NaMnO_4$ to oxidize VOCs to inert compounds and use an SVE system to remove, treat and contain any residual VOCs remaining within the soil. Both alternatives will achieve the soil PRGs.

Alternative 3 ($NaMnO_4$ Injection) will provide an effective long-term remedy for VOCs present in the soil. Alternative 3 will permanently destroy some, if not all, of the existing adsorbed phase VOCs come into contact with oxidant in the vicinity of the dry wells. This will also reduce, if not eliminate, this area as a continuing source of groundwater contamination, thereby, reducing the transport of contaminants off-site.

Alternative 1 (No Action) will have a minimal long-term effectiveness. Implementation of Alternative 1 will result in a gradual reduction of VOCs in the soil as the natural attenuation processes continue to occur.

6.2.5 Reduction in Mobility, Toxicity, and Volume

The comparative evaluation of the reduction of mobility, toxicity, and volume focuses on the ability of the alternative employed to address the impacted material on-site, the mass of material destroyed or treated, the irreversibility of the process employed, and the nature of the impacted materials after implementation of the alternative.

Alternative 1 would rely on natural attenuation and degradation to reduce the volume and toxicity of VOCs in the soil. Contaminants would continue to migrate (volume expansion) throughout the environment and their toxicity would remain relatively the same, with natural attenuation having a minimal effect on the concentration levels of VOCs.

Alternative 2 (SVE) and Alternative 4 ($NaMnO_4$ Injection and SVE) will reduce the overall volume of toxic contaminants present in the soil, provide a permanent remedy for the reduction of contaminant toxicity, mobility, and volume through treatment, and meet the USEPA statutory preference for treatment as a principal element.

Alternative 3 ($NaMnO_4$ Injection) will also reduce the overall toxic contaminant present in the soil, provide a permanent remedy for the reduction of contaminant toxicity, mobility, and volume through treatment, as long as the oxidant comes into contact with the VOCs.

6.2.6 Implementability

The comparative evaluation of implementability focuses on the feasibility of construction and operation of each alternative, the administrative feasibility, the availability or required disposal facilities, technical and service personnel, and contractors.

Alternative 1 (No Action) is readily implementable. No construction would be required to implement this alternative. Subsequently, technical feasibility and performance are not an issue.

Alternative 2 (SVE), Alternative 3 ($NaMnO_4$ Injection), and Alternative 4 ($NaMnO_4$ Injection and SVE) are all readily implementable. Soil vapor extraction processes are commonly used in the remediation of VOC-contaminated vadose zone soils. The system is reliable and can achieve the specified performance criteria for removal of VOCs. Permanganate has been used at sites throughout the country in a variety of geologic settings for the treatment of the compounds found at the Oser Avenue site. However, due to the uncertainties associated with the Site conditions (especially with dispersive characteristics of the vadose zone), the estimated number of permanganate doses and treatment time may increase. The field pilot test, as described in **Section 5.2.7**, will reduce these uncertainties.

6.2.7 Cost

The comparative evaluation of the cost of remediation is based on the net present worth of each alternative. The total capital, annual O&M, periodic, and present worth costs all Alternatives are presented in **Appendix B**. The costs associated with Alternative 1 are approximately $157,252. The costs associated with Alternative 2 are approximately $2,172,153. The costs associated with Alternative 3 are approximately $2,202,068. Alternative 4 would cost approximately $3,071,937.

6.2.8 Summary

Each alternative was evaluated by each of the criteria described above. Alternative 4 was selected as the preferred alternative. Alternatives 2, 3, and 4 all provide a high degree of protection to human health and the environment for short-term considerations with minimal short-term risks, and, are effective in the long-term. Alternative 4 provides the most flexibility in terms of remedial operation, for approximately the same relative cost as Alternatives 2 and 3. Because of the uncertainties with regards to the number of permanganate injections and implementation time, Alternative 4 will provide a secondary remedial option (SVE) to ensure that the PRGs are met in a timely and cost effective manner. An additional cost savings, not accounted for in **Appendix C**, may be realized, if the soil gas/indoor air vapor extraction system is combined with the source area SVE system.

6.3 Comparative Analysis of Soil Gas/Indoor Air Remedial Alternatives

The Soil Gas/Indoor Air Alternative are:

Alternative 1 – No Action
Alternative 2 – SVE

6.3.1 Overall Protection of Human Health and the Environment

The comparative evaluation of overall protection of human health and the environment evaluates attainment of PRGs, as well as the analysis of other criteria evaluated for each alternative (specifically, short- and long-term effectiveness). The evaluation of this criteria focuses on such factors as the manner in which the remedial alternatives achieve protection over time, the degree to which site risks would be reduced, and the manner in which each source of COPCs would be eliminated, reduced, or controlled.

Alternative 1 (No Action) is not protective of human health and the environment. Alternative 2 (SVE) is protective of human health and the environment. Alternative 2 will effectively reduce the concentrations below the PRGs and prevent contaminated soil vapor from further migration into the site buildings.

Short-term impacts to both human health and the environment during the implementation of Alternative 2 are easily managed. Alternative 2 is considered an effective measure to protect against potential long-term human health risks and environmental impacts.

6.3.2 Compliance with SCG, and ARARs

The comparative evaluation of the compliance of each Alternative focuses on the following criteria:

- Published NYSDEC Standards, Criteria, and Guidance (SCGs)
- Other applicable federal relevant and appropriate requirements (ARARs)

Alternative 1 (No Action) does not comply with the SCGs and ARARs related to the VOCs in the soil gas and indoor air. Alternative 2 complies with the SCGs and ARARs by either extracting, treating and preventing further migration of VOC contaminated soil gas into the site buildings. Alternative 2 would be completed in a manner compliant with action-specific standards (i.e., NYS SPDES , DAR-1, and other applicable criteria).

6.3.3 Short-Term Effectiveness

The short-term effectiveness comparison includes the evaluation of the relative potential for impacts to the nearby communities, site worker exposures, environmental impacts, and the time frame for implementation of the alternatives.

The implementation of Alternative 1 (No Action) would result in the least short-term impact, since no action would be taken to disturb the impacted soil or other media at the site. Alternative 2 (SVE) is anticipated to have the greatest short-term effectiveness. Alternative 2 presents minimal risk to the nearby communities, site workers, and the environment. Any risks associated with implementing Alternative 2 are easily managed. It is anticipated that soil gas/indoor air PRGs will be realized within 5 years.

6.3.4 Long-Term Effectiveness

The comparative evaluation of long-term effectiveness focuses on the reduction of residual risk and adequacy and reliability of controls provided by each alternative.

Alternative 2 (SVE) has the greatest long-term effectiveness. Alternative 2 will permanently capture, remove, and destroy existing VOC concentrations within the soil gas and prevent further migration of VOCs into the Site buildings.

Alternative 1 (No Action) will have a minimal long-term effectiveness. Implementation of Alternative 1 will result in a gradual reduction of VOCs in the soil gas as the natural attenuation processes continue to occur.

6.3.5 Reduction in Mobility, Toxicity, and Volume

The comparative evaluation of the reduction of mobility, toxicity, and volume focuses on the ability of the alternative employed to address the impacted material on-site, the mass of material destroyed or treated, the irreversibility of the process employed, and the nature of the impacted materials after implementation of the alternative.

Alternative 1 would rely on natural attenuation and degradation to reduce the volume and toxicity VOCs in the soil gas. Contaminants would continue to migrate (volume expansion) throughout the environment and their toxicity would remain relatively the same, with natural attenuation having a minimal effect on the concentration levels of VOCs.

Alternative 2 (SVE) will reduce the overall volume of toxic contaminants present in the soil gas, provide a permanent remedy for the reduction of contaminant toxicity, mobility, and volume through treatment, and meet the USEPA statutory preference for treatment as a principal element.

6.3.6 Implementability

The comparative evaluation of implementability focuses on the feasibility of construction and operation of each alternative, the administrative feasibility, the availability or required disposal facilities, technical and service personnel, and contractors.

Alternative 1 (No Action) is readily implementable. No construction would be required to implement this alternative. Subsequently, technical feasibility and performance are not an issue.

Alternative 2 (SVE) is readily implementable. Soil vapor extraction processes are commonly used in the remediation of VOC-contaminated vadose zone soils. The system is reliable and can achieve the specified performance criteria for removal of VOCs.

6.3.7 Cost

The comparative evaluation of the cost of remediation is based on the net present worth of each alternative. The total capital, annual O&M, periodic, and present worth costs for all Alternatives are presented in **Appendix C**. The costs associated with Alternative 1 are approximately $157,252. The costs associated with Alternative 2 are approximately $451,269.

6.3.8 Summary

Each alternative was qualitatively evaluated by each of the criteria described above. Alternative 2 was selected over Alternative 1 as the preferred remedy because it was determined to be more protective of human health and the environment. Alternative 2 is technically and administratively feasible to implement. Short-term risks are minimal and long-term effectiveness is considered to be high.

7.0 CONCLUSIONS

The submittal of this FS represents the completion of activities set forth in the RI/FS Work Plan for 100 Oser Avenue dated August 5, 1999 (IT Corporation, 1999). The evaluations presented within this report are based on the characterization of the Site as presented in the Oser Avenue Remedial Investigation Report dated October 5, 2000 (IT Corporation, 2000) and the Draft Phase II Remedial Investigation Report dated January 17, 2001 (IT Corporation, 2001).

Prior to the implementation of any alternative, further investigation is recommended to confirm the source of indoor air contamination in the buildings at 100 and 110 Oser Avenue. If a secondary source of PCE is located under or adjacent to either building, the scope of the remedial alternatives presented herein may increase in size and duration.

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TABLES

Table 1-1

Grain Size, Total Organic Carbon (%), and pH Results of Soil Samples

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Sampling Location	**Grain Size (% retained)**			**Total Organic Carbon (%)**	**pH**
	Sieve No. < or = 40 Medium Sand (or larger)	Sieve No. 60 - 200 Fine Sand	Sieve No. 270 to PAN Silt or Clay		
ITHP-01 (70'-72')	67.28	31.81	0.91	<0.4	7.0
ITHP-01 (100'-102')	62.93	35.43	1.64	<0.1	7.3
ITHP-01 (160'-162')	65.60	31.40	3.00	na	na
ITHP-02 (50'-52')	73.00	23.57	3.43	na	na
ITHP-02 (60'-62')	na	na	na	<0.2	7.3
ITHP-02 (100'-102')	77.87	21.58	0.55	<0.2	7.1
[illegible]SB-03 (5'-7')	62.78	25.48	11.74	na	na
ITSB-03 (10'-12')	na	na	na	<0.2	7.1
ITSB-03 (20'-22')	71.82	26.84	1.34	na	na
ITSB-03 (30'-32')	66.80	26.10	7.10	na	na
ITSB-03 (33'-35')	na	na	na	<0.2	7.4
ITDWSB-1 (17'-21')	na	na	na	0.56	na
ITDWSB-1 (33'-37')	na	na	na	4.00	na
ITDWSB-2 (15.5'-20')	78.38	21.00	0.62	0.11	na
ITDWSB-2 (28'-32')	na	na	na	0.20	na
ITDWSB-3 (16'-20')	na	na	na	0.14	na
ITDWSB-3 (40'-42')	na	na	na	0.18	na
ITDWSB-4 (16'-20')	75.94	21.33	2.73	0.61	na
ITDWSB-4 (32'-36')	na	na	na	0.16	na
ITDWSB-5 (16'-20')	na	na	na	<0.10	na
ITDWSB-5 (28'-32')	na	na	na	<0.10	na
ITDWSB-6 (10'-16')	na	na	na	0.79	na
ITDWSB-6 (30'-32')	na	na	na	<0.10	na
Background	na	na	na	0.11	na

Notes:
1) na - indicates that the sample was not analyzed for that corresponding method.

Table 1-2

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Well ID	**Date Installed**	**Screen Depth** (below grade)	**Overall Depth** (below grade)	**TOC** (survey by A. Tay)	**DTW 01/31/00** ITMW-1S & 2S = 2/3/00	**Water Table Elevation 01/31/00**	**DTW 03/13/00**	**Water Table Elevation 03/13/00**
ITMW-1S	Nov 1999	64'-84'	85'	115.87	69.71	46.16	69.90	45.97
ITMW-1D / ITHP-2	Nov 1999	160'-180'	180'	115.71	69.3	46.41	69.57	46.14
ITMW-2S	Dec 1999	65'-85'	85'	116.07	69.74	46.33	69.84	46.23
ITMW-3S	Nov 1999	65'-85'	85'	116.23	69.97	46.26	70.17	46.06
ITMW-3D / ITHP-8	Nov 1999	221'-231'	231.5'	116.06	70.76	45.30	71.03	45.03
ITMW-4D / ITHP-6	Oct 1999	162'-182'	182.5'	116.25	69.89	46.36	70.11	46.14
ITMW-5S	Dec 1999	65'-85'	85'	116.19	70.08	46.11	70.22	45.97
ITMW-5D / ITHP-9	Nov 1999	165'-185'	187'	116.14	70.38	45.76	70.54	45.60
ITMW-6S	Dec 1999	70'-90'	90'	123.13	ng	-	77.16	45.97
ITMW-7S	Jan 2000	64'-84'	85'	109.55	63.71	45.84	63.79	45.76
ITMW-8S	Dec 1999	65'-85'	85'	116.21	71.3	44.91	70.31	45.90
SVE-1	Jan 2000	6'-16'	16'	115.91	ng	-	12.39	103.52
ITMW-00-11S	Sep 2000	75'-95'	95'	130.29	na	-	na	-
ITMW-00-12S	Sep 2000	60'-80'	80'	108.81	na	-	na	-
ITMW-00-13S	Sep 2000	75'-95'	95'	120.08	na	-	na	-
ITMW-00-14S	Sep 2000	75'-95'	95'	124.12	na	-	na	-
ITMW-00-15S	Sep 2000	65'-85'	85'	116.41	na	-	na	-

Notes:
1) ng - indicates that the well was not gauged on that date.
2) na - indicates that these wells had not been installed at the time of this sampling event.

Table 1-2

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Well ID	**Date Installed**	**Screen Depth** (below grade)	**Overall Depth** (below grade)	**TOC** (survey by A. Tay)	**DTW 11/01/00**	**Water Table Elevation 11/01/00**	**DTW 02/27/01**	**Water Table Elevation 02/27/01**
ITMW-1S	Nov 1999	64'-84'	85'	115.87	69.34	46.53	70.05	45.82
ITMW-1D / ITHP-2	Nov 1999	160'-180'	180'	115.71	68.97	46.74	69.68	46.03
ITMW-2S	Dec 1999	65'-85'	85'	116.07	69.26	46.81	70.06	46.01
ITMW-3S	Nov 1999	65'-85'	85'	116.23	69.69	46.54	70.40	45.83
ITMW-3D / ITHP-8	Nov 1999	221'-231'	231.5'	116.06	70.96	45.10	71.55	44.51
ITMW-4D / ITHP-6	Oct 1999	162'-182'	182.5'	116.25	69.70	46.55	70.31	45.94
ITMW-5S	Dec 1999	65'-85'	85'	116.19	69.93	46.26	70.53	45.66
ITMW-5D / ITHP-9	Nov 1999	165'-185'	187'	116.14	70.09	46.05	70.83	45.31
ITMW-6S	Dec 1999	70'-90'	90'	123.13	76.73	46.40	77.42	45.71
ITMW-7S	Jan 2000	64'-84'	85'	109.55	63.52	46.03	64.14	45.41
ITMW-8S	Dec 1999	65'-85'	85'	116.21	69.56	46.65	70.56	45.65
SVE-1	Jan 2000	6'-16'	16'	115.91	ng	-	ng	-
ITMW-00-11S	Sep 2000	75'-95'	95'	130.29	83.95	46.34	84.73	45.56
ITMW-00-12S	Sep 2000	60'-80'	80'	108.81	62.73	46.08	63.52	45.29
ITMW-00-13S	Sep 2000	75'-95'	95'	120.08	73.23	46.85	73.95	46.13
ITMW-00-14S	Sep 2000	75'-95'	95'	124.12	74.22	49.90	78.39	45.73
ITMW-00-15S	Sep 2000	65'-85'	85'	116.41	69.45	46.96	70.22	46.19

Notes:
1) ng - indicates that the well was not gauged on that date.
2) na - indicates that these wells had not been installed at the time of this sampling event.

TABLE 1-3
Initial Indoor Air Analytical Results (ug/cu.m.)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	SAMPLE COLLECTED BY/SAMPLE IDENTIFICATION											
	SCDOH A-0999037	IT Corp. ITAQ-01	SCDOH A-0999038	IT Corp. ITAQ-02	SCDOH A-0999039	IT Corp. ITAQ-03	SCDOH A-0999040	IT Corp. ITAQ-04	SCDOH A-0999041	IT Corp. ITAQ-05	SCDOH A-0999042	IT Corp. ITAQ-06
	(NE corner of p.lot)		(SW corner of property)		(N. of fire wall)		(S.of fire wall in corridor)		(R&D Lab)		(Training Room)	
Dichlorodifluoromethane	n/a	3	n/a	3.2	n/a	nd	n/a	3.3	n/a	3.3	n/a	3.3
FREON 12	nd	n/a	nd	n/a	4.9	n/a	4.9	n/a	4.9	n/a	4.9	n/a
Methanol	nd	n/a	nd	n/a	>296	n/a	>240	n/a	>403	n/a	>211	n/a
2-Propenal	nd	n/a	nd	n/a	nd	n/a	9.2	n/a	6.9	n/a	6.9	n/a
Trichlorofluoromethane	n/a	nd	n/a	nd	n/a	nd	n/a	3.4	n/a	3.5	n/a	3.5
Methylene Chloride	nd	nd	3.5	nd	10.4	6.3	10.4	6.3	10.4	6.6	6.3	5.6
MTBE	3.6	n/a	nd	n/a	3.6	n/a	nd	n/a	nd	n/a	nd	n/a
Butanol	nd	n/a	nd	n/a	3	n/a	nd	n/a	nd	n/a	3	n/a
2-Butanone (MEK)	2.9	n/a	nd	n/a	2.9	n/a	nd	n/a	8.9	n/a	5.9	n/a
2,2,4-Trimethylpentane	nd	n/a	nd	n/a	4.7	n/a	nd	n/a	nd	n/a	nd	n/a
Benzene	nd	nd	3.2	2.2	3.2	nd	3.2	nd	3.2	nd	3.2	nd
Trichloroethene	nd	nd	nd	nd	5.4	nd	5.4	5.3	5.4	5.9	5.4	4.8
Pentanal	nd	n/a	nd	n/a	3.5	n/a	7	n/a	3.5	n/a	7	n/a
Methyl Isobutyl Ketone	nd	n/a	nd	n/a	>221.8	n/a	139.6	n/a	>271	n/a	139.6	n/a
Toluene	3.8	6.4	11.3	14.7	11.3	7.9	11.3	8.7	11.3	9	7.5	8.3
Hexanal	nd	n/a	nd	n/a	8.2	n/a	12.3	n/a	8.2	n/a	20.5	n/a
Tetrachloroethene	nd	nd	nd	nd	>312.3	550.4	285.4	543.6	292.2	584.4	265	509.6
Ethyl Benzene	nd	nd	nd	nd	4.3	nd	nd	nd	nd	nd	nd	nd
m-xylene	nd	2.9	4.3	3.8	17.4	10.4	8.7	6.1	8.7	6.9	8.7	5.2
o-xylene	nd	nd	nd	nd	8.7	4.2	4.3	nd	4.3	2.8	4.3	nd
Styrene	nd	nd	nd	nd	4.3	nd	nd	nd	nd	nd	nd	nd
1,3,5-Trimethylbenzene	nd	nd	nd	nd	4.9	nd	nd	nd	4.9	nd	nd	nd
Octanal	nd	n/a	5.2	n/a	5.2	n/a	15.7	n/a	10.5	n/a	10.5	n/a
1,2,4-Trimethylbenzene	nd	nd	nd	nd	19.6	9.8	nd	6.4	14.7	6.9	9.8	5.9
Nonanal	11.6	n/a	11.6	n/a	34.9	n/a	40.7	n/a	34.9	n/a	34.9	n/a
Decanal	38.4	n/a	32	n/a	nd	n/a	51.1	n/a	44.8	n/a	38.4	n/a
Naphthalene	nd	n/a	nd	n/a	5.3	n/a	nd	n/a	5.3	n/a	5.3	n/a
cis-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

NOTES:1) nd = not detected above the method detection limit
2) n/a = compound not analyzed for
3) Suffolk County Department of Health (SCDOH) samples collected using carbon tubes; IT Corp. samples collected using Summa canisters.
4) Sampling date was September 23, 1999.

TABLE 1-4

Indoor/Outdoor Air Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Sampling Location (see Figure -10)	**PCE Analytical Result (ug/cu.m.)**					
Sample Collection Date	*09/99*[1]	*12/99*[2]	*01/00*[2]	*06/00*[2]	*09/00*[2]	*03/01*[2]
100 Oser Avenue						
NE Corner of parking lot (exterior)	nd	ns	ns	ns	ns	ns
SW Corner of property (exterior)	nd	ns	ns	ns	ns	ns
North of fire wall	550.4	48.5	ns	ns	ns	ns
South of fire wall, in hall	543.6	25.5	ns	ns	ns	ns
R&D lab	584.5	39.5	ns	ns	ns	ns
Training Room	509.6	24.5	ns	ns	ns	ns
Assembly (near stairwell)	ns	ns	ns	70	ns	80
Hall (near bulletin board)	ns	ns	ns	70	ns	80
Lab - Back Room	ns	ns	ns	ns	ns	80
110 Oser Avenue						
NE Corner of parking lot	ns	nd	ns	3	ns	80
C. Meyer's office	ns	480	ns	ns	ns	ns
T. Black's office	ns	440	ns	90	ns	150
Lunch room	ns	635	ns	400	ns	1180
Machine shop	ns	490	ns	ns	ns	1100
Leo's room	ns	650	ns	ns	ns	ns
Standard assembly	ns	760	ns	900	ns	1560
90 Oser Avenue						
Store	ns	ns	ns	ns	10	ns
Office	ns	ns	ns	ns	10	ns
Boiler Room	ns	ns	ns	ns	30	ns
Ring Naming Machine	ns	ns	ns	ns	60	ns
Outdoor	ns	ns	ns	ns	nd	ns
95 Oser Avenue						
NW Vacant Room	ns	ns	ns	ns	30	ns
NE Office	ns	ns	ns	ns	80	ns
Conference Room	ns	ns	ns	ns	80	ns
Hall	ns	ns	ns	ns	30	ns
Outdoor	ns	ns	ns	ns	nd	ns

Notes:
1. Samples collected by IT Corporation using Summa canisters.
2. Samples collected by IT Corporation using PCE Passive Sampling Devices.
   PCE Passive Samples analyzed by the NYSDOH.
3. nd indicates analytical results was non-detect.
4. ns indicates that the sampling location was not sampled during that sampling event.

TABLE 1-4

Indoor/Outdoor Air Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Sampling Location (see Figure -10)	**PCE Analytical Result (ug/cu.m.)**					
Sample Collection Date	*09/99*[1]	*12/99*[2]	*01/00*[2]	*06/00*[2]	*09/00*[2]	*03/01*[2]
Residential Area						
22 Holiday Park Drive						
Basement	ns	ns	<5	ns	ns	ns
1st Floor	ns	ns	<5	ns	ns	ns
24 Holiday Park Drive						
Basement	ns	ns	<5	ns	ns	ns
1st Floor	ns	ns	<5	ns	ns	ns
Outside	ns	ns	<5	ns	ns	ns
26 Holiday Park Drive						
Basement	ns	ns	10.5	ns	ns	ns
1st Floor	ns	ns	11.4	ns	ns	ns
28 Holiday Park Drive						
Basement	ns	ns	8.5	ns	ns	ns
1st Floor	ns	ns	9	ns	ns	ns
Outside	ns	ns	<5	ns	ns	ns
30 Holiday Park Drive						
Basement	ns	ns	5.5	ns	ns	ns
1st Floor	ns	ns	<5	ns	ns	ns
Outside	ns	ns	<5	ns	ns	ns
32 Holiday Park Drive						
Basement	ns	ns	<5	ns	ns	ns
1st Floor	ns	ns	<5	ns	ns	ns

Notes:
1. Samples collected by IT Corporation using Summa canisters.
2. Samples collected by IT Corporation using PCE Passive Sampling Devices.
   PCE Passive Samples analyzed by the NYSDOH.
3. nd indicates analytical results was non-detect.
4. ns indicates that the sampling location was not sampled during that sampling event.

Table 1-5

Soil Gas Survey Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	Soil Gas Survey Results (ug/cu.m.)								
	ITSG-01*	**ITSG-02***	**ITSG-03***	**ITSG-04***	**ITSG-05***	**ITSG-06***	**ITSG-07**	**ITSG-08**	**ITSG-09**
Vinyl Chloride	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd
Methylene Chloride	nd	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1--Dichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd
cis-1,2-Dichloroethene	**12,000**	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	**6,000**	**2,000**	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-Dichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	**25,000**	**4,000**	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	**1,000,000**	**590,000**	**860,000**	**4,000**	nd	**5,000**	**2,400**	**510,000**	**2,400,000**
Benzene	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	nd	nd	nd	nd	nd	nd	**480**	nd	nd
Chlorobenzene	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethyl Benzene	nd	nd	nd	nd	nd	nd	nd	nd	nd
m&p-xylene	nd	nd	nd	nd	nd	nd	**530**	nd	nd
o-xylene	nd	nd	nd	nd	nd	nd	nd	nd	nd
Method Detection Limit	200	200	1,000	200	200	200	10	1,000	2,000

Notes:
1) * these samples were analyzed by Mitkem laboratory; all other samples were analyzed by STL's on-site Portable GC.
2) ** ITSG-13 (QA/QC sample) also deteced 1,2,4-trimethylbenzene at 300 J ug/cu.m.
3) nd = not detected above the method detection limit
4) n/a = ITSG-36 was not drilled/sampled per NYSDOH's direction.
5) All soil gas samples were collected at a depth of 10 feet unless otherwise noted.
6) All soil gas samples were collected by IT Corporation.
7) for QA/QC samples: J indicates an estimated value (see lab reports), and E indicates the analyte exceeded the Calibration Range.

Table 1-5

Soil Gas Survey Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	Soil Gas Survey Results (ug/cu.m.)									
	ITSG-10	**ITSG-11**	**ITSG-12**	**ITSG-13**	**ITSG-13*** QA/QC sample**	**ITSG-14**	**ITSG-15**	**ITSG-16**	**ITSG-17**	**ITSG-18**
Vinyl Chloride	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Methylene Chloride	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1--Dichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
cis-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-Dichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	**130,000**	nd
Tetrachloroethene	**7,800,000**	**6,100,000**	**3,500,000**	**110,000**	**61,000 E**	**54,000**	**3,400**	**8,600**	**12,000,000**	**200,000**
Benzene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	nd	**170,000**	nd	nd	**400 J**	**2,700**	**530**	**710**	nd	nd
Chlorobenzene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethyl Benzene	nd	nd	nd	nd	nd	nd	**65**	**130**	nd	nd
m&p-xylene	nd	nd	nd	nd	**500 J (total)**	**1,100**	**370**	**590**	nd	nd
o-xylene	nd	nd	nd	nd	nd	nd	**150**	**220**	nd	nd
Method Detection Limit	4,000	4,000	4,000	100	1	100	10	10	4,000	100

Notes:

1) * these samples were analyzed by Mitkem laboratory; all other samples were analyzed by STL's on-site Portable GC.
2) ** ITSG-13 (QA/QC sample) also deteced 1,2,4-trimethylbenzene at 300 J ug/cu.m.
3) nd = not detected above the method detection limit
4) n/a = ITSG-36 was not drilled/sampled per NYSDOH's direction.
5) All soil gas samples were collected at a depth of 10 feet unless otherwise noted.
6) All soil gas samples were collected by IT Corporation.
7) for QA/QC samples: J indicates an estimated value (see lab reports), and E indicates the analyte exceeded the Calibration Range.

Table 1-5

Soil Gas Survey Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	Soil Gas Survey Results (ug/cu.m.)									
	ITSG-19	ITSG-20	ITSG-21	ITSG-22	ITSG-23	ITSG-24	ITSG-25 @15'	ITSG-25 @25'	ITSG-25 @35'	ITSG-25@35' * QA/QC sample
Vinyl Chloride	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Methylene Chloride	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1--Dichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
cis-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-Dichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	**370,000**	**84,000**	**350,000**	**3,500**	**290,000**	**650,000**	**20**	**1,500**	nd	**600 J**
Benzene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	nd	nd	**2,100**	**400**	nd	nd	nd	nd	nd	nd
Chlorobenzene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethyl Benzene	**5,700**	**6,100**	**6,500**	nd	nd	nd	nd	nd	nd	nd
m&p-xylene	**2,000**	**2,100**	**2,400**	**300**	nd	nd	nd	nd	nd	nd
o-xylene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Method Detection Limit	100	100	100	10	100	500	10	10	10	1

Notes:
1) * these samples were analyzed by Mitkem laboratory; all other samples were analyzed by STL's on-site Portable GC.
2) ** ITSG-13 (QA/QC sample) also deteced 1,2,4-trimethylbenzene at 300 J ug/cu.m.
3) nd = not detected above the method detection limit
4) n/a = ITSG-36 was not drilled/sampled per NYSDOH's direction.
5) All soil gas samples were collected at a depth of 10 feet unless otherwise noted.
6) All soil gas samples were collected by IT Corporation.
7) for QA/QC samples: J indicates an estimated value (see lab reports), and E indicates the analyte exceeded the Calibration Range.

Table 1-5

Soil Gas Survey Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	Soil Gas Survey Results (ug/cu.m.)									
	ITSG-25 @45'	ITSG-25 @51'	ITSG-26	ITSG-27	ITSG-28	ITSG-29	ITSG-30	ITSG-30 * QA/QC sample	ITSG-31	ITSG-32
Vinyl Chloride	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Methylene Chloride	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1--Dichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
cis-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	nd	nd	nd	nd	nd	nd	nd	**500 J**	nd	nd
Carbon Tet.	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-Dichloroethane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	nd	nd	nd	nd	nd	nd	nd	**800 J**	nd	nd
Tetrachloroethene	**19,200**	**400**	**400**	**1,000**	**180,000**	**600**	**300,000**	**450,000 E**	**9,600**	**300**
Benzene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	nd	nd	nd	**77**	nd	**100**	nd	nd	nd	**300**
Chlorobenzene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethyl Benzene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
m&p-xylene	nd	nd	nd	**45**	nd	**100**	nd	nd	nd	**200**
o-xylene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Method Detection Limit	10	10	10	10	100	10	100	1	100	10

Notes:
1) * these samples were analyzed by Mitkem laboratory; all other samples were analyzed by STL's on-site Portable GC.
2) ** ITSG-13 (QA/QC sample) also deteced 1,2,4-trimethylbenzene at 300 J ug/cu.m.
3) nd = not detected above the method detection limit
4) n/a = ITSG-36 was not drilled/sampled per NYSDOH's direction.
5) All soil gas samples were collected at a depth of 10 feet unless otherwise noted.
6) All soil gas samples were collected by IT Corporation.
7) for QA/QC samples: J indicates an estimated value (see lab reports), and E indicates the analyte exceeded the Calibration Range.

Table 1-5

Soil Gas Survey Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	Soil Gas Survey Results (ug/cu.m.)									
	ITSG-33	ITSG-34	ITSG-35	ITSG-36	ITSG-37 @10'	ITSG-37 @20'	ITSG-37 @30'	ITSG-37 @40'	ITSG-37 @50'	ITSG-38
Vinyl Chloride	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
Methylene Chloride	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
t-1,2-Dichloroethene	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
1,1--Dichloroethane	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
cis-1,2-Dichloroethene	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	nd	nd	**200**	n/a	nd	nd	nd	nd	nd	nd
Carbon Tet.	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
1,2-Dichloroethane	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
Trichloroethene	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
Tetrachloroethene	nd	**300**	**200**	n/a	**300**	nd	**50**	**1,400**	**1,200**	**3,100**
Benzene	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
Toluene	nd	nd	nd	n/a	**100**	**800**	nd	nd	nd	**500**
Chlorobenzene	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
Ethyl Benzene	nd	nd	nd	n/a	**100**	**200**	nd	nd	nd	**200**
m&p-xylene	nd	nd	nd	n/a	**100**	**600**	nd	nd	nd	**500**
o-xylene	nd	nd	nd	n/a	nd	nd	nd	nd	nd	nd
Method Detection Limit	10	10	10	n/a	10	10	10	10	10	10

Notes:
1) * these samples were analyzed by Mitkem laboratory; all other samples were analyzed by STL's on-site Portable GC.
2) ** ITSG-13 (QA/QC sample) also deteced 1,2,4-trimethylbenzene at 300 J ug/cu.m.
3) nd = not detected above the method detection limit
4) n/a = ITSG-36 was not drilled/sampled per NYSDOH's direction.
5) All soil gas samples were collected at a depth of 10 feet unless otherwise noted.
6) All soil gas samples were collected by IT Corporation.
7) for QA/QC samples: J indicates an estimated value (see lab reports), and E indicates the analyte exceeded the Calibration Range.

Table 1-5

Soil Gas Survey Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	Soil Gas Survey Results (ug/cu.m.)					
	FSG-1	**FSG-2**	**FSG-3**	**FSG-4**	**FSG-5**	**FSG-6**
Vinyl Chloride	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	nd	nd	nd	nd	nd	nd
Methylene Chloride	nd	nd	nd	nd	nd	nd
t-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd
1,1--Dichloroethane	nd	nd	nd	nd	nd	nd
cis-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	nd	nd	nd	nd	nd	nd
Carbon Tet.	nd	nd	nd	nd	nd	nd
1,2-Dichloroethane	nd	nd	nd	nd	nd	nd
Trichloroethene	nd	nd	nd	nd	nd	nd
Tetrachloroethene	**35,000,000**	**66,000,000**	**76,000,000**	**7,500,00**	**4,000,000**	**27,000,000**
Benzene	nd	nd	nd	nd	nd	nd
Toluene	nd	nd	nd	nd	nd	nd
Chlorobenzene	nd	nd	nd	nd	nd	nd
Ethyl Benzene	nd	nd	nd	nd	nd	nd
m&p-xylene	nd	nd	nd	nd	nd	nd
o-xylene	nd	nd	nd	nd	nd	nd
Method Detection Limit	20,000/10,000	20,000/10,000	20,000/10,000	8,000	8,000	8,000

Notes:

1) * these samples were analyzed by Mitkem laboratory; all other samples were analyzed by STL's on-site Portable GC.
2) ** ITSG-13 (QA/QC sample) also deteced 1,2,4-trimethylbenzene at 300 J ug/cu.m.
3) nd = not detected above the method detection limit
4) n/a = ITSG-36 was not drilled/sampled per NYSDOH's direction.
5) All soil gas samples were collected at a depth of 10 feet unless otherwise noted.
6) All soil gas samples were collected by IT Corporation.
7) for QA/QC samples: J indicates an estimated value (see lab reports), and E indicates the analyte exceeded the Calibration Range.

Table 1-6

Soil Boring Analytical Results (ppm)
Volatile Organic Compounds

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITSB-01							ITSB-02								
		6' - 8' PGC	10' - 12' PGC	14' - 16' PGC	20' - 22' PGC	22' - 24' PGC	22'-24' LAB	30' - 32' PGC	5' - 7' PGC	10' - 12' PGC	10'-12' LAB	15' - 17' PGC	20' - 22' PGC	25' - 27' PGC	30' - 32' PGC	35' - 37' PGC	35'-37' LAB
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	nd	nd	.002 J	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	0.15	nd	nd	nd	nd	.010 J	nd	**3.5**	**1.9**	.002 JB	0.2	**1.8**	0.0091	0.019	0.016	0.010 J
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
method detection limit		0.005	0.001	0.005	0.005	0.005	0.011	0.005	0.5	0.1	0.011	0.005	0.1	0.001	0.001	0.005	0.01

Notes:

1) Samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC).

2) nd - indicates that the analyte was not detected above the method detection limit.

3) ITSB-01 and ITSB-02 drilled on 10/27/99; ITSB-03 through ITSB-05 drilled on 10/26/99.

4) Shaded cells indicate concentrations above the NYSDEC TAGM Soil Clean-up Objectives.

5) A small percentage of soil samples were forwarded to Mitkem Laboratory for QA/QC purposes - see Laboratory Analytical Reports.

Table 1-6

Soil Boring Analytical Results (ppm)
Volatile Organic Compounds

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITSB-03								ITSB-04						
		5' - 7' PGC	5'-7' LAB	10' - 12' PGC	15' - 17' PGC	20' - 22' PGC	30' - 32' PGC	32' - 34' PGC	33'-35' LAB	5' - 7' PGC	5'-7' LAB	10' - 12' PGC	15' - 17' PGC	25' - 27' PGC	25'-27' LAB	30' - 32' PGC
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	nd	nd	nd	nd	.001 J	nd	nd	nd	nd	nd	nd	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	**1.8**	**0.096 B**	0.063	**7.9**	<.005	<.005	<.005	.012 B	0.43	0.87 B	**49**	0.051	<.005	0.007 JB	0.05
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
method detection limit		0.1	0.052	0.005	0.1	0.005	0.005	0.005	0.01	0.1	0.11	5	0.005	0.005	0.01	0.005

Notes:

1) Samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC).

2) nd - indicates that the analyte was not detected above the method detection limit.

3) ITSB-01 and ITSB-02 drilled on 10/27/99; ITSB-03 through ITSB-05 drilled on 10/26/99.

4) Shaded cells indicate concentrations above the NYSDEC TAGM Soil Clean-up Objectives.

5) A small percentage of soil samples were forwarded to Mitkem Laboratory for QA/QC purposes - see Laboratory Analytical Reports.

Table 1-6

Soil Boring Analytical Results (ppm)
Volatile Organic Compounds

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITSB-05								
		4' - 6' PGC	4'-6' LAB	9' - 11' PGC	14' - 16' PGC	19' - 21' PGC	24' - 26' PGC	24'-26' LAB	29' - 31' PGC	35' - 37' PGC
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	**3.1 J**	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	**350**	**900 E**	**570**	**2900**	**1500**	**360**	**1,100 E**	**160**	**150**
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
method detection limit		100	27	100	100	500	50	26	10	10

Notes:

1) Samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC).

2) nd - indicates that the analyte was not detected above the method detection limit.

3) ITSB-01 and ITSB-02 drilled on 10/27/99; ITSB-03 through ITSB-05 drilled on 10/26/99.

4) Shaded cells indicate concentrations above the NYSDEC TAGM Soil Clean-up Objectives.

5) A small percentage of soil samples were forwarded to Mitkem Laboratory for QA/QC purposes - see Laboratory Analytical Repo

Table 1-7

HydroPunch Soil Samples
Laboratory and PGC Analytical Data - VOC Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITHP-01								
		PGC	PGC	PGC	PGC	PGC	LAB	PGC	PGC	PGC
		10'-12'	50'-52'	70'-72'	100'-102'	130'-132'	130'-132'	160'-162'	190'-192'	214'-216'
Acetone	0.2	na	na	na	na	na	.007 JB	na	na	na
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	nd	nd	0.004 J	nd	nd	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	nd	nd	0.11	0.0028	nd	nd	nd	nd	nd
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd
lab method detection limit		*0.001*	*0.001*	*0.01*	*0.001*	*0.001*	*0.012*	*0.001*	*0.01*	*0.001*

Notes:

1) NYSDEC Div. of Haz. Waste Remediation Technical and Administrative Guidance Memorandum (TAGM 4046): Determination of Soil Cleanup Objectives and Cleanup Levels - Recommended Soil Cleanup Objectives used for this table.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) na - indicates that particular analyte was not analyzed for by the PGC.

4) Soil samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or at Mitkem Laboratory (LAB).

5) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) Chloroform was detected in ITHP-04 / 100'-102' and ITHP-06 / 180'-182' (lab samples) at concentrations of .001 ppm (JB) and .003 J, respectively. The TAGM Standard for Chloroform is 0.3 ppm

Table 1-7

HydroPunch Soil Samples
Laboratory and PGC Analytical Data - VOC Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITHP-02																		
		PGC	PGC	PGC	PGC	PGC	PGC	PGC	PGC	LAB	PGC	PGC	LAB	PGC	PGC	LAB	PGC	PGC	LAB	PGC
		10'-12'	15'-17'	20'-22'	25'-27'	30'-32'	40'-42'	50'-52'	60'-62'	60'-62'	80'-82'	100'-102'	100'-102'	123'-125'	148'-150'	148'-150'	160'-162'	178'-180	178'-180	197'-199'
Acetone	0.2	na	na	na	na	na	na	na	na	.002 J	na	na	.008 J	na	na	.002 J	na	na	.002 JB	na
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	.005 J	nd	nd	nd	nd	nd	.002 JB	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	.002 J	0.003	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.0018	nd	nd	nd
Tetrachloroethene	1.4	nd	nd	nd	nd	nd	nd	nd	0.0019	nd	0.27	nd	nd	0.0026	0.02	.011 J	0.0066	nd	nd	nd
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
lab method detection limit		*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.01*	*0.0185*	*0.001*	*0.012*	*0.001*	*0.001*	*0.012*	*0.001*	*0.001*	*0.011*	*0.001*

Notes:

1) NYSDEC Div. of Haz. Waste Remediation Technical and Administrative Guidance Memorandum (TAGM 4046): Determination of Soil Cleanup Objectives and Cleanup Levels - Recommended Soil Cleanup Objectives used for this table.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) na - indicates that particular analyte was not analyzed for by the PGC.

4) Soil samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or at Mitkem Laboratory (LAB).

5) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) Chloroform was detected in ITHP-04 / 100'-102' and ITHP-06 / 180'-182' (lab samples) at concentrations of .001 ppm (JB) and .003 J, respectively. The TAGM Standard for Chloroform is 0.3 ppm

Table 1-7

HydroPunch Soil Samples
Laboratory and PGC Analytical Data - VOC Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITHP-03																			
		PGC	PGC	PGC	PGC	PGC	PGC	LAB	PGC	PGC	PGC	LAB	PGC	LAB	PGC	PGC	PGC	LAB	PGC	LAB	PGC
		5'-7'	10'-12'	15'-17'	20'-22'	25'-27'	30'-32'	30'-32'	40'-42'	50'-52'	60'-62	60'-62'	90'-92'	90'-92'	110'-112'	140'-142'	180'-182'	180'-182'	200'-202'	200'-202'	240'-242'
Acetone	0.2	na	na	na	na	na	na	.004 J	na	na	na	.005 J	na	.006 J	na	na	na	.006 JB	na	.008 JB	na
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	nd	nd	nd	.003 JB	nd	nd	nd	.003 JB	nd	.004 JB	nd	nd	nd	.005 J	nd	.007 J	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	nd	nd	nd	0.0078	0.0033	0.0026	nd	0.011	0.0048	0.011	nd	0.34	0.021	0.032	0.0012	0.0039	nd	nd	nd	nd
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	.002 J	nd	.004 J	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	.001 J	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	.005 J	nd	.008 J	nd
lab method detection limit		*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.01*	*0.001*	*0.001*	*0.001*		*0.01*		*0.001*	*0.001*	*0.001*	*0.011*	*0.001*	*0.012*	*0.001*

Notes:

1) NYSDEC Div. of Haz. Waste Remediation Technical and Administrative Guidance Memorandum (TAGM 4046): Determination of Soil Cleanup Objectives and Cleanup Levels - Recommended Soil Cleanup Objectives used for this table.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) na - indicates that particular analyte was not analyzed for by the PGC.

4) Soil samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or at Mitkem Laboratory (LAB).

5) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) Chloroform was detected in ITHP-04 / 100'-102' and ITHP-06 / 180'-182' (lab samples) at concentrations of .001 ppm (JB) and .003 J, respectively. The TAGM Standard for Chloroform is 0.3 ppm

Table 1-7

HydroPunch Soil Samples
Laboratory and PGC Analytical Data - VOC Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITHP-04				
		PGC	LAB	PGC	PGC	PGC
		100'-102'	100'-102'	130'-132'	160'-162'	220'-222'
Acetone	0.2	na	0.023 B	na	na	na
Vinyl Chloride	0.2	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	.008 JB	nd	nd	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	nd	nd	nd	nd	nd
Bezene	0.06	nd	nd	nd	nd	nd
Toluene	1.5	nd	.001 J	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	.001 JB	nd	nd	nd
Xylenes (total)	1.2	nd	.004 J	nd	nd	nd
lab method detection limit		*0.001*	*0.01*	*0.001*	*0.001*	*0.02*

Notes:

1) NYSDEC Div. of Haz. Waste Remediation Technical and Administrative Guidance Memorandum (TAGM 4046): Deten of Soil Cleanup Objectives and Cleanup Levels - Recommended Soil Cleanup Objectives used for this table.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) na - indicates that particular analyte was not analyzed for by the PGC.

4) Soil samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or at Mitkem Lat

5) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) Chloroform was detected in ITHP-04 / 100'-102' and ITHP-06 / 180'-182' (lab samples) at concentrations of .001 ppm The TAGM Standard for Chloroform is 0.3 ppm

Table 1-7

HydroPunch Soil Samples
Laboratory and PGC Analytical Data - VOC Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITHP-05											
		PGC	PGC	PGC	LAB	PGC	PGC	PGC	PGC	PGC	LAB	PGC	LAB
		7' - 9'	18' - 20'	38' - 40'	38'-40'	58' - 60'	78' - 80'	110'-112'	132'-134'	148'-150'	148'-150'	165'-167'	165'-167'
Acetone	0.2	na	na	na	.008 JB	na	na	na	na	na	.008 JB	na	nd
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	.004 JB	nd	nd	nd	nd	nd	.008 JB	nd	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.0011	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	0.084	0.027	0.099	.003 J	0.049	0.0035	0.0012	0.0024	0.0013	.007 J	0.0022	nd
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	.004 J
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
lab method detection limit		*0.005*	*0.005*	*0.005*	*0.011*	*0.005*	*0.001*	*0.001*	*0.001*	*0.001*	*0.012*	*0.001*	*0.012*

Notes:

1) NYSDEC Div. of Haz. Waste Remediation Technical and Administrative Guidance Memorandum (TAGM 4046): Determination of Soil Cleanup Objectives and Cleanup Levels - Recommended Soil Cleanup Objectives used for this table.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) na - indicates that particular analyte was not analyzed for by the PGC.

4) Soil samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or at Mitkem Laboratory (LAB).

5) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) Chloroform was detected in ITHP-04 / 100'-102' and ITHP-06 / 180'-182' (lab samples) at concentrations of .001 ppm (JB) and .003 J, respectively. The TAGM Standard for Chloroform is 0.3 ppm

Table 1-7

HydroPunch Soil Samples
Laboratory and PGC Analytical Data - VOC Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITHP-06					
		PGC	PGC	LAB	PGC	PGC	LAB
		18' - 20'	110'-112'	110'-112'	130'-132'	180'-182'	180'-182'
Acetone	0.2	na	na	0.004 J	na	na	0.005 J
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	0.003 J	nd	nd	0.007 JB
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	0.038	0.1	.053 B	0.0032	0.015	0.013
Bezene	0.06	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	0.002 J
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	0.002 J
lab method detection limit		*0.005*	*0.005*	*0.013*	*0.001*	*0.001*	*0.012*

Notes:

1) NYSDEC Div. of Haz. Waste Remediation Technical and Administrative Guidance Memorandum (TAGM 4046): Determi
of Soil Cleanup Objectives and Cleanup Levels - Recommended Soil Cleanup Objectives used for this table.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) na - indicates that particular analyte was not analyzed for by the PGC.

4) Soil samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or at Mitkem Labo

5) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) Chloroform was detected in ITHP-04 / 100'-102' and ITHP-06 / 180'-182' (lab samples) at concentrations of .001 ppm (J
The TAGM Standard for Chloroform is 0.3 ppm

Table 1-7

HydroPunch Soil Samples
Laboratory and PGC Analytical Data - VOC Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITHP-08														
		PGC	PGC	PGC	LAB	PGC	PGC	LAB	PGC	PGC	PGC	PGC	PGC	LAB	PGC	PGC
		10'-12'	15' - 17'	38' - 40'	38' - 40'	50'-52'	58' - 60'	68' - 70'	78' - 80'	101'-103'	130'-132'	150'-152'	154'-156'	154'-156'	188'-190'	216'-218'
Acetone	0.2	na	na	na	.003 J	na	na	.007J	na	na	na	na	na	.007 JB	na	na
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	.003 J	nd	nd	.01 J	nd	nd	nd	nd	nd	.004 JB	nd	nd
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	.001 J	nd	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	0.0043	0.064	0.038	.008 JB	0.036	0.03	.14 B	0.013	0.0021	0.007	0.0013	nd	.003 J	nd	nd
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
lab method detection limit		*0.001*	*0.005*	*0.005*	*0.011*	*0.001*	*0.005*	*0.012*	*0.005*	*0.001*	*0.001*	*0.001*	*0.001*	*0.011*	*0.005*	*0.001*

Notes:

1) NYSDEC Div. of Haz. Waste Remediation Technical and Administrative Guidance Memorandum (TAGM 4046): Determination of Soil Cleanup Objectives and Cleanup Levels - Recommended Soil Cleanup Objectives used for this table.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) na - indicates that particular analyte was not analyzed for by the PGC.

4) Soil samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or at Mitkem Laboratory (LAB).

5) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) Chloroform was detected in ITHP-04 / 100'-102' and ITHP-06 / 180'-182' (lab samples) at concentrations of .001 ppm (JB) and .003 J, respectively. The TAGM Standard for Chloroform is 0.3 ppm

Table 1-7

HydroPunch Soil Samples
Laboratory and PGC Analytical Data - VOC Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITHP-09											
		PGC	PGC	PGC	LAB	PGC	PGC	PGC	PGC	PGC	PGC	PGC	LAB
		5'-7'	30'-32'	60'-62'	60' - 62'	90'-92'	145'-147'	152'-154'	158'-160'	170'-172'	180'-182'	189'-190'	189'-190'
Acetone	0.2	na	na	na	.002 JB	na	na	na	na	na	na	na	.005 JB
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd	.004 JB	nd	nd	nd	nd	nd	nd	nd	.014 B
t-1,2-DCE	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd	nd	nd	nd	nd	nn	nd	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd	nd	nd	nd	0.0017	nd	0.0012	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	0.0019	0.0013	0.0056	nd	nd	nd
Tetrachloroethene	1.4	0.014	0.0038	0.0098	nd	0.0019	nd	0.0014	nd	0.0018	nd	nd	nd
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
lab method detection limit		*0.005*	*0.001*	*0.001*	*0.009*	*0.001*	*0.001*	*0.001*	*0.001*	*0.01*	*0.001*	*0.005*	*0.012*

Notes:

1) NYSDEC Div. of Haz. Waste Remediation Technical and Administrative Guidance Memorandum (TAGM 4046): Determination of Soil Cleanup Objectives and Cleanup Levels - Recommended Soil Cleanup Objectives used for this table.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) na - indicates that particular analyte was not analyzed for by the PGC.

4) Soil samples were analyzed by Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or at Mitkem Laboratory (LAB).

5) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) Chloroform was detected in ITHP-04 / 100'-102' and ITHP-06 / 180'-182' (lab samples) at concentrations of .001 ppm (JB) and .003 J, respectively. The TAGM Standard for Chloroform is 0.3 ppm

Table 1-8

Source Area Soil Analytical Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Standards (ppm)	**DWSB-1** 17'-21'	**DWSB-1** 33'-37'	**DWSB-2** 15'-20'	**DWSB-2** 28'-32'	**DWSB-3** 16'-20'	**DWSB-3** 40'-42'	**DWSB-4** 16'-20'	**DWSB-4** 32'-36'
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	0.4	nd	nd	nd	nd	nd	nd	nd	nd
Methylene Chloride	0.1	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-Dichloroethene	0.3	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	0.2	nd	nd	0.002J	nd	nd	nd	nd	nd
c-1,2-Dichloroethene	n/a	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	0.8	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd	nd	nd	nd	nd	nd
1,2-Dichloroethane	0.1	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	1.4	0.15	**41**	0.069	**160**	**6.5B**	**1,100**	0.093	**9,400**
Bezene	0.06	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	1.5	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd	nd	nd	nd	nd	nd
method detection limit		0.012	2.300	0.010	9.800	1.100	94.000	0.026	1,000.000

Notes:
1) Samples were analyzed by Mitkem.
2) nd - indicates that the analyte was not detected above the method detection limit.
3) Borings were advanced from April 24 to April 28, 2000.

Table 1-8

Source Area Soil Analytical Results (ppm)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	DWSB-5 16'-20'	DWSB-5 28'-32'	DWSB-6 10'-16'	DWSB-6 30'-32'	UOSB-1 17'-20'	UOSB-2 11'-15'
Vinyl Chloride	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	nd	nd	nd	nd	nd	nd
Methylene Chloride	nd	nd	nd	nd	nd	nd
t-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	nd	nd	nd	nd	nd	nd
c-1,2-Dichloroethene	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	nd	nd	nd	nd	nd	nd
Carbon Tet.	nd	nd	nd	nd	nd	nd
1,2-Dichloroethane	nd	nd	nd	nd	nd	nd
Trichloroethene	nd	nd	nd	nd	nd	nd
Tetrachloroethene	3,900	1,200	6,200	18	0.068	0.049
Bezene	nd	nd	nd	nd	nd	nd
Toluene	nd	nd	nd	nd	nd	nd
Chlorobenzene	nd	nd	nd	nd	nd	nd
Ethylbenzene	nd	nd	nd	nd	nd	nd
Xylenes (total)	nd	nd	nd	nd	nd	nd
method detection limit	410.000	930.000	580.000	1.800	0.010	0.010

Notes:

1) Samples were analyzed by Mitkem.

2) nd - indicates that the analyte was not detected above the method detection limit.

3) Borings were advanced from April 24 to April 28, 2000.

Table 1-9

Hydropunch Groundwater Samples
Laboratory and PGC Analytical Data - VOC Results (ppb)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC GW Standard	ITHP-01							
		PGC	LAB	PGC	PGC	PGC	PGC	PGC	PGC
	(ppb)	76'	76'	89'	108'	136'	166'	198'	212'
Acetone	50 (guid)	na	nd	na	na	na	na	na	na
Vinyl Chloride	2	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	5	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-DCE	5	nd	61 J *	nd	nd	nd	nd	nd	nd
1,1-DCA	5	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	5	nd	*	nd	nd	nd	nd	nd	nd
1,1,1-TCA	5	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	5	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.6	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	5	nd	45 J	nd	nd	nd	nd	nd	nd
Tetrachloroethene	5	**3,300**	**4,200**	**1,800**	**750**	**9.9**	**6.8**	**23**	nd
Benzene	1	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	5	nd	nd	nd	nd	1.6	1.6	**34**	4.1
Chlorobenzene	5	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	5/isomer	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	na	nd	na	na	na	na	na	na
Bromodichloromethane	50 (guid)	na	nd	na	na	na	na	na	na
Dibromochloromethane	50 (guid)	na	nd	na	na	na	na	na	na
Methyl ethyl ketone	50 (guid)	na	nd	na	na	na	na	na	na
lab method detection limit		*100*	*250*	*100*	*50*	*1*	*1*	*1*	*1*

Notes:

1) New York State Department of Environmental Conservation Division of Water Technical and Operational

2) Groundwater samples were analyzed by either Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or Mitkem's fixed laboratory (LAB).

3) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

5) na - indicates that particular analyte was not analyzed for by the PGC.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) * The analytical result for t-1,2-DCE is actually the sum of t-1,2-DCE and c-1,2-DCE.

Table 1-9

Hydropunch Groundwater Samples
Laboratory and PGC Analytical Data - VOC Results (ppb)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC GW Standard	ITHP-02									
		PGC	PGC	PGC	PGC	PGC	LAB	PGC	PGC	LAB	PGC
	(ppb)	74'	86'	106'	129'	154'	154'	166'	184'	184'	203'
Acetone	50 (guid)	na	na	na	na	na	46 J	na	na	4 J	na
Vinyl Chloride	2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	5	nd	nd	nd	nd	nd	**8 J**	nd	**24**	**11**	nd
MethyleneChloride	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd	1 J *	nd
1,1-DCA	5	nd	nd	nd	nd	nd	nd	nd	nd	1 J	nd
c-1,2-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd	*	nd
1,1,1-TCA	5	nd	nd	nd	nd	**51**	**50**	nd	**37**	**37**	nd
Carbon Tet.	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	5	nd	nd	nd	nd	nd	**12 J**	nd	**130**	**110**	nd
Tetrachloroethene	5	**22,000**	**7,000**	**230**	**600**	**780**	**550**	**3,000**	**68**	**55 B**	2.5
Bezene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	5	nd	nd	nd	nd	nd	nd	nd	**36**	**31**	**19**
Chlorobenzene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	5/isomer	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	na	na	na	na	na	nd	na	na	1 J	na
Bromodichloromethan	50 (guid)	na	na	na	na	na	nd	na	na	nd	na
Dibromochloromethan	50 (guid)	na	na	na	na	na	nd	na	na	nd	na
Methyl ethyl ketone	50 (guid)	na	na	na	na	na	nd	na	na	nd	na
lab method detection limit		*1000*	*1000*	*10*	*50*	*50*	*50*	*500*	*10*	*10*	*1*

Notes:

1) New York State Department of Environmental Conservation Division of Water Technical and Operational

2) Groundwater samples were analyzed by either Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or Mitkem's fixed laboratory (LAB).

3) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

5) na - indicates that particular analyte was not analyzed for by the PGC.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) * The analytical result for t-1,2-DCE is actually the sum of t-1,2-DCE and c-1,2-DCE.

Table 1-9

Hydropunch Groundwater Samples
Laboratory and PGC Analytical Data - VOC Results (ppb)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	**NYSDEC GW Standard**	ITHP-03						
		PGC	LAB	PGC	PGC	PGC	LAB	PGC
	(ppb)	80'	80'	96'	116'	146'	146'	185'
Acetone	50 (guid)	na	nd	na	na	na	nd	na
Vinyl Chloride	2	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	5	nd	nd	nd	nd	nd	nd	**19**
MethyleneChloride	5	nd	nd	nd	nd	nd	nd	nd
t-1,2-DCE	5	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	5	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	5	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	5	nd	nd	nd	nd	nd	3	**30**
Carbon Tet.	5	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.6	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	5	nd	5	nd	nd	nd	1	**100**
Tetrachloroethene	5	**7,800**	**6,600**	**800**	**1,400**	**130**	**120**	**130**
Bezene	1	nd	nd	nd	nd	nd	nd	nd
Toluene	5	nd	**29**	nd	nd	nd	2	**10**
Chlorobenzene	5	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	5/isomer	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	na	nd	na	na	na	nd	na
Bromodichloromethan	50 (guid)	na	nd	na	na	na	nd	na
Dibromochloromethan	50 (guid)	na	nd	na	na	na	nd	na
Methyl ethyl ketone	50 (guid)	na	nd	na	na	na	nd	na
lab method detection limit		*500*	*10*	*100*	*50*	*10*	*10*	*5*

Notes:

1) New York State Department of Environmental Conservation Division of Water Technical and Operational

2) Groundwater samples were analyzed by either Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or Mitkem's fixed laboratory (LAB).

3) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

5) na - indicates that particular analyte was not analyzed for by the PGC.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) * The analytical result for t-1,2-DCE is actually the sum of t-1,2-DCE and c-1,2-DCE.

Table 1-9

Hydropunch Groundwater Samples
Laboratory and PGC Analytical Data - VOC Results (ppb)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	**NYSDEC GW Standard**	**ITHP-04**		
		PGC	PGC	PGC
	(ppb)	106'	136'	166'
Acetone	50 (guid)	na	na	na
Vinyl Chloride	2	nd	nd	nd
1,1-DCE	5	nd	nd	nd
MethyleneChloride	5	nd	nd	nd
t-1,2-DCE	5	nd	nd	nd
1,1-DCA	5	nd	nd	nd
c-1,2-DCE	5	nd	nd	nd
1,1,1-TCA	5	nd	nd	2.2
Carbon Tet.	5	nd	nd	nd
1,2-DCA	0.6	nd	nd	nd
Trichloroethene	5	nd	nd	3.2
Tetrachloroethene	5	1.2	**5.6**	**9.8**
Bezene	1	nd	nd	nd
Toluene	5	**23**	3.3	1.4
Chlorobenzene	5	nd	nd	nd
Ethylbenzene	5	nd	nd	nd
Xylenes (total)	5/isomer	nd	nd	nd
Chloroform	7	na	na	na
Bromodichloromethane	50 (guid)	na	na	na
Dibromochloromethane	50 (guid)	na	na	na
Methyl ethyl ketone	50 (guid)	na	na	na
lab method detection limit		*1*	*1*	*1*

Notes:

1) New York State Department of Environmental Conservation Division of Water Technical and Operational

2) Groundwater samples were analyzed by either Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or Mitkem's fixed laboratory (LAB).

3) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

5) na - indicates that particular analyte was not analyzed for by the PGC.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) * The analytical result for t-1,2-DCE is actually the sum of t-1,2-DCE and c-1,2-DCE.

Table 1-9

Hydropunch Groundwater Samples
Laboratory and PGC Analytical Data - VOC Results (ppb)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	**NYSDEC GW Standard**	**ITHP-05**			
		PGC	PGC	PGC	LAB
	(ppb)	74'	88'	132'	132'
Acetone	50 (guid)	na	na	na	nd
Vinyl Chloride	2	nd	nd	nd	nd
1,1-DCE	5	nd	nd	nd	nd
MethyleneChloride	5	nd	nd	nd	nd
t-1,2-DCE	5	nd	nd	nd	nd
1,1-DCA	5	nd	nd	nd	nd
c-1,2-DCE	5	nd	nd	nd	nd
1,1,1-TCA	5	nd	nd	nd	nd
Carbon Tet.	5	nd	nd	nd	nd
1,2-DCA	0.6	nd	nd	nd	nd
Trichloroethene	5	nd	nd	nd	nd
Tetrachloroethene	5	**100,000**	**98**	3.3	4.0
Bezene	1	nd	nd	nd	nd
Toluene	5	nd	**15**	nd	nd
Chlorobenzene	5	nd	nd	nd	nd
Ethylbenzene	5	nd	nd	nd	nd
Xylenes (total)	5/isomer	nd	nd	nd	nd
Chloroform	7	na	na	na	nd
Bromodichloromethan	50 (guid)	na	na	na	nd
Dibromochloromethan	50 (guid)	na	na	na	nd
Methyl ethyl ketone	50 (guid)	na	na	na	nd
lab method detection limit		*5000*	*10*	*1*	*10*

Notes:

1) New York State Department of Environmental Conservation Division of Water Technical and Operational

2) Groundwater samples were analyzed by either Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or Mitkem's fixed laboratory (LAB).
3) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

5) na - indicates that particular analyte was not analyzed for by the PGC.
6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.
7) * The analytical result for t-1,2-DCE is actually the sum of t-1,2-DCE and c-1,2-DCE.

Table 1-9

Hydropunch Groundwater Samples
Laboratory and PGC Analytical Data - VOC Results (ppb)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	**NYSDEC GW Standard**	**ITHP-06**						
		PGC	PGC	LAB	PGC	PGC	PGC	LAB
	(ppb)	80'	100'	100'	130'	165'	185'	185'
Acetone	50 (guid)	na	na	**16 JB**	na	na	na	**8 J**
Vinyl Chloride	2	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	5	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	5	nd	nd	**7 JB**	nd	nd	nd	nd
t-1,2-DCE	5	nd	nd	**6 J** *	nd	nd	nd	nd
1,1-DCA	5	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	5	nd	nd	*	nd	nd	nd	nd
1,1,1-TCA	5	nd	nd	nd	nd	nd	nd	nd
Carbon Tet.	5	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.6	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	5	nd	nd	**11 J**	nd	nd	nd	2 J
Tetrachloroethene	5	**400**	**370**	**290**	**120**	**220**	**47**	**48**
Bezene	1	nd	nd	nd	nd	nd	nd	nd
Toluene	5	nd	nd	nd	nd	nd	nd	1 J
Chlorobenzene	5	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	5/isomer	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	na	na	nd	na	na	na	**22**
Bromodichloromethan	50 (guid)	na	na	nd	na	na	na	3 J
Dibromochloromethan	50 (guid)	na	na	nd	na	na	na	2 J
Methyl ethyl ketone	50 (guid)	na	na	9 J	na	na	na	nd
lab method detection limit		*100*	*50*	*50*	*10*	*10*	*10*	*10*

Notes:

1) New York State Department of Environmental Conservation Division of Water Technical and Operational

2) Groundwater samples were analyzed by either Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or Mitkem's fixed laboratory (LAB).

5) na - indicates that particular analyte was not analyzed for by the PGC.
6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.
7) * The analytical result for t-1,2-DCE is actually the sum of t-1,2-DCE and c-1,2-DCE.

Table 1-9

Hydropunch Groundwater Samples
Laboratory and PGC Analytical Data - VOC Results (ppb)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC GW Standard	ITHP-08									
		PGC	PGC	PGC	LAB	PGC	PGC	LAB	PGC	PGC	LAB
	(ppb)	74'	84'	101'	101'	130'	150'	150'	163.5'	222'	222'
Acetone	50 (guid)	na	na	na	4 J	na	na	4 J	na	na	2 J
Vinyl Chloride	2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd	1.7	nd
MethyleneChloride	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	**10 B**
t-1,2-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	5	nd	nd	**6.1**	**8 J**	nd	nd	nd	nd	2.5	nd
Carbon Tet.	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	5	nd	nd	nd	nd	nd	nd	nd	nd	**14**	nd
Tetrachloroethene	5	**2,400**	**16**	2.5	4 J	**7.7**	4.8	6 J	2.5	3.9	**7 J**
Bezene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	5/isomer	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	na	na	na	nd	na	na	nd	na	na	2 J
Bromodichloromethan	50 (guid)	na	na	na	nd	na	na	nd	na	na	nd
Dibromochloromethan	50 (guid)	na	na	na	nd	na	na	nd	na	na	nd
Methyl ethyl ketone	50 (guid)	na	na	na	nd	na	na	nd	na	na	nd
lab method detection limit		*100*	*1*	*1*	*10*	*1*	*1*	*10*	*1*	*1*	*10*

Notes:

1) New York State Department of Environmental Conservation Division of Water Technical and Operational

2) Groundwater samples were analyzed by either Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or Mitkem's fixed laboratory (LAB).

3) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

5) na - indicates that particular analyte was not analyzed for by the PGC.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) * The analytical result for t-1,2-DCE is actually the sum of t-1,2-DCE and c-1,2-DCE.

Table 1-9

Hydropunch Groundwater Samples
Laboratory and PGC Analytical Data - VOC Results (ppb)

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Analyte	NYSDEC GW Standard	ITHP-09										
		PGC	LAB	PGC	PGC	PGC	PGC	PGC	PGC	PGC	LAB	PGC
	(ppb)	74'	74'	96'	124'	150'	164'	174'	186'	194'	194'	203'
Acetone	50 (guid)	na	2 J	na	na	na	na	na	na	na	3 J	na
Vinyl Chloride	2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MethyleneChloride	5	nd	10 B	nd	nd	nd	nd	nd	nd	nd	nd	nd
t-1,2-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-DCA	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
c-1,2-DCE	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-TCA	5	nd	nd	nd	nd	**22**	nd	nd	nd	nd	3 J	nd
Carbon Tet.	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-DCA	0.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	5	nd	nd	nd	nd	nd	nd	**14**	nd	nd	**17**	nd
Tetrachloroethene	5	**63,000**	**140**	**130**	**54**	**40**	**110**	**190**	**800**	nd	**13**	4.5
Bezene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Toluene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Xylenes (total)	5/isomer	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	**7**	na	2 J	na	na	na	na	na	na	na	nd	na
Bromodichloromethan	50 (guid)	na	nd	na	na	na	na	na	na	na	nd	na
Dibromochloromethan	50 (guid)	na	nd	na	na	na	na	na	na	na	nd	na
Methyl ethyl ketone	50 (guid)	na	nd	na	na	na	na	na	na	na	nd	na
lab method detection limit		*5000*	*10*	*10*	*10*	*10*	*10*	*10*	*100*	*1*	*10*	*1*

Notes:

1) New York State Department of Environmental Conservation Division of Water Technical and Operational

2) Groundwater samples were analyzed by either Severn Trent Laboratory's on-site portable gas chromatograph (PGC) or Mitkem's fixed laboratory (LAB).

3) HydroPunch activities occurred between October 27, 1999 and January 6, 2000.

5) na - indicates that particular analyte was not analyzed for by the PGC.

6) J indicates an estimated value; B indicates the analyte was also detected in the associated Method Blank.

7) * The analytical result for t-1,2-DCE is actually the sum of t-1,2-DCE and c-1,2-DCE.

Table 1-10

Groundwater Monitoring Well Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Well Designation		ITMW-01S			ITMW-01D			ITMW-02S			ITMW-03S			ITMW-03D	
Sampling Event		03-Feb-00	02-Nov-00	01-Mar-01	03-Feb-00	02-Nov-00	27-Feb-01	03-Feb-00	06-Nov-00	01-Mar-01	03-Feb-00	06-Nov-00	01-Mar-01	01-Feb-00	28-Feb-01
VOCs (ug/L)	NYSDEC GW Standards*														
Methylene Chloride	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	5	nd	nd	nd	**24**	**27J**	**85**	nd	nd	nd	nd	nd	nd	1 J	nd
1,1-Dichloroethane	5	nd	nd	nd	**3 J**	nd	**6 J**	nd	nd	nd	nd	nd	nd	nd	nd
Acetone	50 (guid)	nd	nd	nd	7 J	17 J	nd	nd	nd	nd	nd	nd	nd	6 J	5J
1,2-Dichloroethene (total)	5/ea isomer	nd	nd	nd	**8 J**	**9 J**	15 J	nd	nd	nd	**130 J**	nd	**120 J**	nd	nd
2-Butanone	SNA	nd	nd	nd	2 J	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	nd	nd	nd	2 J	nd	2 J	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	5	nd	nd	nd	**85**	**99**	**240**	nd	nd	nd	nd	nd	nd	4 J	nd
Trichloroethene	5	nd	nd	nd	**74**	**87**	**240**	nd	nd	nd	**160 J**	**220 J**	**120 J**	**16**	**52**
Bromodichloromethane	50 (guid)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Disulfide	SNA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,2-Trichloro-1,2,2-trifluoroethane	5	na	nd	nd	na	**11 J**	nd	na	nd	nd	na	nd	nd	na	nd
Tetrachloroethene	5	**3,300**	**33,000 B**	**14,000**	**51**	**390 B**	**120**	**7,000**	**26,000**	**19,000**	**19,000**	**29,000**	**20,000**	**9 J**	**44**
Lab Dilution Factor		25	250	100	1	5	2	50	200	100	100	200	100	1	10
SVOCs (ug/L)															
4-Methylphenol	SNA	nd	na	na	6 J	na	na	na	na	na	nd	na	na	nd	na
bis (2-ethylhexyl) phthalate	5	2 JB	na	na	2 JB	na	na	na	na	na	2 JB	na	na	nd	na
Fluoranthene	50 (guid)	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Pyrene	50 (guid)	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Benzo (a) anthracene	0.002 (guid)	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Chrysene	0.002 (guid)	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Benzo (b) fluoranthene	0.002 (guid)	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Benzo (k) fluoranthene	0.002 (guid)	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Benzo (a) pyrene	ND**	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Ideno (1,2,3-cd) pyrene	0.002 (guid)	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Benzo (g,h,i) perylene	SNA	nd	na	na	nd	na	na	na	na	na	nd	na	na	nd	na
Lab Dilution Factor		1	na	na	1	na	na	na	na	na	1	na	na	1	na

Notes:

Series (1.1.1) Ambient Water Quality Standards and Guidance Values.
2. ND** - means a non-detectable concentration by the approved analytical method is the Standard, per NYSDEC TOGS (1.1.1).
3. SNA - means that a Standard is not currently available for this analyte.
4. (guid) - indicates a standard was not listed, therefore the Guidance Value was used.
5. nd - indicates that the analyte was not detected above the laboratory's method detection limit.
6. na - indicates that the sample was not analyzed for that analyte.
7. All other analytes typically listed for lab methods ASP 95-1 and 95-2, not on the above table, are to be considered nd.
8. J - indicates an estimated value.
9. E - indicates the analyte concentration exceeded the Calibration Range.
10. B - indicates that the analyte was also detected in the associated Method Blank.
11. D- indicates thr analyte concentration was obtained from a diluted analysis.
12. ns - indicates that the well was not sampled due to thick snow and ice cover.

Table 1-10

Groundwater Monitoring Well Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Well Designation		ITMW-04D	ITMW-04DDL (diluted)	ITMW-04D		ITMW-05S	ITMW-05SDL (diluted)	ITMW-05S		ITMW-05D	ITMW-05DDL (diluted)	ITMW-05D
Sampling Event		01-Feb-00		06-Nov-00	27-Feb-01	01-Feb-00		02-Nov-00	01-Mar-01	01-Feb-00		28-Feb-01
VOCs (ug/L)	**NYSDEC GW Standards***											
Methylene Chloride	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	**120 DJ**	nd
1,1-Dichloroethene	5	**6 J**	nd	2 J	14	nd	nd	nd	nd	3 J	nd	nd
1,1-Dichloroethane	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	**78 DJ**	nd
Acetone	50 (guid)	7 J	nd	nd	nd	nd	nd	nd	nd	3 J	nd	nd
1,2-Dichloroethene (total)	5/ea isomer	**5 J**	nd	nd	2 J	**57**	nd	nd	**280 J**	**59**	nd	**200**
2-Butanone	SNA	nd	30 DJ	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	nd	nd	nd	nd	nd	nd	nd	nd	1 J	nd	nd
1,1,1-Trichloroethane	5	**29**	nd	**10**	**44**	nd	nd	nd	nd	**14**	nd	nd
Trichloroethene	5	**35**	**37 DJ**	**5 J**	**35**	**35**	nd	nd	nd	**83**	**94 DJ**	**160**
Bromodichloromethane	50 (guid)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Disulfide	SNA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,2-Trichloro-1,2,2-trifluoroethane	5	na	na	nd	nd	na	na	nd	nd	na	na	nd
Tetrachloroethene	5	**1,100 E**	**1300 D**	**8 J**	**110**	**4,300 E**	**5,500**	**42,000 B**	**34,000**	**3,500 E**	**8200 D**	**16,000**
Lab Dilution Factor		1	20	20	1	1	50	500	200	1	50	1,000
SVOCs (ug/L)												
4-Methylphenol	SNA	na	na	na	na	na	na	na	na	na	na	na
bis (2-ethylhexyl) phthalate	5	na	na	na	na	na	na	na	na	na	na	na
Fluoranthene	50 (guid)	na	na	na	na	na	na	na	na	na	na	na
Pyrene	50 (guid)	na	na	na	na	na	na	na	na	na	na	na
Benzo (a) anthracene	0.002 (guid)	na	na	na	na	na	na	na	na	na	na	na
Chrysene	0.002 (guid)	na	na	na	na	na	na	na	na	na	na	na
Benzo (b) fluoranthene	0.002 (guid)	na	na	na	na	na	na	na	na	na	na	na
Benzo (k) fluoranthene	0.002 (guid)	na	na	na	na	na	na	na	na	na	na	na
Benzo (a) pyrene	ND**	na	na	na	na	na	na	na	na	na	na	na
Ideno (1,2,3-cd) pyrene	0.002 (guid)	na	na	na	na	na	na	na	na	na	na	na
Benzo (g,h,I) perylene	SNA	na	na	na	na	na	na	na	na	na	na	na
Lab Dilution Factor		na	na	na	na	na	na	na	na	na	na	na

Notes:

Series (1.1.1) Ambient Water Quality Standards and Guidance Values
2. ND** - means a non-detectable concentration by the approved analytical method is the Standard, per NYSDEC TOGS (1.1.1)
3. SNA - means that a Standard is not currently available for this analyte.
4. (guid) - indicates a standard was not listed, therefore the Guidance Value was used.
5. nd - indicates that the analyte was not detected above the laboratory's method detection limit
6. na - indicates that the sample was not analyzed for that analyte.
7. All other analytes typically listed for lab methods ASP 95-1 and 95-2, not on the above table, are to be considered nd.
8. J - indicates an estimated value.
9. E - indicates the analyte concentration exceeded the Calibration Range.
10. B - indicates that the analyte was also detected in the associated Method Blank.
11. D- indicates thr analyte concentration was obtained from a diluted analysis.
12. ns - indicates that the well was not sampled due to thick snow and ice cover.

Table 1-10

Groundwater Monitoring Well Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Well Designation		ITMW-06S			ITMW-07S			ITMW-08S			ITMW-09S	ITMW-09SDL (diluted)
Sampling Event		21-Feb-00	02-Nov-00	28-Feb-01	03-Feb-00	06-Nov-00	28-Feb-01	03-Feb-00	01-Nov-00	28-Feb-01	31-Jan-00	
VOCs (ug/L)	**NYSDEC GW Standards***											
Methylene Chloride	5	ns	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	5	ns	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	5	ns	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Acetone	50 (guid)	ns	nd	nd	nd	nd	nd	nd	nd	nd	6 J	190 DJ
1,2-Dichloroethene (total)	5/ea isomer	ns	nd	nd	**72 J**	nd	**52**	nd	**21 J**	nd	**39**	nd
2-Butanone	SNA	ns	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	ns	nd	nd	nd	nd	nd	nd	nd	nd	2 J	nd
1,1,1-Trichloroethane	5	ns	nd	nd	nd	nd	nd	nd	nd	nd	3 J	nd
Trichloroethene	5	ns	nd	nd	**53 J**	**42 J**	nd	nd	**29 J**	nd	**35**	nd
Bromodichloromethane	50 (guid)	ns	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Disulfide	SNA	ns	nd	nd	nd	nd	nd	nd	nd	nd		
1,1,2-Trichloro-1,2,2-trifluoroethane	5	ns	nd	nd	na	nd	nd	na	nd	nd		
Tetrachloroethene	5	ns	**1,000 B**	**6,600**	**6,900**	**5,200**	**6,400**	**3,400**	**3200 B**	**17,000**	**3,100 E**	**4000 D**
Lab Dilution Factor		ns	10	400	50	40	500	20	20	1,000	1	50
SVOCs (ug/L)												
4-Methylphenol	SNA	ns	na	na	na	na	na	na	na	na	na	na
bis (2-ethylhexyl) phthalate	5	ns	na	na	na	na	na	na	na	na	na	na
Fluoranthene	50 (guid)	ns	na	na	na	na	na	na	na	na	na	na
Pyrene	50 (guid)	ns	na	na	na	na	na	na	na	na	na	na
Benzo (a) anthracene	0.002 (guid)	ns	na	na	na	na	na	na	na	na	na	na
Chrysene	0.002 (guid)	ns	na	na	na	na	na	na	na	na	na	na
Benzo (b) fluoranthene	0.002 (guid)	ns	na	na	na	na	na	na	na	na	na	na
Benzo (k) fluoranthene	0.002 (guid)	ns	na	na	na	na	na	na	na	na	na	na
Benzo (a) pyrene	ND**	ns	na	na	na	na	na	na	na	na	na	na
Ideno (1,2,3-cd) pyrene	0.002 (guid)	ns	na	na	na	na	na	na	na	na	na	na
Benzo (g,h,I) perylene	SNA	ns	na	na	na	na	na	na	na	na	na	na
Lab Dilution Factor		ns	na	na	na	na	na	na	na	na	na	na

Notes:

Series (1.1.1) Ambient Water Quality Standards and Guidance Values

2. ND** - means a non-detectable concentration by the approved analytical method is the Standard, per NYSDEC TOGS (1.1.1)
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9. E - indicates the analyte concentration exceeded the Calibration Range.
10. B - indicates that the analyte was also detected in the associated Method Blank.
11. D- indicates thr analyte concentration was obtained from a diluted analysis.
12. ns - indicates that the well was not sampled due to thick snow and ice cover.

Table 1-10

Groundwater Monitoring Well Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Well Designation		ITMW-09D	ITMW-10D	ITMW-00-11S		ITMW-00-12S		ITMW-00-13S	ITMW-00-13S (diluted)	ITMW-00-13S
Sampling Event		31-Jan-00	31-Jan-00	03-Nov-00	27-Feb-01	06-Nov-00	28-Feb-01	03-Nov-00		27-Feb-01
VOCs (ug/L)	**NYSDEC GW Standards***									
Methylene Chloride	5	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	5	nd	3 J	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	5	nd	nd	nd	nd	nd	nd	nd	nd	nd
Acetone	50 (guid)	8 J	6 J	nd	nd	nd	nd	nd	nd	nd
1,2-Dichloroethene (total)	5/ea isomer	nd	nd	nd	nd	nd	nd	**17**	**19 DJ**	**35 J**
2-Butanone	SNA	2 J	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	**8 J**	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	5	nd	**12**	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	5	nd	**18**	nd	nd	nd	nd	**10**	**12 DJ**	**14 J**
Bromodichloromethane	50 (guid)	2 J	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Disulfide	SNA			nd	nd	nd	nd	nd	nd	nd
1,1,2-Trichloro-1,2,2-trifluoroethane	5			nd	nd	nd	nd	nd	nd	nd
Tetrachloroethene	5	nd	**11**	nd	nd	**12,000**	**19,000**	**910 E**	**860 DB**	**1500**
Lab Dilution Factor		1	1	1	1	100	1,000	1	10	10
SVOCs (ug/L)										
4-Methylphenol	SNA	nd	na	na	na	na	na	na	na	na
bis (2-ethylhexyl) phthalate	5	4 JB	na	na	na	na	na	na	na	na
Fluoranthene	50 (guid)	nd	na	na	na	na	na	na	na	na
Pyrene	50 (guid)	nd	na	na	na	na	na	na	na	na
Benzo (a) anthracene	0.002 (guid)	nd	na	na	na	na	na	na	na	na
Chrysene	0.002 (guid)	nd	na	na	na	na	na	na	na	na
Benzo (b) fluoranthene	0.002 (guid)	nd	na	na	na	na	na	na	na	na
Benzo (k) fluoranthene	0.002 (guid)	nd	na	na	na	na	na	na	na	na
Benzo (a) pyrene	ND**	nd	na	na	na	na	na	na	na	na
Ideno (1,2,3-cd) pyrene	0.002 (guid)	nd	na	na	na	na	na	na	na	na
Benzo (g,h,I) perylene	SNA	nd	na	na	na	na	na	na	na	na
Lab Dilution Factor		1	na	na	na	na	na	na	na	na

Notes:

Series (1.1.1) Ambient Water Quality Standards and Guidance Values

2. ND** - means a non-detectable concentration by the approved analytical method is the Standard, per NYSDEC TOGS (1.1.1)
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11. D- indicates thr analyte concentration was obtained from a diluted analysis.
12. ns - indicates that the well was not sampled due to thick snow and ice cover.

Table 1-10

Groundwater Monitoring Well Analytical Results

100 Oser Avenue - Operable Unit 1
Hauppauge, New York

Well Designation		**ITMW-00-14S**		**ITMW-00-15S**		**MW-09 (pre-existing)**			**MW-13 (pre-existing)**		
Sampling Event		01-Nov-00	28-Feb-01	01-Nov-00	28-Feb-01	03-Feb-00	01-Nov-00	28-Feb-01	03-Feb-00	07-Nov-00	01-Mar-01
VOCs (ug/L)	**NYSDEC GW Standards***										
Methylene Chloride	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Acetone	50 (guid)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2-Dichloroethene (total)	5/ea isomer	nd	nd	nd	nd	nd	nd	nd	**2,200 J**	**770 J**	**280 J**
2-Butanone	SNA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloroform	7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trichloroethene	5	nd	nd	nd	nd	nd	nd	nd	**1,100 J**	**560 J**	nd
Bromodichloromethane	50 (guid)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Carbon Disulfide	SNA	9 J	nd	nd	nd	nd	11 J	nd	nd	nd	nd
1,1,2-Trichloro-1,2,2-trifluoroethane	5	nd	nd	nd	nd	na	nd	nd	na	nd	nd
Tetrachloroethene	5	**370 B**	**380**	**900 B**	**4,000**	**860**	**660 B**	**360**	**87,000**	**79,000**	**33,000**
Lab Dilution Factor		2	20	10	400	10	5	20	1,000	400	200
SVOCs (ug/L)											
4-Methylphenol	SNA	na	na	na	na	nd	na	na	na	na	na
bis (2-ethylhexyl) phthalate	5	na	na	na	na	2 JB	na	na	na	na	na
Fluoranthene	50 (guid)	na	na	na	na	2 J	na	na	na	na	na
Pyrene	50 (guid)	na	na	na	na	2 J	na	na	na	na	na
Benzo (a) anthracene	0.002 (guid)	na	na	na	na	**0.8 J**	na	na	na	na	na
Chrysene	0.002 (guid)	na	na	na	na	**1 J**	na	na	na	na	na
Benzo (b) fluoranthene	0.002 (guid)	na	na	na	na	**2 J**	na	na	na	na	na
Benzo (k) fluoranthene	0.002 (guid)	na	na	na	na	**1 J**	na	na	na	na	na
Benzo (a) pyrene	ND**	na	na	na	na	**1J**	na	na	na	na	na
Ideno (1,2,3-cd) pyrene	0.002 (guid)	na	na	na	na	**2 J**	na	na	na	na	na
Benzo (g,h,I) perylene	SNA	na	na	na	na	**2 J**	na	na	na	na	na
Lab Dilution Factor		na	na	na	na	1	na	na	na	na	na

Notes:

Series (1.1.1) Ambient Water Quality Standards and Guidance Values

2. ND** - means a non-detectable concentration by the approved analytical method is the Standard, per NYSDEC TOGS (1.1.1)
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11. D- indicates thr analyte concentration was obtained from a diluted analysis.
12. ns - indicates that the well was not sampled due to thick snow and ice cover.

Table 2-1

Preliminary Clean-up Criteria for Groundwater

100 Oser Avenue – Operable Unit 1
Hauppauge, New York

Chemicals of Potential Concern (COPC)	US EPA Primary MCL (μg/l)	US EPA Secondary MCL (μg/l)	US EPA Suggested No Adverse Response Levels (SNARL) (μg/l)	National Academy of Sciences (NAS) Suggested No Adverse Response Levels (μg/l)	NYS Water Quality Standards 6 NYCRR 703.5 (μg/l)
1,1 -Dichloroethene	7	NA	7	100	5
1,2- Dichloroethene*	100	NA	100	NA	5
Tetrachloroethylene	5	NA	2000 (10 day)	NA	5
Trichloroethene	5	NA	NA	NA	5
1,1,1-Trichloroethene	5	NA	NA	NA	5
1,1,1Trichloroethane	200	NA	200	3800	5

NA – Not Available
*Values presented are for the trans 1,2-DCE isomer.

Table 2-2

Preliminary Clean-up Goals for Soil

100 Oser Avenue – Operable Unit 1
Hauppauge, New York

Chemicals of Potential Concern	US EPA Health Based Carcinogen (mg/kg)	US EPA Health Based Systemic Toxicants (mg/kg)	Suffolk County Department of Health Soil Cleanup Criteria SOP No. 9-95 (mg/kg)	NYSDEC TAGM 4046 Recommended Cleanup Objective (mg/kg)
Tetrachloroethylene	14	800	1.4	1.4

Table 2-3

Preliminary Clean-up Goals for Indoor Air

100 Oser Avenue – Operable Unit 1
Haugppague, New York

Chemicals of Potential Concern (COPC)	USEPA Region III Ambient Air Risk-Based Concentrations (μg/m^3)	NYS Department of Health Indoor Air Quality Guidelines (μg/m^3)
Methylene chloride	3.8	
1,2, 4-Trimethylbenzene	6.2	
Methyl isobutyl ketone	73	
Tetrachloroethene	3.1	100
Toluene	420	

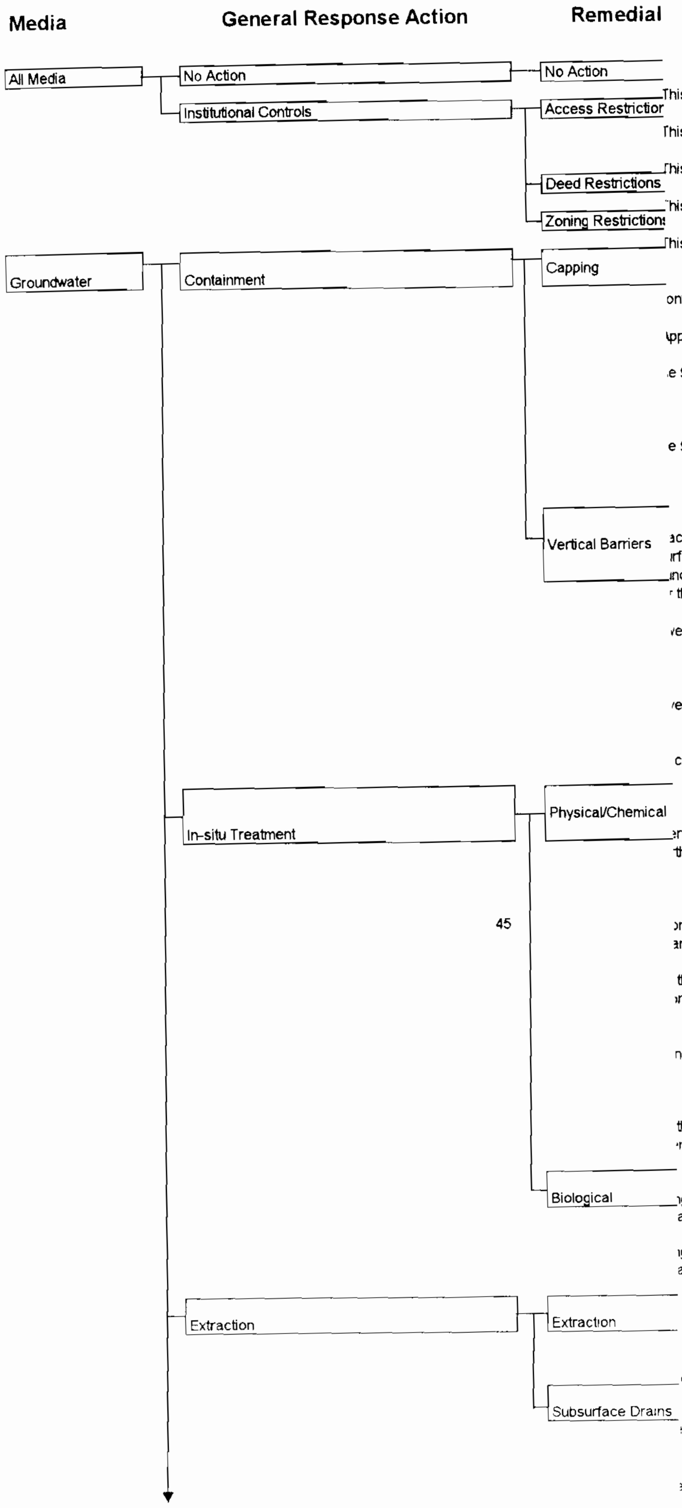
Table 2-4

Off-Gas Discharge Requirements

100 Oser Avenue – Operable Unit 1
Hauppauge, New York

Chemical of Potential Concern (COPC)	SGC Short Term Guideline Concentrations (µg/m$^{3)}$ NYS DEC DAR –1	AGC Annual Guideline Concentrations (µg/m^3) NYS DEC DAR –1
Hydrogen Chloride	150	20
1,1-Dichloroethene	NA	20
1,2-Dichloroethene	NA	3.8 x 10-2
1,1,1-trichloroethane	NA	NA
Tetrachloroethene	1000	1.0
Trichloroethene	54000	4.5 x10-1

NA – Not applicable



Screening Comment

This option has been retained for comparison analysis as required by the NCP.

This option has been retained for further analysis

This option has been retained for further analysis

'his option has been retained for further analysis.

This option has been retained for further analysis

ontact with the groundwater is not an exposure route at OU1.

\pproximately 90% of OU1 is currently covered with asphaltic pavement.

.e 90% of OU1 is currently covered with asphaltic pavement, an additional barrier is not

e 90% of OU1 is currently covered with asphaltic pavement, an additional barrier is not

ace barriers are typically limited to depths less than 50-feet. To improve
ırface barriers are typically keyed into a low permeability layer such as clay or
ındwater is a depth greater than 50 feet and the underlying clay is thin, this technology
r this site.

ve

/e.

complete containment of the groundwater plume is not required, this option will not be

ermanganate is a viable option for the treatment of VOCs in groundwater, this option
ther analysis.

on is not retained, because of the depth of contamination air sparging would be
and control

this technology is not proven for the chlorinated organics present at OU1, it is not
onsideration

nology is not applicable to ethene organics.

the depth of groundwater contamination is greater than 50-feet, a reactive wall would
ment.

ıg is not applicable, as it tends to promote an aerobic atmosphere and ethenes do
an aerobic atmosphere

ıg is not applicable, as it tends to promote an aerobic atmosphere and ethenes do
an aerobic atmosphere

well points have a depth limitation of 20-feet

option may be used to extract groundwater from the contaminated aquifer

ter at 100 Oser Ave is too deep

Media

General Response Action

Remedia

Screening Comment

Groundwater Cont.

On-Site Extracted Groundwater Treatment

Physical/Chemica

This option is retained as a potentially viable option for the treatment of metals in ater.

halogenation is generally used to chemically alter PCBs in dielectric fluids.

This option may be used in conjunction with chemical precipitation

This option is retained as a potentially viable option for the treatment of metals in ater.

This option is retained as a potentially viable option for the treatment of metals in ater.

tion is not an economically viable alternative for the treatment of the extracted

tion is not an economically viable alternative for the treatment of the extracted

tion is not an economically viable alternative for the treatment of the extracted

iid-phase separation is used to separate two immisicible layers The extracted contain immisicible layers.

his option is retained as an option for treating extracted groundwater.

ion is not retained, since it is an enhancement of air stripping and not necessary

on is not retained, as it is an inappropriate technology for VOC contaminated water

ion is not retained, as it is cost prohibitive.

Biological

on is not retained because the organic substrate in the groundwater is insufficient to wth It is also difficult to develop a biomass culture that is amenable to all constituents ndwater and the process is sensitive to variations in the influent quality and quantity

on is not retained because the organic substrate in the groundwater is insufficient to wth. It is also difficult to develop a biomass culture that is amenable to all constituents ndwater and the process is sensitive to variations in the influent quality and quantity

nic substrate of the extracted groundwater is not amenable to aerobic bioremediation.

nic substrate of the extracted groundwater is not amenable to aerobic bioremediation

nic substrate of the extracted groundwater is not amenable to aerobic bioremediation

Disposal Groundwater

On-site

Off-site

icipal wastewater treatment plants do not have the capacity to handle the volume of

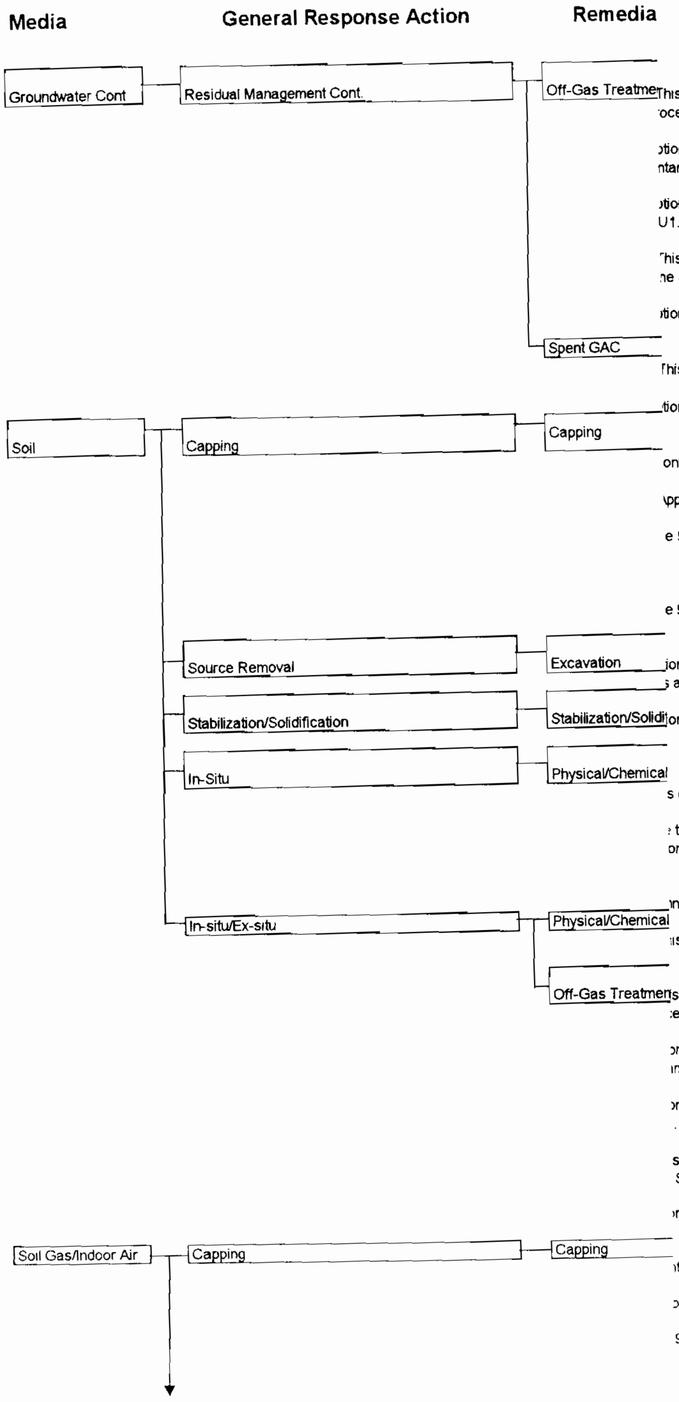
Residual Management

Sludge

option is retained as an option for treating sludge from a chemical precipitation

option is retained as an option for treating sludge from a chemical precipitation

option is retained as an option for treating sludge from a chemical precipitation



Screening Comment

This option may be used to remove organic contaminants from the off-gas stream from
·ocess vents, soil vapor extraction, and other treatment processes.

ɔtion is not retained because it is not a practical process when off-gases contain a
ntaminants, such as would emanate from an OU1 unit processes.

ɔtion is not retained, because it will not remove halogenated hydrocarbons such as
U1.

'his option is retained. It is already incorporated in an interim remedial measure
ne Site.

ɔtion is not retained because it is impractical to incinerate gas streams with extremely

This option may be used to regenerate spent GAC or resin.

tion is not retained, because off-site regeneration is more practical than disposal.

ontact with the groundwater is not an exposure route at OU1

\pproximately 90% of OU1 is currently covered with asphaltic pavement.

e 90% of OU1 is currently covered with asphaltic pavement, an additional barrier is not

e 90% of OU1 is currently covered with asphaltic pavement, an additional barrier is not

ion is not retained because the location of the source, between buildings 100 and 110,
; and technical practicality of the source removal would prohibit it.

on is not retained for further consideration, because it is not applicable to organic

s option is retained as potentially viable treatment of PCE in the vadose zone.

: this technology is not proven for the chlorinated organics present at OU1, it is not
onsideration.

ınology is not applicable to ethene organics

ıis option is retained, because of the volatilization rate of PCE at OU1.

s option may be used to remove organic contaminants from the off-gas stream from
:ess vents, soil vapor extraction, and other treatment processes

ɔn is not retained because it is not a practical process when off-gases contain a
ıminants, such as would emanate from an OU1 unit processes.

ɔn is not retained, because it will not remove halogenated hydrocarbons such as
.

s option is retained. It is already incorporated in an interim remedial measure
Site.

ɔn is not retained because it is impractical to incinerate gas streams with extremely

ıtact with the groundwater is not an exposure route at OU1

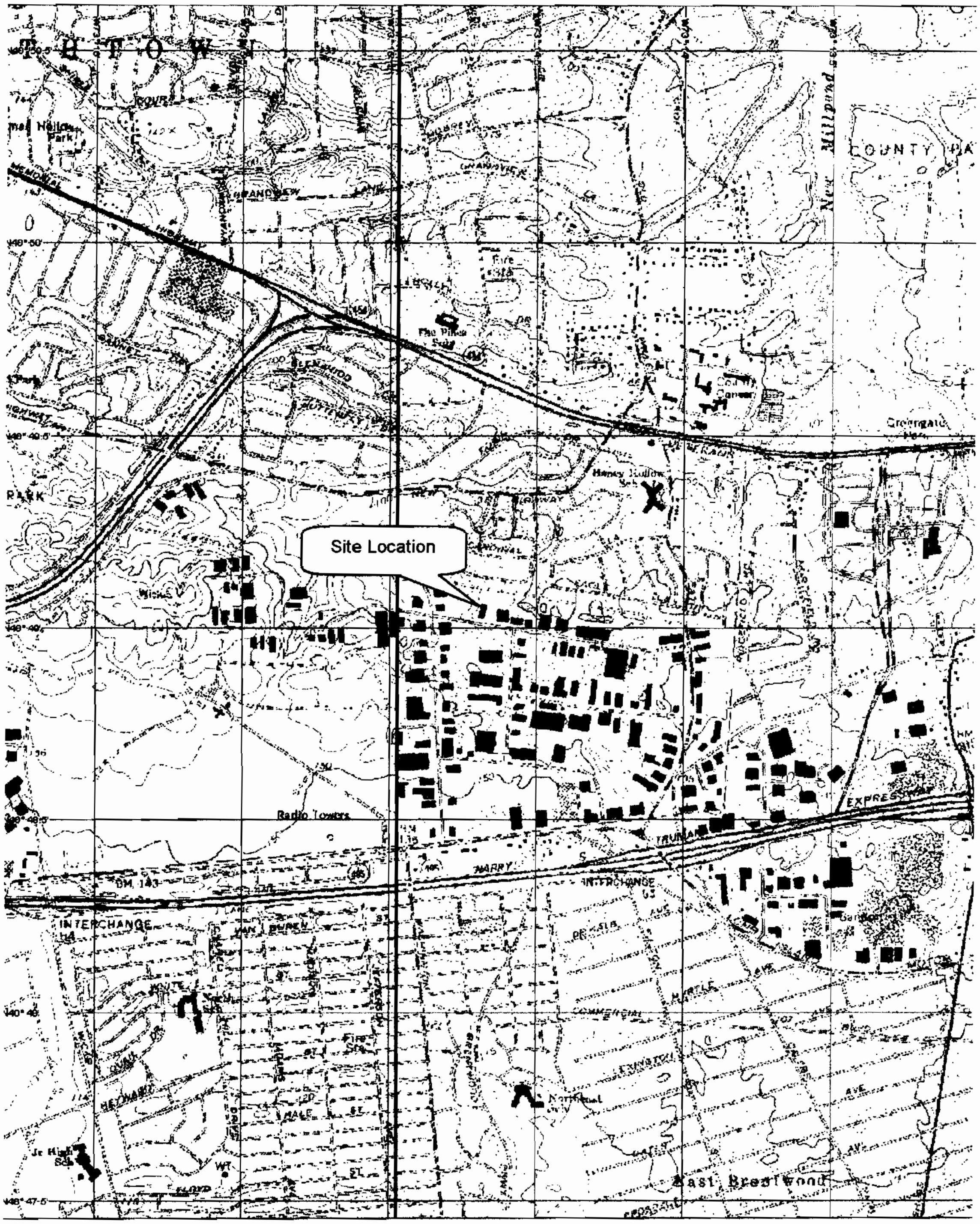
ɔroximately 90% of OU1 is currently covered with asphaltic pavement

90% of OU1 is currently covered with asphaltic pavement, an additional barrier is not

90% of OU1 is currently covered with asphaltic pavement an additional barrier is not

Media	General Response Action	Remedi	Screening Comment
Soil Gas/Indoor Air Cont.	In-Situ/Ex-Situ	Physical/Chemic	This option is retained, because of the volatilization rate of PCE at OU1.
		Off-Gas Treatm	his option may be used to remove organic contaminants from the off-gas stream from ocess vents, soil vapor extraction, and other treatment processes.
			tion is not retained because it is not a practical process when off-gases contain a taminants, such as would emanate from an OU1 unit processes
			tion is not retained, because it will not remove halogenated hydrocarbons such as)1.
			his option is retained. It is already incorporated in an interim remedial measure e Site.
			tion is not retained because it is impractical to incinerate gas streams with extremely

FIGURES



Scale: 1:24,000

Reference:
DeLorme 3-D Topo Quads, 1999
Yarmouth, Me.
Datum WGS84

IT CORPORATION

NYSDEC

Figure 1-1
Site Location Map
NYSDEC Oser Avenue – OU1

APPENDIX A

PILOT TEST DATA

Permanganate Treatability Study
NYSDEC Oser Avenue
100 Oser Avenue
Hauppauge, New York

Two borings were advanced at the site using hollow stem auger drilling methods from February 8 to February 10, 2001. Boring ITFSSB-01-01 was advanced on the northwest corner of the 110 Oser Avenue property, in the vicinity of ITMW-00-11. Boring ITFSSB-01-02 was advanced in the vicinity of the overflow dry well, through the former boring ITDWSB-4. A soil sample was collected from boring ITFSSB-01-01 from 85 to 87 feet below ground surface (bgs). Soil samples were collected from boring ITFSSB-01-02 from 35 to 37, 50 to 52, 60 to 62, 70 to 72, and 80 to 82 feet bgs.

The soil sample collected from boring ITFSSB-01-01 from 85 to 87 feet bgs and the soil samples collected from boring ITFSSB-01-02 from 60 to 62 and 80 to 82 were submitted to Mitkem Corporation for analysis for volatile organic compounds (VOCs), total organic carbon, and grain size distribution analysis. The results of these analyses are summarized in the attached table. Additionally, the sample collected from boring ITFSSB-01-01 from 85 to 87 feet bgs and the sample collected from boring ITFSSB-01-02 from 80 to 82 feet bgs were retained for an oxidant demand test completed at the IT Corporation office in Latham, New York. Groundwater samples were collected from ITMW-00-11S (background) and MW-13 (source) for use in the oxidant demand test. The methods for the test are detailed in the attached instruction manual.

The test kit revealed that the oxidant demand from the soil samples collected from the source (ITFSSB-01-02) and the background (ITFSSB-01-01) borings were 10.5 and less than 4.5 pounds of permanganate per cubic yard, respectfully. The soil sample collected from the background boring did not contain concentrations of VOCs above the respective laboratory reporting limit. This value represents the matrix (soil) oxidant demand. The extremely low matrix demand resulted in an value that was not quantifiable by the test kit. The soil sample collected from the source area boring contained a concentration of tetrachoroethene of 62 micrograms per kilogram. This value is comparable to the chemical oxidant demand.

Oxidant Demand Test Data

NYSDEC Oser Avenue
100 Oser Avenue
Hauppauge, New York

Permanganate Dose	Headspace VOC	Color	Odor
Background Test			
0.00%	16.9	Clear	None
0.10%	4.6	Dark Purple	None
0.25%	3.6	Dark Purple	None
0.50%	3.4	Dark Purple	None
0.75%	3.6	Dark Purple	None
1.00%	2.8	Dark Purple	None
2.00%	15.2	Dark Purple	None
Source Test			
0.00%	>2,000	Clear	Very Strong Chemical Odor
0.10%	>2,000	Clear	Strong Chemical Odor
0.25%	1,115	Purple	Chlorine Odor
0.50%	1,034	Dark Purple	Chlorine Odor
0.75%	651	Dark Purple	Chlorine Odor
1.00%	469	Dark Purple	Chlorine Odor
2.00%	99.3	Dark Purple	Chlorine Odor

Source:	IT Corporation Field Notes, 2001
Notes:	Headspace readings according to a photovac 2020. Concentrations listed in parts per million.

PermOX-IT
Permanganate Test Kit
Instructions

Date 11-02-00

Revision 01

Developed by IT Corp.

Permanganate Test Kit

The oxidant demand is the amount of an oxidizer needed to consume a particular contaminant and the organics in the matrix. In this case $KMnO_4$ (in pounds) needed per cubic yard of soil.

This Permanganate Test Kit makes measurement of soil oxidant demand possible in the field. Performing this test prior to bench scale testing is both time and cost effective.

Disclaimer

- This permanganate test kit is intended for determination of oxidant demand on soil and groundwater in field screening applications only. IT Corporation is not responsible for nor does it endorse any other use of this product.

Permanganate Test Kit Advantages

- Saves time
- Provides vital information
- Easy to follow instructions

Source Area Physical Characteristics Analytical Results

100 Oser Avenue
Hauppauge, New York

Sampling Location	Grain Size (% retained)			Total Organic Carbon (%)
	Sieve No. < or = 40 Medium Sand (or larger)	Sieve No. 60 - 200 Fine Sand	Sieve No. 270 to PAN Silt or Clay	
ITFSSB-01-01 (85 to 87)	40.83	56.34	1.30	0.28
ITFSSB-01-02 (60 to 62)	73.15	20.72	8.85	0.27
ITFSSB-01-02 (80 to 82)	59.91	37.27	1.59	0.54

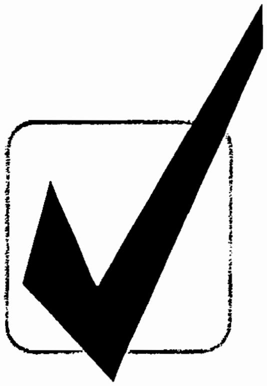
Soil Boring Analytical Results (ppm)
Volatile Organic Compounds

100 Oser Avenue
Hauppauge, New York

Analyte	NYSDEC TAGM Soil Cln-up Obj. (ppm)	ITFSSB-01-01	ITFSSB-01-02	
		85 to 87	60 to 62	80 to 82
Vinyl Chloride	0.2	nd	nd	nd
1,1-DCE	0.4	nd	nd	nd
MethyleneChloride	0.1	nd	nd	nd
t-1,2-DCE	0.3	nd	nd	nd
1,1-DCA	0.2	nd	nd	nd
c-1,2-DCE	n/a	nd	nd	nd
1,1,1-TCA	0.8	nd	nd	nd
Carbon Tet.	0.6	nd	nd	nd
1,2-DCA	0.1	nd	nd	nd
Trichloroethene	0.7	nd	nd	nd
Tetrachloroethene	1.4	nd	**2,900**	0.062
Bezene	0.06	nd	nd	nd
Toluene	1.5	nd	nd	nd
Chlorobenzene	1.7	nd	nd	nd
Ethylbenzene	5.5	nd	nd	nd
Xylenes (total)	1.2	nd	nd	nd
Acetone		0.002 JB	110 JB	0.006
method detection limit		0.011	260	0.011

Notes:
1) Samples were analyzed by Mitkem Corporation.
2) nd - indicates that the analyte was not detected above the method detection limit.
3) Shaded cells indicate concentrations above the NYSDEC TAGM Soil Clean-up Objectives.

Permanganate Test Kit Contents



- Make sure that your kit contains
  - 1 material safety data sheet
  - 1 test tube rack
  - 1 60 ml syringe
  - 1 pair of safety goggles
  - 1 plastic spoon
  - 2 pair of safety gloves
  - 7 test tubes
  - 7 funnels
  - 7 bottles containing $KMnO_4$ in the increments of 2, 1, 0.75, 0.5, 0.25, and 0.1 percent
  - 9 filter papers

Permanganate Test Kit Contents

Permanganate Test Kit Procedures

- Arrange the bottles in descending percentage order
- Fill each bottle to the black line with site groundwater
- Cap bottles tightly
- Shake bottles until all of the solids are dissolved
- Set bottles aside
- Pull base of plunger tip down to 40 ml graduation
- Loosely pack 40 ml of soil into the syringe (may require a small scoop or spoon)
- Add 40 ml of soil to each bottle

Permanganate Test Kit Procedures

- Shake bottles for two to three minutes
- Place bottles back into their original packaging and into a convenient and moderately tempered spot
  (aprox. 70° F ± 10°)
- Allow test kit to react for 48 hours

(see next page for monitoring procedures)

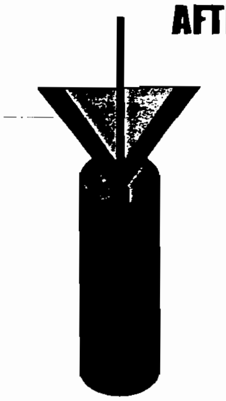
Permanganate Test Kit Procedure

Important

- Shake each bottle periodically for at least 3 minutes.
  - Approximately 4 times over 48 hours

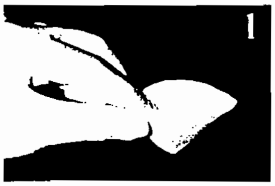
Permanganate Test Kit Filtration

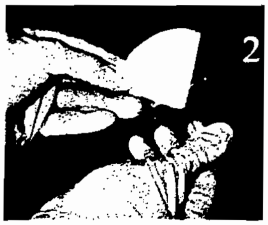
AFTER 48 HOURS

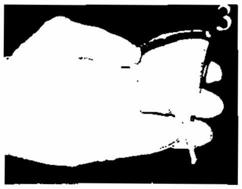


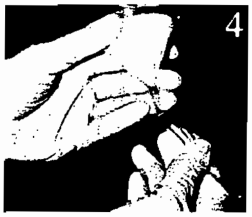
- Place the labeled test tubes into the test tube rack in descending order
- Place one funnel into each test tube
- Place one pre folded filter into each funnel (see next page for examples)
- Pour a small amount from each bottle into the corresponding test tube, through the filter

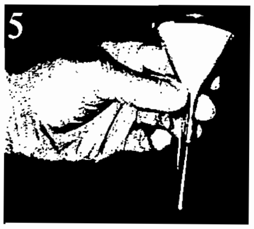
Permanganate Test Kit
Filtration Set Up





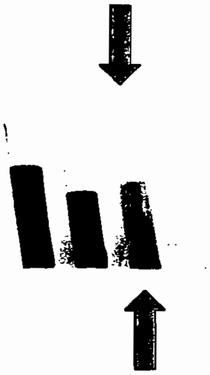




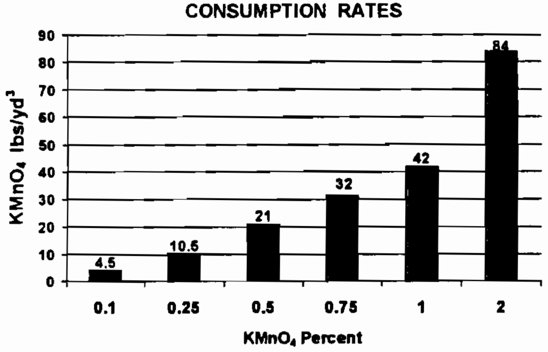


Permanganate Test Kit
Oxidant Demand Determination

- The arrows shown point to the tube from which the oxidant demand will be determined



Permanganate Test Kit Determining Oxidant Demand



- **After filtration is complete**
- select the tube with the lightest purple color (this will be the tube directly after the last clear tube)
- to find the oxidant demand, find the bar on the chart that corresponds to the percentage on the bottle selected (con't)

Interpreting the Results

- Example

  If the test tube that you selected is labeled 0.25% you would look along the x-axis of the chart to find 0.25 $KMnO_4$ percent. The height of that bar, as measured by the y-axis, in this case 10.5 indicates the oxidant demand in pounds per cubic yard.

Permanganate Test Kit
Disposal

- Dispose of bottle and test tube contents by allowing permanganate to be consumed by an excess of soil and then dispose with site soils or personal protective equipment.

Technical Support

- If you should have any questions or need further information concerning the Permanganate Test Kit please feel free to contact

Amy Van Hout
IT Corp.
(865) 690-3211 ext. 2435
fax (865)-694-9573
Avanhout@theitgroup.com

APPENDIX B

REMEDIAL ALTERNATIVE COST ESTIMATES

Table 5-1
REMEDIAL ALTERNATIVE COST SUMMARY

Alternative 1
NO ACTION

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Groundwater Alternative 1 consists of natural attenuation with annual groundwater monitoring of 4 wells for a period of 60 years.

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$0	$0	1.00	$0.00	
O&M Cost	1-60	$414,000	See Table	See Table	$147,722	See PVA Calculations Table for Details
Periodic Cost	5	$5,000	$5,000	0.713	$3,565	5-yr review of Natural Attenuation
Periodic Cost	10	$5,000	$5,000	0.508	$2,540	5-yr review of Natural Attenuation
Periodic Cost	15	$2,500	$2,500	0.362	$905	5-yr review of Natural Attenuation
Periodic Cost	20	$2,500	$2,500	0.258	$645	5-yr review of Natural Attenuation
Periodic Cost	25	$2,500	$2,500	0.184	$460	5-yr review of Natural Attenuation
Periodic Cost	30	$2,500	$2,500	0.131	$328	5-yr review of Natural Attenuation
Periodic Cost	35	$2,500	$2,500	0.0937	$234	5-yr review of Natural Attenuation
Periodic Cost	40	$2,500	$2,500	0.0668	$167	5-yr review of Natural Attenuation
Periodic Cost	45	$2,500	$2,500	0.0476	$119	5-yr review of Natural Attenuation
Periodic Cost	50	$2,500	$2,500	0.0339	$85	5-yr review of Natural Attenuation
Periodic Cost	55	$2,500	$2,500	0.0242	$61	5-yr review of Natural Attenuation
Periodic Cost	60	$24,406	$24,406	0.0173	$422	Demob, abandon, RA report
		$470,906			$157,252	
TOTAL PRESENT VALUE OF ALTERNATIVE					$157,252	

Table 5-1
REMEDIAL ALTERNATIVE COST SUMMARY

Alternative 1
NO ACTION

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Groundwater Alternative 1 consists of natural attenuation with annual groundwater monitoring of 4 wells for a period of 60 years.

O&M COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Years 1-5						
Groundwater sampling & analysis	1-5	16	samples	$900	$14,400	4 wells tested quarterly
Years 6-10						
Groundwater sampling & analysis	6-10	16	samples	$900	$14,400	4 wells tested quarterly
Years 11-15						
Groundwater sampling & analysis	11-15	8	samples	$900	$7,200	4 wells tested semi-annually
Years 16-20						
Groundwater sampling & analysis	16-20	8	samples	$900	$7,200	4 wells tested semi-annually
Years 21-25						
Groundwater sampling & analysis	21-25	8	samples	$900	$7,200	4 wells tested semi-annually
Years 26-30						
Groundwater sampling & analysis	26-30	8	samples	$900	$7,200	4 wells tested semi-annually One report
Years 31-35						
Groundwater sampling & analysis	31-35	8	samples	$900	$7,200	4 wells tested semi-annually
Years 36-40						
Groundwater sampling & analysis	36-40	4	samples	$900	$3,600	4 wells tested annually
Years 41-45						
Groundwater sampling & analysis	41-45	4	samples	$900	$3,600	4 wells tested annually
Years 46-50						
Groundwater sampling & analysis	46-50	4	samples	$900	$3,600	4 wells tested annually
Years 51-55						
Groundwater sampling & analysis	51-55	4	samples	$900	$3,600	4 wells tested annually
Years 56-60						
Groundwater sampling & analysis	56-60	4	samples	$900	$3,600	4 wells tested annually

Table 5-1
REMEDIAL ALTERNATIVE COST SUMMARY

Alternative 1
NO ACTION

COST ESTIMATE SUMMARY

PERIODIC COSTS

Five Year Review Report	5	1	ls	$5,000	$5,000	
Five Year Review Report	10	1	ls	$5,000	$5,000	
Five Year Review Report	15	1	ls	$2,500	$2,500	
Five Year Review Report	20	1	ls	$2,500	$2,500	
Five Year Review Report	25	1	ls	$2,500	$2,500	
Five-year Review Report	30	1	ls	$2,500	$2,500	
Five-year Review Report	35	1	ls	$2,500	$2,500	
Five-year Review Report	40	1	ls	$2,500	$2,500	
Five-year Review Report	45	1	ls	$2,500	$2,500	
Five-year Review Report	50	1	ls	$2,500	$2,500	
Five-year Review Report	55	1	ls	$2,500	$2,500	
Well Abandonment	60	5	EA	$500	$2,500	
Contingency (% of Sum)		25	%		$1,525	% of construction activities
Project Mgt. (% Sum + Contingency)		5	%		$381	% of constr. +contingency
Final RA Report	60	1	ea	$20,000	$20,000	
Year 60 Subtotal					**$24,406**	

Table 5-1 ADDENDUM
REMEDIAL ALTERNATIVE COST SUMMARY
Alternative 1
NO ACTION

PVA CALCULATIONS

YEAR	O&M	Discount Factor 7%		CUMMULATIVE DISCOUNTED	CUMMULATIVE UNDISCOUNTED
1	$14,400	0.9350	$13,464	$13,464	$14,400
2	$14,400	0.8730	$12,571	$26,035	$28,800
3	$14,400	0.8160	$11,750	$37,786	$43,200
4	$14,400	0.7629	$10,986	$48,771	$57,600
5	$14,400	0.7130	$10,267	$59,039	$72,000
6	$14,400	0.6664	$9,596	$68,635	$86,400
7	$14,400	0.6228	$8,968	$77,603	$100,800
8	$14,400	0.5820	$8,381	$85,984	$115,200
9	$14,400	0.5439	$7,832	$93,816	$129,600
10	$14,400	0.5084	$7,321	$101,137	$144,000
11	$7,200	0.4751	$3,421	$104,558	$151,200
12	$7,200	0.4440	$3,197	$107,754	$158,400
13	$7,200	0.415	$2,988	$110,742	$165,600
14	$7,200	0.3878	$2,792	$113,535	$172,800
15	$7,200	0.3625	$2,610	**$116,145**	$180,000
16	$7,200	0.3387	$2,439	$118,583	$187,200
17	$7,200	0.3166	$2,280	$120,863	$194,400
18	$7,200	0.2959	$2,130	$122,993	$201,600
19	$7,200	0.2765	$1,991	$124,984	$208,800
20	$7,200	0.2584	$1,860	$126,845	$216,000
21	$7,200	0.2415	$1,739	$128,583	$223,200
22	$7,200	0.2257	$1,625	$130,208	$230,400
23	$7,200	0.2110	$1,519	$131,728	$237,600
24	$7,200	0.1972	$1,420	$133,147	$244,800
25	$7,200	0.1843	$1,327	$134,474	$252,000
26	$7,200	0.1722	$1,240	$135,714	$259,200
27	$7,200	0.1609	$1,158	$136,873	$266,400
28	$7,200	0.1504	$1,083	$137,956	$273,600
29	$7,200	0.1406	$1,012	$138,968	$280,800
30	$7,200	0.1314	$946	$139,914	$288,000
31	$7,200	0.1228	$884	$140,798	$295,200
32	$7,200	0.1148	$827	$141,625	$302,400
33	$7,200	0.1072	$772	$142,397	$309,600
34	$7,200	0.1002	$721	$143,118	$316,800
35	$7,200	0.0937	$675	$143,793	$324,000
36	$3,600	0.0875	$315	$144,108	$327,600
37	$3,600	0.0818	$294	$144,402	$331,200
38	$3,600	0.0765	$275	$144,678	$334,800
39	$3,600	0.0715	$257	$144,935	$338,400
40	$3,600	0.0668	$240	$145,175	$342,000
41	$3,600	0.0624	$225	$145,400	$345,600
42	$3,600	0.0583	$210	$145,610	$349,200
43	$3,600	0.0545	$196	$145,806	$352,800
44	$3,600	0.0509	$183	$145,989	$356,400
45	$3,600	0.0476	$171	$146,161	$360,000
46	$3,600	0.0445	$160	$146,321	$363,600
47	$3,600	0.0416	$150	$146,471	$367,200
48	$3,600	0.0389	$140	$146,611	$370,800
49	$3,600	0.0363	$131	$146,741	$374,400
50	$3,600	0.0339	$122	$146,863	$378,000
51	$3,600	0.0317	$114	$146,978	$381,600

52	$3,600	0.0297	$107	$147,084	$385,200
53	$3,600	0.0277	$100	$147,184	$388,800
54	$3,600	0.0259	$93	$147,277	$392,400
55	$3,600	0.0242	$87	$147,365	$396,000
56	$3,600	0.0226	$81	$147,446	$399,600
57	$3,600	0.0211	$76	$147,522	$403,200
58	$3,600	0.0198	$71	$147,593	$406,800
59	$3,600	0.0185	$67	$147,660	$410,400
60	$3,600	0.0173	$62	$147,722	$414,000

Table 5-2
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 2
PUMP AND TREAT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Groundwater Alternative 2 consists of soil vapor extraction to treat approx. 150 gpm of the groundwater extracted from the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-35. Due to diminishing carbon usage and groundwater monitoring requirements, additional O&M costs associated with those factors are calculated over 5-

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$1,141,808	$1,141,808	1	$1,141,807.50	
Annual O&M Cos	1-35	$12,290,835	See Table	See Table	$4,808,783	See PVA Calculations Table for details
Periodic Cost	5	$20,000	$20,000	0.713	$14,260	5-yr review, update i.c. plan
Periodic Cost	10	$20,000	$20,000	0.508	$10,160	5-yr review, update i.c. plan
Periodic Cost	15	$20,000	$20,000	0.362	$7,240	5-yr review, update i.c. plan
Periodic Cost	20	$20,000	$20,000	0.258	$5,160	5-yr review, update i.c. plan
Periodic Cost	25	$20,000	$20,000	0.184	$3,680	5-yr review, update i.c. plan
Periodic Cost	30	$20,000	$20,000	0.131	$2,620	Demob, abandon, RA report
Periodic Cost	35	$312,981	$312,981	0.0937	$29,326	
		$13,865,624			$6,023,037	

TOTAL PRESENT VALUE OF ALTERNATIVE $6,023,037

Table 5-2
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 2
PUMP AND TREAT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Groundwater Alternative 2 consists of groundwater extraction system to treat approx. 150 gpm of the groundwater extracted from the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-40 (last 5-years are monitoring only). Due to diminishing carbon usage and groundwater monitoring requirements, additional O&M costs associated with those factors are calculated over 5-year periods.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization/Demobilization					
Construction Equipment	1	LS	$25,000	$25,000	Excavators, loaders, etc.
Permitting	1	LS	$25,000	$25,000	Environmental permits
Submittals/Implementation Plans	1	LS	$50,000	$50,000	QAPP, SSHP, etc.
Temporary Facilities & Utilities	1	LS	$10,000	$10,000	Fence, roads, signs, trailers, etc.
Post-Construction Submittals	1	LS	$25,000	$25,000	Post-constr. reports
SUBTOTAL				**$135,000**	
Monitoring, Sampling , Testing, and Analysis					
Monitoring Wells	10	EA	$900	$9,000	Quarterly sampling, analysis and equipment
Geotechnical Testing	1	LS	$5,000	$5,000	
Pilot Testing	1	LS	$50,000	$50,000	
SUBTOTAL				**$55,000**	
Site Work					
Dry well abandonment	1	LS	$10,000	$10,000	
Surveying	1	LS	$1,500	$1,500	Well layout, treatment bldg
Geotechnical (Geoprobe)	1	DAY	$1,000	$1,000	Foundation, footing, site ci
SUBTOTAL				**$12,500**	
Well Construction					
Monitoring Wells	5	each	$7,500	$37,500	5 add'l wells (150-ft deep)
Extraction Wells and Vaults	5	each	$2,000	$10,000	
Recovery Trench and piping	700	ft	$20	$14,000	
Electrical Hookup	1	LS		$0	
Startup and Testing	1	LS	$5,000	$5,000	
SUBTOTAL				**$66,500**	
Pre-Fab Treatment Bldg and Installation	1	LS	$55,000	$55,000	40' x 80' Building
SUBTOTAL				**$55,000**	
Pump & Treat System Equipment					
Recovery Well Pumps	5	ea	$500	$2,500	
Equalization Tank	1	LS	$5,500	$5,500	
EQ Tank Transfer Pump	1	EA	$4,500	$4,500	
Bag Filters	1	SET	$8,000	$8,000	Based on duplex filters
Air Stripper with Pump and Blower	1	LS	$30,000	$30,000	Based on one 6-tray low profile air stripper
LP Carbon System	1	EA	$13,000	$13,000	Based on one 5000-lb adso
VP Carbon System	1	EA	$13,000	$13,000	Based on one 5000-lb adso
Duct Heater	1	ea	$7,000	$7,000	
Treated Water Tank	2	EA	$5,500	$11,000	
Discharge Pump	1	EA	$2,000	$2,000	
Building Sump Pump	1	ea	$500	$500	
Instrumentation and Controls	1	LS	$25,000	$25,000	
SUBTOTAL				**$122,000**	
Subcontract Work					

Table 5-2
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 2
PUMP AND TREAT

COST ESTIMATE SUMMARY

Electrical Hookup	1	LS	$70,000	$70,000	
Mechanical Work	1	LS	$75,000	$75,000	
Civil Work	1	LS	$85,000	$85,000	Building foundation
Utilties Hookup	1	LS	$3,000	$3,000	Telephone, water, etc.
SUBTOTAL				**$233,000**	
Off-Site Disposal					
Off-Site Transport of Soil Cuttings	1	LS	$500	$500	
Disposal of Soil Cuttings	1	LS	$2,000	$2,000	
Wastewater Discharge/Testing	1	LS	$1,000	$1,000	
SUBTOTAL				**$3,500**	
SUBTOTAL				**$682,500**	
Contingency	30	%		$204,750	
SUBTOTAL				**$887,250**	
Procurement	2	%		$17,745	
Project Management	5	%		$44,363	
Remedial Design	10	%		$88,725	
Construction Management	10	%		$88,725	
Institutional Controls					
Institutional Controls Plan	1	LS		$5,000	
Groundwater Use Restriction	1	LS		$5,000	
Site Information Database	1	LS		$5,000	
SUBTOTAL				**$15,000**	
TOTAL CAPITAL COST				**1,141,808**	

O&M COSTS (Year 1-35)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Performance Costs					
Influent Sampling & Analysis	16	ea	$900	$14,400	4 wells analyzed quarterly
Air Emissions Testing	4	ea	$500	$2,000	one sample every quarter
Treated Water Sampling and Analys	12	ea	$400	$4,800	one sample every month
SUBTOTAL				**$21,200**	
Pump & Treat Operations (Annual Basis)					
Operations Labor	2080	hrs	$45	$93,600	Based on 40-hrs/52 wks
Maintenance Labor	416		$45	$18,720	Based on 8 hrs per week
Equipment Repair (Spare Parts)	10	%		$12,200	Based on 10% of Equipment Capital
LP Spent Carbon Replacement	5000	lbs	$1.50	$7,500	Based on carbon replacement once/year
VP Spent Carbon Replacement	20000	lbs	$2.00	$40,000	Based on carbon replacement once/quarter
Utilities	1	LS	$30,000	$30,000	Based on 365 MWh/yr @ $0.08/kWh
SUBTOTAL				**$202,020**	
Off-Site Treatment					
Solid Waste Disposal	1	LS		$4,000	Filter bags, PPE, etc.
Wastewater Discharge/Testing	1	LS		$1,000	
SUBTOTAL				**$5,000**	
SUBTOTAL				**$228,220**	

Table 5-2
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 2
PUMP AND TREAT

COST ESTIMATE SUMMARY

Contingency	15	%		$34,233	
SUBTOTAL				**$262,453**	
Project Management	5	%		$13,123	
Technical Support	10	%		$26,245	
Institutional Controls - Site Info Data	1	LS	$10,000	$10,000	Update and maintain datab
Quarterly Reports	4	ea	$1,000	$4,000	Interim reports
TOTAL ANNUAL O&M COST				**$315,821**	

	YEAR	QTY	UNIT	UNIT COST	TOTAL	
ANNUALO&M COSTS (YEARS 1-5)						
Groundwater sampling	1-5	16	samples	$900	$14,400	4 wells tested quarterly
Liquid Phase Carbon Replacement	1-5	4	times	$7,500	$30,000	Carbon replaced every 500 days
Vapor Phase Carbon Replacement	1-5	10	times	$10,000	$100,000	Carbon replaced twice/yr
SUBTOTAL					**$144,400**	
ANNUALO&M COSTS (YEARS 6-10)						
Groundwater sampling	6-10	16	samples	$900	$14,400	4 wells tested quarterly
Liquid Phase Carbon Replacement	6-10	2.5	times	$7,500	$18,750	Carbon replaced once/2 yrs
Vapor Phase Carbon Replacement	6-10	2	times	$10,000	$20,000	Replaced twice in 5 years
SUBTOTAL					**$53,150**	
ANNUALO&M COSTS (YEARS 11-15)						
Groundwater sampling	11-15	8	samples	$900	$7,200	4 wells tested semi-annually
Liquid Phase Carbon Replacement	11-15	2.5	times	$7,500	$18,750	Carbon replaced once/2 yrs
Vapor Phase Carbon Replacement	11-15	0	times	$10,000	$0	VP carbon phased out
SUBTOTAL					**$25,950**	
ANNUALO&M COSTS (YEARS 16-20)						
Groundwater sampling	16-20	8	samples	$900	$7,200	4 wells tested semi-annually
Liquid Phase Carbon Replacement	16-20	1	times	$7,500	$7,500	Carbon replaced once/5 yrs
SUBTOTAL					**$14,700**	
ANNUALO&M COSTS (YEARS 21-25)						
Groundwater sampling	21-25	8	samples	$900	$7,200	4 wells tested semi-annually
Liquid Phase Carbon Replacement	21-25	1	times	$7,500	$7,500	Carbon replaced once/5 yrs
SUBTOTAL					**$14,700**	
ANNUAL O&M COSTS (YEARS 26-30)						
Groundwater sampling	26-30	8	samples	$900	$7,200	4 wells tested semi-annually
Liquid Phase Carbon Replacement	26-30	1	times	$7,500	$7,500	Carbon replaced once/5 yrs
SUBTOTAL					**$14,700**	
ANNUALO&M COSTS (YEARS 31-35)						
Groundwater sampling	30-35	8	samples	$900	$7,200	4 wells tested semi-annually

PERIODIC COSTS	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
YEAR 5						
Five-year Review Report	5	1	ea	$15,000	$15,000	One report

Table 5-2
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 2
PUMP AND TREAT

COST ESTIMATE SUMMARY

Update Institutional Controls Plan	5	1	ea	$5,000	$5,000	Update plan
SUBTOTAL					**$20,000**	
YEAR 10						
Five-year Review Report	15	1	ea	$15,000	$15,000	One report
Update Institutional Controls Plan	15	1	ea	$5,000	$5,000	Update plan
SUBTOTAL					**$20,000**	
YEAR 15						
Five-year Review Report	15	1	ea	$15,000	$15,000	One report
Update Institutional Controls Plan	15	1	ea	$5,000	$5,000	Update plan
SUBTOTAL					**$20,000**	
YEAR 20						
Five-year Review Report	20	1	ea	$15,000	$15,000	One report
Update Institutional Controls Plan	20	1	ea	$5,000	$5,000	Update Plan
SUBTOTAL					**$20,000**	
YEAR 25						
Five-year Review Report	25	1	ea	$15,000	$15,000	One report
Update Institutional Controls Plan	25	1	ea	$5,000	$5,000	Update Plan
SUBTOTAL					$20,000	
YEAR 30						
Five-year Review Report	30	1	ea	$15,000	$15,000	One report
Update Institutional Controls Plan	30	1	ea	$5,000	$5,000	Update Plan
SUBTOTAL					**$20,000**	
YEAR 35						
Demobilize Pump & Treat System	35	1	LS	$40,000	$40,000	Remove equipment, bldg,e
Well Abandonment	35	5	EA	$500	$2,500	
Contingency (% of Sum)		25	%		$10,625	% of construction activities
Project Mgt. (% Sum + Contingency)		5	%		$2,656	% of constr. +contingency
Remedial Action Report	35	1	ea	$10,000	$10,000	
SUBTOTAL					**$312,981**	

Table 5-2 ADDENDUM
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 2

PUMP AND TREAT

PVA CALCULATIONS

YEAR	O&M	Discount Factor 7%		CUMMULATIVE DISCOUNTED	CUMMULATIVE UNDISCOUNTED
1	315,821	0.9350	295,293	295,293	315,821
2	460,221	0.8730	401,773	697,066	776,042
3	460,221	0.8160	375,540	1,072,606	1,236,263
4	460,221	0.7629	351,103	1,423,709	1,696,484
5	460,221	0.7130	328,138	1,751,846	2,156,705
6	368,971	0.6664	245,882	1,997,728	2,525,676
7	368,971	0.6228	229,795	2,227,523	2,894,647
8	368,971	0.5820	214,741	2,442,265	3,263,618
9	368,971	0.5439	200,683	2,642,948	3,632,589
10	368,971	0.5084	187,585	2,830,533	4,001,560
11	341,771	0.4751	162,375	2,992,908	4,343,331
12	341,771	0.4440	151,746	3,144,655	4,685,102
13	341,771	0.415	141,835	3,286,489	5,026,873
14	341,771	0.3878	132,539	3,419,028	5,368,644
15	341,771	0.3625	123,892	**3,542,920**	5,710,415
16	330,521	0.3387	111,947	3,654,868	6,040,936
17	330,521	0.3166	104,643	3,759,511	6,371,457
18	330,521	0.2959	97,801	3,857,312	6,701,978
19	330,521	0.2765	91,389	3,948,701	7,032,499
20	330,521	0.2584	85,407	4,034,108	7,363,020
21	330,521	0.2415	79,821	4,113,928	7,693,541
22	330,521	0.2257	74,599	4,188,527	8,024,062
23	330,521	0.2110	69,740	4,258,267	8,354,583
24	330,521	0.1972	65,179	4,323,446	8,685,104
25	330,521	0.1843	60,915	4,384,361	9,015,625
26	330,521	0.1722	56,916	4,441,276	9,346,146
27	330,521	0.1609	53,181	4,494,457	9,676,667
28	330,521	0.1504	49,710	4,544,168	10,007,188
29	330,521	0.1406	46,471	4,590,639	10,337,709
30	330,521	0.1314	43,430	4,634,069	10,668,230
31	323,021	0.1228	39,667	4,673,736	10,991,251
32	323,021	0.1148	37,083	4,710,819	11,314,272
33	323,021	0.1072	34,628	4,745,447	11,637,293
34	323,021	0.1002	32,367	4,777,814	11,960,314
35	330,521	0.0937	30,970	4,808,783	12,290,835

Table 5-3
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 3
KMnO4 INJECTION

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: GW Alternative 3 consists of KMnO4 injection at the source followed 2 years of groundwater monitoring. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-2.

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$1,733,280	$1,733,280	1	$1,733,280.00	
Annual O&M Cost	1	$41,120	$20,560	0.935	$38,447	
Annual O&M Cost	2	$41,120	$20,560	0.873	$35,898	
Annual O&M Cost	3	$41,120	$20,560	0.816	$33,566	
Annual O&M Cost	4	$41,120	$20,560	0.763	$31,370	
Annual O&M Cost	5	$41,120	$20,560	0.713	$29,318	
Periodic Cost	5	$12,625	$12,625	0.713	$9,001	Final Report, abandon wells, etc.
		$1,951,505			$1,910,881	

TOTAL PRESENT VALUE OF ALTERNATIVE $1,910,881

Task 2: Pre-Design Field Activities

After work plan approval and issuance of the NTP, the Engineer shall be required to start field activities including a pump test and a chemical oxidation bench scale test, per the schedule provided in the approved work plan. The Engineer shall be responsible for providing on-site field oversight of subcontractors, preparing daily field logs, evaluating data and preparing a report which describes the findings, conclusions and recommendations. The Engineer shall evaluate this new information in conjunction with existing site data to determine if any additional data is required to support design of the remedy.

Note the Engineer is responsible for determining that the analytical laboratory has and maintains DOH ELAP certification in all categories of CLP and Solid and Hazardous Waste analytical testing for the duration of the project. Select data submittals shall include "Category B" deliverables and Data Usability Summary Report on the selected data as identified in the approved work plan.

Subtask 2.1: Pump Test and Treatability Study

The Engineer shall conduct a pump test to provide information to efficiently design the groundwater extraction system. Results of the pump test will be used to assess optimum rates and well layouts for pumping wells. A treatability study should be performed on representative groundwater samples collected during the pre-design investigation to assess appropriate treatment methods for contaminated groundwater at this site.

Subtask 2.2: Chemical Oxidation Bench Scale Test

The primary objective of the bench scale test is to assess appropriate oxidant type to remediate the contaminants of concern at the site, primarily pesticides. The test should provide information regarding the type of reagents, concentration of reagents, rate of application, and any other information necessary to design the oxidant delivery system. The Engineer shall prepare a work plan and procure the services of a qualified vendor to perform the bench scale test. The findings of the bench scale test should be summarized in a report format.

Task 3: Plans and Specifications:

The Engineer shall prepare complete plans and specifications to be used in competitively bidding the construction, operation, and maintenance of the selected remedy in conformance with New York State and applicable federal laws, rules, regulations, and guidelines. This submittal will include a complete design for the groundwater treatment system, (well locations, pumping rates, etc.) oxidant delivery system and system O&M. The Engineer will utilize the Department's standard construction contract clauses and format (issued 7/2000) to prepare contract documents. Included in this task will be the development of minimum requirements for the construction quality assurance/health and safety plans (the plans themselves will be prepared by the construction contractor).

The Engineer will be responsible for obtaining all necessary surveys to allow for the NYSDEC temporary and long-term easements.

Subtask 3.1 Preliminary Design:

The Engineer shall submit to the NYSDEC six copies of preliminary construction plans and specifications when the design is 30% complete. The Engineer shall have verified the existing field conditions. Supporting data, documentation, and design calculations shall be provided with the design documents defining the functional aspects of the project and how it complies with any applicable regulations (air permit calculations, wastewater discharge requirements, etc.). County deed records (to the extent necessary and currently available) must be searched and reviewed to identify all potentially impacted property owners, and/or those parties with property rights, and an updated tax map must be provided to the NYSDEC. A preliminary listing of all temporary and permanent easements, right of ways and permits necessary in order to implement the proposed remedial design and associated operation and maintenance must be provided.

Additionally, all non-property permits with which the design must be in substantive compliance (e.g. Article 15, Stream Protection, Air Pollution Permit, Part 360 requirements, etc.) must be identified. The preliminary design must also demonstrate substantive compliance when necessary. Note this may include a completed permit application(s) with supporting data/information.

A schedule for meeting the critical access and permit requirements to allow bidding the project must be developed in cooperation with the DEC Project Manager, and agreement reached as to who (DEC or the Consultant) will be responsible for obtaining required permits, completing applications and obtaining access agreements. This information must be updated, as appropriate, in subsequent design submissions. Coordination with the DEC Project Manager is important to insure DEC has secured all necessary access agreements, right of ways and permits by the time of design completion and preparation of final bid documents.

Subtask 3.2 Intermediate Design:

At the option of the Department, the Engineer shall submit to the NYSDEC three copies of intermediate construction plans and specifications when the design is 60% complete. The work assignment budget shall reflect the difference in the overall project cost if this submittal is not required.

Subtask 3.3 Final Design:

Upon completion of the design documents, the Engineer shall submit to the NYSDEC for review, seven copies of the final plans, and specifications. Prior to this submittal, the Engineer shall have thoroughly coordinated and cross-checked the bid form, specifications, and drawings to ensure consistency with the contract documents. Written documents will be provided by the

NYSDEC describing the changes required to consider the plans and specifications acceptable for bidding. The Final Design must bear the seal and signature of a professional engineer registered to practice in New York State.

Along with the final design, the Engineer shall submit a Limited Site Data Summary Report that will be issued along with the bid documents to bidders for their information. This report will include a summary of the site conditions and analytical data available to help bidders understand the requirements of the project.

After approval of the final design by the NYSDEC, the Engineer shall submit seventy-five (75) copies of the plans, specifications, and limited Site Data Report.

Subtask 3.4 Project Cost Estimate:

At the final design stage the Engineer shall prepare a pre-bid construction, operation, and maintenance cost estimate for the project. The pre-bid estimate shall be supported by quantity take-off sheets and the basis for the development of unit and lump sum prices used in the estimate.

Subtask 3.5 Design Report:

As the design progresses, the Engineer shall prepare a Design Report that describes the major elements of the project, the basis of design, supporting data, documentation, design calculations, assumptions, and uncertainties. Corresponding portions of the Design Report will be submitted along with each major submittal of the plans and specifications (i.e., 30%, 60% (if required), and final design).

Task 4: Pre-award Services

These services are optional and will be exercised at the discretion of the Department. The Engineer shall provide support services to the NYSDEC for the purposes of competitively bidding the site remediation contract.

Subtask 4.1: Pre-Bid Conference and Public Meetings

The Engineer shall conduct a pre-bid conference with prospective bidders. At the pre-bid conference the Engineer will emphasize to the prospective bidders important items of the project, tour of the project site, answer any questions and prepare minutes to the meeting. The Engineer shall prepare any necessary addenda to the plans and specifications for the timely transmittal to prospective bidders. The Engineer shall respond to all questions from prospective bidders.

At the public meetings, the Engineer will answer any questions raised concerning the design of the project, construction techniques and project scheduling, and prepare meeting minutes.

Subtask 4.2: Bid Review

The Engineer shall review all plans required by the contract documents and submitted by the contractor with the bid, including, but not limited to, the health and safety plan.

III. Estimate of Work Assignment Budget

Task	Description	LOE (Hrs)	Labor Cost	Other Cost	Total
1	Work Plan	150	$12,000.00	$600.00	$12,600.00
2A	Bench Scale Test	75	$6,000.00	$13,000.00	$19,000.00
2B	Pump Test	120	$9,600.00	$5,000.00	$14,600.00
3	Plans & Specs	800	$64,000.00	$10,000.00	$74,000.00
4	Pre-Award Services	100	$6,500.00	$1,000.00	$7,500.00
	TOTAL	1,245	$98,100.00	$29,600.00	**$127,700.00**

IV. Period of Performance

The Remedial Design shall be completed within 200 days of the receipt of the work assignment.

V. Work Plan Development Authorization

The Engineer is authorized to spend up to $12,600 to perform Task 1.

VI. Project Schedule with Milestones

Completion of Task	Days (From Issuance of Work Assignment)
1.0 - Work Plan*	45
2.0 - Pre-Design Field Activities	85
3.1 - 30% Design*	125
3.2 - 60% Design	160
3.3 - Final Design*	200
4.0 - Pre-award Services	to be determined

* Denotes project milestones where performance evaluations are due.

Table 5-3
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 3
KMnO4 INJECTION

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: GW Alternative 3 consists of KMnO4 injection at the source followed 2 years of groundwater monitoring. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-2.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
KMnO4 INJECTION					
Dry Well Abandonment	1	LS		$10,000	
Pilot Test	1	LS		$160,000	
Work Plan Generation, Permit Applications and HASP	1	LS		$35,000	
KMnO4 Addition Equipment Setup	1	LS		$352,000	
Pre-Addition Sampling, Analysis and Monitoring	1	LS		$175,000	
KMnO4 Addition Activities	1	LS		$265,000	
Seconday KMnO4 Addition with activities	1	LS		$370,200	
Performance of Post-Addition Monitoring, Sampling and Analysis	1	LS		$117,500	
Meetings, Reports, and Presentation to Agencies	1	LS		$32,500	
SUBTOTAL				**$1,507,200**	
Contingency	15	%		$226,080	
CAPITAL COST FOR KMnO4 Injection				**$1,733,280**	

O&M COSTS FOR GROUNDWATER MONITORING

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Groundwater Sampling & Analysis	16	ea	$900	$14,400	4 wells on quarterly basis
SUBTOTAL				**$14,400**	
Project Management	5	%		$720	
Technical Support	10	%		$1,440	
Quarterly Reports	4	ea	$1,000	$4,000	Interim reports
TOTAL ANNUAL O&M COST				**$20,560**	

Periodic O&M Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Year 5						
Well Abandonment	2	4	EA	$500	$2,000	
Contingency (% of Sum)		25	%		$500	% of construction activities
Project Mgt. (% Sum + Contingency)		5	%		$125	% of constr. +contingency
Remedial Action Report	2	1	ea	$10,000	$10,000	
SUBTOTAL					**$12,625**	

Table 5-4
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 2
$KMnO_4$ INJECTION AND PUMP AND TREAT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: GW Alternative 4 consists of $KMnO_4$ injection at the source followed by pump and treat. Groundwater will be treated at a rate of 150 gpm for approx. 15 years. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-15.

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$2,449,358	$2,449,358	1	$2,449,358	
Annual O&M Cos	1-15	$5,409,369	See Table	See Table	$3,342,315	See PVA Calculations Table for details
Periodic Cost	5	$20,000	$20,000	0.713	$14,260	
Periodic Cost	10	$20,000	$20,000	0.508	$10,160	5-yr review, update l.c. plan
Periodic Cost	15	$85,781	$85,781	0.362	$31,053	Demob, abandon, RA report
		$7,984,508			$5,847,145	

TOTAL PRESENT VALUE OF ALTERNATIVE $5,847,145

Table 5-4
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 4
KMnO4 INJECTION AND PUMP AND TREAT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppauge, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: GW Alternative 4 consists of KMnO4 injection at the source followed by pump and treat. Groundwater will be treated at a rate of 150 gpm for approx. 15 years. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-15.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
I. KMnO4 INJECTION					
Pilot Plant Test	1	LS		$160,000	
Work Plan Generation, Permit Applications and HASP	1	LS		$35,000	
KMnO4 Addition Equipment Setup	1	LS		$352,000	
Pre-Addition Sampling, Analysis and Monitoring	1	LS		$175,000	
KMnO4 Addition Activities	1	LS		$265,000	
Performance of Post-Addition Monitoring, Sampling and Analysis	1	LS		$117,500	
Meetings, Reports, and Presentation to Agencies	1	LS		$32,500	
SUBTOTAL				**$1,137,000**	
Contingency	15	%		$170,550	
CAPITAL COST FOR KMnO4 Injection				**$1,307,550**	
II. PUMP AND TREAT SYSTEM					
Mobilization/Demobilization					
Construction Equipment	1	LS	$25,000	$25,000	Excavators, loaders, etc.
Permitting	1	LS	$25,000	$25,000	Environmental permits
Submittals/Implementation Pla	1	LS	$50,000	$50,000	QAPP, SSHP, etc.
Temporary Facilities & Utilities	1	LS	$10,000	$10,000	Fence, roads, signs, trailers, etc.
Post-Construction Submittals	1	LS	$25,000	$25,000	Post-constr. reports
SUBTOTAL				**$135,000**	
Monitoring, Sampling , Testing, and Analysis					
Monitoring Wells	10	EA	$900	$9,000	Quarterly sampling, analysis and equipment
Geotechnical Testing	1	LS	$5,000	$5,000	
Pilot Testing	1	LS	$50,000	$50,000	
SUBTOTAL				**$55,000**	
Site Work					
Dry Well Abandonment	1	LS	$10,000	$10,000	Dry Well Abandonment and re-r
Surveying	1	LS	$1,500	$1,500	Well layout, treatment bldg
Geotechnical (Geoprobe)	1	DAY	$1,000	$1,000	Foundation, footing, site civil
SUBTOTAL				**$12,500**	
Well Construction					
Monitoring Wells	5	each	$7,500	$37,500	5 add'l wells (150-ft deep)
Extraction Wells and Vaults	5	each	$2,000	$10,000	
Recovery Trench and piping	700	ft	$20	$14,000	
Electrical Hookup	1	LS		$0	
Startup and Testing	1	LS	$5,000	$5,000	
SUBTOTAL				**$66,500**	
Pre-Fab Treatment Bldg and Install	1	LS	$55,000	$55,000	40' x 80' Building
SUBTOTAL				**$55,000**	

Table 5-4
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 4
KMnO4 INJECTION AND PUMP AND TREAT

COST ESTIMATE SUMMARY

Pump & Treat System Equipment					
Recovery Well Pumps	5	ea	$500	$2,500	
Equalization Tank	1	LS	$5,500	$5,500	
EQ Tank Transfer Pump	1	EA	$4,500	$4,500	
Bag Filters	1	SET	$8,000	$8,000	Based on duplex filters
Air Stripper with Pump and Blo	1	LS	$30,000	$30,000	Based on one 6-tray low profile air stripper
LP Carbon System	1	EA	$13,000	$13,000	Based on one 5000-lb adsorber
VP Carbon System	1	EA	$13,000	$13,000	Based on one 5000-lb adsorber
Duct Heater	1	ea	$7,000	$7,000	
Treated Water Tank	2	EA	$5,500	$11,000	
Discharge Pump	1	EA	$2,000	$2,000	
Building Sump Pump	1	ea	$500	$500	
Instrumentation and Controls	1	LS	$25,000	$25,000	
SUBTOTAL				**$122,000**	
Subcontract Work					
Electrical Hookup	1	LS	$70,000	$70,000	
Mechanical Work	1	LS	$75,000	$75,000	
Civil Work	1	LS	$85,000	$85,000	Building foundation
Utilties Hookup	1	LS	$3,000	$3,000	Telephone, water, etc.
SUBTOTAL				**$233,000**	
Off-Site Disposal					
Off-Site Transport of Soil Cuttir	1	LS	$500	$500	
Disposal of Soil Cuttings	1	LS	$2,000	$2,000	
Wastewater Discharge/Testing	1	LS	$1,000	$1,000	
SUBTOTAL				**$3,500**	
SUBTOTAL				**$682,500**	
Contingency	30	%		$204,750	
SUBTOTAL				**$887,250**	
Procurement	2	%		$17,745	
Project Management	5	%		$44,363	
Remedial Design	10	%		$88,725	
Construction Management	10	%		$88,725	
Institutional Controls					
Institutional Controls Plan	1	LS		$5,000	
Groundwater Use Restriction	1	LS		$5,000	
Site Information Database	1	LS		$5,000	
SUBTOTAL				**$15,000**	
TOTAL CAPITAL COST (PUMP AND TREAT)				**1,141,808**	
GRAND TOTAL CAPITAL COST				**$2,449,358**	

O&M COSTS FOR PUMP AND TREAT ONLY (Year 1-15)

DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**TOTAL**	**NOTES**
Annual Performance Costs					
Influent Sampling & Analysis	4	ea	$900	$3,600	Based on 4 qtrs/yr
Air Emissions Testing	4	ea	$500	$2,000	Based on 4 qtrs/yr
Treated Water Sampling and A	12	ea	$400	$4,800	Based on monthly sampling
SUBTOTAL				**$10,400**	
Pump & Treat Operations (Annual Basis)					

Table 5-4
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 4
KMnO4 INJECTION AND PUMP AND TREAT

COST ESTIMATE SUMMARY

Operations Labor	2080	hrs	$45	$93,600	Based on 40-hrs/52 wks
Maintenance Labor	416		$45	$18,720	Based on 8 hrs per week
Equipment Repair (Spare Part	10	%		$12,200	Based on 10% of Equipment Capital
LP Spent Carbon Replacemen	5,000	lbs	$1.50	$7,500	Based on carbon replacement once/year
VP Spent Carbon Replacemen	20,000	lbs	$2.00	$40,000	Based on carbon replacement once/quarter
Utilities	1	LS	$30,000	$30,000	Based on 365 MWh/yr @ $0.08/kWh
SUBTOTAL				**$202,020**	
Off-Site Treatment					
Solid Waste Disposal	1	LS		$4,000	Filter bags, PPE, etc.
Wastewater Discharge/Testing	1	LS		$1,000	
SUBTOTAL				**$5,000**	
SUBTOTAL				**$217,420**	
Contingency	15	%		$32,613	
SUBTOTAL				**$250,033**	
Project Management	5	%		$12,502	
Technical Support	10	%		$25,003	
Quarterly Reports	4	ea	$1,000	$4,000	Interim reports
TOTAL ANNUAL O&M COST				**$291,538**	

Periodic O&M Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Years 2-5						
GW Sampling and Analysis	1-5	16	samples	$900	$14,400	4 wells quarterly
Liquid Phase Carbon Replacer	1-5	4	times	$7,500	$30,000	Carbon replaced every 2 years
Vapor Phase Carbon Replacer	1-5	10	times	$10,000	$100,000	Carbon replaced twice/yr
SUBTOTAL					**$144,400**	
Years 6-10						
GW Sampling and Analysis	1-5	16	samples	$900	$14,400	4 wells quarterly
Liquid Phase Carbon Replacer	6-10	2.5	times	$7,500	$18,750	Carbon replaced once/2 yrs
Vapor Phase Carbon Replacer	6-10	2	times	$10,000	$20,000	Replaced twice in 5 years
SUBTOTAL					**$53,150**	
Years 11-15						
GW Sampling and Analysis	1-5	8	samples	$900	$7,200	4 wells semi-annually
Liquid Phase Carbon Replacer	11-15	2.5	times	$7,500	$18,750	Carbon replaced once/2 yrs
Vapor Phase Carbon Replacer	11-15	0	times	$10,000	$0	VP carbon phased out
SUBTOTAL					**$25,950**	
Years 16-20						
GW Sampling and Analysis	1-5	8	samples	$900	$7,200	4 wells semi-annually
SUBTOTAL					**$7,200**	

Table 5-4
REMEDIAL ALTERNATIVE COST SUMMARY

Groundwater Alternative 4
$KMnO_4$ INJECTION AND PUMP AND TREAT

COST ESTIMATE SUMMARY

PERIODIC COSTS

Year 5						
Five-year Review Report	5	1	ea	$15,000	$15,000	One report
Update Institutional Controls Pl	5	1	ea	$5,000	$5,000	Update plan
SUBTOTAL					**$20,000**	
Year 10						
Five-year Review Report	10	1	ea	$15,000	$15,000	One report
Update Institutional Controls Pl	10	1	ea	$5,000	$5,000	Update plan
SUBTOTAL					**$20,000**	
Year 15						
Five-year Review Report	15	1	ea	$15,000	$15,000	One report
Update Institutional Controls Pl	15	1	ea	$5,000	$5,000	Update plan
Demobilize Pump & Treat Syst	35	1	LS	$40,000	$40,000	Remove equipment, bldg,etc.
Well Abandonment	35	5	EA	$500	$2,500	
Contingency (% of Sum)		25	%		$10,625	% of construction activities
Project Mgt. (% Sum + Contingency)		5	%		$2,656	% of constr. +contingency
Remedial Action Report	35	1	ea	$10,000	$10,000	
SUBTOTAL					**$85,781**	

Table 5-4 ADDENDUM
REMEDIAL ALTERNATIVE COST SUMMARY
Groundwater Alternative 4
KMnO4 INJECTION AND PUMP AND TREAT

PVA CALCULATIONS

YEAR	O&M	Discount Factor 7%		CUMMULATIVE DISCOUNTED	CUMMULATIVE UNDISCOUNTED
1	291,538	0.9350	272,588	272,588	291,538
2	435,938	0.8730	380,574	653,162	727,476
3	435,938	0.8160	355,725	1,008,887	1,163,414
4	435,938	0.7629	332,577	1,341,464	1,599,352
5	435,938	0.7130	310,824	1,652,288	2,035,290
6	344,688	0.6664	229,700	1,881,988	2,379,978
7	344,688	0.6228	214,672	2,096,660	2,724,666
8	344,688	0.5820	200,608	2,297,268	3,069,354
9	344,688	0.5439	187,476	2,484,744	3,414,042
10	344,688	0.5084	175,239	2,659,983	3,758,730
11	317,488	0.4751	150,839	2,810,822	4,076,217
12	317,488	0.4440	140,965	2,951,786	4,393,705
13	317,488	0.415	131,757	3,083,544	4,711,193
14	317,488	0.3878	123,122	3,206,666	5,028,681
15	344,688	0.3625	124,949	3,331,615	5,373,369
16	7,200	0.3387	2,439	3,334,054	5,380,569
17	7,200	0.3166	2,279	3,336,333	5,387,769
18	7,200	0.2959	2,130	3,338,464	5,394,969
19	7,200	0.2765	1,991	3,340,454	5,402,169
20	7,200	0.2584	1,861	3,342,315	5,409,369

Table 5-5
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 2 - SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 2 consists of soil vapor extraction system (150 CFM) to treat soil in the source area. Capital costs occur in Year 0. Annual O&M costs occur in Year 1 and 2. Due to phasing out CATOX system and substituting it with carbon system in Year 3, O&M costs for Years 3, 4 and 5 are calculated separately to account for diminishing carbon usage and monitoring requirements.

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$595,800	$595,800	1	$595,800	See PVA Calculations Table for details
Annual O&M Cost	1-5	$1,714,864	See Table	See Table	$1,576,353	
		$2,310,664			$2,172,153	

TOTAL PRESENT VALUE OF ALTERNATIVE $\boxed{\$2,172,153}$

Table 5-5
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 2 - SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 2 consists of soil vapor extraction system (150 CFM) to treat soil in the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-2. Due to phasing out CATOX unit with Vapor Phase Carbon in Year 3, O&M costs in Years 3, 4 and 5 are calculated separately to account for diminishing carbon usage and monitoring requirements.

O&M COSTS (YEAR 1 & 2)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Performance Costs					
SVE Vapor Monitoring	60	each	$500	$30,000	1 smple/mo * 5 SVE wells
CATOX Emissions Monitoring	24	each	$500	$12,000	2 smpls/mo - CATOX exhaust
Chemicals	1	LS		$15,000	VP Carbon replacement
Soil Vapor Extraction					
Operations Labor (OL)	12	MO	$2,000	$24,000	40 hrs/mo
Maintenance Labor (ML)	12	MO	$2,000	$24,000	40 hrs/mo
Equipment Repair (ER)	10	%		$28,350	10% of Equipment Cost
Utilities	12	MO	$1,500	$18,000	Electricity + fuel
Contingency	15	%		$14,153	15% of OL+ML+ER
CATOX System					
Operations Labor	1	week	$800	$800	40 hr first week of operation
Operations Labor	1	LS		$1,280	40 hrs for 1st month of operation
Operations Labor (OL)	10	MO	$320	$3,200	8 hours per month - rest of the year
Maintenance Labor (ML)	12	MO	$2,000	$24,000	40 hrs/mo
Equipment Repair (ER)	10	%		$2,928	10% of Equipment Cost
Utilities	12	MO	$3,000	$36,000	Electricity + fuel
Contingency	15	%		$10,231	15% of OL+ML+ER
Off-Site Treatment/Disposal					
Wastewater Discharge/Testing	1	LS	$1	$1,000	
SUBTOTAL				**$187,942**	
Contingency	30	%		**$56,383**	10% scope + 20% bid
SUBTOTAL				**$244,324**	
Project Management	5	%		$12,216	
Technical Support	10	%		$24,432	
Institutional Controls-Site Info Databas	1	LS	$5,000	$5,000	Update and maintain database
Quarterly Reporting	4	ea	$1,000	$4,000	quarterly reports
TOTAL ANNUAL O&M COSTS (YEAR 1 & 2)				**$289,973**	

Table 5-5
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 2 - SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 2 consists of soil vapor extraction system (150 CFM) to treat soil in the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-2. Due to phasing out CATOX unit with Vapor Phase Carbon in Year 3, O&M costs in Years 3, 4 and 5 are calculated separately to account for diminishing carbon usage and monitoring requirements.

CAPITAL COSTS (one-time charge):

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization/Demobilization					
Construction Equipment	1	LS	$3,000	$3,000	Excavation, loaders, etc.
Submittals/Implementation Plans	1	LS	$25,000	$25,000	QAPP, SSHP, permits, etc.
Temporary Facilities & Utilities	1	LS	$1,500	$1,500	Fence, roads, signs, trailers, etc.
Post-construction Submittals	1	LS	$25,000	$25,000	Post-construction reports
SUBTOTAL				**$54,500**	
Monitoring, Sampling, Testing, and Analysis					
Geotechnical Testing	1	LS	$5,000	$5,000	MW screen interval soil sample
Pilot Testing	1	LS	$25,000	$25,000	
SUBTOTAL				**$30,000**	
Site Work (Pre-Construction)					
Dry Well Abandonment	1	LS	$10,000	$10,000	Abandon and re-route storm drains
Clearing and Grubbing	1	LS	$2,500	$2,500	Work Area
SUBTOTAL				**$12,500**	
Soil Vapor Extraction (Equipment and Installation)					
SVE Extraction Wells	2	EACH	$5,000	$10,000	
SVE System	1	LS	$45,000	$45,000	150 cfm unit w/60"H2O blower
Pre-Fab Building	1	LS	$10,000	$10,000	
SVE Piping, Trenching, Yardwork	1	LS	$20,000	$20,000	Piping, valves, fittings, etc.
Electrical Hookup	1	LS	$5,000	$5,000	
Startup and Testing	1	LS	$10,000	$10,000	
Vapor Treatment (Carbon)				$0	Existing Carbon vessel will be used after 2 yrs of CATOX operation
CATOX (existing)				$0	Existing CATOX unit used for first 2 yrs of operation then off-gas to be treated with carbon
Scrubber system	1	LS	$60,000	$60,000	
50% Sodium Hydroxide	9500	gal	$13.00	$123,500	
SUBTOTAL				**$283,500**	
Off-Site Disposal (Pre-Construction)					
Off-Site Transport of Soil Cuttings	1	LS	$500	$500	Transport of drums for off-site disposal
Disposal of Soil Cuttings	1	LS	$2,000	$2,000	Drum disposal fee
Wastewater Discharge/Testing	1	LS		$1,000	
SUBTOTAL				**$3,500**	
SUBTOTAL				**$384,000**	
Contingency	25	%		$96,000	Based on 25% of Capital Cost Subtotal
SUBTOTAL				**$480,000**	
Procurement	2	%		$9,600	
Project Management	5	%		$24,000	
Remedial Design	8	%		$38,400	
Construction Management	6	%		$28,800	
Institutional Controls					
Institutional Controls Plan	1	LS	$5,000	$5,000	
Groundwater Use Restriction	1	LS	$5,000	$5,000	Legal fees
Site Information Database	1	LS	$5,000	$5,000	Setup data management system
SUBTOTAL				**$15,000**	
TOTAL CAPITAL COST				**$595,800**	

Table 5-5
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 2 - SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 2 consists of soil vapor extraction system (150 CFM) to treat soil in the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-2. Due to phasing out CATOX unit with Vapor Phase Carbon in Year 3, O&M costs in Years 3, 4 and 5 are calculated separately to account for diminishing carbon usage and monitoring requirements.

O&M COSTS (YEAR 3) - phasing out CATOX and substituting it with Vapor Phase Carbon System

Performance Costs						
SVE Vapor Monitoring	3	20	samples	$500	$10,000	1 smple/3 months -- 5 SVE wells
Carbon Off-Gas Sampling	3	4	samples	$500	$2,000	1 smple/3 months
Soil Vapor Extraction						
Operations Labor (OL)	3	12	mo	$2,000	$24,000	40 hours per month
Maintenance Labor (ML)	3	12	mo	$2,000	$24,000	40 hrs per month
Equipment Repair (ER)	3	10	%		$4,800	10% of Equipment Cost
Utilities	3	12	mo	$1,500	$4,500	Electricity + fuel
Vapor Phase Carbon System						
Carbon replacement	3	1	LS		$15,000	10,000 lbs @ $1.50/lb
YEAR 3 SUBTOTAL					**$84,300**	

O&M COSTS (YEAR 4)

Performance Costs						
SVE Vapor Monitoring	4	10	samples	$500	$5,000	1 smple/6 months -- 5 SVE wells
Carbon Off-Gas Monitoring	4	2	samples	$500	$1,000	1 sample/6 months
Soil Vapor Extraction						
Operations Labor (OL)	4	12	mo	$1,000	$12,000	20 hours per month
Maintenance Labor (ML)	4	12	mo	$1,000	$12,000	20 hrs per month
Equipment Repair (ER)	4	10	%		$2,400	10% of Equipment Cost
Utilities	4	12	mo	$1,000	$4,000	Electricity + fuel
YEAR 4 SUBTOTAL					**$36,400**	

O&M COSTS (YEAR 5)

Demobilize SVE System	5	1	LS	$10,000	$10,000	Remove Equipm't & Piping
Well Abandonment	5	1	LS		$5,000	2 sve AND 7 Monitoring Wells
Demobilize CATOX system	5	1	LS		$25,000	Remove Equipm't & Piping
Contingency (% of Sum)		25	%		$2,500	% of construction activities
Project Mgt (% of Sum + Cont.)		5	%		$500	% of construction + contingency
Remedial Action Report	5	1	ea	$10,000	$10,000	RA report
YEAR 5 SUBTOTAL					**$53,000**	

Table 5-5 ADDENDUM
REMEDIAL ALTERNATIVE COST SUMMARY
Soil Alternative 2
SOIL VAPOR EXTRACTION

PVA CALCULATIONS

YEAR	O&M	Discount Factor 7%		CUMMULATIVE DISCOUNTED	CUMMULATIVE UNDISCOUNTED
1	289,973	0.9350	271,125	271,125	289,973
2	579,946	0.8730	506,293	777,417	1,159,891
3	374,273	0.8160	305,407	1,082,824	1,122,819
4	326,373	0.7629	248,990	1,331,814	1,305,491
5	342,973	0.7130	244,540	**1,576,353**	1,714,864

Table 5-6
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 3
NaMnO4 INJECTION

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 3 consists of NaMnO4 injection at the source followed 2 years of groundwater monitoring. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-2.

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$2,155,148	$2,155,148	1	$2,155,148.30	
Annual O&M Cost	1-2	$41,120	$20,560	0.873	$35,898	
Periodic Cost	2	$12,625	$12,625	0.873	$11,022	Final Report, abandon wells, etc.
		$2,208,893			$2,202,068	

TOTAL PRESENT VALUE OF ALTERNATIVE $2,202,068

Table 5-6
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative #3
NaMnO4 INJECTION

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 3 consists of NaMnO4 injection at the source followed 2 years of groundwater monitoring. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-2.

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
KMnO4 INJECTION					
Dry Well Abandonment	1	LS		10,000	
Pilot Test	1	LS			Assume Pilot Test from GW remedy
Work Plan Generation, Permit Applications and HASP	1	LS		$35,000	
KMnO4 Addition Equipment Setup	1	LS		$1,137,898	
Pre-Addition Sampling, Analysis and Monitoring	1	LS		$23,000	
KMnO4 Addition Activities	1	LS		$90,000	
Additional NaMnO4 injections	1	LS		$500,000	
Performance of Post-Addition Monitoring, Sampling and Analysis	1	LS		$45,644	
Meetings, Reports, and Presentation to Agencies	1	LS		$32,500	
SUBTOTAL				**$1,874,042**	
Contingency	15	%		$281,106	
CAPITAL COST FOR KMnO4 Injection				**$2,155,148**	

O&M COSTS FOR GROUNDWATER MONITORING

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Groundwater Sampling & Analysis	16	ea	$900	$14,400	4 wells on quarterly basis
SUBTOTAL				**$14,400**	
Project Management	5	%		$720	
Technical Support	10	%		$1,440	
Quarterly Reports	4	ea	$1,000	$4,000	Interim reports
TOTAL ANNUAL O&M COST				**$20,560**	

Periodic O&M Costs

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Year 2						
Well Abandonment	2	4	EA	$500	$2,000	
Contingency (% of Sum)		25	%		$500	% of construction activities
Project Mgt. (% Sum + Contingency)		5	%		$125	% of constr. +contingency
Remedial Action Report	2	1	ea	$10,000	$10,000	
SUBTOTAL					**$12,625**	

Table 5-7
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 4 - NaMnO4 Injection and SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 4 consists of sodium permanganate injection and soil vapor extraction system (150 CFM) for soil treatment at the source area. Capital costs occur in Year 0. Annual O&M costs occur in Year 1-3. Due to reduced soil gas concentrations after sodium permanganate injection, CATOX unit will operate during the first year of O&M followed by carbon treatment for the remainder of the SVE system operation. O&M costs for years 2 and 3 of operation are calculated separately to account for diminishing carbon usage and monitoring requirements.

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$1,978,411	$1,978,411	1	$1,978,411	
Annual O&M Cost	1-3	$1,247,889	See Table	See Table	$1,093,526	See PVA Calculations Table for details
Periodic Cost	3	$72,500	$72,500	0.816	$59,160	
		$3,226,301			$3,071,937	

TOTAL PRESENT VALUE OF ALTERNATIVE $3,071,937

3131097

Table 5-7
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 4 - NaMnO4 Injection and SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 4 consists of sodium permanganate injection and soil vapor extraction system (150 CFM) for soil treatment at the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-3. Due to reduced soil gas concentrations after sodium permanganate injection, CATOX unit will operate only during the first year of O&M followed by carbon treatment for the remainder of the SVE system operation. O&M costs for years 2 and 3 are calculated separately to account for the diminishing carbon usage and monitoring requirements.

CAPITAL COSTS (one-time charge):

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
I. NaMnO4 INJECTION					
Work Plan Generation, Permit Applications and HASP	1	LS		$35,000	
NaMnO4 Addition Equipment Setup	1	LS		$1,137,900	
Pre-Addition Sampling, Analysis and Monitoring	1	LS		$23,300	
NaMnO4 Addition Activities	1	LS		$89,600	
Performance of Post-Addition Monitoring, Sampling and Analysis	1	LS		$45,600	
Meetings, Reports, and Presentation to the Agencies	1	LS		$33,300	
SUBTOTAL				**$1,364,700**	
Contingency	15	%		$204,705	
CAPITAL COST FOR NaMnO4 ADDITION				**$1,569,405**	
II. SVE TREATMENT					
Mobilization/Demobilization					
Construction Equipment	1	LS	$3,000	$3,000	Excavation, loaders, etc.
Submittals/Implementation Plans	1	LS	$25,000	$25,000	QAPP, SSHP, permits, etc.
Temporary Facilities & Utilities	1	LS	$1,500	$1,500	Fence, roads, signs, trailers, etc.
Post-construction Submittals	1	LS	$25,000	$25,000	Post-construction reports
SUBTOTAL				**$54,500**	
Monitoring, Sampling, Testing, and Analysis					
Geotechnical Testing	1	LS	$5,000	$5,000	MW screen interval soil sample
Pilot Testing	1	LS	$25,000	$25,000	
SUBTOTAL				**$30,000**	
Site Work (Pre-Construction)					
Dry Well Abandonment	1	LS	$10,000	$10,000	Re-routea and abandon dry wells
Clearing and Grubbing	1	LS	$2,500	$2,500	Work Area
SUBTOTAL				**$12,500**	
Soil Vapor Extraction (Equipment and Installation)					
SVE Extraction Wells	2	EACH	$5,000	$10,000	
SVE System	1	LS	$45,000	$45,000	150 cfm unit w/60"H2O blower
Pre-Fab Building	1	LS	$10,000	$10,000	
SVE Piping, Trenching, Yardwork	1	LS	$20,000	$20,000	Piping, valves, fittings, etc.
Electrical Hookup	1	LS	$5,000	$5,000	
Startup and Testing	1	LS	$10,000	$10,000	
Vapor Treatment (Carbon)				$0	Existing Carbon vessel will be used after 1 year of CATOX operation
CATOX (existing)				$0	Existing CATOX unit used for first year of operation then off-gas to be treated with carbon
Scrubber System	1	LS		$60,000	
SUBTOTAL				**$160,000**	
Off-Site Disposal (Pre-Construction)					
Off-Site Transport of Soil Cuttings	1	LS	$500	$500	Transport of drums for off-site disposal

Table 5-7
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 4 - NaMnO4 Injection and SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 4 consists of sodium permanganate injection and soil vapor extraction system (150 CFM) for soil treatment at the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-3. Due to reduced soil gas concentrations after sodium permanganate injection, CATOX unit will operate only during the first year of O&M followed by carbon treatment for the remainder of the SVE system operation. O&M costs for years 2 and 3 are calculated

Disposal of Soil Cuttings	1	LS	$2,000	$2,000	Drum disposal fee
Wastewater Discharge/Testing	1	LS		$1,000	
SUBTOTAL				**$3,500**	
SUBTOTAL				**$260,500**	
Contingency	25	%		$65,125	Based on 25% of Capital Cost Subtotal
SUBTOTAL				**$325,625**	
Procurement	2	%		$6,513	
Project Management	5	%		$16,281	
Remedial Design	8	%		$26,050	
Construction Management	6	%		$19,538	
Institutional Controls					
Institutional Controls Plan	1	LS	$5,000	$5,000	
Groundwater Use Restriction	1	LS	$5,000	$5,000	Legal fees
Site Information Database	1	LS	$5,000	$5,000	Setup data management system
SUBTOTAL				**$15,000**	
CAPITAL COST FOR SVE TREATMENT SYSTEM				**$409,006**	
TOTAL CAPITAL FOR SOIL ALTERNATIVE 4				**$1,978,411**	

Table 5-7
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 4 - NaMnO4 Injection and SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 4 consists of sodium permanganate injection and soil vapor extraction system (150 CFM) for soil treatment at the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-3. Due to reduced soil gas concentrations after sodium permanganate injection, CATOX unit will operate only during the first year of O&M followed by carbon treatment for the remainder of the SVE system operation. O&M costs for years 2 and 3 are calculated

O&M COSTS (YEAR 1)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Performance Costs					
SVE Vapor Monitoring	60	each	$500	$30,000	1 smple/mo * 5 SVE wells
CATOX Emissions Monitoring	24	each	$500	$12,000	2 smpls/mo - CATOX exhaust
Chemicals	1	LS		$15,000	VP Carbon replacement
50% Sodium Hydroxide	5000	gal	$13	$65,000	
SUBTOTAL				**$122,000**	
Soil Vapor Extraction					
Operations Labor (OL)	12	MO	$2,000	$24,000	40 hrs/mo
Maintenance Labor (ML)	12	MO	$2,000	$24,000	40 hrs/mo
Equipment Repair (ER)	10	%		$16,000	10% of Equipment Cost
Utilities	12	MO	$1,500	$18,000	Electricity + fuel
Contingency	15	%		$12,300	15% of OL+ML+ER
SUBTOTAL				**$94,300**	
CATOX System					
Operations Labor	1	week	$800	$800	40 hr first week of operation
Operations Labor	1	LS		$1,280	40 hrs for 1st month of operation
Operations Labor (OL)	10	MO	$320	$3,200	8 hours per month - rest of the year
Maintenance Labor (ML)	12	MO	$2,000	$24,000	40 hrs/mo
Equipment Repair (ER)	10	%		$2,928	10% of Equipment Cost
Utilities	12	MO	$3,000	$36,000	Electricity + fuel
SUBTOTAL				**$68,208**	
Contingency	15	%		$10,231	15% of OL+ML+ER
Off-Site Treatment/Disposal					
Wastewater Discharge/Testing	1	LS	$1	$1,000	
SUBTOTAL				**$294,739**	
Contingency	30	%		**$88,422**	10% scope + 20% bid
SUBTOTAL				**$383,161**	
Project Management	5	%		$19,158	
Technical Support	10	%		$38,316	
Institutional Controls-Site Info Databas	1	LS	$5,000	$5,000	Update and maintain database
Quarterly Reporting	4	ea	$1,000	$4,000	quarterly reports
TOTAL ANNUAL O&M COSTS (YEAR 1)				**$449,635**	

Table 5-7
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 4 - NaMnO4 Injection and SVE
IN SITU TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Soil Alternative 4 consists of sodium permanganate injection and soil vapor extraction system (150 CFM) for soil treatment at the source area. Capital costs occur in Year 0. Annual O&M costs occur in Years 1-3. Due to reduced soil gas concentrations after sodium permanganate injection, CATOX unit will operate only during the first year of O&M followed by carbon treatment for the remainder of the SVE system operation. O&M costs for years 2 and 3 are calculated

O&M COSTS (YEAR 2) - phasing out CATOX and substituting it with Vapor Phase Carbon System

Performance Costs						
SVE Vapor Monitoring	2	20	samples	$500	$10,000	1 smple/3 months -- 5 SVE wells
Carbon Off-Gas Sampling	2	4	samples	$500	$2,000	1 smple/3 months
Soil Vapor Extraction						
Operations Labor (OL)	2	12	mo	$2,000	$24,000	40 hours per month
Maintenance Labor (ML)	2	12	mo	$2,000	$24,000	40 hrs per month
Equipment Repair (ER)	2	10	%		$4,800	10% of Equipment Cost
Utilities	2	12	mo	$1,500	$3,000	Electricity + fuel
Vapor Phase Carbon System						
Carbon replacement	2	1	LS		$15,000	10,000 lbs @ $1.50/lb
Groundwater Sampling						
GW Sampling and Analysis	2	8	samples	$900	$7,200	4 wells semi-annually
YEAR 2 SUBTOTAL					**$78,000**	

O&M COSTS (YEAR 3)

Performance Costs						
SVE Vapor Monitoring	3	10	samples	$500	$5,000	1 smple/6 months -- 5 SVE wells
Carbon Off-Gas Monitoring	3	2	samples	$500	$1,000	1 sample/6 months
Soil Vapor Extraction						
Operations Labor (OL)	3	12	mo	$1,000	$12,000	20 hours per month
Maintenance Labor (ML)	3	12	mo	$1,000	$12,000	20 hrs per month
Equipment Repair (ER)	3	10	%		$2,400	10% of Equipment Cost
Utilities	3	12	mo	$1,000	$3,000	Electricity + fuel
YEAR 3 SUBTOTAL					**$35,400**	

PERIODIC COSTS

Demobilize CATOX/SVE System	3	1	LS	$25,000	$25,000	Remove Equipm't & Piping
Well Abandonment	3	1	LS		$5,000	2 SVE and 7 Monitoring Wells
Demobilize CATOX system	3	1	LS		$25,000	Remove Equipm't & Piping
Contingency (% of Sum)		25	%		$6,250	% of construction activities
Project Mgt (% of Sum + Cont.)		5	%		$1,250	% of construction + contingency
Remedial Action Report	5	1	ea	$10,000	$10,000	RA report
SUBTOTAL					**$72,500**	

Table 5-7 ADDENDUM
REMEDIAL ALTERNATIVE COST SUMMARY

Soil Alternative 4

KMnO4 INJECTION AND SOIL VAPOR EXTRACTION

PVA CALCULATIONS

YEAR	O&M	Discount Factor 7%		CUMMULATIVE DISCOUNTED	CUMMULATIVE UNDISCOUNTED
1	449,635	0.9350	420,409	420,409	449,635
2	381,427	0.8730	332,986	753,395	831,062
3	416,827	0.8160	340,131	1,093,526	1,247,889

Table 5-7
REMEDIAL ALTERNATIVE COST SUMMARY

Indoor Air Alternative 2 -SVE

INDOOR AIR TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue		**Description:**	Indoor Air Alternative 2 consists of soil vapor extraction to treat indoor air in the building. Capital costs occur in Year 0. Annual O&M costs occur in **Years 1-2. SVE emissions will be treated with vapor phase carbon for the duration of treatment.**
Location: Hauppague, New York			
Phase: Feasibility Study (-30% to + 50%)			
Base Year: 2001			
Date:			

PRESENT VALUE ANALYSIS

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$300,141	$300,141	1	$300,141	
Annual O&M Cost	1-2	$130,800	$130,800	0.935	$122,298	Based on one additional year of operation
Periodic Cost	2	$33,025	$33,025	0.873	$28,831	Demob, abandon, RA Report
		$463,966			$451,269	

TOTAL PRESENT VALUE OF ALTERNATIVE **$451,269**

Table 5-7
REMEDIAL ALTERNATIVE COST SUMMARY

Indoor Air Alternative 2 -SVE
INDOOR AIR TREATMENT

COST ESTIMATE SUMMARY

Site: 100 Oser Avenue
Location: Hauppague, New York
Phase: Feasibility Study (-30% to + 50%)
Base Year: 2001
Date:

Description: Indoor Air Alternative 2 consists of soil vapor extraction to treat indoor air in the building. Capital costs occur in Year 0. Annual O&M costs occur in **Years 1-2. SVE emissions will be treated with vapor phase carbon for the duration of treatment .**

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization/Demobilization					
Construction Equipment	1	LS	$3,000	$3,000	
Submittals/Implementation Plans	1	LS	$25,000	$25,000	
Temporary Facilities & Utilities	1	LS	$1,500	$1,500	
Post-construction Submittals	1	LS	$5,000	$5,000	
SUBTOTAL				**$34,500**	
Site Work					
Clearing and Grubbing	1	LS	$5,000	$5,000	
Building Interior	1	LS	$20,000	$20,000	
SUBTOTAL				**$25,000**	
Soil Vapor Extraction					
SVE Extraction Wells	16	EACH	$2,500	$40,000	16 wells x 50 cfm/well=800 cfm
SVE System	1	LS	$60,000	$60,000	
Pre-Fab Building	1	LS	$10,000	$10,000	
SVE Piping	1	LS	$15,000	$15,000	
Electrical Hookup	1	LS	$5,000	$5,000	
Startup and Testing	1	LS	$15,000	$15,000	
Vapor Treatment (Carbon)	10000	lbs	$2	$15,000	
SUBTOTAL				**$160,000**	
Off-Site Disposal					
Off-Site Transport of Soil Cuttings	1	LS	$1,000	$1,000	
Disposal of Soil Cuttings	1	LS	$5,000	$5,000	
SUBTOTAL				**$6,000**	
SUBTOTAL				**$225,500**	
Contingency	10	%		$22,550	% of Capital Cost Subtotal
SUBTOTAL				**$248,050**	
Procurement	2	%		$4,961	% of Capital + Contingency
Project Management	5	%		$12,403	% of Capital + Contingency
Remedial Design	8	%		$19,844	% of Capital + Contingency
Construction Management	6	%		$14,883	% of Capital + Contingency
SUBTOTAL				**$52,091**	
TOTAL CAPITAL COST				**$300,141**	

O&M COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Performance Costs					
SVE Vapor Monitoring	64	each	$500	$32,000	4 smpls/well * 16wells
SVE Emissions Monitoring	24	each	$500	$12,000	2 smpls/mo - CATOX exhaust
Indoor Air Monitoring	12	each	$500	$6,000	1 sample/mo
SUBTOTAL				**$44,000**	

Table 5-7
REMEDIAL ALTERNATIVE COST SUMMARY

Indoor Air Alternative 2 -SVE
INDOOR AIR TREATMENT

COST ESTIMATE SUMMARY

Soil Vapor Extraction					
Operations Labor	12	MO	$2,000	$24,000	40 hrs/month @ $50/hr
Maintenance Labor	12	MO	$1,000	$12,000	20 hrs/month @ $50/hr
Carbon Replacement	20,000	lbs	$1.50	$30,000	Replaced twice first year
Equipment Repair	10	%		$16,000	% of Equipment Capital
Utilities	12	MO	$400	$4,800	
SUBTOTAL				**$86,800**	
TOTAL ANNUAL O&M COSTS				**$130,800**	

PERIODIC COSTS:

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Demobilize SVE System	2	1	LS	$10,000	$10,000	Remove Equipm't & Piping
Well Abandonment	2	16	ea	$500	$8,000	
Contingency (% of Sum)		25	%		$4,500	% of construction activities
Project Mgt (% of Sum + Cont.)		5	%		$525	% construction + contingency
Remedial Action Report	2	1	ea	$10,000	$10,000	RA Report
SUBTOTAL					**$33,025**	

APPENDIX C

GROUNDWATER MODELING RESULTS

Appendix
Groundwater Modeling Activities

Objectives:
To aid in the evaluation of remedial pump and treat technologies, a simple groundwater model was developed to simulate site hydrogeology and to predict capture zones for various groundwater extraction scenarios. The following sections provide a description of the model design and pumping strategies modeled, an uncertainty analysis and a brief discussion of the modeling results and a treatment time evaluation.

Conceptual Site Model:
The site geology and hydrogeology were described in detail in the Remedial Investigation Report (IT, 2000). This discussion outlines the major features described in that report as they apply to the development of the groundwater model. The site is part of the Upper Glacial Aquifer of Long Island and is composed of poorly sorted sand and gravel with lenses of fine sand, silt and clay. The Upper Glacial Aquifer overlays the Magothy Formation, the primary drinking water aquifer in the area. The base of the Upper Glacial Aquifer is approximately 200 feet bgs at the site and is separated from the Magothy formation in the southwest portion of the site, by a thin layer of organic clay. The site is approximately 2400 feet northwest of the Ronkonkoma terminal moraine, which corresponds to the main groundwater divide across Long Island (Jensen and Soren, 1974). Groundwater flow is generally northeast with a gentle gradient across the 100 Oser Avenue property and adjacent properties (referred to as Operable Unit 1 [OU1]). Northeast of OU1, the groundwater gradient is steeper and more easterly.

Model Design:
Groundwater flow at the site was modeled as a single-layer, unconfined aquifer over a 3000 by 2200-foot area, divided into 50 by 50-foot square model cells. The base of the aquifer was assumed to be 80 feet below mean sea level (msl), which corresponds to approximately 210 feet below ground surface at the site. The model grid was oriented with the y-axis approximately southwest-to-northeast, parallel to groundwater flow at the 100 Oser Avenue property.

Boundary Conditions:
Boundary conditions were developed based on groundwater elevations measured at the site and regional data obtained by the United States Geological Survey (USGS). No-flow boundary conditions were used as the southeast and northwest model boundaries. These boundary conditions are appropriate for a model grid oriented parallel to groundwater flow. No-flow boundaries are model cells not included in the finite difference solution, and necessitate groundwater flow approximately parallel to the boundary at the adjacent model cell.

The northeast boundary was modeled as a specified-head boundary condition with an assigned head value ranging between 43.5 feet above msl (amsl) at and west of ITMW-18S to 26 feet amsl at ITMW-17S to 27 feet amsl at and east of ITMW-19S. These head values were taken from the September 2000 groundwater elevation gauging results.

The up-gradient boundary was modeled as a general head boundary, which is a specified head boundary condition combined with a conductance term. The conductance term, among other uses, allows the use of a specified head from beyond the model domain to be included as a model boundary condition corrected for the distance to the boundary and the conductivity of the intervening soil strata. This boundary condition was based on a USGS Hydrologic Investigations Atlas (Jensen and Soren, 1974) for Suffolk County, Long Island. A water table elevation data for the groundwater divide at the Ronkonkoma terminal moraine indicated a head of between 45 and 50 feet amsl. A specified head value of 47.5 feet and a conductivity of 85 feet^2/day (based on distance and site hydraulic conductivity data) was used for this boundary.

Aquifer Parameters:
Jensen and Soren (1974) indicate that annual precipitation is approximately 50 inches per year in the area of the site with approximately half percolating down to the water table to recharge the aquifer. Therefore, a

recharge value of 25 inches per year was used in the model. Immediately east of OU1, there is a detention pond, which receives surface water runoff from the roof drains and parking lots in the area. Recharge at the detention pond was assumed to be 50 inches per year.

Aquifer slug testing data indicated an average hydraulic conductivity of approximately 8 feet per day at the site with an order of magnitude greater conductivity estimated for wells near the ground surface than estimated for MW-3D (screened 105 to 115 feet below msl). Because the model is a single layer model, the model hydraulic conductivity value for the site will have to be an average value between the shallow and deeper aquifer values. Given the limited data (3 slug tests), the gentle hydraulic gradient across the site and the distance that the plume has migrated, the average value obtained from the slug tests was believed to be low. Therefore, the hydraulic conductivity value was allowed to vary during the calibration of the model.

Two additional hydraulic conductivity zones were used in the model to simulate the steeper gradient observed down-gradient of the OU1 site. Figure 1 depicts the hydraulic conductivity zones in the model domain. A summary of hydraulic conductivity zone parameters used in the calibrated model is provided in Table 1.

Because the model was run as a steady-state model, storage values for the aquifer were not modeled. Effective porosity, which is necessary to calculate flow times using MODPATH, was assumed to be 0.25.

Model Codes:
The model code that was used to develop the site-wide groundwater flow model is MODFLOW (McDonald and Harbaugh, 1988), a three-dimensional, finite-difference, groundwater flow model developed by the United States Geological Survey. MODFLOW allows the 3-dimensional simulation of groundwater flow and its interactions with lakes, streams, groundwater recharge, pumping wells, and barriers to flow. MODFLOW is well documented has been verified for a wide range of field problems (EPA, 1993b). Model pre- and post-processing was performed in a graphical user interface environment, Visual MODFLOW (Waterloo Hydrogeologic, Inc.), which is a widely used pre-processor that has been successfully used for numerous field problems. Groundwater flow paths and recovery well capture zones were simulated with the model code MODPATH (Pollock, 1994). MODPATH is a three-dimensional, numerical, particle tracking code for calculating groundwater flow paths from the head solution output by MODFLOW. MODPATH is well documented and has been verified for a range of field problems.

Model Calibration:
The groundwater flow model was calibrated to a series of groundwater measurements taken in September 2000. Groundwater elevations from all monitoring wells on OU1 measured in September 2000, except ITMW-14, as well as ITMW-9S and ITMW-10D, were used in the calibration data set. ITMW-14 was excluded based on discussions with field personnel who indicated that head fluctuations at this location varied with the amount of recent rainfall. Calibration was based on (1) minimizing the standard error between the simulated and observed groundwater elevations, while eliminating systematic error (local bias high or low) and (2) accurately predicting the travel time for horizontal migration from the suspected source area (dry wells west of the 100 Oser Avenue site building) to ITMW-17S. Based on the operational history for the 100 Oser Avenue facility, the release is believed to have occurred at some point between 1972 and 1985. Given that PCE has been detected at ITMW-17S at a concentration of approximately 26 mg/L, it is believed that the PCE detected there was released between 15 and 28 years ago. Therefore, the model calibration was only accepted when particle travel time from the dry well to ITMW-17S was between 12 and 35 years, which allows some uncertainty for the assumed value of effective porosity.

Based on the model calibration, the hydraulic conductivity at the site was assigned as 28 feet/day. A summary of calibration statistics is presented in Table 2. The relative root mean square error (RMS) (the RMS divided by the range of heads in the calibration data set) was 10.17%, and the travel time from the dry wells to ITMW-17S was 15 years. This is considered an adequate calibration to the groundwater flow regime.

Sensitivity Analysis:

Because of the limited data describing the hydraulic conductivity at the site, a sensitivity analysis was conducted to assess how potential variability in this parameter might affect the assessment of capture zones for the various pumping strategies simulated. Reasonable calibration was achieved for site hydraulic conductivity values as high as 40 feet/day (RSD, 10.72%; travel time, 12 years) and as low as 14 feet/day (RSD, 9.6 %; travel time, 32 years). Sensitivity analyses on the simulated pumping strategies were conducted using these two potential model solutions.

Capture Zone Simulation and Pumping Rate Assessment:

To assess the efficacy of various pumping strategies for containing the VOC plume in OU1, several coupled MODFLOW-MODPATH simulations were run. Because the extent of the plume has not been fully delineated, the objective of the pumping was to capture all groundwater on the OU1 site. The minimum pumping rate to achieve capture of OU1 groundwater was determined to be 5 wells screened from above the water table (approximately 46 feet amsl) to the base of the aquifer (approximately 80 feet blow msl) each pumping at 12 gpm (60 gpm total). Higher pumping rates (150 gpm and 250 gpm were evaluated) allowed the location of the wells to be moved further up-gradient, while still maintaining capture. The optimal pumping rate was selected based on groundwater travel time and fate and transport calculations (see below).

The well location selected does not address contamination in the Magothy Aquifer. Because the base of the upper glacial aquifer is approximately 80 feet below msl as simulated in the model, the installation of a well screened over a deeper interval would imply a proportionally larger pumping rate. For example, for a well screened to 300 feet bgs would be screened over a 225 foot saturated thickness, as opposed to the 125 foot saturated thickness simulated in the model, an 80% higher pumping rate would be appropriate. However, there is additional uncertainty associated with the gradients across the Magothy aquifer, which has a lower hydraulic conductivity but may have a steeper gradient due to pumping of down-gradient public supply wells.

Treatment Time Evaluation:

Particle tracking techniques were used to estimate the amount of time that would be required under each scenario to achieve cleanup goals for the primary VOCs detected on site. MODPATH was used to estimate the time it takes for water to travel to the extraction wells from selected locations (i.e., monitoring wells displaying high concentrations of CVOCs). These travel times were then input into an analytical model that accounts for retardation of the contaminants in the CVOC plume.

The application of the analytical model, referred to as the mixed linear reservoir, or "batch flush" model, to the evaluation of remedial alternatives is well documented (e.g., Brusseau, 1996; USEPA, 1988; and Zheng, et al., 1991). The "batch flush" model determines the number of pore volumes of clean recharge water that must be circulated through a contaminated zone to achieve the cleanup goals.

The batch flush equation assumes that the concentrations of chemicals in groundwater are the sole source of contamination to the aquifer (i.e., it assumes that the source of the plume has been eliminated). The time until the constituent contaminants in the plume are reduced to below cleanup standards can be calculated for each chemical as follows:

$$t_c = t_v \times PV;$$

where

t_c = time to achieve cleanup (years);
t_v = time to flush one pore volume from a given monitoring well to an extraction well (years); and
PV = number of pore volumes required to reduce a chemical to GW-1 standards.

The number of pore volumes required to reduce a chemical to cleanup standards (PV) is calculated as follows:

$$PV = R_f \times \ln\left(\frac{C_i}{C_e}\right);$$

where

R_f = retardation factor;
C_i = the concentration of chemical at an observation point (micrograms per liter); and
C_e = the groundwater cleanup standard for that chemical (micrograms per liter).

The retardation factor for each chemical is calculated as:

$$R_f = 1 + \left(\frac{\rho_b f_{oc} K_{oc}}{\eta}\right);$$

where

ρ_b = the bulk density of soil (assumed to be 1.68 g/cm^3);
f_{oc} = the fractional content of organic carbon in soil (assumed to be 0.0008 g/g);
K_{oc} = the organic carbon-water partitioning coefficient for the chemical (cm^3/g); and
η = the porosity of the aquifer (assumed to be 0.25).

The values for fractional organic carbon content and soil bulk density were assumed to be 0.001 and 1.68 g/cm^3, respectively.

The batch flush model was applied to two scenarios: (1) pump and treat along and (2) pump and treat following a permanganate injection. The pump and treat technology alone evaluated transport from three locations, monitoring wells ITMW-3S and ITMW-13 and a location along the 1,000 µg/L isopleth. These locations were chosen because they are likely locations for high concentrations of CVOCs and which are located significant distances from the extraction wells. Thus, particles placed at these wells have significant simulated travel times and long cleanup times. Concentrations detected up-gradient of the site building were not considered in the treatment time evaluation, as these are believed to be related to off-site releases.

The combined pump and treat and permanganate injection option did not include transport from ITMW-13, which is near the source area and is expected to be eliminated by the permanganate injection. In this scenario, transport was evaluated from beneath the site building (based on interpolation of groundwater concentration data), assuming a 60% reduction in contaminant concentrations. It was assumed that the concentrations beneath the building were eliminated in the scenario incorporating a second permanganate injection.

The parameters used in the batch flush model and the batch flush calculations are presented in Tables 3A and 3B, respectively.

Based on the results of the batch flush model, the operational duration for the groundwater extraction and treatment system is approximately 29 years for a pumping rate of 150 gpm. However, due to the uncertainties in the data, a more conservative time frame of 35 years was used. Pumping at a rate of 250 gpm resulted in a calculated treatment time of approximately 18 years, and lower pumping rates increased the calculated treatment time significantly.

It should be noted that these estimated cleanup times are approximations only. A number of factors could cause actual cleanup times to be either shorter or longer. Natural attenuation of VOCs could reduce cleanup times. More significantly, continued leaching from residual PCE in the subsurface could drastically increase cleanup times. Leaching from soils in the source area would not expected to be a significant process following a permanganate injection. The batch flush model cannot quantify the affect of leaching on the treatment time evaluation.

Combined technologies incorporating pump and treat technology and permanganate injection were evaluated. For a total pumping rate of 150 gpm and a single permanganate injection, the calculated treatment time was not significantly reduced, although additional treatment time due to leaching of PCE from the soil matrix would be eliminated. If a second permanganate injection is performed to treat any residual high concentrations emanating from under the site building following the first injection, the calculated clean up time was reduced to 14 years. This latter reduction is contingent upon being able to effectively time the second application of permanganate to obtain optimal treatment of residual high concentrations. For a total pumping rate of 250 gpm, a single permanganate injection reduced the calculated treatment time to 11 years and a second injection reduced the calculated treatment time to 9 years. Due to the importance of timing the second permanganate injection, those cleanup time estimates is subject to greater uncertainty.

Table 1

Summary of Aquifer Parameters Used in Groundwater Model
100 Oser Avenue
Hauppage, New York

Property Zone	Hydraulic Conductivity (feet/day)	Porosity
1	28	0.25
2	12	0.25
3	5	0.25

Notes:

Zone 1 is OU1 and surrounding area.

Zones 2 and 3 are progressively down-gradient.

Table 2
Summary of Calibration Statistics
100 Oser Avenue
Hauppage, New York

Monitoring Well	Observed Head (feet)	Predicted Head (feet)	Residual
ITMW-9S	45.50	45.41	-0.09
ITMW-10D	45.60	45.60	0.00
ITMW-12S	46.08	45.94	-0.14
ITMW-7S	46.03	46.01	-0.02
ITMW-5S	46.26	46.31	0.05
ITMW-6S	46.40	46.35	-0.05
ITMW-8S	46.65	46.34	-0.31
ITMW-11S	46.34	46.56	0.22
ITMW-3S	46.54	46.59	0.05
ITMS-4D	46.55	46.67	0.12
ITMS-2S	46.81	46.65	-0.16
ITMW-1S	46.53	46.80	0.27
ITMW-13	46.85	46.96	0.11
ITMW-15	46.96	47.00	0.04
Mean Error			0.006
Absolute Mean Error			0.116
Root Mean Square Error (RMS)			0.148
Relative RMS[1]			10.14%

Notes:

Residual = Predicted - Observed.

[1] = RMS/range of heads.

Table 3A
Chemical-Specific Parameters for Batch Flush Model
100 Oser Avenue
Hauppage, New York

Chemical Characteristics

Chemical	Octanol/ Water Partition Coefficient[1] log K_{ow}	Sorption Partition Coefficient[2] K_{oc}	Monitoring Well and Contaminant Concentrations[3] (micrograms per liter)	
	unitless	cm^3/g	MW-13	MW-3S
cis-1,2-Dichloroethene	1.86	40.0	2,200	130
Tetrachloroethene	2.88	249.7	87,000	19,000
Trichloroethene	2.42	109.3	1,100	160

Notes:

1. MacKay, Shiu & Ma, *Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals, (Volume 3: Volatile Organic Compounds), Lewis Publishers, 1993*
2. USEPA, Soil Screening Guidance: Technical Background Document, EPA/540/R-5/128, May 1996, (for VOCs: log Koc = 0.78 * log Kow +0.151)
3. VOC concentrations are from January and February 2000.

Retardation Factor Calculations

Chemical	Effective Porosity, η	Bulk Density, ρ_B (g/cm^3)	Soil Organic Carbon Fraction, f_{oc}	K_{oc} (cm^3/g)	Retardation Factor (R_f)
cis-1,2-Dichloroethene	0.25	1.7	0.001	40	1.27
Tetrachloroethene	0.25	1.7	0.001	250	2.70
Trichloroethene	0.25	1.7	0.001	109	1.74

Notes:

Soil characteristics are assumed values.

Parameters are unitless except where specified.

$R_f = 1+\rho_B/\eta *_{foc} * K_{oc}$

Table 3B
Batch Flush Calculations
5 Wells at 30 gpm Each
100 Oser Avenue
Hauppage, New York

Monitoring Well	**MW-3S Area**
Pore Volume Travel Time (t_{pv})	0.6 years

Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	130	70	1.27	0.8	0
Tetrachloroethene	19,000	5	2.70	22.2	13
Trichloroethene	160	5	1.74	6.0	4

Monitoring Well	**MW-13S Area**
Pore Volume Travel Time (t_{pv})	1.1 years

Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	2,200	70	1.27	4.4	3
Tetrachloroethene	87,000	5	2.70	26.3	29
Trichloroethene	1,100	5	1.74	9.4	10

Monitoring Well	**1 ppm Isopleth**
Pore Volume Travel Time (t_{pv})	1.3 year

Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	0	70	1.27	0.0	0
Tetrachloroethene	1,000	5	2.70	14.3	19
Trichloroethene	0	5	1.74	0.0	0

Monitoring Well	**Center of Building**
Pore Volume Travel Time (t_{pv})	1.2 year

Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	0	70	1.27	0.0	0
Tetrachloroethene	25,000	5	2.70	23.0	28
Trichloroethene	0	5	1.74	0.0	0

NOTES:

Concentions under building and location of 1 ppm isopleth interpolated from January and February 2000 analytical data.

C_i = Concentration of contaminant in monitoring well at time of system start-up (micrograms per liter).

C_e = GW-1 standard which must be met for the contaminant (micrograms per liter).

R_f = Retardation factor $= 1 + (K_{oc} * f_{oc} * \rho_B)/\eta$ (See Table 3A.)

PV = Number of pore volumes needed to reduce concentration to GW-1 standard.

t_c = Time to achieve cleanup of contamination detected at the monitoring well (years).

Table 3C
Batch Flush Calculations
5 Wells at 50 gpm Each
100 Oser Avenue
Hauppage, New York

Monitoring Well	**MW-3S Area**				
Pore Volume Travel Time (t_{pv})	0.5 years				
Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	130	70	1.27	0.8	0
Tetrachloroethene	19,000	5	2.70	22.2	11
Trichloroethene	160	5	1.74	6.0	3

Monitoring Well	**MW-13 Area**				
Pore Volume Travel Time (t_{pv})	0.7 years				
Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	2,200	70	1.27	4.4	2
Tetrachloroethene	87,000	5	2.70	26.3	18
Trichloroethene	1,100	5	1.74	9.4	5

Monitoring Well	**1 ppm Isopleth at y ~ source**				
Pore Volume Travel Time (t_{pv})	0.6 year				
Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	0	70	1.27	0.0	0
Tetrachloroethene	1,000	5	2.70	14.3	9
Trichloroethene	0	5	1.74	0.0	0

Monitoring Well	**Center of Building**				
Pore Volume Travel Time (t_{pv})	0.5 year				
Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	0	70	1.27	0.0	0
Tetrachloroethene	25,000	5	2.70	23.0	11
Trichloroethene	0	5	1.74	0.0	0

NOTES:

Concentions under building and location of 1 ppm isopleth interpolated from January and February 2000 analytical data.

C_i = Concentration of contaminant in monitoring well at time of system start-up (micrograms per liter).

C_e = GW-1 standard which must be met for the contaminant (micrograms per liter).

R_f = Retardation factor = $1 + (K_{oc} * f_{oc} * \rho_B)/\eta$ (See Table 3A.)

PV = Number of pore volumes needed to reduce concentration to GW-1 standard.

t_c = Time to achieve cleanup of contamination detected at the monitoring well (years).

Table 3D
Batch Flush Calculations
5 Wells at 12 gpm Each
100 Oser Avenue
Hauppage, New York

Monitoring Well	**MW-3S Area**				
Pore Volume Travel Time (t_{pv})	1.9 years				
Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	130	70	1.27	0.8	1
Tetrachloroethene	19,000	5	2.70	22.2	42
Trichloroethene	160	5	1.74	6.0	11

Monitoring Well	**MW-13S Area**				
Pore Volume Travel Time (t_{pv})	3.4 years				
Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	2,200	70	1.27	4.4	8
Tetrachloroethene	87,000	5	2.70	26.3	90
Trichloroethene	1,100	5	1.74	9.4	18

Monitoring Well	**1 ppm Isopleth at y ~ source**				
Pore Volume Travel Time (t_{pv})	1.3 year				
Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	0	70	1.27	0.0	0
Tetrachloroethene	1,000	5	2.70	14.3	19
Trichloroethene	0	5	1.74	0.0	0

Monitoring Well	**Center of Building**				
Pore Volume Travel Time (t_{pv})	5 year				
Chemical	**C_i**	**C_e**	**R_f**	**PV**	**t_c**
cis-1,2-Dichloroethene	0	70	1.27	0.0	0
Tetrachloroethene	25,000	5	2.70	23.0	115
Trichloroethene	0	5	1.74	0.0	0

NOTES:

Concentions under building and location of 1 ppm isopleth interpolated from January and February 2000 analytical data.

C_i = Concentration of contaminant in monitoring well at time of system start-up (micrograms per liter).

C_e = GW-1 standard which must be met for the contaminant (micrograms per liter).

R_f = Retardation factor = $1 + (K_{oc} * f_{oc} * \rho_B)/\eta$ (See Table 3A.)

PV = Number of pore volumes needed to reduce concentration to GW-1 standard.

t_c = Time to achieve cleanup of contamination detected at the monitoring well (years).