NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SUPERFUND STANDBY CONTRACT

BECKER ELECTRONICS MANUFACTURING SITE
EAST DURHAM, NEW YORK

WORK ASSIGNMENT NO. D002472-15

REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT
VOLUME II
FEASIBILITY STUDY

MARCH 1995

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1.0 INTRODUCTION

ABB Environmental Services (ABB-ES), under contract to the New York State Department of Environmental Conservation (NYSDEC) Division of Hazardous Waste Remediation (DHWR), is submitting this Feasibility Study (FS) Report for the Becker Electronics Manufacturing Site (Becker) located in East Durham, Greene County, New York. The Becker site is listed as a Class 2 hazardous waste site, Number (No.) 4-20-007, in the *Registry of Inactive Hazardous Waste Sites in New York State* (NYSDEC, 1993). ABB-ES prepared this FS report in accordance with the requirements of NYSDEC as identified in Work Assignment (WA) No. D002472-15, dated November 24, 1993, under the New York State (NYS) Superfund Standby Contract and its Supplemental Agreement No. 1.

The Remedial Investigation (RI) and FS for the Becker site are being conducted in accordance with the Comprehensive Environmental Response Compensation, and Liability Act (CERCLA) of 1980 as amended by the 1986 Superfund Amendment and Reauthorization Act (SARA), and NYS regulations (United States Environmental Protection Agency [USEPA], 1988a and NYSDEC, 1990).

This FS (Phase III) has been completed considering the results of the RI (Volume I), and the previously completed Phase I and II FS (Metcalf & Eddy of New York, Inc. [M&E], 1992).

1.1 ORGANIZATION, PURPOSE, AND SCOPE OF THE FEASIBILITY STUDY

Volume IA of the RI/FS Report presents the results of the RI at the Becker site, including text, tables, and figures. Volume IB contains the RI appendices. Refer to Volume IA for applicable or relevant and appropriate requirements (ARARs), standards, criteria, and guidelines (SCGs), site geology and hydrogeology, contamination assessments for soil, groundwater, surface water, and sediment, discussion of contaminant fate and transport, site conceptual model, and qualitative risk assessment (RA).

Volume II presents the FS report. It contains text, tables, figures, and appendices. Section 1 of the FS report includes the introduction, organization, purpose, scope of the FS, and relevant RI information. Section 2 contains remedial action objectives, remediation goals (RGs) and general response actions. Section 3 presents the identification and development of technologies and remedial alternatives. Sections 4, 5, and 6 present the detailed analysis of soil, groundwater, and potable water supply alternatives, respectively. Section 7 presents the comparative analysis of alternatives, by medium. Section 8 presents the selection of the remedy by medium and the conceptual plan.

The purpose of this FS is to develop potential remedial alternatives for soil, groundwater, and potable water such that the NYSDEC can select remedies for the Becker site that meet the following criteria (USEPA, 1988a and NYSDEC, 1990):

- protect human health and the environment;
- comply with ARARs and NYS SCGs;
- implement permanent solutions to the maximum extent practicable, given feasible and available technologies;
- reduce the toxicity, mobility, and volume of waste; and

- minimize costs.

The scope of the work required to fulfill the objectives of the FS is presented in the site-specific Work Plan (ABB-ES, 1994) and consists of the following major tasks:

- Phase I and II FS Review (Task 2);
- Phase III FS Report Preparation (Detailed Analysis of Alternatives) (Task 4);
- Community Relations Support (Task 5); and
- Final RI/FS Report Preparation (Task 6).

1.2 RELEVANT RI INFORMATION

This section includes relevant information from the RI (Volume IA). This section is not intended to be all inclusive. It was developed as a convenient reference for the reader. The information presented in this section is considered pertinent and critical to the FS. The reader is directed to the complete RI (Volume IA and Volume IB) for detailed data and assessments.

1.2.1 Site Description

The Becker site is approximately 13 acres in size, and is comprised of several abandoned buildings which were once used for manufacturing high fidelity speakers and components, shipping, and maintenance. The existing facilities comprise approximately 114,500 square feet. Other than the existing buildings and several paved or gravel parking areas, the site is grass covered and contains a wooded area in the northeast corner, a solid waste (wood debris) area, a fire pond, and drainage ditches.

1.2.2 Geology and Hydrogeology

The geology at the site consists of a layer of overburden (till) or fill overlying bedrock. Overburden varies in thickness from 0 (no overburden) to 17 feet. Up to several feet of weathered bedrock overlies competent bedrock. Bedrock is identified as shale and siltstone of the Catskill formation (M&E, 1992; see Section 4.0 of the RI - Volume 1A).

The hydrogeologic investigation completed in the Phase II RI shows that shallow groundwater is present in overburden/weathered bedrock and that deep groundwater is present in bedrock. Vertical hydraulic gradients are downward beneath the site, indicating that shallow groundwater recharges bedrock. Groundwater flow directions in overburden and bedrock are toward Catskill Creek and Thorp Creek, north and east of the Becker site. Upward hydraulic gradients between bedrock groundwater and the creeks, and the presence of seeps contaminated by VOCs along Catskill Creek, show that the groundwater contamination from the site is discharging to these surface water bodies.

1.2.3 Contamination Assessment

Based on results of the RI and other sampling events, organic and inorganic contaminants have been detected in soil, sediment, surface water, and groundwater. The primary source of VOC groundwater contamination is believed to be soil contamination at the chemical storage building. Other secondary sources appear to be isolated VOC contamination associated with the septic system leachfield no. 2 and the debris pile (solid waste). The principal site contaminants are chlorinated VOCs; primarily 1,1,1-TCA, TCE, toluene, 2-butanone, and xylenes. Semivolatile organic compounds (SVOCs), primarily bis(2-ethylhexyl)phthalate and inorganics are present on-site but have not been associated with the disposal of hazardous waste at the Becker site.

Tables 5-4, 5-5, 5-6, 5-7, and 5-8 in Section 5.0 of the RI Report (Volume IA) summarize Phase II RI analytical results for subsurface soil, surface soil, sediment, surface water, and groundwater, respectively to identify site contaminants. Tables in Section 7.0 of the RI Report (Volume IA) compare maximum and average concentrations of site contaminants to potential chemical specific ARARs and

SCGs to identify contaminants of potential concern (CPCs) by media. The list of CPCs for the site is summarized by media in Table 1-1.

The list of CPCs in Table 1-1 shows several VOCs, SVOCs, and inorganics that are present at concentrations that may pose threats to public health or ecological receptors. CPCs were developed by comparing average chemical concentrations to ARARs and NYS SCGs. Overall, concentrations of VOCs in soil at the chemical storage building are believed to be the primary source of groundwater contamination, and soil at the location of the leachfield for septic system no. 2 is believed to be a secondary source of groundwater contamination. Groundwater VOC contamination has been shown to discharge to on-site drainage ditches and to Thorp Creek and Catskill Creek via seeps. VOC contamination is diluted to non-detectable levels upon entering the creeks.

The SVOCs and inorganic CPCs in soil, sediment, and surface water Table 1-1 are not directly attributable to hazardous waste disposal at the site; they are related, however, to disposal of solid wastes (including the surface wood debris piles and buried metallic debris and other materials) and other anthropogenic sources. SVOCs have not been detected in surface water or groundwater at or downgradient of the site. Inorganics are most often listed as CPCs in surface water in on-site drainage ditches; inorganics do not exceed background or CPC criteria in Thorp Creek and Catskill Creek.

Homes and businesses in the vicinity of the Becker site receive their potable water from bedrock water supply wells. Several of these wells have been impacted by VOC contamination originating from the Becker site. SVOCs have not been detected in bedrock water supply wells, and inorganics (except for sporadic detections of barium) are at background in bedrock water supply wells. The RI (Volume IA) presents a summary of organic and inorganic analytical data from residential well sampling events. All water supply wells affected by VOC groundwater contamination migrating from the Becker site have wellhead treatment systems in place, breakthough of VOC contamination through these wellhead treatment systems have been occasionally documented.

1.2.4 Applicable or Relevant and Appropriate Requirements and Standards, Criteria, and Guidance

ARARs and SCGs are presented in the RI report (Volume IA). Refer to Tables 2-8, 2-9, and 2-11 for location-, chemical-, and action-specific ARARs and SCGs, respectively.

2.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES, REMEDIATION GOALS, AND GENERAL RESPONSE ACTIONS

This section presents the development of remedial action objectives, RGs, and general response actions. Remedial action objectives serve as the basis for developing remedial alternatives. RGs are numerical standards that apply to a medium of concern to guide remediation. RGs are based on ARARs and SCGs. Remedial alternatives must meet RGs to achieve the remedial action objectives. This section also presents estimates of volumes of contaminated media.

2.1 Remedial Action Objectives

Remedial action objectives are statements of proposed cleanup goals associated with site-related waste material and associated chemical contamination. These objectives were developed considering ARARs, SCGs, and the qualitative RA, to address potential human health or environmental concerns. Remedial action objectives are used to guide the identification and screening of remedial technologies and the development and evaluation of remedial alternatives.

The remedial action objectives developed for the Becker site focus on remediation of the following media:

- source area soil;
- source area groundwater; and
- potable water supply to residences.

The relationships that exist among these media require that site objectives be formulated and implemented for all media to ensure that the selected comprehensive site response protects human health and the environment. A site conceptual model is presented in Subsection 6.3 of the RI (Volume I). The remedial action objectives developed for each medium of concern are presented in Table 2-1.

Remedial action objectives were not specifically developed for surface water and sediment. Contaminated surface water (from drainage ditches and seeps) and sediment will be addressed as part of the source area groundwater remedial action objective.

2.2 REMEDIATION GOALS

RGs are established for media to which they are appropriate to protect human health and the environment. In this stage of the remedial process, RGs are established to determine areas or volumes of media to which remedial alternatives would apply. Cleanup goals would be finalized during preparation of the Proposed Remedial Action Plan and the Record of Decision. Cleanup goals will be used to determine to what levels contaminated media must be treated prior to backfill or discharge. RGs are used to evaluate the feasibility of various remedial alternatives. Because the RA performed for this site was qualitative only, risk-based RGs were not established. Proposed RGs are based on ARARs and NYS SCGs. This subsection presents the rationale for developing or not developing RGs for each of the media of concern.

2.2.1 Source Area Soil

NYS Technical and Administrative Guidance Memorandum (TAGM) No. 4046, "Determination of Soil Cleanup Objectives and Cleanup Levels" (NYSDEC, 1994) has been used to develop RGs for soil at the Becker site. The TAGM presents a procedure to determine soil cleanup levels. There are three methodologies in the TAGM that can be used to determine soil cleanup levels for organics. The first two methodologies are based on quantitative human health RA calculations. ABB-ES was not tasked to perform a quantitative RA in the RI, therefore, soil cleanup levels can not be calculated using results of a human health assessment. The third methodology uses the water-soil equilibrium partition theory to calculate soil cleanup levels which are protective of groundwater/drinking water quality. This is the basis that was used to develop RGs for the Becker site. It is likely that the RGs developed to protect groundwater would also be protective of human and ecological receptors potentially exposed directly to VOC soil contamination. The following equation was used:

$$C_s = f_{oc} * K_{oc} * C_w * cf$$

where: f_{oc} = fraction of organic carbon of natural soil (1 percent used as default)

K_{oc} = partition coefficient between water and soil media

C_w = water quality value from Technical Operational Guidance Series 1.1.1

C_s = allowable soil concentration

cf = correction factor, consistent with USEPA's dilution attenuation factor (USEPA, 1990b)

Consistent with TAGM No. 4046, a default f_{oc} of 1 percent was used for Becker because site-specific organic carbon data is not available for source soil. A cf accounts for various fate and transport mechanisms such as volatility, sorption and desorption, leaching and diffusion, transformation and degradation, and change in concentration (dilution) of contaminants after reaching and/or mixing with groundwater. For the Becker site, the NYSDEC Technology Section recommended a cf of 70 for chemicals of concern (COCs) (VOCs) in soil. The cf was decreased from the standard 100 to 70 primarily because treated soil will be in contact with groundwater. Table 2-2 presents RGs for COCs in soil, based on NYS TAGM No. 4046, using an f_{oc} of 1 percent and a cf of 70. COCs include

VOCs because SVOCs and inorganics present on-site have not been associated with the disposal of hazardous waste at the Becker site.

Depending on actual site conditions and the treatment process, NYSDEC may need to decide during the remedial action to increase the soil RGs and/or deal with the soil in another manner. Contingency actions are described in Section 8.

2.2.2 Source Area Groundwater

NYS Class GA groundwater quality standards are the RGs for groundwater at Becker. NYS groundwater quality standards are contained in 6 NYCRR Parts 701-705. Table 2-3 presents RGs for COCs in groundwater. COCs include VOCs only. SVOC CPCs are not present in groundwater; and inorganic CPCs in soil have not been detected in bedrock water supply wells at concentrations exceeding background.

2.2.3 Potable Water Supply

NYS Department of Health (NYSDOH) maximum contaminant levels (MCLs) for drinking water supplies are the RGs for potable water used by residences in the vicinity of Becker. NYSDOH MCLs are contained in Chapter 1, State Sanitary Code, Subpart 5-1, Public Water Systems. Table 2-4 presents RGs for COCs in potable water.

2.3 GENERAL RESPONSE ACTIONS

General response actions are medium-specific strategies that focus technology evaluation and screening on satisfying the remedial action objectives (see Table 2-1).

General response actions may include treatment, containment, excavation, extraction, disposal, institutional actions, or a combination of these. General response actions were identified to address source area soil, source area groundwater, and potable water supplies to residences.

2.3.1 Source Area Soil

A set of general response actions was developed to reduce leaching of VOCs from source soil to groundwater and reduce potential human health and ecological risks associated with exposure to contaminated soil. The following are general response actions for source area soil:

No Action. No actions would be implemented at the site to achieve the remedial action objectives. No Action is included as a baseline condition to which other alternatives will be compared in the detailed analysis.

Minimal Action. Minimal action would include institutional controls such as fencing of the site to limit site access and deed restrictions to limit land use at the site. Minimal Action would also include environmental monitoring.

Containment. Containment would limit the potential for exposure to contaminants in soil and reduce infiltration of rainwater through the soil. These goals could be attained by constructing and maintaining a low permeability cover over areas of concern.

In-situ Treatment. Contaminated material would be treated in place without excavation. This type of treatment would remove, immobilize, or degrade contaminants to achieve the remedial action objectives.

Ex-situ Treatment. Contaminated material would be excavated and treated either on- or off-site.

Disposal. Materials requiring disposal (such as treatment residuals) would be disposed of off-site to comply with ARARs and SCGs.

2.3.2 Source Area Groundwater

A set of general response actions was developed to address contaminated groundwater to reduce potential human health risks associated with exposure to groundwater contamination and mitigate discharge of shallow groundwater to on-site drainages and to Thorp Creek and Catskill Creek via seeps. The following are general response actions for groundwater, which range from No Action to Extraction and Treatment:

No Action. No actions would be implemented to address the remedial action objectives. No Action is included as a baseline condition to which other alternatives will be compared in the detailed analysis.

Minimal Action. Minimal action would include deed restrictions to limit aquifer use, and environmental monitoring to record the dispersion, degradation, and migration of contaminants in the groundwater.

Containment. Containment would restrict migration of contaminated groundwater. Containment could be achieved by constructing low-permeability vertical barriers around the area of concern. Groundwater extraction may be required as part of this response action to control groundwater elevations within the contained area.

Groundwater Extraction. Groundwater extraction would be required in any alternative that required control of groundwater elevation, flow direction, and/or treatment.

Groundwater Treatment. Contaminants in groundwater would be removed or destroyed. This general response action would be included with any groundwater extraction system to meet discharge requirements.

Discharge. Treated groundwater would require disposal and could be discharged to either surface water or groundwater through various mechanisms. Discharge requirements would need to be developed for each of these discharge options.

2.3.3 Potable Water Supply

A set of general response actions was developed for potable water to reduce human health risks associated with ingestion and dermal contact of contaminated groundwater used for drinking water.

No Action. No actions would be implemented to address the remedial action objectives. No Action is included as a baseline condition to which other alternatives will be compared in the detailed analysis.

Wellhead Treatment. Groundwater would be treated at each residence before use such that contaminants are removed or destroyed. This general response action consists of continued use of the existing wellhead treatment systems modifications of the existing wellhead treatment systems.

Alternate Water Supply. Existing wells would be abandoned. A new, contaminant free, water supply well would be installed, with associated piping and connections to form a community water district; or potable water would be piped from an existing public or private water system.

2.4 Contaminated Media Volume Estimates

Estimates of volumes and areas of contaminated media (soil, wood debris, groundwater, and potable water) to which remedial alternatives will apply have been developed for use in evaluating alternatives during the screening and detailed analysis phases of the FS.

2.4.1 Volume of Contaminated Source Area Soil

The volume of contaminated soil that may be subject to remediation was estimated based on results of the RI (Volume IA). This estimate is necessary to evaluate technologies or alternatives, and to estimate costs in the detailed analysis of alternatives. Both analytical data and field information was used to estimated the areas to be excavated.

Soil in the chemical storage building area is contaminated with VOCs. Based on field observations and measurements, soil in the septic system no. 2 leachfield is believed to be contaminated. Soil volumes were estimated for both of these areas.

ABB-ES has assumed that the chemical storage building would be removed as part of the remedial action, and that sheet piling or other stabilization techniques would not be required to protect the truck/warehouse maintenance building. Depending on the results of the subsurface soil investigation (refer to Subsection 3.3.1.2) sheet pile installation may be further evaluated in the predesign phase.

The volume of contaminated soil in the chemical storage building area was estimated based on exceedances of RGs. The approximate limits of septic system no. 2 as determined during the RI were used as the limits of excavation (i.e., contaminated soil). Contamination in both areas is assumed to extend to bedrock (approximately 8 to 10 feet bgs). The estimated volume of contaminated soil at the chemical storage building area is 1,100 cubic yards (cy), and the volume of contaminated soil estimated at the septic system no. 2 area is 1,400 cy. See Appendix A for volume calculations and assumptions.

2.4.2 Volume of Surficial Solid Waste

The volume of surficial solid waste (wood debris) at the site was estimated to provide a cost for its removal and disposal. ABB-ES assumed that only wood debris located aboveground would be removed. The volume of wood debris was estimated to be 6,100 cy (see Appendix A).

2.4.3 Volume of Contaminated Groundwater

The volume of contaminated groundwater was estimated based on the interpreted extent of VOC contamination and an assumed bulk bedrock and overburden porosity of 0.15 (Volume I). The volume of contaminated groundwater for the plume bounded by upgradient well, MW-101, cross gradient wells, MW-110 and MW-113 and Catskill Creek (located downgradient) is approximately 112 million gallons. The volume of the plume with total VOC concentrations greater than 500 parts per billion (ppb) is approximately one half of the total volume or 56 million gallons. The 500 ppb limit is a consideration for design of the extraction system based on guidance from NYSDEC and described in Section 3.0 of this FS. Calculations for these volume estimations are included in Appendix A.

2.4.4 Estimation of Potable Water Usage

Potable water demand for the residential users in the path of the plume was estimated based on national averages for per capita water demand and assumptions concerning the number of users being served in this area (Merritt, 1983). There are currently nine private wells affected by groundwater contamination and consequently subject to wellhead treatment systems. Six of these wells serve private residences and it was assumed that each of these systems serves 3 persons. Three of the wells serve businesses serving an estimated maximum of 120 people during peak operation. It was estimated that 36,500 gallons per day (25 gallons per minute [gpm]) would be required for a peak day. The hourly maximum usage rate was estimated to be 38 gpm. These calculations are estimates based on peak population and activity in the summer months. Due to highly seasonal variations in local population, usage rates during winter months are likely to be less than 5 gpm. More accurate estimation of water usage would require analysis of water meter readings from the wellhead treatment systems since their installation and the actual seasonal variance in occupancy. This data was not available during the preparation of this FS. Calculations for the usage rates are included in Appendix A.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND DEVELOPMENT OF REMEDIAL ALTERNATIVES

Section 3 presents the identification and screening of technologies that may be applicable for meeting the response action objectives identified in Section 2.0. Following the technology screening, these technologies are developed into alternatives which are then described in detail.

3.1 TECHNOLOGY IDENTIFICATION

Candidate technologies were identified based on a review of literature, vendor information, performance data and experience on other similar remediation projects, and discussions between ABB-ES and NYSDEC. Technologies identified for soil are presented in Table 3-1. Technologies identified for groundwater are presented in Table 3-2. Technologies identified for potable water supply are identified in Table 3-3. A total of 17 soil, 14 groundwater, and three potable water supply technologies were identified. These technologies address the general response actions of Institutional Controls, Containment, Removal, Treatment, and Disposal/Discharge to provide a range of options to be screened.

Other technologies may be necessary as support for treatment, or disposal actions. These technologies are known as ancillary actions and include actions such as physically screening soils to meet maximum particle size constraints. Ancillary actions are not listed in Tables 3-1, 3-2, or 3-3, but are described for each alternative that undergoes detailed analysis.

3.2 Technology Screening

The purpose of technology screening is to reduce the number of potentially applicable technologies and process options on the basis of technical effectiveness and implementability. Cost is not considered during the technology screening process. Technologies retained after screening are incorporated into site remedial alternatives.

Technology screening was conducted separately for soil, groundwater, and potable water. Advantages, disadvantages, and conclusions with respect to the criteria for each technology are presented in Tables 3-4, 3-5, and 3-6. Emphasis is placed on preserving a range of technologies representing different general response actions where appropriate.

Technologies considered not effective or implementable were eliminated from further consideration. Technologies remaining after the screening were used to develop remedial alternatives in Section 3.3. Tables 3-7, 3-8, and 3-9 summarize the technologies evaluated in this section and their status after the screening process.

3.3 Development of Remedial Alternatives

The retained technologies listed in Tables 3-7, 3-8, and 3-9 are considered technically feasible and applicable to the waste types and site conditions at Becker. These medium-specific technologies were assembled into potential remedial alternatives capable of achieving the remedial action objectives.

Alternatives were developed for three media to provide comprehensive responses: soil, groundwater, and potable water. A limited number of technologies remained following the technology screening, resulting in the development of three soil alternatives, two groundwater alternatives, and three potable water supply alternatives. Because of the limited number of alternatives developed, screening of remedial alternatives was not performed, all of the alternatives were retained for detailed analysis and are presented in Sections 4, 5, and 6.

These alternatives cover a range of possible remedial approaches, varying in the degree to which they provide permanent remediation and eliminate the need for long-term management. This range of alternatives extends from a no-action alternative to alternatives that achieve permanent reductions in toxicity, mobility, and volume through treatment. Minimal-action, treatment, and removal alternatives are included, where appropriate.

A detailed description of the technologies or processes used is provided for each alternative. Where appropriate, the description includes preliminary site layouts, process flow diagrams, preliminary design calculations, sizing of key components, and a discussion of limitations, assumptions, and uncertainties for each component. These descriptions are intended to provide a conceptual design of each alternative and are used for cost estimating purposes only. Table 3-10 summarizes the key components of the alternatives retained for detailed analysis.

3.3.1 Remedial Alternatives for Soil

Three alternatives were developed to address contaminated soil. Alternative S-1 is a no action alternative. Alternative S-2 is an ex-situ source soil treatment alternative, and Alternative S-3 is an off-site source soil treatment and disposal alternative.

3.3.1.1 Alternative S-1 - No Action. Alternative S-1 was developed as a baseline against which to compare other soil remedial alternatives. This alternative would involve no actions to protect human health or the environment. This alternative would not meet the remedial action objectives because it would not include any remedial measures that would reduce source area contamination. Environmental monitoring and five-year reviews would be conducted as part of a groundwater remedial alternative.

3.3.1.2 Alternative S-2 - Ex-situ Source Soil Treatment. Alternative S-2 is an ex-situ source soil treatment that would include active remediation of source area soil. The alternative consists of the following components:

- site preparation/mobilization
- source soil excavation
- removal and disposal of debris pile
- construction of an engineered soil pile
- ex-situ soil venting
- off-gas treatment
- backfill of treated soil

Figure 3-1 is a process flow diagram for ex-situ soil venting treatment. Source area soil would be treated using ex-situ soil venting to extract VOCs. Removing the source of VOCs would eliminate further groundwater contamination from soil in the unsaturated and saturated zones. Institutional controls, environmental monitoring, and five-year reviews would be implemented as part of a groundwater remedial action. Each component of the alternative is discussed in the following paragraphs.

Site Preparation/Mobilization. Site preparation and mobilization would include all activities required to prepare for the remedial action. These activities would include delivery of site trailer(s) and equipment; connections to existing utilities; preparation of equipment staging and soil treatment areas; and construction of a decontamination pad.

Excavation. In the predesign phase, additional sampling would be performed in the chemical storage building area to better determine the extent of contamination. A GeoProbe℠ or similar drilling and sampling system (see Volume I for GeoProbe℠ description) would be used to collect soil samples. Samples would be collected from locations adjacent to and beneath the building and analyzed off-site for Target Compound List (TCL) VOCs. Additional sampling would also be performed in the septic system no. 2 leachfield; VOC contamination is suspected in this area based on RI investigations.

Proposed excavation limits are shown on Figure 3-2. These limits may be refined after predesign sampling activities. An estimated 1,400 cubic yards (cy) of soil would be excavated from the chemical storage building area based on proposed excavation limits, and an excavation depth of 10 feet bgs (approximate depth to bedrock). Trees and brush would need to be removed from the area prior to excavation.

An estimated 1,600 cy of soil would be excavated from septic system no. 2 leachfield, based on proposed excavation limits and an excavation depth of 8 feet bgs (bedrock surface).

Based on soil sampling results, the chemical storage building and adjacent concrete pad may need to be removed to permit excavation of contaminated soil from beneath the building. For cost estimating purposes, it was assumed that the building would be removed.

If soil sampling indicates that soil adjacent to and below the depth of the warehouse/truck maintenance building is contaminated, sheet piles would be required to protect the building during excavation. For cost estimating purposes, it was assumed that sheet piles would not be required. Based on the Occupational Safety and Health Act (OSHA) sideslopes of the excavation would be 1½:1 (OSHA, 1970).

Excavation would be completed using a backhoe. Large pieces of debris and rocks would be separated from the soil. Trucks would be loaded with soil, and the soil would be moved to the treatment area.

During excavation, confirmatory samples would be collected and analyzed to verify that soil with contaminants above RGs have been excavated. It was assumed that confirmatory excavation samples would be sent to an off-site laboratory and analyzed for TCL VOCs. Use of an on-site field screening laboratory will be evaluated during the predesign phase. For cost estimating purposes, it was assumed that at the chemical storage building area, six samples would be collected from the walls of the excavation at 10 feet, and 5 feet, below ground surface (bgs) and at ground surface, for a total of 18 samples. The samples would be spaced approximately equal distance apart. At septic system no. 2, four samples would be collected from the walls of the excavation at depths of 8 feet, and 4 feet bgs, and at ground surface, for a total of 12 samples. The samples would be spaced approximately equal distance apart. The sampling plan described here is for cost estimating purposes only. A final, detailed sampling plan would be developed and submitted for NYSDEC review and comment before implementation.

A secured chain-link fence and warning signs would be erected to protect persons from falling into the excavations. The excavations may also need to be partially backfilled to provide additional side slope stability if they are to remain open for the duration of the treatment time.

A total of 3,000 cy of soil would be excavated. Approximately 2,200 cy are expected to be contaminated. It was assumed that 2,500 cy of soil would need to be treated due to clean soil sloughing into the excavation and subsequently becoming contaminated. The remaining 500 cy of clean soil would be stockpiled separately and would not be treated.

For cost-estimating purposes, it was assumed that dewatering using extraction wells would not be required. It is likely, however, that a sump pump would be required at the bottom of the excavation to prevent water from accumulating in the excavation. This water would be collected for on-site treatment.

Air would be monitored during excavation activities, and depending on the amount of contaminant volatilization measured, some controls for VOC emissions may be required; however, this was not included in the cost estimates.

Removal and Disposal of Debris Pile. An estimated 6,100 cy of solid waste (wood debris) would be removed from the site. The debris disposal location is not known. Cost were developed to load the debris into trucks, pending transportation and disposal. The disposal location would be identified during the predesign phase, and the cost estimate completed.

Construction of an Engineered Soil Pile. Excavated soil would be constructed into an engineered pile on-site. There are many possible configurations of the soil pile (Figure 3-3), including multiple soil piles. The excavated soil would be placed on a treatment pad that would consist of a 6-mil polyethylene (PE) liner and a 6-inch sand drainage layer. The treatment pad would be sloped such that water draining from the soil could be collected at a low point in the pad. Collected water would be treated prior to discharge. A berm would be constructed around the soil pile to promote drainage away from the contaminated soil. Perforated polyvinyl chloride (PVC) pipes would be installed at approximately mid-depth, 15-feet on center. The pipes would be manifolded and connected to a blower. Air would be drawn out of the soil pile via these pipes. A 6-mil PE liner would be secured over the pile to reduce water infiltration and runoff, air leakage, and fugitive dust emissions. It is assumed that air inlet pipes would not be necessary because there would be sufficient air leaks through the liner.

A security fence with a visual barrier could be erected around the soil pile and ex-situ venting system to protect them from vandalism. It may also be feasible to construct the pile and treat the soil inside one of the existing buildings at the Becker site.

Ex-situ Soil Venting. Once construction of the engineered soil pile is complete, ex-situ soil venting would begin. Figure 3-4 shows the proposed location of the soil treatment, equipment staging, and decontamination area. The principle of ex-situ soil venting is similar to that of in-situ soil vapor extraction (SVE). A pressure gradient is established and maintained through the soil such that mass transfer of VOCs from the soil matrix to the air occurs. Several factors affect the performance of the ex-situ soil venting system, including soil type, moisture content, air temperature, and contaminant type and concentration. The soil at Becker is expected to be more amenable to ex-situ soil venting than to in-situ SVE due to the geologic and hydrogeologic properties of the site (i.e., low soil permeability, saturated soil).

Ex-situ soil venting is well suited to highly volatile organics. The ventability of a compound can be estimated from its vapor pressure and/or Henry's constant. Generally, compounds with a vapor pressure greater than 100 millimeters of mercury (mm Hg) at 20°C can be successfully vented; those in the range of 20 to 100 mm Hg may be successfully or effectively vented; and those with a vapor pressure less than 20 mm Hg will not be efficiently vented. The vapor pressure rule applies when the contaminant is present as a pure liquid (Pedersen, Curtis and Fan, 1990). When the contaminant is in solution, Henry's constant is a more accurate estimate of ventability. Compounds with Henry's Law constants greater than 0.1 can be readily vented (Pedersen, Curtis and Fan, 1991). Because chlorinated VOCs at the Becker site are believed to be present in the aqueous rather than pure phase, Henry's constant is a better estimate of their ventability. Table 3-11 lists the physical-chemical data for organic COCs at the Becker site.

The rate of VOC removal is also influenced by the air conductivity in soil, which is a function of the intrinsic permeability of the soil matrix and the degree of water saturation. As water saturation increases, contaminants become more difficult to vent. The soil at the Becker site is saturated from approximately 2 feet bgs to bedrock. Ex-situ soil venting will allow saturated soil to be excavated and dried out, while, the PE liner will prevent soil from becoming rewetted. The average hydraulic conductivity, K, of the soil at the Becker site is 1.10×10^{-3} centimeters per second (cm/sec) and the geometric mean is 6.7×10^{-5} cm/sec. The geometric mean is more representative of the soil permeability at the site. A K of 10^{-5} cm/sec is indicative of a fairly tight soil (Holtz, 1981). Excavation will rework the soil and increase the soil permeability.

The soil at the Becker site is classified as a silty gravel or silty sand. Soil type will affect the performance of the system as air will choose the path of least resistance and will flow through zones of higher permeability (i.e, sand or gravel vs. silt). If this occurs, diffusion becomes the primary contaminant removal mechanism and remediation slows (Brown, Kroopnick, Bush, 1991). Through excavation and placement of soil in a pile, mixing of the soil will occur which will allow for a more homogeneous soil matrix and better movement of air through the soil pile.

The soil at the Becker site is expected to have a low organic carbon content. Soils high in organic matter tend to sorb VOCs more tightly, increasing the time required for venting. Therefore, soils with low organic carbon content are better suited for venting. The organic carbon partition coefficient (K_{oc}) is an indicator of a chemical's tendency to partition between groundwater and soil. Compounds with relatively low K_{oc}s are predicted to readily partition to water and are not easily sorbed to the organic carbon fraction of soil. The COCs at the Becker site have relatively low K_{oc}s and are therefore predicted to be amendable to ex-situ soil venting (Table 3-11).

There are several different modifications that could be made to the system to increase the rate of volatilization of contaminants from the soil pile, potentially reducing the concentrations of contaminants in the pile to the calculated RGs. These include:

- mixing a non-hazardous chemical additive into the pile to increase the temperature of the soil;
- remixing the soil at some time during the treatment process;
- pulsing the system; and
- adding more perforated pipes to draw more air thorough the pile.

As vapor is drawn through the pile and the discharge pipes, it will pass through a vapor/liquid separator. The vapor/liquid separator removes liquids from the vapor stream, protecting the blower from corrosion and short-circuiting.

Samples of both soil and soil vapor would be collected periodically throughout the treatment process to assess the effectiveness of the ex-situ soil venting system. The sampling plan described here is for cost estimating purposes only. A final, detailed sampling plan would be developed and submitted for NYSDEC review and comment before implementation. It was assumed that samples would be sent to an off-site laboratory and analyzed for TCL VOCs. Use of an on-site field laboratory will be evaluated during the predesign phase. Soil vapor samples would be collected and analyzed monthly. One vapor sample would be collected from each discharge (suction) pipe. Soil samples would be collected once every three months. One sample per 150 cy would be collected and analyzed. Treatment would be complete once soil RGs are achieved. Treatment is expected to take 10 months. Depending on actual operating conditions, treatment time could vary.

Off-gas Treatment. For cost estimating purposes, it was assumed that off-gases would require treatment before discharge to the atmosphere. Concentrations of contaminants in the off-gas would be reduced to below NYS and federal air emissions standards. Liquid from the vapor/liquid separator would require treatment to remove contaminants before discharge.

Depending on the phasing of the soil and groundwater remedial actions, it is possible that the vapor and liquid waste streams from the ex-situ soil venting system could be treated at the groundwater treatment plant. For cost estimating purposes, it was assumed that off-gas control in the groundwater treatment plant would not be available and that granular activated carbon (GAC) would be used to treat soil vapor and liquid.

Backfill of Treated Soil. Before backfilling the treated soil, water that has accumulated in the excavation would be pumped into a storage container and treated in the groundwater treatment plant. It is estimated that 600,000 gallons of water would require treatment. The security fence would be removed, and the ex-situ soil venting system would be disconnected. Treated soil would be backfilled into the original excavation, compacted, and graded to promote positive drainage.

3.3.1.3 Alternative S-3 - Off-site Source Soil Incineration and Disposal. Source soil would be removed and treated off-site. This action would eliminate further groundwater contamination from soil in the unsaturated and saturated zones. This alternative includes the following components:

- site preparation/mobilization
- source soil excavation
- backfill of clean soil
- removal and disposal of debris pile
- off-site incineration and disposal

Institutional controls, environmental monitoring, and five-year reviews would be implemented as part of a groundwater remedial action. Each component of the alternative is discussed in the following paragraphs.

Site Preparation/Mobilization. Site preparation and mobilization would include all activities required to prepare for the remedial action. These would include delivery of equipment, and construction of decontamination facilities.

Excavation. Similar excavation procedures as those described in Subsection 3.3.1.2 would be implemented for this alternative, with one exception: trucks or roll-offs would be loaded with contaminated soil and transported to an off-site incinerator.

Backfill of Clean Soil. As soon as possible after the source area soil has been excavated, clean soil would be backfilled into the excavation, compacted, and graded to promote positive drainage.

Removal and Disposal of Debris Pile. The same procedures for removal and disposal of the debris pile as described in Subsection 3.3.1.2 would be implemented for this alternative.

Off-site Incineration and Disposal. Excavated soil would be transported to Chemical Waste Management's incineration facility in Sauget, Illinois. Excavated soils must be treated before land disposal because contaminant concentrations exceed the Universal Treatment Standards (USEPA, 1995). Incineration technologies destroy organic contaminants in soil by subjecting them to temperatures as high as 2,600°F in the presence of oxygen. This environment causes the organic contaminants to volatilize and oxidize, yielding high destruction percentages. This technology is applicable for a wide range of organic contaminants, including VOCs, SVOCs, pesticides, and polychlorinated biphenyls.

Three types of combustion chambers are available: (1) infrared, (2) fluidized bed, and (3) rotary kiln. The rotary kiln combustion chamber accommodates the widest variety of waste types and is the most widely available. Chemical Waste Management uses this type of incinerator. Figure 3-5 shows an illustration of a typical rotary kiln incinerator.

Rotary kiln incinerators are slightly inclined, refractory-lined cylinders. Wastes and auxiliary fuel are injected into the high end of the kiln and passed through the combustion zone as the kiln slowly rotates. Depending on the requirements of the waste feed mechanism, the soil may need to be screened to remove large objects, and shredded to reduce particle size.

The rotation of the kiln creates turbulence that helps to uniformly expose the waste to the high temperature conditions, improving the degree of combustion of organic contaminants. Retention time for the material in the kiln can vary from several minutes to an hour or more, depending on the physical and chemical characteristics of the waste. Organic matter is substantially oxidized to gases. The remainder of the waste, left as an inert ash, is removed at the lower end of the kiln. Flue gases are passed through a secondary combustion chamber to destroy unburned organics. The off-gases then pass through air pollution control (APC) units for particulate removal and acid gas neutralization. APC equipment that can be used include venturi scrubbers, wet electrostatic precipitators, baghouses, and packed scrubbers (USEPA, 1988a, 1990c). Treated gases are then discharged to the atmosphere.

Three major wastestreams are generated by incineration: ash from the incinerator and APC system, water from the APC system, and emissions from the incinerator. The APC system's solids, such as fly ash, may contain high concentrations of volatiles or metals. If these residues fail required Toxicity Characteristic Leaching Procedure (TCLP) analysis, they can be treated by a process such as stabilization/ solidification and disposed of in a permitted disposal facility. Liquid waste from the APC system may contain highly caustic residuals, high chlorides, volatile metals, trace organics, metal particulates, and inorganic particulates. Treatment may require neutralization, chemical precipitation, reverse osmosis, settling, evaporation, filtration, or carbon adsorption before discharge.

3.3.2 Remedial Alternatives for Groundwater

Two alternatives were developed to address contaminated groundwater. Alternative GW-1 is a no action alternative. Alternative GW-2 is a plume control groundwater extraction and treatment alternative. These alternatives are developed and described in the following subsections.

3.3.2.1 Alternative GW-1 - No Action. Alternative GW-1 was developed as a baseline for comparison to the other groundwater remedial alternative. This alternative would involve no actions to address remediation of groundwater contamination. It would include environmental monitoring and five-year reviews. This alternative would not meet the remedial action objective for groundwater contamination reduction because it would not include any remedial measures that would remove or treat groundwater contamination. The components of the No Action Alternative are described in the following paragraphs.

Environmental Monitoring. The objectives of the environmental monitoring program would be to evaluate whether the source area at the site is continuing to degrade groundwater quality and to monitor the migration of contamination in groundwater. The monitoring plan developed and described in this FS is for cost-estimating purposes only. The final, detailed monitoring plan would be developed and submitted for NYSDEC review and comment before implementation.

Environmental monitoring would involve the routine periodic sampling of groundwater at Becker. Samples would be analyzed for TCL VOCs. It is assumed that groundwater from seven monitoring wells and three groundwater seeps and one surface water drainage ditch would be sampled and analyzed to monitor source contribution to groundwater contamination, the migration of the plume, and the discharge of groundwater to Thorp Creek and Catskill Creek and the upgradient drainage ditch. The locations of these sampling locations are shown in Figure 3-6.

Groundwater from one upgradient well (i.e., MW-101D) would be sampled and analyzed to provide data on the quality of groundwater as it enters the site and before it encounters the source of contamination. Groundwater from one existing monitoring well in the center of the plume would be sampled and analyzed (i.e., MW-106D). This well, located near the source of contamination and historically having the highest detected contaminant concentrations, would provide information on the attenuation and degradation of contaminants in the most concentrated area of groundwater contamination. Another well would be installed downgradient of the source area to the northeast of Route 145 in the center of the plume (i.e., MW-114) to monitor the migration of the highly contaminated groundwater toward Catskill Creek.

Groundwater from two wells located near Thorp Creek and Catskill Creek would be sampled and analyzed (i.e., MW-111, and MW-112). Monitoring wells MW-111 and MW-112 are bedrock wells that will provide an indication of contamination that is migrating toward and discharging to the creeks. MW-110 and MW-113 would be sampled and analyzed to provide information that would help to characterize the lateral dispersion of contamination near the side edges of the plume.

Groundwater seeps at Catskill Creek would be sampled to monitor the concentrations of contaminants being discharged with groundwater to the creek. As the plume moves downgradient, these concentrations may increase. The proposed sampling locations would include SW-107, SW-108, and SW-109. Another surface water sample (SW-102) would be collected to evaluate groundwater contamination from the industrial leachfield and debris pile seeping to the drainage ditch that runs upgradient of the primary source area.

For cost-estimating purposes, it is assumed that environmental monitoring would be conducted annually for 30 years. For the first two years, quarterly sampling would occur to increase the database on contaminant concentrations and distribution and to provide a better basis for statistical evaluation of trends. Quarterly sampling would also show how seasonal variations affect contaminant migration. After the second year, sampling would occur annually to monitor changes in contaminant concentrations and distribution over time.

Five-year Reviews. At sites where wastes have not been treated permanently, five-year site reviews are conducted to assure that human health and the environment are being protected. The five-year review would present, organize, and interpret all data gathered during sampling events in report format. The review would recommend future remedial actions at the site. This recommendation could be to continue environmental monitoring and five-year reviews, to pump and treat the groundwater, or to implement a source control remedial action, if not already completed.

3.3.2.2 Alternative GW-2 - Plume Control. Alternative GW-2 would implement a groundwater pump-and-treat scenario to address groundwater contamination near the source where concentrations encountered are the highest. It also includes collection of groundwater seeps from the embankment below the leachfield. These groundwater seeps would represent a minor component of the overall groundwater extraction. The alternative consists of the following components:

- site preparation/mobilization
- groundwater extraction
- upgradient groundwater seep recovery
- groundwater treatment (air stripping or UV/reduction)
- reinjection of treated water
- institutional controls

- environmental monitoring
- five-year reviews

A groundwater extraction system would be installed near the source to cut off the plume and reduce the mass of contamination migrating toward Catskill Creek. The downgradient portion of the plume would detach from the site and continue to migrate toward Catskill Creek. Institutional controls, environmental monitoring, and five-year reviews would be implemented to protect human health and monitor the location and migration of contamination. Each component of the alternative is described in greater detail in the following paragraphs.

Site Preparation/Mobilization. Before construction of the alternative begins, the site would be prepared and the contractor would mobilize equipment. This would include security measures, equipment and materials staging, decon pad construction, and temporary office trailer set up.

Groundwater Extraction. Conceptual design of the extraction system requires information about the nature and distribution of groundwater contamination, aquifer characteristics, and local land use. For the purposes of this evaluation, ABB-ES has used information from the scientific literature and has made simplifying assumptions about site conditions. The final number of wells, well depths, screened intervals, and pumping rates will be determined during the design and construction phase.

The plume, as characterized in Section 5.0 the RI (see Volume 1A), is approximately 1,200 feet long and 1,000 feet wide at its widest point. The objective of the groundwater extraction system for this alternative would be to cut off off-site migration of contaminant VOCs and reduce the mass of contaminants migrating toward Thorp Creek and Catskill Creek. To accomplish this objective, an extraction system strategy was developed in consultation with NYSDEC to capture the on-site groundwater plume with concentrations greater than 500 μg/L.

Calculations were performed to estimate the extraction flow rate required to capture the desired portion of the plume and are included in Appendix A. These calculations assume a plume width of 500 feet and a thickness of 100 feet. It was estimated that the pumping rate required to capture the 500 μg/L VOC plume would be 90 gpm. Aquifer characteristics used in the analysis of groundwater extraction were taken from data collected during the RI. The aquifer in the site vicinity consists of fractured bedrock with overburden and fill materials. The simplifying assumption was made that bedrock behaves as a homogeneous, isotropic, porous medium. During the design stage, additional studies would be required to determine actual hydraulic properties at extraction well locations and verify construction of an extraction system adequate to meet the capture strategy. It is recommended that the extraction wells be installed and tested to verify capture and determine design concentrations before design of the treatment system.

For the purposes of this FS the groundwater extraction system was assumed to consists of four wells. It may be possible to achieve capture with fewer wells; however, this can not be determined before installation and testing of the wells. The extraction wells would be situated as shown in Figure 3-7. The first well would be installed in the source area near MW-106D. Based on the yield and capture zone of this well, other wells would be installed to complete the extraction system. Each well would require pumping tests due the heterogeneous nature of the bedrock. The wells would pump an estimated total of 90 gpm to be treated and recharged to the aquifer via a reinjection wells.

The system would remove one pore volume of the source plume every 2.4 years (see Appendix A). Restoration of fractured bedrock aquifers by extraction and treatment has been found to be extremely difficult (USEPA, 1988b and USEPA, 1993). The extraction system is expected to meet the response objective for groundwater, but it is not likely to restore the site to groundwater quality standards in a reasonable time frame. Calculations of time to achieve restoration would not be accurate because of the limited information on expected extraction well capture zones and the errors introduced by modeling the bedrock as a porous, homogeneous medium. For cost estimating purposes, it was assumed that extraction would continue for 30 years.

Upgradient Groundwater Seep Recovery. A low-flow groundwater seep from the leachfield area to the site drainage ditch has resulted in detections of contamination in surface water samples collected from the drainage ditch. A collection system would be installed as part of this alternative to isolate and collect the groundwater seep and pump it to the treatment plant. Surface water runoff would be collected separately and drain off-site without contacting water from the groundwater seeps. Figure 3-8 shows a possible cross-section detail of the drainage ditch reconstruction to accomplish this.

Groundwater Treatment. The two water treatment technologies for organics retained following technology screening are air stripping and ultraviolet (UV)/reduction. Both technologies would effectively treat VOCs. The technologies offer very similar characteristics for consideration during a detailed analysis. The primary factor in choosing one technology over the other would be site-specific costs. Treatability studies to accurately assess effectiveness and costs are recommended as a basis to select between the technologies. For this reason, costs for this alternative were developed based only on the air stripping technology with a VOC destructive off-gas treatment. The final decision between air stripping and UV/reduction would be made during the design stage based on treatability studies and economic analysis.

Prior to organics treatment, it would be necessary to remove iron and manganese from the extracted groundwater. Dissolved iron and manganese oxidize to a less soluble form and precipitate out of solution in the presence of air or other oxidants. This precipitate can foul the packing material in the air stripper, reducing the efficiency of the treatment system and increasing costs. Iron and manganese concentrations found as high as 13.9 mg/L and 3.5 mg/L, respectively in the extraction area, suggests pretreatment would be required. This would be verified by sampling water from pumping tests of the new extraction wells. For cost-estimating purposes, it was assumed that the treatment plant would be located on site in a part of the warehouse/truck maintenance building as shown in Figure 3-7.

Based on the iron and manganese concentrations observed at the site pretreatment would be completed using greensand filters. If during pumping tests, higher iron and manganese concentrations are observed, an oxidation/coagulation/settling process may be used instead. Analysis of this alternative includes pretreatment of the raw water by the following processes:

- greensand filtration
- backwashing
- sludge handling

A schematic flow diagram of the overall treatment process is shown in Figure 3-9. The first step in pretreatment would be to oxidize the iron and manganese to their insoluble forms. Potassium permanganate ($KMnO_4$) would be used in the greensand filter to oxidize the dissolved iron from the relatively soluble +II state to the more insoluble +III state. Dissolved manganese would also be oxidized from the +II state to the more insoluble +IV state. The precipitates would consist primarily of ferric hydroxide and manganese dioxide. Greensand filters would inject the $KMnO_4$ directly into the bed of the filter with the influent water. The products of the reaction, an insoluble ferric hydroxide and manganese dioxide, are immediately filtered out by the sand.

The conceptual design of the pretreatment system includes three greensand filters arranged in parallel. This allows for continuous operation of the system when one of the filters requires backwashing. Backwash from the greensand filter (containing the precipitated metals) would be thickened in a gravity thickener to a concentration of approximately 3 percent solids. Sludge would be further thickened by a sludge filter press, tested for characteristics of hazardous waste, and properly disposed of off site.

After pretreatment, the water would be treated to remove VOCs, primarily 1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCE, TCE, 2-Butanone, and chloroethane. Air stripping is one of the technology options for VOC removal presented in this alternative. Air stripping is a method frequently used to remove VOCs from groundwater. During the process, contaminated water contacts large volumes of clean air. Contaminated water enters the top of the air stripping tower and trickles down through the packing material, while air enters at the bottom and is blown upward through the packing material. The contaminants are transferred from the liquid phase to the gas phase and carried off with the effluent air. The air stripping column design is essentially dictated by the column fluid dynamics and the desired removal efficiencies for the compounds of concern. Several vendors can custom-design a tower if a standard-size tower does not meet design specifications.

An air stripper treating water from the Becker plume for this alternative is estimated to emit a maximum of about 37 pounds per day of VOCs. This emission rate was calculated based on a water flow rate of 90 gpm and maximum total VOC concentrations of approximately 34 mg/L. If these concentrations are not encountered during remediation or concentrations decline rapidly, actual emissions could be significantly lower. for instance, a total VOC influent concentration of 500 μg/L results in 0.54 lbs/day in emissions (see Appendix A). If air stripping were implemented, actual emission rates would be determined and compared to the NYS air guidelines to evaluate the need for off-gas treatment.

Typically, if emissions rates are greater than half a pound per hour, off-gas treatment is required. The estimated emission rate suggests that off-gas treatment would be required initially, although long-term off-gas controls may not be necessary.

There are several off-gas treatment technologies available to address the airstream emitted from the air stripper. The choice of control technology depends on the type and concentration of VOCs, the desired level of destruction, and the duration of the project. For cost-estimating purposes, it was assumed that off-gas treatment with thermal or catalytic incineration would be used for air emissions from the air stripper. Vapor phase carbon (VPC) could also be evaluated during remedial design; however, due to the presence of vinyl chloride in the groundwater, VPC is not expected to be cost effective.

Thermal and catalytic incinerators are commercially available for destroying gaseous organic compounds. Thermal incineration of VOCs occurs at temperatures averaging 1,600°F. The operating temperature would be determined by field testing to achieve the desired destruction removal efficiencies. Catalytic incinerators operate at lower temperatures and can, in principle, be used to destroy essentially any organic compound in an airstream (van der Vaart et al., 1991).

Another process option suitable for treating VOCs is UV/reduction. UV/reduction is proposed over UV/oxidation due to the presence of halogenated ethanes which are not effectively treated by oxidation processes. The UV/reduction process destroys organic compounds in water through chemical reduction enhanced by exposure to UV light. A catalyst is added to the water to generate hydrated electrons (e_{aq}^-) in the UV/reduction vessel. The hydrated electron is a strong reducing agent that reacts with halogenated organics to produce inorganic halide ions. Treatability studies would be used to determine the expected concentrations of these compounds and evaluate if further treatment would be required before discharge.

UV/reduction occurs in a stainless steel chamber containing vertically or horizontally mounted UV lamps. A solution of catalyst is metered into the influent waste stream.

Treatability studies prior to full-scale design would provide the necessary information for economic and technical evaluation for final selection of the treatment process flow and for detailed design and operation of the system. The final design would be subject to regulatory agency review and approval before implementation.

Reinjection. Treated groundwater would be piped to reinjection wells located on the north side of Route 145 and returned to the aquifer. Public sewers are not available at this site; therefore discharge to a POTW was eliminated during technology screening. Discharge to surface water is possible; however, this would require meeting more stringent surface water quality criteria that are protective of aquatic receptors. The extraction of groundwater from the source is anticipated to lower the water table in the vicinity of the residential water supply wells; therefore reinjection is recommended to prevent these wells from going dry. Water would be returned to the aquifer and undergo additional filtration through soils and bedrock before reaching residential wells. The proposed location of the reinjection wells are shown in Figure 3-7. During the design and construction phase, hydraulic testing of the reinjection wells would be required to verify their ability to accept the volume of water generated by the treatment plant.

Institutional Controls. As part of this alternative, institutional controls would be implemented to restrict any additional use of groundwater from the aquifer in the path of the plume. Construction of new wells to extract water from the aquifer may be restricted through permitting or deed restriction processes.

Environmental Monitoring. Monitoring would be included as part of this alternative as described for the No Action Alternative in Subsection 3.3.2.1. It would be used to evaluate whether the source area at the site is continuing to degrade groundwater quality and to monitor the effectiveness of remediation.

Five-year Reviews. Because contaminated groundwater below 500 μg/l would remain untreated, five-year reviews would be conducted to evaluate the status of the contamination. Five-year reviews would be conducted as described for the No Action Alternative in Subsection 3.3.2.1.

3.3.3 Potable Water Supply Alternatives

Three alternatives were developed to address supply of potable water to the residences located downgradient of the Site. These included a no-action alternative, a wellhead treatment alternative, and an alternative water supply alternative.

3.3.3.1 Alternative WS-1 - No Action. The No Action Alternative does not include any measures to provide potable water to residences. Existing wellhead treatment systems for residential wells would not be maintained. It would be necessary to replumb the existing systems to bypass the filters. This alternative would not meet the response action objectives but provides a baseline for comparison with other alternatives.

3.3.3.2 Alternative WS-2 - Wellhead Treatment. Nine private water wells currently have been equipped with wellhead treatment equipment to treat water extracted from these wells prior domestic use. Two other locations are routinely monitored for contamination but do not have treatment equipment. Under this alternative, existing wellhead treatment systems would be operated and maintained to provide potable water to the residences.

The existing treatment equipment installed on the residential wells typically consists of a prefilter to remove particulates, two granular activated carbon

(GAC) filters in series for VOC removal, and an ultraviolet disinfection unit as shown in Figure 3-10. Some variation in configuration and size occurs between systems. Collection and analysis of samples to evaluate the treatment effectiveness are conducted every four months. Maintenance occurs approximately yearly, although variation between residences occurs. Under this alternative, monitoring of the influent and effluent of each wellhead treatment unit would be conducted quarterly. Carbon would be replaced as necessary to maintain effective treatment. It is anticipated that the carbon usage rates will increase with time as the plume migrates and more heavily contaminated groundwater reaches these residential wells. For cost estimating purposes, it was assumed that maintenance would be required annually for all systems. As part of this alternative, the sampling and maintenance frequencies would be reevaluated and improvements to the treatment system considered.

3.3.3.3 Alternative WS-3 - Alternative Water Supply. Alternative WS-3 consists of extending the public water supply lines along to the site. Houses that are currently supplied by residential wells with wellhead treatment equipment would be switched to the public water supply. The nearest public water main is located approximately six miles from the site. Under this alternative the line would be extended to the site and house connections would be installed. It is assumed that the existing water supply and capacity is adequate to handle the additional demand.

Because of the distance to the nearest water main is large, the alternative water supply could also be established by developing a new water supply in the vicinity of the site. Under this alternative a new water supply well would be installed upgradient or cross-gradient from the site in an area of uncontaminated water. The well would be designed and developed to provide an adequate water supply to all of the residences currently with wellhead treatment on their private wells. Some conventional water treatment may be required to remove particulates and inorganics. A water reservoir may be installed to provided adequate supply during peak demand, and water lines and pumps would be installed to deliver the water to the residences. Figure 3-11 shows a potential new community water supply well location and pipeline. Development of this system would require installation of a well, pumping tests to verify yield and evaluate water quality, and installation of storage, pumping, and treatment equipment as required.

4.0 DETAILED ANALYSIS OF SOIL ALTERNATIVES

This section presents the detailed analysis of the three soil alternatives for Becker, which are summarized in Table 3-10. These analyses present the relevant information that will allow the NYSDEC to select a site remedy for soil. The detailed analysis of each alternative compares the alternative against the seven evaluation criteria outlined in the NCP (USEPA, 1990a.), NYSDEC TAGM No. 4030 (NYSDEC, 1990), summarized in Table 4-1. Costs presented in this analysis are intended to be within the target accuracy range of -30 to +50 percent of actual cost (USEPA, 1988a). ARARs and SCGs are identified in Section 3 of the RI Report.

4.1 COMPLIANCE WITH ARARS AND NYS SCGS

Each alternative was evaluated to determine whether it meets the chemical-, location-, and action-specific ARARs and NYS SCGs that were identified in Volume I of this RI/FS.

4.1.1 Alternative S-1 - No Action

Because Alternative S-1 does not involve any remedial actions, no significant change in soil contaminant concentrations would be expected. Consequently, soil with contaminants in excess of chemical-specific ARARs and SCGs would remain on-site. Location- and action-specific ARARs and SCGs would not be invoked because no remedial actions would occur.

4.1.2 Alternative S-2 - Ex-situ Source Soil Treatment

Alternative S-2 would reduce the concentrations of contaminants in source soil to levels protective of groundwater. It is expected that the RGs would be protective of human health and the environment, however, a quantitative RA was not conducted for the site. If needed, vapors from the ex-situ soil venting process would be collected and treated to remove contaminants before discharge to the atmosphere. Off-gas concentrations would comply with the Federal Clean Air Act (CAA) and NYS ambient air quality regulations.

Contaminant emissions during excavation may be high enough to exceed ambient air quality regulations; however, engineering controls could be used to meet the regulations if necessary. Such engineering controls were not included in cost estimates for this alternative.

Removal of the surficial wood debris pile would comply with location-specific ARARs and SCGs. No other location-specific ARARs and SCGs have been identified for Becker.

Operation of the ex-situ soil venting system would require compliance with state and federal Resource Conservation and Recovery Act (RCRA) regulations for hazardous waste treatment, storage, and disposal facilities (TSDFs). Excavation of source soil, installation of sheet piles if needed, and construction and operation of the treatment system would be performed in accordance with OSHA requirements.

4.1.3 Alternative S-3 - Off-site Source Soil Treatment and Disposal

Alternative S-3 includes excavation of contaminated soil from the site for off-site treatment. Excavation would remove contaminated soil from the site, and off-site treatment would destroy contaminants; human health and environmental risks from soil would be eliminated. Contaminant emissions during excavation may be high enough to exceed ambient air quality regulations; however, engineering controls could be used to meet NYS and federal CAA regulations if necessary. Such engineering controls were not included in cost estimates for this alternative.

Removal of the surficial wood debris pile would comply with location-specific ARARs and SCGs. No other location-specific ARARs and SCGs have been identified for Becker.

Excavation of contaminated soil would require compliance with State and RCRA regulations for hazardous waste TSDFs. Excavation would require health and safety training and safe working practices as outlined under OSHA. Vendors who handle the transportation and off-site treatment of soils would be required to comply with the appropriate NYSDEC, RCRA, and Department of

Transportation (DOT) regulations for manifesting, transporting, stockpiling, and incinerating soil.

4.2 Protection of Human Health and the Environment

Each alternative was evaluated to determine whether it provides protection of human health and the environment.

4.2.1 Alternative S-1 - No Action

This alternative would provide no additional protection to human and ecological receptors over existing conditions. Direct contact and incidental ingestion risks would remain. Because the No Action Alternative would not meet the remedial action objectives, contamination from the source area would continue to degrade groundwater quality. Some decrease in risks to human health and the environment would result after decades of natural degradation and dispersion processes reduce contamination in source soil.

4.2.2 Alternative S-2 - Ex-situ Source Soil Treatment

This alternative would provide protection of human health and the environment by reducing the concentrations of contaminants in source area soil. Contaminated soil would be excavated and treated on-site, reducing direct contact and incidental ingestion risks, and leaching of contaminants from soil to groundwater. Some short-term impacts may be experienced by on-site workers and the community, see Subsection 4.3.2.

4.2.3 Alternative S-3 - Off-site Source Soil Treatment and Disposal

This alternative would provide protection of human health and the environment. Contaminated soil would be excavated and treated off-site, eliminating direct contact and incidental ingestion risks as well as leaching of contaminants from soil to groundwater. Some short-term impacts may be experienced by on-site workers and the community, see Subsection 4.3.3.

4.3 Short-term Impacts and Effectiveness

Each alternative was evaluated to determine what effects it will have on the community, on-site workers, and the environment during its construction and implementation.

4.3.1 Alternative S-1 - No Action

This alternative would not include any remedial actions, therefore, no short-term impacts would occur.

4.3.2 Alternative S-2 - Ex-situ Source Soil Treatment

Implementation of ex-situ soil venting would not result in significant short-term impacts to the community.

Soil excavation may pose risks to on-site workers. The excavation would extend approximately eight to 10 feet bgs. Excavating to this depth may require the installation of sheet piling to protect adjacent buildings. Driving the sheet piling to this depth would cause a significant increase in noise levels near the site. Heavy equipment including a crane, backhoe, and trucks would increase noise and traffic.

Excavation workers may require some respiratory protective equipment during excavation to minimize the possibility of exposure to volatilized contaminants. If contaminant emissions from the excavation become excessive, engineering controls would be implemented. These would include use of fans, and placement of covers over the disturbed soil (to minimize volatilization of contaminants from soil during downtime and between work shifts).

If contaminant concentrations exceed NYS and federal CAA regulations, vapors from the treatment system would be collected and treated to remove contaminants prior to discharge to the environment. Therefore, this would not pose a health hazard to the community or on-site workers.

The blower may pose a noise nuisance for people on-site, however, the distance to local residences is too great for the noise to affect the community. Depending on the size of the blower, inlet and outlet silencers may be used.

Hazards associated with work in and around open excavations and heavy equipment can be minimized by safe work practices. It will be required that workers are OSHA-trained and certified to perform work on a hazardous waste site. A site-specific Health and Safety Plan (HASP) will be implemented to minimize risks to workers during soil sampling and excavation, installation of sheeting, and construction and operation of the ex-situ soil venting system. The site would require secure fencing around it to minimize the possibility of trespassing by unauthorized persons.

The excavations may remain open for approximately one year. Although a security fence would be installed around the excavations, there would be some hazards associated with the open excavation.

The estimated time for procurement and construction activities is three to six months. The source soil treatment time to achieve RGs is eight to 14 months. Once RGs are achieved, soil treatment will be complete.

4.3.3 Alternative S-3 - Off-site Source Soil Treatment and Disposal

The most significant short-term impacts from Alternative S-3 are associated with excavation of source soil. The excavation would extend approximately eight to 10 feet bgs. Excavating to this depth may require the installation of sheeting to protect adjacent buildings. Driving the sheeting to this depth would cause a significant increase in noise levels near the site. Heavy equipment including a crane, backhoe, and trucks would increase noise and traffic.

Excavation workers may require some respiratory protective equipment during excavation to minimize the possibility of exposure to volatilized contaminants. If required, fans would be used to direct contaminants away from workers; covers would be used to minimize the volatilization of contaminants from disturbed soil during downtime and between work shifts.

Hazards associated with work in and around open excavations and heavy equipment can be minimized by safe work practices. All workers would be required to have OSHA health and safety training for work at a hazardous waste site. A site-specific HASP would be followed to minimize risks to workers. The site would require secure fencing around it to minimize the possibility of trespassing by unauthorized persons.

Contaminated soil loaded onto trucks for transport to the off-site treatment facility would be covered securely to minimize loss of material and volatilization of contaminants. The arrival and departure of trucks would increase the amount of local truck traffic. Because treatment would take place off-site, air quality impacts due to incineration of source soil would not affect the community in the vicinity of Becker.

The estimated time to procure and implement this alternative is six months.

4.4 LONG-TERM EFFECTIVENESS AND PERMANENCE

Each alternative was evaluated to determine what extent it will be effective after the response objectives have been met.

4.4.1 Alternative S-1 - No Action

This alternative has no long-term effectiveness and permanence because no actions would be taken to reduce the concentrations of contaminants in soil.

4.4.2 Alternative S-2 - Ex-situ Source Soil Treatment

VOCs would be removed from source soil to concentrations protective of groundwater. It is assumed that RGs would protect human health and ecological receptors.

Initially, the venting system would be operated as described in Subsection 3.3.1.2. If removal rates were not high enough, however, changes to the system may be required. The RGs for soil are low. The process would undoubtedly remove the majority of contamination, but the RGs may not be achieved. The water/soil partition theory provides a conservative estimate of soil cleanup levels necessary to prevent further groundwater contamination. Actual contaminant levels necessary to prevent further leaching may be higher than the RGs. If RGs are not achievable with ex-situ soil venting, a contingent remedial action would be implemented (see Section 8).

4.4.3 Alternative S-3 - Off-site Source Soil Treatment and Disposal

The excavation and removal of contaminated soil from the site would reduce the health risks associated with direct contact and incidental ingestion of contaminated soil. The remaining concentrations of COCs in soil would not exceed the RGs. Leaching of contaminants from soil to groundwater would be eliminated. The site would be backfilled with a clean fill material and graded.

4.5 Reduction of Toxicity, Mobility, or Volume

This evaluation criterion addresses the regulatory preference for selecting a remedial action that permanently and significantly reduces the toxicity mobility, or volume of contaminants.

4.5.1 Alternative S-1 - No Action

No treatment processes would be implemented under this alternative, therefore, no reduction in toxicity, mobility, or volume of contaminated soil would occur.

4.5.2 Alternative S-2 - Ex-situ Source Soil Treatment

Soil venting is an irreversible process that would transfer VOCs from the aqueous and sorbed phases to the vapor phase. Typically both the aqueous and vapor phases of contaminants are extracted due to the presence of water in the soil matrix. These phases would be separated and treated for removal and destruction of contaminants. Contaminants would be removed from the extracted water using activated carbon.

Vapor phase activated carbon, an afterburner, or a catalytic incinerator could be used to remove contaminants from the vapor. Contaminants sorbed to carbon would be destroyed in a regeneration process conducted off-site. This would yield a reduction in toxicity, mobility, and volume. Carbon may also be disposed of in an off-site hazardous waste landfill, resulting in a reduction of mobility and volume. An afterburner or catalytic incinerator would destroy vapor phase contaminants, resulting in a reduction in mobility, toxicity, and volume.

The mass of contaminants in soil would be reduced substantially. Achieving the target cleanup level of 10 μg/kg for 1,1,1-TCA would yield a removal efficiency of 99.98 %. A total of about 200 pounds of chlorinated VOCs (primarily 1,1,1-TCA) would be removed from soil at the chemical storage building area in this process. Reducing the mobility, toxicity, and volume of source contaminants would reduce the amount of leaching of contaminants to groundwater.

4.5.3 Alternative S-3 - Off-site Source Soil Treatment and Disposal

Approximately 2,500 cy of soil from the site, contaminated with chlorinated VOCs, ethylbenzene, xylenes, and toluene would be excavated and incinerated at an off-site facility. Removing the contaminated soil from the site would eliminate incidental ingestion and direct contact risks.

The off-site incinerator would obtain a minimum 99.99% destruction removal efficiency for the contaminants of concern. Incineration would provide a permanent, irreversible treatment method because contaminants are completely destroyed in the process.

The treated residuals from the incinerator must be tested for TCLP prior to disposal. Results of the TCLP analysis may require that the treated soil be solidified/stabilized prior to disposal to reduce leachable metal concentrations; however, this is not expected to be necessary. This type of treatment would increase the soil volume to be disposed. Water generated by the APC system may require treatment prior to discharge. Treated off-gases are released from the APC system to the atmosphere.

Alternative S-3 would result in a reduction of toxicity, mobility, and volume of contaminants in source soil.

4.6 Implementability

Each alternative was evaluated to determine its technical and administrative feasibility of implementing each alternative.

4.6.1 Alternative S-1 - No Action

No technology would be used as part of this alternative. No services or materials are required to implement this alternative. Coordination with state and federal agencies is not required, and the No Action Alternative would not interfere with other potential remedial actions at the site.

4.6.2 Alternative S-2 - Ex-situ Source Soil Treatment

Excavation and sheet piling techniques are commonly used in construction. There are several contractors qualified to work at hazardous waste sites in NYS.

Several ex-situ soil venting and in-situ SVE systems are in operation throughout the country, and several vendors would be available to provide competitive bids. This technology has been demonstrated to effectively remove VOCs from soil. Operation of the system is not complicated; significant downtime is not expected. Because the estimated treatment time for this alternative is eight to 14 months, replacement of equipment is not expected.

Soil venting would not prevent additional remedial actions from being undertaken if deemed necessary. Some coordination between different state and federal agencies would be required; this is not anticipated to pose difficulties.

4.6.3 Alternative S-3 - Off-site Source Soil Treatment and Disposal

Excavation and sheet pile techniques are commonly used in construction. Several contractors qualified to work at hazardous waste sites would be contacted for competitive bidding on construction.

Incineration is a proven technology for the destruction of organic contaminants in soil such as chlorinated VOCs, toluene, ethylbenzene, and xylenes. The process is well developed and can reliably meet performance goals. Operation of an incinerator, however, is mechanically complex and has stringent monitoring requirements to assure proper performance. The incinerator and associated facilities require highly trained staff and substantial attention. An inventory of off-site incineration facilities would be conducted at the time of the remedial design to determine the availability of these facilities to receive waste.

This alternative would require coordination with several regulatory agencies.

4.7 COST

The cost of each alternative is summarized in this subsection.

4.7.1 Alternative S-1 - No Action

The cost for this alternative is $0. Costs associated with environmental monitoring and five-year reviews are presented in the No Action Groundwater Alternative (GW-1).

4.7.2 Alternative S-2 - Ex-situ Source Soil Treatment

Capital and indirect costs for Alternative S-2 are presented in Table 4-2. Cost backup is presented in Appendix B. Based on an ex-situ soil venting treatment process, capital and indirect costs are $375,000 and $114,000, respectively. The total present worth cost for Alternative S-2 is estimated to be $587,000. This total includes a contingency of $98,000 (20 percent of the subtotal of capital and indirect costs) to account for unforeseen costs that could increase the cost of this alternative.

4.7.3 Alternative S-3 - Off-site Source Soil Treatment and Disposal

Capital and indirect costs for Alternative S-3 are presented in Table 4-3. Cost backup is presented in Appendix B. Based on an off-site incineration treatment process, capital and indirect costs are $5,339,000 and $1,602,000, respectively. The total present worth cost for Alternative S-3 is estimated to be $8,329,000. This total includes a contingency of $1,388,000 (20 percent of the subtotal of capital and indirect costs) to account for unforeseen costs that could increase the cost of this alternative.

5.0 DETAILED ANALYSIS OF GROUNDWATER ALTERNATIVES

This section presents the detailed analysis of the remaining groundwater alternatives for Becker, which are summarized in Table 3-10. These analyses present the relevant information that will allow decision-makers to select a site remedy. The detailed analysis of each alternative includes evaluation against the seven evaluation criteria outlined in the NCP (USEPA, 1990) and in the NYSDEC TAGM No. 4030 (NYSDEC, 1990). The seven criteria are the same as used for the soil alternatives analysis, and are listed in Table 4-1.

5.1 COMPLIANCE WITH ARARS AND NEW YORK SCGS

Each alternative was evaluated to determine whether it meets the chemical-, location-, and action-specific ARARs and NYS SCGs that were identified in Section 3 of the RI (Volume IA).

5.1.1 Alternative GW-1 - No Action

Because Alternative 1 would not involve any remedial actions, no change in contaminant concentrations in soil and water would be expected. This would leave concentrations that are not in compliance with chemical-specific ARARs and NYS SCGs. Groundwater contamination would remain at levels above state drinking water regulations, federal MCLs, and federal Maximum Contaminant Level Goals (MCLGs). NYS Class GA groundwater quality standards would also not be met. No releases of contaminants to the air are expected for this alternative; therefore, federal and state ambient air quality regulations would be met.

Few location-specific ARARs and SCGs apply at the Becker site. The only actions associated with this alternative include the installation and sampling of monitoring wells. This would require safe working practices to be followed according to OSHA regulations.

5.1.2 Alternative GW-2 - Plume Control

Alternative GW-2 includes the extraction and treatment of contaminated groundwater near the source. Groundwater contamination in the vicinity of the source would be reduced to levels in compliance with state drinking water regulations, and federal MCLs and MCLGs. NYSW Class GA groundwater quality standards may not be met; however, significant reductions in contaminant concentrations would be achieved. However, groundwater contamination downgradient of the source area would remain at levels above state drinking water regulations, federal MCLs, and federal MCLGs, and would continue to migrate toward Thorp Creek and Catskill Creek. Protection of human health would be maintained by implementing institutional controls. NYS groundwater quality standards would not be met for this portion of the plume. Treatment of off-gases from the air stripper would comply with NYSDEC and CAA regulations for emissions. Sludge generated from metals treatment would analyzed and disposed of according to State and federal regulations. Sludge may have to be handled as a hazardous waste.

Few location-specific ARARs and SCGs apply at the Becker site. This alternative is expected to comply with location-specific ARARs and SCGs. Construction and operation of the treatment plant would require health and safety training and safe working practices as outlined in OSHA regulations.

5.2 Protection of Human Health and the Environment

Each alternative was evaluated to determine whether it provides protection of human health and the environment.

5.2.1 Alternative GW-1 - No Action

This alternative would provide no additional protection to human or ecological receptors over existing conditions. Because the No Action Alternative would not meet the remedial action objectives, contamination from the source area would continue to degrade groundwater quality and the contaminant plume would continue to migrate. Some decrease in risks to human health and the environment would result after decades of natural degradation and dispersion processes act to reduce contamination in source soils and groundwater. No institutional controls would be implemented to prevent the use of contaminated groundwater for domestic purposes.

5.2.2 Alternative GW-2 - Plume Control

Alternative GW-2 would provide an increased protection of human health over baseline conditions. Groundwater extraction would remove contaminated groundwater from the highest concentration areas near the on-site source(s). A portion of the VOC contaminant groundwater plume would not be treated as part of this alternative. It would detach from the site and continue to migrate toward Thorp Creek and Catskill Creek. With time, VOC groundwater contaminant discharges to Thorp Creek and Catskill Creek would decrease and eventually cease. Human health risks associated with ingestion of VOC contaminated groundwater would be addressed by the potable water supply alternatives. Institutional controls would prohibit the installation of new private wells in the vicinity of the groundwater plume.

5.3 Short-Term Impacts and Effectiveness

Each alternative was evaluated to determine what effects it will have on the community, on-site workers, and the environment during its construction and implementation.

5.3.1 Alternative GW-1 - No Action

The No Action Alternative would not include any remedial actions to provide protection from contamination; however, construction of a monitoring well and environmental monitoring would be associated with this alternative that would require OSHA health and safety training for hazardous waste sites. A HASP and safe work practices would be followed.

5.3.2 Alternative GW-2 - Plume Control

Implementation of Alternative GW-2 is not expected to result in any significant adverse impacts to the community or on-site workers. Construction activities associated with this alternative, including installation of injection and extraction wells, piping, and construction of the treatment plant, would cause some temporary inconveniences for the nearby community. These inconveniences may be increased truck traffic and additional noise. Emissions from the air stripper would not pose a safety hazard to workers or the community. Off-gases from the air stripping towers would be captured and treated to remove contaminants by thermal or catalytic incineration.

Due to the industrial nature of the site, construction activities would not significantly impact the environment. The estimated time for well installation and design and construction of a treatment plant is two years. Groundwater treatment would continue until the RGs are met. For cost-estimating purposes it was assumed that groundwater extraction and treatment would be continued for 30 years.

Workers would be required to have OSHA-required health and safety training for work at hazardous waste sites. An appropriate HASP would be followed to minimize risks to workers during construction activities. Personal protective equipment would minimize the possibility of exposure to contamination.

The short-term effectiveness of the environmental monitoring and five-year review components of this alternative would be similar to that discussed in Subsection 5.3.1 under Alternative GW-1 - No Action.

5.4 LONG-TERM EFFECTIVENESS AND PERMANENCE

Each alternative was evaluated to determine to what extent it will be effective after the response objectives have been met.

5.4.1 Alternative GW-1 - No Action

The No Action Alternative would not reduce the risks posed by the contaminants of concern in groundwater. Many decades would likely be required before natural mechanisms restore the site to acceptable levels.

5.4.2 Alternative GW-2 - Plume Control

Groundwater extraction would remove contaminants from the source area(s). The groundwater extraction and treatment scenario for this alternative would reduce the amount of contamination located within the saturated zone. This groundwater would be treated until contaminant levels reach NYS Class GA groundwater quality standards. If these levels are achieved, the source-area groundwater would be considered remediated. However, contaminated groundwater downgradient of the source area would continue to migrate.

Extracted groundwater would be treated to remove VOCs using either air stripping or UV/reduction. Treatability testing would determine the more effective of the technologies for VOC treatment. This testing would also be used to optimize pretreatment and organic treatment parameters for removing VOCs from water. For the source area wells, it has been assumed that catalytic oxidation or incineration would be used for air pollution control of the air-stripper off-gas. It is expected that APC equipment will be necessary to meet state ambient air guidelines. UV/reduction is an innovative technology that destroys organic compounds by reducing them to simpler, non-toxic compounds. The metals sludge generated by pretreatment (if necessary) would be sampled and analyzed for hazardous waste characteristics to determine proper disposal requirements. Reinjection of treated water would maintain the hydraulic balance for the aquifer, reducing the overall effect of extracting a large amount of water.

The long-term effectiveness and permanence of environmental monitoring is similar to that described in Subsection 5.4.1 for the portion of the plume that would not be treated under this alternative. Samples collected from monitoring wells located near the source would provide information to help characterize the effectiveness of the extraction system, both for the capture of contaminated groundwater and the reduction of contaminant concentrations.

5.5 Reduction of Toxicity, Mobility, or Volume

Each alternative was evaluated to its effectiveness at meeting the regulatory preference for selecting a remedial action that permanently and significantly reduces the toxicity, mobility, or volume of contaminants.

5.5.1 Alternative GW-1 - No Action

Treatment processes would not be employed to address site contamination. No reduction in toxicity, mobility, or volume of contaminated groundwater would be achieved.

5.5.2 Alternative GW-2 - Plume Control

Groundwater extraction in the source area would remove contaminants for treatment. The toxicity, mobility, and volume of these contaminants would be reduced during the treatment process. UV/reduction would destroy contaminants by reducing them to simpler nontoxic compounds. Air stripping would transfer contaminants to the vapor phase where they would be destroyed by thermal or catalytic incineration. If vinyl chloride is not found during remediation and UPC is used instead of incineration, contaminants would only be destroyed if the carbon is regenerated. Regardless of which treatment method is used, reduction of mobility, toxicity, or volume of contaminated groundwater would be achieved. Concentrations of contaminants in the source area may reach NYS groundwater quality standards.

The plume of contaminated groundwater not captured by the extraction wells would migrate away from the source. No treatment would be implemented for this portion of the plume. Therefore, no reduction in toxicity, mobility, or volume for this portion of contaminated groundwater would be achieved.

5.6 IMPLEMENTABILITY

Each alternative was evaluated to determine its technical and administrative feasibility.

5.6.1 Alternative GW-1 - No Action

Installing a monitoring well and routine sampling would be the only activities associated with this alternative. Equipment, materials, and services for installing monitoring wells, sampling groundwater, and laboratory analyses are readily available. Some coordination between the state, local officials, and the contractor would be required. The No Action Alternative would not interfere with possible future remedial actions such as pump and treat or source removal.

5.6.2 Alternative GW-2 - Plume Control

Groundwater injection and extraction wells have been installed at many hazardous waste sites. These construction services are commonly available and several contractors would be contacted for competitive bidding. Construction activities associated with installation of extraction wells would require coordination among the state, the local officials, the contractor, and the property owners to secure the necessary right-of-ways.

The processes involved in the pretreatment of groundwater for iron and manganese removal are well developed, reliable, and commonly used in industrial and municipal water treatment applications. Treatability studies would help determine the proper processes, chemical dosages, and other parameters to optimize the system. Influent and effluent to the pretreatment system would be monitored to ensure system performance. Sludge generated in the pretreatment processes would be tested to determine disposal requirements. The availability and capacity of waste disposal facilities would be investigated prior to implementation of this alternative.

Air stripping and off-gas treatment are commonly used, well developed, and available technologies for removing VOCs from water. Vendors are available to supply the required equipment, and several would be contacted for competitive bidding. UV/reduction is an innovative technology that has not been as widely used as air stripping.

For preliminary cost estimating, it was assumed that the treatment plant could be located on site in the existing warehouse/truck maintenance building. Coordination among the state, the local officials, the contractors, and the property owners would be required to obtain the necessary right-of-ways for building and treatment plant construction.

5.7 COST

The cost of each alternative is summarized in this subsection.

5.7.1 Alternative GW-1 - No Action

Capital, indirect, and operation and maintenance costs for Alternative GW-1 are presented in Table 5-1 and are $9,000, $3,000, and $318,000, respectively. Cost backup is presented in Appendix B. The total present-worth cost for Alternative GW-1 is estimated to be $396,000. This total includes a contingency of $66,000 (20 percent of the subtotal of capital, indirect, and present-worth operating costs) to account for unforeseen costs.

5.7.2 Alternative GW-2 - Plume Control

Capital, indirect, and operation and maintenance costs for Alternative GW-2 is presented in Table 5-2. Cost backups are presented in Appendix B. Based on an air stripping treatment process, capital, indirect, and operation and maintenance costs are $1,177,000, $354,000, and $3,550,000, respectively. The total present-worth cost for Alternative GW-2 is estimated to be $6,097,000. This total includes a contingency of $1,016,000 (20 percent of the subtotal of capital, indirect, and present-worth operating costs) to account for unforeseen costs that could increase the cost of this alternative.

6.0 DETAILED ANALYSIS OF POTABLE WATER SUPPLY ALTERNATIVES

This section presents the detailed analysis of the potable water supply alternatives for Becker, which are summarized in Table 3-10. These analyses present the relevant information that will allow decision-makers to select a site remedy. The detailed analysis of each alternative includes evaluation against the seven evaluation criteria outlined in the NCP (USEPA, 1990) and in the NYSDEC TAGM No. 4030 (NYSDEC, 1990). The seven criteria are the same as used for the soil and groundwater alternatives analysis and are listed in Table 4-1.

6.1 COMPLIANCE WITH ARARS AND NEW YORK SCGS

Each alternative was evaluated to determine whether it meets the ARARs and NYS SCGs that were identified in Volume I of this RI/FS. Chemical-, location-, and action-specific ARARs and NYS SCGs were considered.

6.1.1 Alternative WS-1 - No Action

No actions would be performed to maintain a potable water supply for residences with wells located in the Becker groundwater contamination plume. Groundwater extracted from the residential wells would not meet federal MCLs or NYSDOH public water supply drinking water standards.

6.1.2 Alternative WS-2 - Wellhead Treatment

Wellhead treatment to provide water to residents downgradient from the site would be maintained to comply with ARARs and New York SCGs for drinking water.

6.1.3 Alternative WS-3 - Alternative Water Supply

Extension to the closest public water to the site supply or development of a new community water supply system would be completed in accordance with local regulations, ARARs, and NYS SCGs. The water supply provided to the community would be required to meet federal and state standards for drinking water.

6.2 Protection of Human Health and the Environment

Each alternative was evaluated to determine whether it provides protection of human health and the environment.

6.2.1 Alternative WS-1 - No Action

This alternative would provide not protect of human health because contaminated groundwater would be extracted by residential wells and consumed without treatment. The potable water supply alternatives do not address protection of the environment.

6.2.2 Alternative WS-2 - Wellhead Treatment

This alternative is protective of human health as long as carbon is replaced before drinking water standards are exceeded in the effluent of the wellhead treatment equipment. Historically, carbon has not always been replaced often enough to prevent breakthrough. In addition, vinyl chloride is present in the plume and has been detected at low concentrations in the raw water from some private wells. If vinyl chloride concentrations increase, it could create problems with early breakthrough. Protection of the environment is not addressed by potable water supply alternatives.

6.2.3 Alternative WS-3 - Alternative Water Supply

Upon connection of residences to the public water supply or new community water supply, protection of human health would be provided. Wellhead treatment would be maintained until the public water supply is connected. Protection of the environment is not addressed by potable water supply alternatives.

6.3 Short-term Impacts and Effectiveness

Each alternative was evaluated to determine what effects it will have on the community, on-site workers, and the environment during the construction and implementation.

6.3.1 Alternative WS-1 - No Action

This alternative does not include any actions, so there would be no short-term impacts to the community and the environment during implementation.

6.3.2 Alternative WS-2 - Wellhead Treatment

This alternative includes no actions beyond the continued operation of the existing wellhead treatment equipment. Short-term impacts would not occur and the treatment system would be immediately effective.

6.3.3 Alternative WS-2 - Alternative Water Supply

Construction of the water main extension or the new community water supply system would not involve hazardous materials and therefore would not pose any risk to workers or the community beyond those associated with conventional construction projects. Wellhead treatment would be maintained until the public water supply is connected to the residences.

6.4 Long-term Effectiveness and Permanence

Each alternative was evaluated to determine to what extent it will be effective after the response objectives have been met.

6.4.1 Alternative WS-1 - No Action

This alternative does not include any measures to provide a potable water supply. Acceptable drinking water quality would not be achieved until contaminants are removed by natural mechanisms. This would not be expected to occur until several decades have passed.

6.4.2 Alternative WS-2 - Wellhead Treatment

This alternative offers a long-term solution to providing potable water to residences as long as the wellhead treatment equipment is monitored and maintained. Carbon adsorption offers an effective treatment of the extracted groundwater, but carbon must be replaced on a regular basis to maintain effective treatment. Carbon adsorption is not very effective for treatment of vinyl chloride. If the vinyl chloride concentrations increase with time, it could reduce the effectiveness of treatment.

6.4.3 Alternative WS-3 - Alternative Water Supply

Alternative WS-3 offers a long-term and permanent solution to potable water supply for the residences downgradient from the Becker site. Once the water main or new community water supply is installed and connected to the residences, routine maintenance would be required to maintain the effectiveness of the system. Institutional controls would also have to be maintained to prevent the use of existing residential wells.

6.5 Reduction of Toxicity, Mobility, or Volume

This evaluation criterion addresses the regulatory preference for selecting a remedial action that permanently and significantly reduces the toxicity mobility, or volume of contaminants.

6.5.1 Alternative WS-1 - No Action

This alternative would not include any treatment that reduces toxicity, mobility, or volume of contamination at the Becker site.

6.5.2 Alternative WS-2 - Wellhead Treatment

This alternative would include treatment at residential wells that would reduce the contamination in groundwater; however, the volume of groundwater extracted by residential wells is not significant compared to overall contamination of the groundwater plume. In addition, because the spent carbon is disposed of in a landfill, contaminants are not destroyed.

6.5.3 Alternative WS-3 - Alternative Water Supply

This alternative would not include any treatment that reduces toxicity, mobility, or volume of contamination at the Becker site.

6.6 IMPLEMENTABILITY

Each alternative was evaluated to determine its technical and administrative feasibility.

6.6.1 Alternative WS-1 - No Action

This alternative does not include any measures to implement; however, resistance to acceptance of this alternative by the public would prevent its implementation.

6.6.2 Alternative WS-2 - Wellhead Treatment

Wellhead treatment equipment is already in place and does not require additional implementation. This alternative does require the routine operational and maintenance visits to each of the residences to sample water quality and to replace filters and UV bulbs. These visits require the coordination of operation and maintenance personnel with the property owners to access the treatment equipment.

6.6.3 Alternative WS-3 - Alternative Water Supply

Implementation of this alternative would involve routine design and construction procedures. Design, construction, and start-up of the new water main and residential connections would have to be coordinated with the local municipal water utility. Implementation of a new community water supply would be dependent on establishing a location for the new water supply well. The distance of the well from the residences would be minimized to reduce pipe length and costs; however, the well must also be located away from groundwater contamination and provide adequate yield to meet the demand of all the residences connected. These requirements eliminate location of a well on site. Location of a site could require the acquisition of lands or easements. Once a location has been established, installation of the water supply well and associated treatment and storage would not be difficult.

6.7 COST

The cost of each alternative is summarized in this subsection.

6.7.1 Alternative WS-1 - No Action

This alternative would have costs only for disconnection of the existing treatment systems. It was assumed that the equipment would be left in place but that plumbing to by-pass the filters would be required to prevent filter clogging and a decrease in water pressure in the household systems. The overall cost of Alternative WS-1 is presented in Table 6-1 and was estimated to be $5,000.

6.7.2 Alternative WS-2 - Wellhead Treatment

Costs for Alternative WS-2 were developed based on existing information for operation and maintenance of the residential wellhead treatment systems and are presented in Table 6-2. It was assumed that as the plume migrates, more frequent replacement of the carbon would be required to maintain acceptable drinking water characteristics. The operation and maintenance of the wellhead treatment systems was assumed to continue for 30 years before groundwater concentrations decrease to acceptable levels and wellhead treatment is no longer required. A cost summary is presented in Table 6-2. The overall present-worth cost for the alternative was estimated to be $793,000. This does not include any capital cost. Annual operation and maintenance costs were estimated to be $43,000.

6.7.3 Alternative WS-3 - Alternative Water Supply

The cost for Alternative WS-3 was estimated separately for extension of an existing water main and development of a new community water supply and are presented in Tables 6-3 and 6-4, respectively. The cost for extending of an existing public water supply was estimated to be $2,200,000. This includes the capital costs for construction of the water main extension and individual residential water hook-ups for those residences currently using wellhead treatment. The alternative also includes some operation and maintenance costs since the user fees from the few residences connected would not cover the full cost for maintenance of the full water main extension.

The cost for development of a new community water supply system was estimated to be $1,433,000. The costs were estimated based on the system location indicated in Figure 3-11. Actual costs would vary depending on the final location of the extraction well and the level of treatment and storage required. For the purposes of the cost estimate, it was assumed that no unusual treatment would be required. Operation and maintenance of the community water supply system for a 30 year period was assumed.

7.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The comparative analysis evaluates the relative performance of each alternative using the same criteria by which the detailed analysis of each alternative was conducted. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another to aid in selecting a remedy for the Becker site.

Subsection 7.1 presents the comparative analysis for the soil alternatives. Subsection 7.2 presents the comparative analysis for the groundwater alternatives, and Subsection 7.3 presents the comparative analysis for the potable water supply alternatives.

7.1 SOIL ALTERNATIVES

The following subsections present the comparative analysis of soil alternatives.

7.1.1 Compliance with ARARs and New York State SCGs

Alternative S-3 would be in compliance with all ARARs and NYS SCGs. Providing that RGs could be achieved, Alternative S-2 would be in compliance with all ARARs and NYS SCGs. Alternative S-1 would not comply with chemical-specific ARARs and SCGs.

7.1.2 Overall Protection of Human Health and the Environment

Alternative S-1 would not provide protection of human health and the environment; Alternative S-1 includes no remedial actions. Alternatives S-2 and S-3 would reduce leaching of contaminants from soil to groundwater by reducing the concentrations of contaminants. Both are also expected to provide protection to human health (USEPA, 1994).

7.1.3 Short-term Impacts and Effectiveness

Alternative S-1 would have no short-term impacts because no actions would be taken. Alternatives S-2 and S-3 would involve excavation activities which may generate VOC emissions. Construction accidents associated with the excavation and use of heavy equipment are possible. Vapors from the ex-situ soil venting system (Alterative S-2) would be collected and treated; the effects on the community would be minimal. As part of Alternative S-2, the excavations would remain open for approximately one year, potentially posing a safety concern. Alternative S-3 would increase local truck traffic and noise during off-site transportation. Health and safety measures would be required for workers involved in either Alternative S-2 or S-3.

7.1.4 Long-term Effectiveness and Permanence

Alternative S-1 would not be effective at reducing risk because no actions would be taken. Alternative S-2 is ex-situ soil venting which would effectively and permanently remove contaminants from soil. It may be difficult to achieve RGs with soil venting. There is little doubt, however, that a significant portion of the contamination would be removed. Alternative S-3 includes off-site incineration which would effectively destroy soil contaminants.

7.1.5 Reduction of Toxicity, Mobility, or Volume

Alternative S-1 does not include any soil treatment, therefore, no reduction in toxicity, mobility, or volume through treatment would be achieved. Both Alternatives S-2 and S-3 involve treatments that would reduce the toxicity, mobility, and volume of contaminants in soil. It is estimated that if RGs are achieved, ex-situ soil venting would remove the bulk of contaminants. Incineration would remove a minimum of 99.99% of contaminants.

7.1.6 Implementability

Alternative S-1 would not be difficult to implement because no actions would occur. Excavation may be difficult to implement as part of Alternatives S-2 and S-3 due to the close proximity of the truck/warehouse maintenance building, the type of soil being excavated, and the location of the water table. Some difficulties may be encountered during start-up of the soil venting operation, however, several systems are in operation at other sites and fixing minor equipment and operational problems should be relatively easy. It is not likely that a large number of trucks will be available to transport soil to the incinerator, therefore, transportation time will increase for Alternative S-3. The availability of off-site incinerators would need to be evaluated before soil excavation.

Excavation equipment, and materials and supplies for ex-situ soil venting should be readily available.

7.1.7 Cost

The costs for the three soil alternatives range from $0 for Alternative S-1 (No Action) to $8,329,000 for Alternative S-3 (Off-Site Source Soil Treatment and Disposal). The cost for Alternative S-2 (Ex-Situ Soil Venting) is $587,000.

7.1.8 Summary of Comparative Analysis for Soil Alternatives

While the No Action Alternative (S-1) has advantages over the excavation and treatment alternatives (S-2 and S-3) in terms of cost, implementability, and short-term impacts, it does not meet any of the more critical evaluation criteria. Both Alternatives S-2 and S-3 meet the response objectives, comply with ARARs and SCGs, provide protection of human health, the environment, and ecological receptors, reduce toxicity, mobility, and volume of contamination, and offer a long-term and permanent solution for source soil at the site. Alternative S-3 (Off-site Incineration and Disposal) is significantly more costly than Alternative S-2 (Ex-situ Source Soil Treatment).

7.2 GROUNDWATER ALTERNATIVES

The following subsections present the comparative analysis of groundwater alternatives.

7.2.1 Compliance with ARARs and SCGs

Alternative GW-1 would not comply with chemical-specific ARARs and SCGs. Alternative GW-2 would comply with all action- and location-specific ARARs and SCGs, and may comply with chemical-specific ARARS in the area of groundwater treatment. Part of the plume would be left untreated and would exceed regulatory levels.

7.2.2 Protection of Human Health and the Environment

Alternative GW-1 would provide the least protection of human health and the environment because it involves no groundwater remediation. Alternative GW-2 would provide some protection to human health and the environment through treatment of the most highly contaminated groundwater and maintaining institutional controls on new water supply wells; however, contaminated groundwater would remain with Alternative GW-2 because it would not address all of the plume.

7.2.3 Short-term Impacts and Effectiveness

Alternative GW-2 would have the most short-term impacts to the local community and the environment. This alternative includes the more aggressive strategy to remediate groundwater at the site. Alternative GW-1 would have no significant short-term impacts associated with it.

7.2.4 Long-term Effectiveness and Permanence

Alternative GW-1 does not include any long-term or permanent remedies to address groundwater contamination at the site. Alternative GW-2 provides long-term and permanent remediation of groundwater for the most contaminated portion of the site; however, if the source of groundwater contamination in soils is not addressed, groundwater remediation may not be permanent.

7.2.5 Reduction of Toxicity, Mobility or Volume

Alternative GW-1 includes no reduction of toxicity, mobility, or volume of contamination. Alternative GW-2 includes reductions of toxicity, mobility, and volume of contaminants for groundwater in the area being addressed. The treatment system would permanently reduce the toxicity, mobility, and volume of contamination through destruction of the chemicals.

7.2.6 Implementability

Alternative GW-1 requires no unusual or difficult measures to implement. Alternative GW-2 includes a more complex extraction and treatment system that would require more coordination to implement; however, all equipment and construction services are readily available.

7.2.7 Cost

Alternative GW-1 would cost a total of $396,000 to implement over a 30 year time period. Alternative GW-2 would cost $6,047,000 to implement, including design, construction, and operation.

7.2.8 Summary of Comparative Analysis for Groundwater Alternatives

While the No Action Alternative (GW-1) has advantages over the extraction and treatment alternative (GW-2) in terms of cost, implementability, and short-term effectiveness, it does not meet many of the more critical evaluation criteria. Alternative GW-2 is the only alternative that meets response action objectives, achieves compliance with ARARs and SCGs for a portion of the site, provides additional protection of human health and the environment, reduces toxicity, mobility, and volume of contamination, and offers a long-term and permanent solution for the groundwater at the site.

7.3 POTABLE WATER SUPPLY ALTERNATIVES

The following subsections present the comparative analysis of the water supply alternatives.

7.3.1 Compliance with ARARs and SCGs

Alternative WS-1 would not comply with ARARs or SCGs for drinking water. Alternatives WS-2, and WS-3 provide drinking water that is expected to comply with ARARs and New York State SCGs.

7.3.2 Protection of Human Health and the Environment

Alternative WS-1 does not provide any protection of human health. Alternatives WS-2 and WS-3 protect human health by preventing exposure to contaminants in groundwater. The water supply alternatives do not address protection of the environment.

7.3.3 Short-term Impacts and Effectiveness

There would be no short-term impacts associated with Alternative WS-1 because no action would be taken. Alternative WS-2 would have no short-term impacts due to construction because the wellhead treatment units are already in operation. Alternative WS-2 would require periodic entry into residences for routine operation and maintenance. Alternative WS-3 would have minimal impacts associated with construction of water lines in the community.

7.3.4 Long-term Effectiveness and Permanence

Alternative WS-1 would not provide a long-term or permanent solution to potable water supply for residences in the plume path. Alternative WS-2 provides a solution that is effective but requires regular filter changes to maintain effectiveness. Alternative WS-3 provides a long-term and permanent potable water supply.

7.3.5 Reduction of Toxicity, Mobility, or Volume

Only Alternative WS-2 includes any possible reduction of toxicity, mobility, and volume of contamination, and this occurs only if spent GAC is regenerated to destroy organics adsorbed to the carbon. The quantity of contaminants that may be destroyed by this process would be a small fraction of the overall mass of contamination present at the site. Alternative WS-1 and WS-3 do no include any reduction of toxicity, mobility, or volume of contamination.

7.3.6 Implementability

Alternatives WS-1 and WS-2 require no significant measures to implement. Some coordination with residential owners to arrange maintenance visits for Alternative WS-2 would be necessary. Alternative WS-3 includes common construction processes but would include more extensive organization than Alternatives WS-1 or WS-2.

7.3.7 Cost

Alternative WS-1 would cost $5,000 to implement. Alternative WS-2 would cost an estimated $793,000 to implement due to routine operation and maintenance. Alternative WS-3 would require $2,200,000 to extend a water main from an existing public water supply or $1,433,000 to provide a new community water supply system.

7.3.8 Summary of Comparative Analysis of Water Supply Alternatives

Alternative WS-1 requires no actions to implement and consequently has few negatives associated with cost, implementability, or short-term impacts and effectiveness. However, Alternative WS-1 does not address the response action objective, does not comply with ARARs or New York State SCGs, and does not provide any protection of human health. Alternatives WS-2 and WS-3 provide similar compliance with ARARs and SCGs, protection of human health, and short-term impacts. The major differences between Alternatives WS-2 and WS-3 are that Alternative WS-2 is already in place and running and would cost less than Alternative WS-3, while alternative WS-3 would provide a more permanent and possibly more effective solution to potable water supply.

8.0 PREFERRED REMEDY

As a conclusion to the detailed and comparative analyses, preferred remedies for the media of concern at the Becker site were developed. The preferred remedies for the source area soil, groundwater, and potable water supply are the following:

- excavation of source area soil, treatment of soil in an on-site above-ground vapor extraction system, and backfilling on-site.
- installation of a groundwater extraction, treatment, and reinjection system to remove contamination from the plume source area; and
- continued operation and maintenance of the existing residential wellhead treatment systems.

The rationale for selecting these remedies and eliminating other alternatives are presented below.

To be considered as a preferred remedy, an alternative must meet the threshold criteria. These criteria are defined in TAGM No. 4030 "Selection of Remedial Actions at Inactive Hazardous Waste Sites" (NYSDEC, 1990) as follows:

- the selected remedy must be protective of public health and the environment; and

- the selected remedy must meet ARARs and SCGs or provide appropriate justification for a waiver.

The selected remedy must also satisfy the preference for reduction of toxicity, mobility, and volume of hazardous constituents and must be cost-effective. Among those alternatives that meet the threshold criteria, the preferred remedy is selected by identifying the alternatives that would provide the best overall mix of advantages and disadvantages with respect to the remaining (balancing) criteria.

8.1 SOIL PREFERRED REMEDY

Alternative S-1 (No Action) was eliminated because it would not protect human health and the environment.

Alternative S-3 (Off-Site Source Soil Incineration and Disposal) was eliminated primarily due to cost. This alternative would provide protection of human health and the environment, and would meet ARARs and SCGs. It would also provide long-term effectiveness. The short-term impacts would include noise, dust, and traffic.

Alternative S-2 (Ex-Situ Source Soil Treatment) is the preferred remedy. This alternative would provide protection of human health and the environment, would meet ARARs and SCGs, and would be cost-effective. This alternative is considered a permanent remedy.

8.2 Groundwater Preferred Remedy

Alternative GW-1 (No Action) is eliminated because it would not protect public health and the environment and would not include any reduction of toxicity, mobility, or volume of contamination.

Alternative GW-2 would comply with ARARs and SCGs and would provide protection of public health and the environment. The toxicity, mobility, and volume of contamination would be reduced through permanent treatment of contaminants.

8.3 Potable Water Supply Preferred Remedy

The preferred remedy for the potable water supply to residences in the path of the plume is Alternative WS-2, long-term monitoring and maintenance of existing residential wellhead treatment equipment. Alternative WS-1 was eliminated because it does not offer protection of human health, nor does it comply with ARARs and New York SCGs. Alternative WS-3 was eliminated because it is the most expensive and may be difficult to implement administratively. Alternative WS-2 offers a small reduction of toxicity, mobility, and volume of contamination, would be the easiest to implement, and is the most cost effective.

8.4 CONCEPTUAL PLAN

The conceptual plan describes all of the components of the selected remedial action and includes a site plan, process flow diagrams, a proposed implementation schedule, preliminary equipment lists, and a cost estimate. It contains information presented previously in the description of Alternatives in Section 3 as well as additional information to address some necessary contingencies.

The selected remedy would combine a source area groundwater extraction and treatment system with residential wellhead treatment and ex-situ soil vapor extraction of source area soils. The preferred remedy would consist of the following components:

- maintain wellhead treatment units (existing or modified)

- soil excavation
- soil treatment (ex-situ soil venting)
- backfill treated soil
- remove and dispose of surficial solid waste (wood debris) pile
- groundwater extraction
- groundwater treatment
- reinjection of treated groundwater
- institutional controls
- environmental monitoring
- contingency plans
- five-year reviews

A site layout for the conceptual plan is shown in Figure 8-1.

8.4.1 Alternative WS-2 - Wellhead Treatment

Nine private water wells currently have been equipped with wellhead treatment equipment to treat water extracted from these wells prior domestic use. Two other locations are routinely monitored for contamination but do not have treatment equipment. Under this conceptual plan, existing wellhead treatment systems would be operated and maintained to provide potable water to the residences.

The treatment equipment installed on the residential wells typically consists of a prefilter to remove particulates, two granular activated carbon (GAC) filters in series for VOC removal, and an ultraviolet disinfection unit as shown in Figure 3-10. Some variation in configuration and size occurs between systems. Collection and analysis of samples to evaluate the treatment effectiveness are conducted every four months. Maintenance occurs approximately yearly, although variation between residences occurs. Under this conceptual plan, monitoring of the influent and effluent of each wellhead treatment unit would be conducted quarterly. Carbon would be replaced as necessary to maintain effective treatment. It is anticipated that the carbon usage rates will increase with time as the plume migrates and more heavily contaminated groundwater reaches these residential wells. For cost estimating purposes, it was assumed that maintenance would be required annually for all systems. As part of this conceptual plan, the sampling and maintenance frequencies would be reevaluated and improvements to the treatment system considered.

8.4.2 Ex-Situ Soil Treatment

Soil venting is an innovative approach to remediating soil contaminated with VOCs. VOCs are removed from the soil matrix by mechanically drawing air through the soil using a system of perforated pipes. The contaminated soil is gradually remediated as the VOCs volatilize from the soil and are drawn off by means of vacuum extraction equipment. A summary of the process and the limiting factors are presented in Subsection 3.3.1.2. For the purposes of this evaluation, ABB-ES has used information from scientific literature and has made simplifying assumptions about site conditions.

Several tasks should be completed in the predesign phase prior to implementing the soil remedy. These tasks include:

- additional soil investigation to better define soil volumes;
- sheetpile installation evaluation for the truck/warehouse maintenance building;
- cost estimate for dewatering;

- evaluation of use of on-site field laboratory vs. off-site analytical laboratory; and
- debris pile disposal location and cost estimate.

The soil at the Becker site is expected to be amenable to soil venting after it has been excavated because water content would decrease and permeability would increase. The soil is classified as a silty sand and gravel. The porosity is estimated at 30 percent and the fraction of organic carbon at .005 to .01. Excavation of the soil would allow the water content in soil to decrease. It was estimated that after the soil has been excavated and allowed to drain, the moisture content would be 5 percent. In-situ soil permeability is approximately 10^{-5} cm/s, handling and mixing of the soil would be expected to increase the soil permeability to an estimated 10^{-4} to 10^{-3} cm/s.

Preliminary design calculations for ex-situ soil venting were based on the following estimations and assumptions:

- coefficient of permeability (K) = 10^{-3} to 10^{-4} cm/s (0.1 to 1.0 Darcies)

- fraction of organic carbon (f_{oc}) = 0.01 to 0.005 (1% to .5%)
- temperature = 283 Kelvin (10 degrees C)
- well radius of influence = 20 feet (4800 μg/kg)
- indicator COCs = TCE (4,800 μg/kg), toluene (43,000 μg/kg), 1,1,1-TCA (64,000 μg/kg)

Assuming the most conservative conditions, (i.e., K = 10^{-4} cm/s (k = 0.1 Darcy), f_{oc} = 0.01, and RGs in Table 2-2), and a wellhead vacuum of 0.85 atm (60 inches of water), total system flow would be approximately 30 standard cubic feet per minute (scfm). Estimated time to meet RGs assuming these conditions would be 10 months. Remediation time is sensitive to air permeability, therefore, if the air permeability in the soil pile increases, RGs could be achieved in substantially less time. Treatment was reevaluated given a change in one initial condition. For a f_{oc} of 0.005, remediation time was estimated to be five months; for a K = 10^{-3} cm/s, remediation time was estimated to be one month; and for a concentration of toluene of 2,000,000 μg/kg, remediation time was estimated to be 20 months. Water draining through the piles would be collected in a sump, removed and treated before discharge. See Appendix A for calculations.

To treat 2,500 cy of soil, the pile could be constructed to be 50 feet wide, 10 feet high, and 135 feet long. Perforated pipes would be laid horizontally, 15 feet on center, across the width of the pile; eight pipes would be placed (Figure 3-1). The pipes would be perforated over 40 feet of the pipe and may be surrounded by sand to prevent the perforations from becoming blocked. The pile would be constructed on a treatment pad consisting of a sand drainage layer and an impermeable liner. Water draining through the piles would be collected in a sump, removed and treated before discharge. A liner would be secured over the top and sides of the pile.

Off-gases from the soil venting system may require treatment before discharge to the atmosphere. Water separated by the water/vapor separator may also require treatment prior to discharge. It was estimated that approximately 5,000 pounds of vapor phase GAC would be required. The vapor phase GAC requirement was calculated based on maximum concentrations of three selected COCs (TCE, toluene, and 1,1,1-TCA) and a conservative GAC adsorption rate (Appendix A). A process flow diagram of the treatment system is shown on Figure 3-1.

Once RGs have been achieved, the soil would be backfilled into the excavations and graded to promote positive drainage. Prior to backfilling, water that has accumulated in the excavations would need to be removed and treated. Approximately 600,000 gallons of water would require removal and treatment. Because of the large volume, it was assumed that this water would be treated in the groundwater treatment facility.

It is possible, that RGs may not be achievable. As a contingency, if the calculated RGs can not be achieved, treated soil could be used to regrade the site to assist with stormwater management of the site. Regrading may be necessary to effectively implement the portion of the groundwater remedial action that mitigates the on-site drainage ditch seeps. Treated soil would then be placed above the water table. As a second contingency, the soil could be backfilled into the excavations with a means to collect leachate from the soil.

8.4.3 Groundwater Extraction

Conceptual design of the extraction system requires information about the nature and distribution of groundwater contamination, aquifer characteristics, and local land use. For the purposes of this evaluation, ABB-ES has used information from the scientific literature and has made simplifying assumptions about site conditions. The final number of wells, well depths, screened intervals, and pumping rates will be determined during the design and construction phase.

The plume, as characterized in the RI, is approximately 1,200 feet long and 1,000 feet wide at its widest point. The objective of the groundwater extraction system for this alternative would be to cut off off-site migration of contaminant VOCs and to reduce the mass of contaminants migrating toward Thorp Creek and Catskill Creek. To accomplish this objective, an extraction-system strategy was developed in consultation with NYSDEC to capture the on-site groundwater plume with VOC concentrations greater than 500 μg/L.

Calculations were performed to estimate the extraction flow rate required to capture the desired portion of the plume and are included in Appendix A. These calculations assume a plume width of 500 feet and a thickness of 100 feet. It was estimated that the pumping rate required to capture the 500 ppb VOC plume would be 90 gpm. Aquifer characteristics used in the analysis of groundwater extraction were taken from data collected during the RI. The aquifer in the site vicinity consists of fractured bedrock with overburden and fill materials. The simplifying assumption was made that bedrock behaves as a homogeneous, isotropic, porous medium. During the design stage, additional studies would be required to determine actual hydraulic properties at extraction well locations and verify construction of an extraction system adequate to meet the capture strategy. It is recommended that at least one extraction well be installed and tested to verify capture and determine design concentrations before design of the treatment system.

For the purposes of this FS, the groundwater extraction system was assumed to consists of four wells. It may be possible to achieve capture with fewer wells; however, this can not be determined before installation and testing of the wells. The wells would be situated as shown in Figure 3-7. The first well would be installed in the source area near MW-106D. Based on the yield and capture zone of this well, other wells would be installed to complete the extraction system. Each well would require pumping tests due to the heterogeneous nature of the bedrock. The wells would pump an estimated total of 90 gpm to be treated and recharged to the aquifer via reinjection wells. Extraction and reinjection wells would be installed and tested to verify flow rate and contaminant concentrations before design of the treatment system.

The system would remove one pore volume of the source plume every 2.4 years (see Appendix A). Restoration of fractured bedrock aquifers by extraction and treatment has been found to be extremely difficult (USEPA, 1988b and USEPA, 1993). The extraction system is expected to meet the response objective for groundwater, but it is not likely to restore the site to groundwater quality standards in a reasonable time frame. Calculations of time to achieve restoration would not be accurate because of the limited information on expected extraction well capture zones and the errors introduced by modeling the bedrock as a porous, homogeneous medium. For cost estimating purposes, it was assumed that extraction would continue for 30 years.

A low-flow groundwater seep from the leachfield area to the site drainage ditch has resulted in detections of contamination in surface water samples collected from the drainage ditch. A collection system would be installed as part of this alternative to isolate and collect the groundwater seep and pump it to the treatment plant. Surface water runoff would be collected separately and drain off-site without contacting water from the groundwater seeps. Figure 3-8 shows a possible cross section detail of the drainage ditch reconstruction to accomplish this.

8.4.4 Groundwater Treatment

The two water treatment technologies for organics retained following technology screening are air stripping and UV/reduction. Both technologies would effectively treat VOCs. The technologies offer very similar characteristics for consideration during a detailed analysis. The primary factor in choosing one technology over the other would be site-specific costs. Treatability studies to accurately assess effectiveness and costs are recommended as a basis to select between the technologies. For this reason, costs for this alternative were developed based only on the air stripping technology with a VOC destructive off-gas treatment. The final decision between air stripping and UV/reduction would be made during the design stage based on treatability studies and economic analysis.

Prior to organics treatment, it would be necessary to remove iron and manganese from the extracted groundwater. Dissolved iron and manganese oxidize to a less soluble form and precipitate out of solution in the presence of air or other oxidants. This precipitate can foul the packing material in the air stripper, reducing the efficiency of the treatment system and increasing costs. Iron and manganese concentrations, found as high as 13.9 mg/L and 3.5 mg/L, respectively in the extraction area, suggests pretreatment would be required. This would be verified by sampling water from pumping tests of the new extraction wells. For cost-estimating purposes, it was assumed that the treatment plant would be located on site as shown in Figure 3-7.

Based on the average iron and manganese concentrations observed at the site, pretreatment would be completed using greensand filters. If during pumping tests, higher iron and manganese concentrations are observed, an oxidation/coagulation/settling process may be used instead. Analysis of this alternative includes pretreatment of the raw water by the following processes:

- greensand filtration
- backwashing

- sludge handling

A schematic flow diagram of the overall treatment process is shown in Figure 3-9. The first step in pretreatment would be to oxidize the iron and manganese to their insoluble forms. Potassium permanganate ($KMnO_4$) would be used in the greensand filter to oxidize the dissolved iron from the relatively soluble +II state to the more insoluble +III state. Dissolved manganese would also be oxidized from the +II state to the more insoluble +IV state. The precipitates would consist primarily of ferric hydroxide and manganese dioxide. Greensand filters would inject the $KMnO_4$ directly into the bed of the filter with the influent water. The products of the reaction, an insoluble ferric hydroxide and manganese dioxide, are immediately filtered out by the sand.

The conceptual design of the pretreatment system includes three greensand filters arranged in parallel. This allows for continuous operation of the system when one of the filters requires backwashing. Backwash from the greensand filter (containing the precipitated metals) would be thickened in a gravity thickener to a concentration of approximately 3 percent solids. Sludge would be further thickened by a sludge filter press, tested for characteristics of hazardous waste, and properly disposed of off site.

After pretreatment, the water would be treated to remove VOCs, primarily 1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCE, TCE, 2-Butanone, and chloroethane. Air stripping is one of the technology options for VOC removal presented in this alternative. Air stripping is a method frequently used to remove VOCs from groundwater. During the process, contaminated water contacts large volumes of clean air. Contaminated water enters the top of the air stripping tower and trickles down through the packing material, while air enters at the bottom and is blown upward through the packing material. The contaminants are transferred from the liquid phase to the gas phase and carried off with the effluent air. The air stripping column design is essentially dictated by the column fluid dynamics and the desired removal efficiencies for the compounds of concern. Several vendors can custom-design a tower if a standard-size tower does not meet design specifications.

An air stripper treating water from the Becker plume for this alternative is estimated to emit a maximum of about 37 pounds per day of VOCs. This emission rate was calculated based on a water flow rate of 90 gpm and maximum total VOC concentrations of approximately 34 mg/L. If these concentrations are not encountered during remediation, or concentrations decline rapidly, actual emissions could be significantly lower. For instance a total VOC influent concentration of 500 μg/L results in 0.54 lbs/day in emissions (see Appendix A). Emission rates would be expected to decline over time as contaminant concentrations in groundwater decrease. If air stripping were implemented, actual emission rates would be determined and compared to the NYS air guidelines to evaluate the need for off-gas treatment. Typically, if emissions rates are greater than half a pound per hour, off-gas treatment is required. The estimated emission rate suggests that off-gas treatment would be required initially, although long-term off-gas controls may not be necessary.

There are several off-gas treatment technologies available to address the airstream emitted from the air stripper. The choice of control technology depends on the type and concentration of VOCs, the desired level of destruction, and the duration of the project. For cost-estimating purposes, it was assumed that off-gas treatment with thermal or catalytic incineration would be used for air emissions from the air stripper. VPC could also be evaluated during remedial design;

however, due to the presence of vinyl chloride in the groundwater, VPC is not expected to be cost effective.

Thermal and catalytic incinerators are commercially available for destroying gaseous organic compounds. Thermal incineration of VOCs occurs at temperatures averaging 1,600°F. The operating temperature would be determined by field testing to achieve the desired destruction removal efficiencies. Catalytic incinerators operate at lower temperatures and can, in principle, be used to destroy essentially any organic compound in an airstream (van der Vaart et al., 1991).

Another process option suitable for treating VOCs is UV/reduction. UV/reduction is proposed over UV/oxidation due to the presence of halogenated ethanes which are not effectively treated by oxidation processes. The UV/reduction process destroys organic compounds in water through chemical reduction enhanced by exposure to UV light. A catalyst is added to the water to generate hydrated electrons (e_{aq}^{-}) in the UV/reduction vessel. The hydrated electron is a strong reducing agent that reacts with halogenated organics to produce inorganic halide ions. Treatability studies would be used to determine the expected concentrations of these compounds and evaluate if further treatment would be required before discharge.

UV/reduction occurs in a stainless steel chamber containing vertically or horizontally mounted UV lamps. A solution of catalyst is metered into the influent waste stream.

Treatability studies prior to full-scale design would provide the necessary information for economic and technical evaluation for final selection of the treatment process and for detailed design and operation of the system. The final design would be subject to regulatory agency review and approval before implementation.

8.4.5 Reinjection

Treated groundwater would be piped to reinjection wells located on the north side of Route 145 and returned to the aquifer. Public sewers are not available at this site; therefore discharge to a POTW was eliminated during technology screening. Discharge to surface water is possible; however, this would require meeting more stringent surface water quality criteria that are protective of aquatic receptors. The extraction of groundwater from the source is anticipated to lower the water table in the vicinity of the residential water supply wells; therefore reinjection is recommended to prevent these wells from going dry. Water would be returned to the aquifer and undergo additional filtration through soils and bedrock before the reaching residential wells. The proposed location of the reinjection wells are shown in Figure 3-7. During the design and construction phase, hydraulic testing of the reinjection wells would be required to verify their ability to accept the volume of water generated by the treatment plant.

8.4.6 Institutional Controls and Environmental Monitoring

Construction of new domestic wells to extract water from the aquifer would be restricted through deed restrictions or a permitting process. The objectives of the environmental monitoring program would be to evaluate whether the source area at the site is continuing to degrade groundwater quality and to monitor the migration of contamination in groundwater. The monitoring plan developed and described in this FS is for cost-estimating purposes only. The final, detailed monitoring plan would be developed and submitted for NYSDEC review and comment before implementation.

Environmental monitoring would involve the routine periodic sampling of groundwater at Becker. Samples would be analyzed for TCL VOCs. It is assumed that groundwater from seven monitoring wells and three groundwater seeps and one surface water drainage ditch would be sampled and analyzed, to monitor source contribution to groundwater contamination, the migration of the plume, and the discharge of groundwater to Thorp Creek and Catskill Creek and the upgradient drainage ditch. The locations of these sampling locations are highlighted in Figure 3-6.

Groundwater from one upgradient well (i.e., MW-101D) would be sampled and analyzed to provide data on the quality of groundwater as it enters the site and before it encounters the source of contamination. Groundwater from one existing monitoring well in the center of the plume would be sampled and analyzed (i.e., MW-106D). This well, located near the source of contamination and historically having the highest detected contaminant concentrations, would provide information on the attenuation and degradation of contaminants in the most concentrated area of groundwater contamination. Another well would be installed downgradient of the source area to the northeast of Route 145 in the center of the plume (i.e., MW-114) to monitor the migration of the highly contaminated groundwater toward Catskill Creek.

Groundwater from two wells located near Thorp Creek and Catskill Creek would be sampled and analyzed (i.e., MW-111, and MW-112). Monitoring wells MW-111 and MW-112 are bedrock wells that will provide an indication of contamination that is migrating toward and discharging to the creeks. MW-110 and MW-113 would be sampled and analyzed to provide information that would help to characterize the lateral dispersion of contamination near the side edges of the plume.

Groundwater seeps at Catskill Creek would be sampled to monitor the concentrations of contaminants being discharged with groundwater to the creek. As the plume moves downgradient, these concentrations may increase. The proposed sampling locations would include SW-107, SW-108, and SW-109. Another surface water sample (SW-102) would be collected to evaluate groundwater contamination from the industrial leachfield and debris pile seeping to the drainage ditch that runs upgradient of the primary source area.

For cost-estimating purposes, it is assumed that environmental monitoring would be conducted annually for 30 years. For the first two years, quarterly sampling would occur to increase the database on contaminant concentrations and distribution and to provide a better basis for statistical evaluation of trends. Quarterly sampling would also show how seasonal variations affect contaminant migration. After the second year, sampling would occur annually to monitor changes in contaminant concentration and distribution over time.

8.4.7 Cost

Capital, indirect, and operation and maintenance costs for the selected remedy are presented in Table 8-1. Cost backup is presented in Appendix B. Based on ex-situ soil venting, air stripping, and wellhead treatment, capital, indirect and operation and maintenance costs are $1,748,000, $524,000, and $3,826,000, respectively. The total present worth cost for the selected remedy is estimated to be $7,318,000. This total includes a contingency of $1,122,000 (20 percent of the subtotal of capital, indirect and present-worth operating costs) for account for unforeseen costs.

8.4.8 Schedule

Figure 8-2 presents a schematic of the remediation process and Figure 8-3 presents a proposed implementation schedule for the selected remedial action. The schematic and schedule are preliminary and will need to be revised, during scoping of the design and remediation.

ABB-ES	ABB Environmental Services
APC	air pollution control
ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
Becker	Becker Electronics Manufacturing Site
bgs	below ground surface
C	celsius
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
cf	correction factor
CLP	Contract Laboratory Program
cm/sec	centimeters per second
COC	chemical of concern
CRQL	contract required quantitation limit
cy	cubic yards
DCA	dichloroethane
DCE	dichloroethene
DHWR	Division of Hazardous Waste Remediation
DOT	Department of Transportation
f_{oc}	fraction of organic carbon content
F	fahrenheit
Fe	Iron
FS	Feasibility Study
GAC	granular activated carbon
gpm	gallons per minute
HASP	Health and Safety Plan
Hg	mercury
K_{oc}	organic carbon partition coefficient
M&E	Metcalf and Eddy of New York, Inc.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDL	method detection limit
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
No.	Number
NYCRR	New York Codes of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSWR	New York State Waste Regulations
NYSDOH	New York State Department of Health
OSHA	Occupational Safety and Health Act
ppb	parts per billion
PE	polyethylene
PVC	polyvinyl chloride
RA	risk assessment
RCRA	Resource Conservation and Recovery Act
RG	Remediation Goal
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act of 1986
scfm	standard cubic feet per minute
SCG	Standards, Criteria, and Guidelines
SOW	Statement of Work
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TAGM	Technical and Administrative Guidance Memorandum
TCA	trichloroethane
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TOGS	Technical Operational Guidance Series
TSDF	treatment, storage and disposal facility

USEPA	U.S. Environmental Protection Agency
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
UV/Ox	ultraviolet-oxidation
VOC	volatile organic compound
VPC	vapor phase carbon
WA	work assignment

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