2290.046

REPORT

# Ludlow Sand & Gravel Site
# North Gravel Pit
# Supplemental Remedial Investigation/Feasibility Study

*Ludlow Sand & Gravel Site*
*Town of Paris*
*Oneida County, New York*

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November 1999

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the SRI/FS work, the final remedy in the North Gravel Pit should be Alternative #5. This alternative consists of the removal of selected locations of PCB impacted soils with the use of caisson technology, the installation of an impermeable membrane to minimize the vertical migration of ground water through the remaining soils in the North Gravel Pit, the installation of sufficient fill to allow for proper drainage,and the establishment of a vegetative cover to minimize erosion. One additional downgradient monitoring well will also be installed. This remedial response is consistent with the source control remedy which was selected at the landfill in Operable Unit No. 1. Off-site ground water, which could potentially be impacted by the residual PCBs in the North Gravel Pit, is already being addressed as part of the off-site ground water remedial component of the Approved Remedial Plan, which is being implemented under the Consent Judgment.

## Executive Summary

The Ludlow Sand & Gravel Site (the "Ludlow site") is a site on the National Priorities List where remediation is being conducted under the terms of a Consent Judgment approved by U.S. District Court Judge Thomas McAvoy of the Northern District of New York in March of 1990. The Ludlow site was divided by the United States Environmental Protection Agency ("USEPA") into two operable units. Operable Unit No. 1 is defined as Source Control (the landfill itself), and Operable Unit No. 2 has been characterized as Off-Site Impacts (areas designated as the North Gravel Pit, ponded wetland and off-site ground water). The Consent Judgment provides for the remediation of both USEPA operable units.

The remedial response required for Operable Unit No. 1, as well as the ponded wetland and a portion of the PCB-impacted soils in the North Gravel Pit, was completed in 1990-1991. The remedial activities were documented in a Construction Documentation Report, which was approved by the New York State Department of Environmental Conservation ("NYSDEC") in May of 1995. Because PCBs were detected in the North Gravel Pit beyond that initially anticipated, supplemental work was performed under the terms and conditions of a "Stipulation Clarifying and Modifying Consent Judgement," which was approved by Judge Thomas McAvoy on August 3, 1996 (the "Stipulation"). This Stipulation required, among other things, the performance of a Supplemental Remedial Investigation/Feasibility Study ("SRI/FS") in the North Gravel Pit.

Furthermore, at the request of the USEPA and the NYSDEC, Special Metals Corporation, the entity responsible under the Consent Judgment for conducting remediation at the Ludlow site, agreed to prepare a separate RI/FS report for Operable Unit No. 2 - Off-Site Impacts. As described in the Work Plan attached to the Stipulation, this report will consolidate the information generated to date on the three areas which make up Operable Unit No. 2.

The USEPA has issued a Record of Decision ("ROD") only for Operable Unit No. 1 and the separate RI/FS report will allow the Agency to issue a separate ROD for Operable Unit No. 2 if it wishes to do so. An appropriate remedial response has already been implemented for both the ponded wetland and off-site ground water under the Consent Judgment.

Implementation of any further remedial action in the North Gravel Pit will be performed under the terms of the Consent Judgment and the Stipulation.

With respect to the North Gravel Pit, the supplemental remedial investigation found that the horizontal extent of the PCB-impacted soils was limited to the bottom of the North Gravel Pit, an area approximately one half acre in size. The vertical extent of the PCB impact could not be fully delineated due to physical limitations associated with drilling through water.

Shallow core samples collected beneath the ground water surface within the gravel pit detected the presence of PCBs ranging from 1.5 to 540 mg/kg. Deeper borings (to depths of ten feet) in this same area had a similar range of concentrations with a maximum concentration of 1,800 mg/kg. However, in each of the four deeper borings, the lower most sample was found to contain lower concentrations then the samples immediately above. Soil samples collected from the five perimeter borings surrounding the area of the shallow core samples indicated detectable PCB concentrations in only 9 of the 23 samples, with all detected concentrations at or below 10 mg/kg.

Of the three ground water sampling events conducted as part of the supplemental remedial investigation, the November 1996 event was the only event that showed detectable concentrations (in unfiltered samples) of PCBs. Detectable concentrations of PCBs, were found in the November 1996 sampling event near the Class GA standard of 0.09 μg/L with PCBs being detected only in unfiltered samples. This indicates that the presence of PCBs in the ground water samples is associated with solids suspended in the ground water. Subsequent Short-Term Monitoring sampling has resulted in detectable concentrations of PCBs in 2 of 6 events at concentrations ranging from 0.11 μg/L to 0.24 μg/L. PCBs have not been detected in ground water since the June 1998 sampling event.

Based upon published PCB mass transport theory, PCBs strongly adsorb to available surfaces, and do not readily solubilize and migrate with ground water. Although it has been nearly thirty years since the North Gravel Pit was reportedly first used for the disposal of PCB containing waste oils, the ground water sampling performed as a part of the supplemental remedial investigation confirms the view that the PCBs detected in soils below the ground water table in the North Gravel Pit have not migrated. In view of this, future PCB migration is unlikely.

Under the Stipulation, the State is to select a final remedy for the North Gravel Pit consistent with the Comprehensive Environmental Response, Compensation, and Liability Act and amendments thereto (CERCLA/SARA) and the terms of the Consent Judgment. On the basis of

# 1. Background and Objectives

## 1.1. Background

The Ludlow Sand and Gravel Site (Ludlow site) is an approximately 60-acre site located roughly six miles south of Utica in the Town of Paris, Oneida County, New York (see Figure 1-1). The Ludlow site is made of two operable units: Operable Unit No. 1- Source Control, which consists of a closed landfill which was remediated in 1990-1991, and Operable Unit No. 2 - Off-Site Impacts, which consists of off-site ground water, a ponded wetland area which borders the landfill to the south and east, and the North Gravel Pit, which was reportedly used for the disposal of waste PCB-containing oils (see Figure 1-2).

The Ludlow site was placed on the National Priorities List (NPL) by the United States Environmental Protection Agency (USEPA) in 1982. The New York State Department of Environmental Conservation (NYSDEC) later placed the site on its Registry of Inactive Hazardous Waste Disposal Sites (Site # 633014), where it was given a classification of "2" ("Significant threat to the public health or environment- action required").

USEPA issued a Record of Decision (ROD) for Operable Unit No. 1 in September 1988. This was followed in March of 1990 by a Consent Judgment entered into among the NYSDEC, the New York State Attorney General's Office (NYSAGO) and the following potentially responsible parties - Ludlow Sanitary Landfill, Inc., Ludlow's Sand and Gravel Company, Inc., James Ludlow and G. Kevin Ludlow (the "Ludlow defendants"), Chesebrough-Pond's Inc. and Special Metals Corporation ("Special Metals"). The Consent Judgment was approved by Judge Thomas McAvoy of the Northern District of New York.

Under the Consent Judgment, Special Metals is obligated to implement an Approved Remedial Plan (ARP) (see Exhibit A), which addresses both of the USEPA designated operable units at the Ludlow site. The ARP was also attached as Exhibit A to the Consent Judgment.

In accordance with the ARP, the landfill was closed and the following remedial components installed: a clay cap and final cover; leachate collection system; leachate treatment; gas collection/lateral drainage layer and gas venting system. As required by the ARP, PCB impacted soil was excavated from the North Gravel Pit and placed within the capped landfill. However, excavation activity was suspended when it was determined that PCB impacted soils extended below the ground water table in the North Gravel Pit.

Because PCBs were detected in the North Gravel Pit beyond areas that were initially anticipated, supplemental work was performed under the terms and conditions of a "Stipulation Clarifying and Modifying Consent Judgement" (see Exhibit B), which was approved by Judge Thomas McAvoy on August 3, 1996 (the "Stipulation"). This Stipulation required, among other things, the performance of a Supplemental Remedial Investigation/Feasibility Study ("SRI/FS") in the North Gravel Pit.

Furthermore, at the request of the USEPA and the NYSDEC, Special Metals Corporation, the entity responsible under the Consent Judgment for conducting remediation at the Ludlow site, agreed to prepare a separate RI/FS report for Operable Unit No. 2 - Off-Site Impacts. As described in the Work Plan attached to the Stipulation, the report will consolidate the information generated to date on the three areas which make up Operable Unit No. 2.

It is only because PCBs continued to be detected in the North Gravel Pit, despite the implementation of removal measures, that additional investigation was conducted in the North Gravel Pit under the work plan. As a matter of administrative convenience, Special Metals agreed, at the request of the NYSDEC, to proceed with the preparation of a separate RI/FS report for Operable Unit No. 2. However, this does not modify the remedial approach previously approved under the Consent Judgment for the ponded wetland or off-site ground water.

## 1.2. Description of USEPA Operable Unit No. 2

As described in Section 1.1, Operable Unit No. 2 consists of the ponded wetland, off-site groundwater and the North Gravel Pit. The Consent Judgment and ARP require certain tasks to be performed with respect to each of these areas. The following sections provide descriptions of the components of this operable unit.

**1.2.1. Ponded Wetland**

The wetland area located south and east of the landfill is a New York State designated wetland under 6 NYCRR Part 664. As reported on page 11 of the ARP, a portion of the designated wetland abuts the fill area and is encompassed in Areas A and C, which were addressed as a part of the closure of the landfill. The designated wetland also includes a shallow pond of approximately 3 acres (the "ponded wetland").

In accordance with the ARP, an additional investigation focusing on biota sampling and risk assessment was conducted during pre-remedial design activities. The results of this focused Feasibility Study were set forth in O'Brien & Gere's Wetlands Investigation and Feasibility Study (March 1990). This report identified removal of select wetland soils by excavation as the recommended approach to address PCB impacted soils in the ponded wetland.

Based on NYSDEC's review and approval of this remedial approach, PCB-impacted soils were excavated from the ponded wetland and then transported and placed in the landfill in connection with the closure of the landfill. The project commenced in the fall of 1990 and was completed in the winter of 1990-1991. Following removal of a 1 ft. layer of these soils, confirmation sampling was performed on a 50 foot by 50 foot grid within the excavated areas. From this sampling, 76 of the 104 confirmation sample locations exhibited PCB concentrations less than the 1 part per million (ppm) cleanup limit established by NYSDEC, and three locations exhibited PCBs greater than 500 ppm. In the areas exhibiting PCBs greater than 1 ppm, 1 additional ft. of sediment was excavated. This material was then placed in the landfill, with the exception of approximately 40 cy of soils with PCB concentrations in excess of 500 ppm that were disposed off-site at an approved disposal facility.

Following the additional excavation of sediment, a second round of confirmation sampling was conducted. The results indicated only two areas remaining with residual PCB concentrations greater than 1 ppm. An additional foot of sediments was then excavated from these areas and a final round of confirmation samples was collected. The results of this sampling at each location indicated non-detectable PCB concentrations.

A Construction Documentation Report (CDR) was submitted in May 1995, documenting construction activities performed at the Ludlow Sanitary Landfill and adjacent wetland areas, including the ponded wetland, from 1989 to 1992. The CDR was approved by NYSDEC in May 1995. A biota sampling was conducted in October 1997, and the results were submitted to NYSDEC under separate cover. In summary, PCB concentrations in fish flesh were found to be substantially lower than levels found in 1986 and 1989.

### 1.2.2. Off-site ground water

From 1984 through 1989, as part of O'Brien & Gere's investigations of the landfill, surrounding leachate seeps, and adjacent wetlands and ground water, 28 monitoring wells (MWs) were installed at various depths both on-site and off-site adjacent to the landfill and North Gravel Pit. The location of these wells are illustrated on Figure 1-2. These wells, in addition to the Clayville public water supply and three residential wells downgradient of the landfill, were utilized to monitor on- and off-site ground water quality in this area. On-site wells include landfill boundary well nests (MWs-1, 5, 6, 13, 14, 15 and 16) and North Gravel Pit wells (MWs-10, 11 and 19), while off-site ground water was monitored via off-site well nests (MWs-7, 8 and 9), private wells (PW-1, 2 and 3) and a public supply well (PU-1).

Although several on-site monitoring wells exhibited detectable levels of PCBs, no PCBs were detected in off-site ground water, as outlined in the North Gravel Pit and Off-Site Ground Water Report (O'Brien & Gere, January 1990). The ARP incorporated the remedial response to the potential for PCB impacts to off-site ground water.

Under the ARP, there is to be a two year period of "Short Term Monitoring" following the completion of remedial measures at the landfill (see page 8 of the ARP). This period commenced in June of 1997 with NYSDEC's approval of the Operation, Maintenance and Monitoring ("OM&M") Plan for the Ludlow site. The parameters to be tested under the Short Term Monitoring are set forth in the OM&M Plan.

The objectives of the Short Term Monitoring are: (a) determine if there has been any short term impacts on water quality resulting from cap placement over the landfill and (b) establish long term monitoring locations, frequencies and parameters. If, at the conclusion of the post-remedial short-term ground water monitoring, it is determined that 1) New York State Drinking Water Standards have been exceeded, or in the absence of such a standard, 2) the federal maximum contaminant level (MCL), or, in the absence of a MCL, 3) the New York State Water Quality Standard and Guidance Values for ground water have been exceeded, an assessment will be performed using the available post-remedial monitoring data to determine the need for and the feasibility of implementing additional corrective measures (see pages 9 and 12 of the ARP).

Following completion of the two year Short-Term Monitoring, a Long-Term Monitoring program is being developed (see page 9 of the ARP). The details of the Long-Term Monitoring will be based on the results of the Short Term Monitoring. Substances not previously detected or detected at insignificant concentrations, defined as less than 25% of the MCL, will be eliminated from routine monitoring. The proposed Long-Term Monitoring plan will be submitted to the NYSDEC with the 1998 annual monitoring report.

**1.2.3. North Gravel Pit**

At the time of the Consent Judgement, the North Gravel Pit was a shallow depression which had resulted from previous sand and gravel operations. Following the 1990-1991 remedial work, excavation of soils increased the depth of the North Gravel to approximately 16-18 feet below the former grade. Soils that were excavated were disposed in the Ludlow Landfill prior to closure.

The North Gravel Pit lies in the northern portion of the Ludlow site as shown on Figure 1-2. The ground surface in the vicinity of the North Gravel Pit is marked by small hills and depressions, which are the result of former Ludlow Sand and Gravel quarrying operations. Ground elevations generally increase south and east of the North Gravel Pit, and decrease north and west of the site.

The North Gravel Pit area is approximately 1 acre in size. The pit is approximately 20 to 30 ft deep, with an area at the bottom approximately 150 to 170 feet in diameter. The bottom of the pit contains a pool of standing water generally ranging up to 5 feet in depth, depending on seasonal variations. The pit is bordered to the south by a stand of trees, and to the west by a grass and brush covered meadow. The pit is bordered to the north by an access road for Ludlow Sand and Gravel operations, and to the east by a dirt and grass covered portion of the Ludlow site.

The closed landfill is located approximately 700-900 ft south of the North Gravel Pit in a meadow primarily covered with grass and brush. A forested area is located between the North Gravel Pit and the landfill.

In the immediate vicinity of the North Gravel Pit, storm water tends to flow into the pit, with no surface water outlet currently existing from the pit. Sauquoit Creek, a tributary of the Mohawk River, is located approximately 4,500 ft west of the North Gravel Pit Site. Tributaries to the creek originate within 2,000 ft west of the North Gravel Pit.

The North Gravel Pit is currently zoned rural residential by the Town of Paris (1962 zoning ordinance; amended in 1985). The North Gravel Pit is enclosed by a six foot high fence with a locked gate, which was installed following the 1991 remediation work at the North Gravel Pit.

## 1.3. Previous North Gravel Pit investigations

Remediation at Operable Unit No. 1 (the closed landfill) and two of the three components of Operable Unit No. 2 (ponded wetland and off-site ground water) has been completed. Work at the North Gravel Pit, the third component of Operable Unit No. 2 was commenced, but not completed due to the finding of PCB impacted soils beyond an area initially anticipated. This supplemental RI/FS addresses the need for further investigation and evaluation of further remedial measures at the North Gravel Pit.

O'Brien & Gere undertook investigations in the North Gravel Pit, the results of which were presented in the Remedial Investigation/Feasibility Study Report (O'Brien & Gere, 1986), as supplemented by submissions made by Special Metals on October 16, 1986 and February 10, 1987.

Dunn Geoscience Corporation (Dunn Geoscience) performed additional investigations in response to site-related constituents identified at the North Gravel Pit during the O'Brien & Gere investigations. The results of the additional investigations were presented in the Supplemental Investigation Ludlow NPL Site Report (Dunn Geoscience, 1987). The additional investigations included the installation of six soil borings in the vicinity of the North Gravel Pit, as shown on Figure 1-3. Soil samples were collected from the borings and analyzed for PCBs.

A maximum concentration of 0.32 mg/kg was detected in DB-1P at a depth of 24-30 ft, and four of the eight soil samples showed no detectable concentrations of PCBs. The boring logs for the soil borings are included as Exhibit C. Although grade elevations for the borings were not reported, comparison of the ground surface elevations in the vicinity of the North Gravel Pit with the sample depths reported in the boring logs suggests that the samples were collected at or near the ground water table.

Six soil samples were collected from the bottom of the North Gravel Pit by Dunn Geoscience as part of a supplemental investigation in September 1988 (Dunn Geoscience, 1989). However, these samples were collected in an area where PCB impacted soils were subsequently excavated and placed in the landfill as part of the landfill closure.

Dunn Geoscience also installed and sampled three ground water monitoring wells (MW-10, MW-11, MW-12) as part of the September 1988 supplemental investigation. The monitoring well locations are shown on Figure 1-3. The ground water samples were analyzed for PCBs, and a summary of the analytical results is presented in Table 1 - 1.

In order to further characterize the nature and extent of ground water impacts in the North Gravel Pit area, O'Brien & Gere collected additional rounds of ground water samples in July and September 1989 from the three monitoring wells installed by Dunn Geoscience in September 1988. The July 1989 ground water samples, and the September 1989 ground water sample from MW-11, were analyzed for PCBs. The September 1989 ground water samples from MW-10 and MW-12 were also analyzed for Target Compound List (TCL) organics, and metals (via CLP Methods 2007, 206.2, 245.1, 270.2, 279.2, 239.2, and 312B).

A summary of the PCB analytical results for the sampling is presented in Table 1-1. No TCL organics were detected above the method detection limits, and filtered metals were all below the standards for New York State Class GA ground water as listed in 6 NYCRR Part 703.5. Unfiltered samples were not analyzed for metals. Ground water elevations measured during O'Brien & Gere's ground water monitoring indicated varying ground water flow directions and gradients, possibly due to the influence of ground water mounding in the North Gravel Pit resulting from surface water flows. (However, as discussed in Section 3.1.3., during the ground water monitoring events performed as part of this SRI/FS, ground water flow direction was consistently to the northwest.)

In accordance with the ARP, the North Gravel Pit area was surveyed, cleared of vegetation, and an access road was constructed in July 1990. Excavation of the PCB-impacted soils and debris in the North Gravel Pit commenced in September 1990. However, heavy autumn rains prevented completion of the work, and excavation resumed in early spring.

In April 1991, visually stained debris and cemented gravel debris were encountered during excavation activities. This discovery prompted additional sampling of the North Gravel Pit soils for disposal characterization. Following the additional soil sampling, excavation of soils resumed in early June 1991 with NYSDEC oversight and concurrence (see May 31, 1991 correspondence from James G Van Hoesen, P.E. to Special Metals in Exhibit D). Excavation activities continued until visually stained soils were encountered beneath the debris in late June 1991.

In response to the continued encounters with PCB-impacted materials in the North Gravel Pit, O'Brien & Gere completed a supplemental soil investigation in June and July 1991 to further define the horizontal and vertical extent of PCB-impacted soils in this area. The soil boring and surface soil sample locations, as well as the revised site topography resulting from the excavation activities, are shown on Figure 1-4. The soil boring logs are included as Appendix A.

Seventeen soil borings were completed and eight surface soil samples were collected in the vicinity of the North Gravel Pit and analyzed for PCBs via CLP Method 608. Twelve of the thirty soil samples indicated no detectable concentrations (that is, <1 mg/kg) of PCBs. The highest concentrations were found within the top one foot layer, with the highest concentration detected being 850 mg/kg at B-24. A summary of the soil boring and surface soil analytical results is shown on Table 1-2.

Based on the additional sampling results, O'Brien & Gere prepared a Focused Feasibility Study in August 1991 (O'Brien & Gere, 1991). Based on the recommendations in the feasibility study, and upon NYSDEC concurrence, excavation of the North Gravel Pit soils resumed with placement in the landfill prior to its closure. However, the work was halted in October 1991 when additional, more-extensive PCB-impacted materials were encountered below the ground water table.

In response to the discovery of the additional PCB-impacted materials, 12 shallow core samples (0-1 ft depth) were collected from the bottom of the North Gravel Pit in October 1991 and analyzed for PCBs. The shallow core sample locations, as well as the revised site topography resulting from the additional excavation activities, are shown on Figure 1-5, with the results summarized in Table 1-3. Aroclor 1254 was the only Aroclor detected, with concentrations ranging from 2 to 2,000 mg/kg.

## 1.4. Objectives of North Gravel Pit Supplemental RI/FS

O'Brien & Gere completed a supplemental remedial investigation/feasibility study (RI/FS) at the North Gravel Pit between November 1996 and January 1998 to determine the extent of remaining PCB impacted media and to evaluate the feasibility of various remedial alternatives for further remedial work at the North Gravel Pit. Details of this investigation are discussed in Chapter 2. This report presents the results of the supplemental investigations, evaluates potential remedial alternatives, and provides recommendations for implementing additional remedial actions at the North Gravel Pit.

# 2. North Gravel Pit supplemental remedial investigation

## 2.1. Introduction

As described in Section 1, excavation of the North Gravel Pit soils was halted in October 1991 when additional PCB-impacted materials were encountered at depths below the ground water table. In response to the discovery of the additional PCB-impacted materials, a supplemental field investigation was recommended and NYSDEC approved the investigation in the proposed O'Brien & Gere work plan, dated May 1994. The work plan was approved for implementation by Judge McAvoy under the Consent Judgment, by order dated August 3, 1996, approving a "Stipulation Clarifying and Modifying Consent Judgment."

By letter dated September 27, 1996, O'Brien & Gere requested that the Department approve a phased approach to the field activities which were to be performed as part of the Supplemental RI/FS (see Exhibit E). These field activities consisted of the following work:

- Soil investigation:
  - The collection of eight shallow core samples
  - The installation of five perimeter soil borings

- Ground water investigation:
  - Installation of three additional monitoring wells (MW-17, MW-18, and MW-19), and the replacement of the inoperable MW-11
  - Three rounds of sampling from the four new monitoring wells plus the existing MW-10

By letter dated October 10, 1996 to O'Brien & Gere (see Exhibit F), NYSDEC approved the phased approach for the supplemental RI/FS field work. Field work commenced in November 1996, and continued through June 1997.

Based on the results of the sampling, O'Brien & Gere proposed the installation of four additional ten foot soil borings in the bottom of the North

Gravel Pit to better evaluate the depth of PCB impacted soils. This extra task, which was described in O'Brien & Gere's letter of July 11, 1997 (see Exhibit G), was approved by the NYSDEC in an August 15, 1997 letter (see Exhibit H). In its letter, NYSDEC also requested the performance of a Fish and Wildlife Impact Analysis (FWIA), which included limited water and soil sampling.

## 2.2. Soil Investigation

The soil investigation activities consisted of the following:

- collection of eight shallow core samples from the bottom of the North Gravel Pit to assess the horizontal extent of PCB impacts;
- the completion of five perimeter soil borings in the vicinity of the North Gravel Pit, including the collection of 23 soil samples at various depths from the borings; and
- the installation of four additional soil borings at the bottom of the pit, with the collection of eighteen additional soil samples from these borings.

The shallow core sampling locations and the soil boring locations are shown on Figure 2-1. These activities were performed in order to further define the horizontal and vertical extent of PCB-impacted soils in the vicinity of the North Gravel Pit. Locations of historical and recent soil borings, along with current ground surface contours, are shown in Figure 2-2.

### 2.2.1. Shallow core sampling

Eight shallow core samples (SED 1 through SED 8) were collected on January 14, 1997 from the soils at the bottom of the North Gravel Pit. The shallow core samples were collected from the top 12 to 18 inches of soils and each sample was analyzed for PCBs in accordance with USEPA Method 8080. As part of the FWIA of the North Gravel Pit, two additional shallow core samples were collected for analysis of total organic carbon.

### 2.2.2. Soil borings

Twenty-three soil samples were collected from the five soil borings (B-1 through B-5) completed in the vicinity of the North Gravel Pit on January 13-14, 1997. The estimated surface elevations and depths of these borings are included in Table 2-1. The soil boring samples were collected at various depths from each boring, and each sample was analyzed for PCBs in accordance with USEPA Method 8080. In addition, one soil sample from each boring was submitted for total organic carbon (TOC) analysis. Following receipt of the analytical results from the shallow core sampling (see Section 3.2.1.), an additional four soil borings were advanced through the bottom of the pit to better delineate the vertical extent of PCB impacts in this area. The soil boring analytical results are discussed in Section 3.2.1.

## 2.3. Ground water investigation

The additional ground water investigation activities consisted of:

- the installation of three new shallow ground water monitoring wells
- the installation of one replacement shallow well
- the installation of a temporary surface water staff gauge
- ground water sample collection and elevation measurements from the five monitoring wells
- surface water elevation measurements from the staff gauge.

These activities were performed in order to assess shallow ground water quality and to further define shallow ground water flow, as previous ground water elevation measurements indicated a variable shallow ground water flow direction and gradient in the vicinity of the North Gravel Pit.

### 2.3.1. Monitoring well installation

Three new monitoring wells (MW-17, MW-18, and MW-19) and one replacement well (MW-11R) were installed in the vicinity of the North Gravel Pit. Monitoring wells were installed using the hollow stem auger method. Head space monitoring was conducted with a photoionization detector (PID), and the PID readings were recorded on the boring logs. Boring logs are contained in Appendix A.

Monitoring wells were constructed in the borings using two inch flush, joint-threaded Schedule 40 PVC well screens and casing. A ten foot section of PVC well screen with a 0.020 slot size was placed across the water table, and a sand pack was placed in the annular space around the screen, extending not less than two feet above the top and at least two inches below the bottom of the screen. A 20 foot section of screen was installed in MW-17 at the request of the on-site NYSDEC Hydrogeologist. Bentonite seals were placed over the sand packs, with grout added over the bentonite seals. Each well was installed with a steel protective outer casing with a locked security cap.

In addition, a staff gauge was installed in the standing water located at the bottom of the North Gravel Pit to assess potential ground water mounding from surface runoff into the North Gravel Pit. The new monitoring well and staff gauge locations, as well as the existing well locations, are shown on Figure 2-3.

MW-11R replaced MW-11, which had become inoperable (reportedly due to a lodged baler). Monitoring well MW-19 was installed in a presumed upgradient location, although subsequent ground water level measurements have indicated that it is in a side-gradient location. Monitoring wells MW-17 and MW-18 were installed to further evaluate potential downgradient impacts to ground water from the North Gravel Pit.

As the variations in the ground water flow direction identified through previous investigation activities may have been caused by surface water drainage and ground water recharge through the bottom of the North Gravel Pit, the staff gauge was installed in order to allow simultaneous measurements of surface water elevations in the pit and ground water elevations in the vicinity of the pit. As discussed in Section 3.1.3, significant mounding of ground water was not detected during the ground water monitoring events conducted as part of this SRI/FS.

### 2.3.2. Monitoring well development

Following installation, each well was developed by pumping ground water to the ground surface to remove fine grained materials from the well. The removal of the fine-grained materials from the well prior to sampling allows the well screen to transmit a representative flow of ground water from the surrounding aquifer, and to minimize the presence of fine-grained materials in subsequent ground water samples.

### 2.3.3. Water level measurements

Three rounds of ground water elevations were measured at MW-10, MW-11R, MW-17, MW-18, and MW-19. The sampling events occurred on November 6, 1996, February 20, 1997, and June 10-11, 1997. In addition, the surface water elevation at the bottom of the North Gravel Pit was measured on February 20, 1997. The February 1997 monitoring round included monitoring the ground water elevation of shallow monitoring well MW-9S, located on the east side of Holman City Road, to allow a more regional assessment of ground water flow direction. The June 1997 sampling event was conducted jointly with the first round of the Short-Term Groundwater Monitoring Plan.

#### 2.3.4. Ground water sampling

Three rounds of ground water samples were collected from MW-10, MW-11R, MW-17, MW-18, and MW-19. The sampling events occurred on November 6, 1996, February 20, 1997, and June 10-11, 1997. Each well was sampled for volatile organic compounds (VOCs) via NYS ASP Method 91-1 and PCBs via USEPA Method 8080. In addition, MW-11R and MW-19 have been included in the short term ground water monitoring plan conducted as part of the landfill closure monitoring.

While the work plan originally required New York State Method 91-3 for PCB analysis, NYSDEC agreed to substitute EPA Method 8080 to provide better quality control procedures for PCBs. This approved modification to the scope of the SRI/FS field work was documented in O'Brien & Gere's first status report to NYSDEC on December 26, 1996. In addition, the pH, temperature, and specific conductivity of each sample were measured in the field.

### 2.4. Surface water sampling

As part of the FWIA of the North Gravel Pit, two surface water samples were collected for analysis of PCBs using EPA Method 8080.

### 2.5. Bench scale treatability testing

Due to the wide range of PCB concentrations encountered in the North Gravel Pit soils, segregation of soils by varying concentrations would be difficult, and this makes the need for treatability testing impracticable. Based on the nature and extent of PCB contamination and the alternative remedial processes chosen for the Supplemental Feasibility Study, bench scale treatability tests were not necessary for the completion of the SRI/FS.

## 2.6. Data qualifications evaluation

As stated in the SRI/FS Work Plan, data quality objectives (DQO) for laboratory analyses were equivalent to Level IV, as described in the USEPA guidance document: Data Quality Objectives for Remedial Response Activities (USEPA 540/G-8 7/1 003). This DQO level requires the use of NYSDEC Superfund analytical methods and deliverables, and is required for data to be used in a quantitative risk assessment. Data validation was performed on laboratory analyses of soil and waters. Field analyses were to adhere to Level I, which requires the use of portable instruments for field screening.

# 3. Results of North Gravel Pit supplemental remedial investigation

## 3.1. Physical characteristics of the site

### 3.1.1. Physiography

As described in Section 1.2.3. of this report, the topography of the North Gravel Pit has resulted from past sand and gravel operations, as well as the 1990-1991 remedial efforts. The ground surface in the vicinity of the North Gravel Pit is marked by small hills and depressions, which are likely the result of past quarrying operations. Ground elevations generally increase south and east of the North Gravel Pit, and decrease north and west of the site.

The North Gravel Pit is approximately one acre in size. The pit is approximately 20 to 30 feet deep with an area at the bottom approximately 150 to 170 feet in diameter. The bottom of the pit contains a pool of standing water. The pit is bordered to the south by a stand of trees, and to the west by a grass and brush covered meadow. The pit is bordered to the north by an access road for Ludlow Sand and Gravel operations, and to the east by a dirt and grass covered clearing. The North Gravel Pit is enclosed by a chain link fence.

### 3.1.2. Site geology

The geology in the vicinity of the North Gravel Pit is characterized by a complex sequence of glacial deposits overlying Silurian age bedrock. The unconsolidated sediments vary in composition and increase in thickness to the west. To the east, the bedrock is exposed at the land surface; whereas, to the west, the bedrock is overlain by at least 150 feet of unconsolidated sediments.

Bedrock geology

The bedrock underlying the North Gravel Pit consists of a sedimentary sequence of Silurian age limestones, dolomites, and shales that dip to the south at one to two degrees (Fisher, 1970). The limestone outcrops throughout the uplands to the east of the North Gravel Pit along Day Hill and is characterized as massive to thinly bedded, and moderately fractured. The shale sequence underlies the limestone and forms the surficial bedrock in the Sauquoit Creek Valley. This rock type is characterized as red, green and gray, thinly bedded, friable, siltstone and mudstone. Bedrock was not encountered at the site during drilling activities.

Unconsolidated deposits

The Mohawk-Hudson surficial geologic map indicates that the site is located within a Kame Moraine. Due to the proximity to the moraine and the effects of deglaciation, the sediments in the area are highly variable in texture and sorting. The sediments encountered vary in composition according to their specific mode of deposition. Three types of glacial sediments have been identified in the vicinity of the North Gravel Pit: glaciofluvial deposits, lacustrine deposits, and till.

*Glacialfluvial deposits* were deposited from sediment laden meltwaters that flowed away from the glacial margin and consist of well sorted sand and gravel with minor lenses of silt at various depths. The materials were encountered immediately east and north of the gravel pit, and may have been representative of the material in the North Gravel Pit prior to the sand and gravel operations.

*Till* was deposited directly by the glacier at its margin or beneath the ice mass. There are two layers of till at the North Gravel Pit: an upper and lower unit. The upper till, where encountered, occurs as discontinuous lenses, and consists of brown, mottled, silty fine sand, with some embedded gravel.

Information obtained during the Ludlow Landfill Remedial Investigation (O'Brien & Gere, 1986) indicates that a lower till unit overlies bedrock. This lower unit is exposed at the land surface along Mohawk Street but is overlain by other deposits beneath the North Gravel Pit. This unit was not encountered at the North Gravel Pit as the monitoring wells were installed to screen the upper portion of the water table. This deeper till layer consists of gray, very dense sandy silt, with some embedded gravel (O'Brien & Gere, 1986).

*Lacustrine deposits* consisting of fine grained sand, silt, and clay were deposited in glacial lakes that formed due to blockage of meltwater drainage by the glacial ice mass.

As previously mentioned, due to the variable nature of the subsurface materials, it is not feasible to correlate units across the site. However, in summary, the soils immediately east, south, and north of the North Gravel Pit are primarily a mixture of glaciofluvial deposits and till. West of the North Gravel Pit, lacustrine deposits were primarily encountered. Two geological cross sections, based on soil boring logs, are included as Figures 3-1 and 3-2. The orientations of these locations are noted on Figure 2-2.

**3.1.3. Site hydrogeology**

Ground water elevation data have been collected from ground water monitoring wells on several occasions to evaluate the ground water flow conditions. A summary of the ground water elevation data is shown in Table 3-1. The data indicates that the depth to ground water varies across the site from approximately 3 ft at MW-9S, to 40 ft at MW-19. This variability is largely due to topographic changes across the site. Ground water elevation maps of the North Gravel Pit are included as Figures 3-3 through 3-5 of this report.

Previous ground water elevation measurements for the wells in the vicinity of the landfill area reportedly indicated a west-northwest shallow ground water flow direction. By contrast, the ground water and surface water elevation data for November 6, 1996, February 20, 1997, and June 10-11, 1997 indicate a north-northwest shallow ground water flow direction (see Figures 3-3 through 3-5).

The variability in the ground water flow direction and gradient may be attributable to ground water recharge through the bottom of the North Gravel Pit. The topography in the vicinity of the pit indicates that surface water runoff from surrounding areas drains to the bottom of the pit with no surface outlet. The standing water at the bottom of the pit indicates that the pit bottom intersects ground water. Therefore, surface water recharge may potentially impact shallow ground water flow in the vicinity of the North Gravel Pit. A staff gauge was placed in the pit for the February 1997 ground water sampling event. However, recharge conditions were not present at the time of this sampling, and ground water mounding was not observed. Subsequent heaving due to freeze/thaw cycles appeared to damage the staff gauge, making further readings unreliable.

*In situ* hydraulic conductivity tests were completed on each well to evaluate the horizontal hydraulic conductivity of the screened interval. At monitoring wells MW-10, MW-11R, MW-17, and MW-18, the tests were completed by purging the wells with a decontaminated stainless steel bailer in order to create a negative potential between the well and the surrounding materials.

The rate at which the water recovered was measured with a water level probe. This method was attempted at MW-19; however, no significant draw-down was observed. Therefore, a PVC rod was inserted into the well, and was allowed to equilibrate. The rod was then removed in order to create a negative potential between the well and the aquifer. The rate of recovery was monitored using a pressure transducer system. The data from these tests were evaluated by the Bouwer & Rice method using the AQTESOLV computer program written by Geraghty & Miller. Hydraulic conductivity calculations are included in Appendix B.

The calculated horizontal hydraulic conductivity for each well is presented below:

| Well | Hydraulic Conductivity | Material Screened |
|---|---|---|
| MW-10 | 2.2 x $10^{-3}$ cm/sec (6.24 ft/day) | Fine to Medium Sand |
| MW-11R | 2.3 x $10^{-4}$ cm/sec (0.652 ft/day) | Silt and Fine Sand |
| MW-17 | 4.9 x $10^{-4}$ cm/sec (1.39 ft/day) | Silt and Fine Sand |
| MW-18 | 1.2 x $10^{-3}$ cm/sec (3.4 ft/day) | Fine to Medium Sand |
| MW-19 | 1.1 x $10^{0}$ cm/sec (3,119 ft/day) | Sand and Gravel |
| Geometric Mean: 3.2 x $10^{-3}$ cm/sec (9.0 ft/day) | | |

The variation in hydraulic conductivity is consistent with the varying subsurface soil encountered at the site. The hydraulic conductivity data ranges from 0.652 ft/day at MW-11R to 3,119 ft/day at MW-19. Given the wide range in hydraulic conductivity values, the geometric mean was calculated to be 9.0 ft/day. The hydraulic conductivity calculated at MW-19 suggests that there could be a localized preferential flow path at this location; however, it is likely limited in areal extent based on the depositional environment of the area. Therefore, the area near MW-19 does not likely represent a significant preferential pathway for ground water transport. In addition, the quantity of ground water flowing through the site is controlled by the finer grained and lower permeable soils. In summary, the geometric mean of the hydraulic conductivity is likely representative of actual conditions at the site.

The ground water flow velocity at the site was calculated using the geometric mean of the hydraulic conductivity data and a range in hydraulic gradients. The ground water velocity at the site was calculated as follows:

$V = K*I/n$

| | | | |
|---|---|---|---|
| *where:* | $V$ = | ground water velocity (ft/day) | |
| | $K$ = | hydraulic conductivity | 9.0 ft/day |
| | $i_{max}$ = | hydraulic gradient on 11/6/97 | 0.015 ft/ft |
| | $i_{min}$ = | hydraulic gradient on 1/19/98 | 0.008 ft/ft |
| | $n$ = | porosity (Driscoll, 1986) | 0.20 |

Based on these values, ground water velocity was calculated to range from 0.36 ft/day to 0.68 ft/day.

## 3.2. Nature and extent of contamination

### 3.2.1. Soil sampling

As previously discussed, five perimeter borings were placed around the North Gravel Pit, with eight shallow soil coring samples being collected from the bottom of the pit. Subsequently, four additional deeper borings were also placed in the bottom of the pit. Soil sample locations are noted in Figure 2-1. Samples were submitted to O'Brien & Gere Laboratories in Syracuse, New York for PCB analyses via EPA Method 8080. Data validation of laboratory results was performed by Data Validation Services of North Creek, New York. Concentrations of Aroclor 1254 were detected in the eight shallow coring samples (ranging from 1.5 to 540 mg/kg, see Table 3-2). Shallow coring sample SED 6 contained the highest concentration of 540 mg/kg, and SED 8 contained the lowest concentration of 1.5 mg/kg.

Concentrations of Aroclor 1254 were detected in four of the five perimeter borings (ranging from 0.057 mg/kg to 10 mg/kg, see Table 3-3). Boring sample B-5 (0-2') contained the highest concentration of 10 mg/kg, and Boring B-3 (6-8') contained the lowest detectable concentration at 0.057 mg/kg. Boring B-4 did not contain detectable concentrations (<0.020 mg/kg).

TOC concentrations ranged from 713 mg/Kg at a depth of 18 to 20 feet in Boring B-2, to 22,300 mg/Kg at a depth of 4 - 6 feet in Boring B-3. As would be expected, TOC concentrations tended to decrease with depth.

Following receipt of the previously discussed soil sampling results, an additional four soil borings were placed in the bottom of the North Gravel Pit to better define the vertical extent of PCB concentrations in this area.

Analytical results from this sampling indicated Aroclor 1254 concentrations ranging from 0.16 to 1,800 mg/kg (see Table 3-4). Boring B-9 had the highest concentrations ranging from 160 mg/kg at the lowest sample (8 ft to 10 ft depth) to a high of 1,800 mg/kg at the 4 ft to 6 ft depth.

TOC concentrations ranged from 6,000 mg/Kg to 110,000 mg/Kg, with a mean value of 34,238 mg/Kg. Analytical results from soil samples collected as part of this investigation are included in Appendix C.

### 3.2.2. Ground water

To evaluate potential impacts to ground water from the North Gravel Pit, five ground water monitoring wells (see Section 2.3 of this report) were sampled on three occasions: November 6, 1996, February 20, 1997, and June 10 and 11, 1997. The five wells were sampled in accordance with the approved SRI/FS Work Plan, with samples being submitted to O'Brien & Gere Laboratories for analysis of VOCs and PCBs via New York State Method 91-1 and modified EPA Method 8080, respectively. In addition, three of these wells (MW-10, MW-11R, and MW-19) have been included in the Short-Term Ground Water monitoring Program.

A summary of the ground water temperature, pH, and conductivity values obtained during sampling are included in Table 3-5. Analytical results from the sampling are summarized in Tables 3-6 and 3-7, which are included in Appendix D. The results are summarized as follows:

*November 6, 1996 sampling event.* Concentrations of Aroclor 1248 were detected in four of the five unfiltered ground water samples (ranging from 0.078 $\mu$g/l to 0.39 $\mu$g/l). MW-10 (the well located the closest to the North Gravel Pit) did not contain detectable concentrations (<0.055 $\mu$g/l), and MW-11R had the highest concentration of 0.39 $\mu$g/l. Filtered ground water samples did not contain detectable concentrations of PCBs, indicating that the detection of PCBs was associated with particulates in the ground water. The only Aroclor detected was 1248.

Trace estimated concentrations of several VOCs were detected in the ground water samples from each of the wells, and this data is summarized in Table 3-7. Methylene chloride and acetone were also detected in the blank, and, therefore, appear to be related to laboratory contamination. 1,1-dichloroethane and 1,1,1-trichloroethane were detected at estimated concentrations ranging from 1 to 4 $\mu$g/l.

*February 20, 1997 sampling event.* PCBs were not detected in either the filtered or unfiltered ground water samples. 1,1-Dichloroethane was also not detected in this round of sampling. Tetrachloroethene and 1,1,1-trichloroethane were detected at estimated concentrations ranging from 1 to 2 $\mu$g/l in MW-17 and MW-18. Methylene chloride was detected in one well, MW-10. However, methylene chloride was also detected in the blank, and therefore appears to be related to laboratory contamination.

*June 10 and 11, 1997 sampling event.* PCBs were not detected in either the filtered or unfiltered samples. These results are consistent with the results of the February 20, 1997 analytical results. Three VOCs were detected. 1,1,1-trichloroethane was detected in three of the five wells (MW-11R, MW-17, and MW- 18) at estimated concentrations of 2 to 8 $\mu$g/l. Tetrachloroethene was detected in only MW-18 at an estimated concentration of 2 $\mu$g/l. Methylene chloride was only detected in MW-10 at an estimated concentration of 2 $\mu$g/l.

*Short Term ground water monitoring.* The first round of Short Term Ground Water monitoring (see Section .1.1) was conducted concurrently with the June 10-11, 1997 sampling as discussed previously. The second round of Short Term Ground Water monitoring was conducted during September, 1997. As part of this monitoring, monitoring wells MW-10, MW-11R, and MW-19 were sampled in the vicinity of the North Gravel Pit with ground water samples being analyzed for PCBs via EPA Method 8082. Samples were not filtered.

PCBs were not detected in MW-10 or MW-19; MW-11R had a detected concentration of Aroclor 1242 of 0.13 $\mu$g/l. This Aroclor had not been detected in the soils of the North Gravel Pit or in ground water during the North Gravel Pit supplemental RI sampling events.

Monitoring well MW-11R was resampled, with the second sample indicating a concentration of Aroclor 1248 of 0.11 $\mu$g/l. However, the analytical result for the resample was noted as being an altered Aroclor which means that the pattern of the analytical results do not exactly match the analytical control pattern of Aroclor 1248. The patterns of Aroclor 1242 and 1248 are similar, and the pattern from the resample could be indicative of weathered Aroclor 1242 or 1248. In both sampling events, the ground water samples were not filtered and the condition of the samples were noted as red in color, indicating the presence of sediment.

The NYS Class GA standard for PCBs in ground water is currently 0.09 $\mu$g/l. Therefore, the two PCB Aroclors detected during the third quarter 1997 sampling event marginally exceeded the Class GA standard for total PCBs.

The third round of Short Term Ground Water monitoring was conducted during December 1997. As before, MW-10, MW-11R, and MW-19 were sampled in the vicinity of the North Gravel Pit, with the samples being unfiltered. PCBs were not detected in these three wells during the December 1997 sampling event (detection level was 0.10 $\mu$g/L). Results of subsequent quarterly rounds of ground water monitoring are summarized in Table 3.6, and have indicated no detectable concentrations of PCBs in the first and third quarter of 1998, with 0.24 $\mu$g/L of Aroclor 1242 being found in MW-11R in the second quarter of 1998. Monitoring wells in the vicinity of the North Gravel Pit did not contain sufficient ground water to obtain representative samples in the fourth quarter. No detectable concentrations of PCBs were found in the first quarter 1999 sampling event.

In summary, existing unfiltered ground water data from MW-17, MW-18, and MW-19 indicate concentrations of PCBs below analytical detection limits since November of 1996. Detectable concentrations of PCBs in MW-11R have been found in 3 of 9 sampling events since November of 1996 using unfiltered sampling techniques. All filtered ground water data from MW-11R, MW-18, and MW-19 have been below detectable levels, and were filtered using 0.45 micron glass fiber filters.

Based upon this data, the following conclusions are drawn:

- The filtered data indicate that dissolved PCBs are not present, and that PCBs have not been detected in unfiltered samples from MW-10, or from MW-17, MW-18 and MW-19 since November 1996.

- The difference between the filtered and unfiltered data, as well as the intermittent nature of the PCB concentrations detected in the unfiltered samples from MW-11R, is a function of the turbidity of the samples so that it is the presence of PCB-impacted solids in the vicinity of the North Gravel Pit, rather than dissolved PCBs, which is reflected in the analytical results.

- Due to the fact that there is no increasing trend in the concentrations detected in the unfiltered samples, the fines are not migrating.

In an attempt to further evaluate this issue, the September 1998 ground water monitoring event, which was a part of the short term monitoring program at the site, included filtered, unfiltered, and low flow sampling techniques (per USEPA document EPA/540/S-95/504 ) for MW-11R. If PCBs had been detected from the sample collected via the low flow method, it could have potentially indicated a dissolved fraction. If there was a difference between the filtered and unfiltered sample results, the results would have indicated the presence of solids affecting the analytical results. However, the results for all three samples were below analytical detection methods. Subsequent short-term monitoring events were sampled and analyzed similar to the September 1998 event, and the analytical results have indicated no detectable concentrations of PCBs in filtered, unfiltered, and low flow samples. Therefore, the most recent data does not indicate the presence of any PCBs in the dissolved fraction and thus in a form which could move from the source area. This data is consistent with existing information about PCBs which indicates that they adsorb to solids and do not readily dissolve into solution.

Analysis of soil samples at the MW-11R location was not required in the approved Work Plan and soil samples were not collected during the field investigation. There has not been any evidence of previous disposal activity in this location. Therefore, the cause of impacted solids at this location is not clear. However, concentrations of PCBs in the unfiltered samples were less than or marginally over NYS Class GA standards. Therefore, PCB concentrations in the solids are estimated to be rather low.

### 3.2.3. North Gravel Pit surface water

As part of the FWIA of the North Gravel Pit, two water samples were collected from the ponded North Gravel Pit water for analysis of PCBs via EPA Method 8080. These samples indicated concentrations of 0.99 $\mu$g/l and 1.5 $\mu$g/l of Aroclor 1242, and 1.5 $\mu$g/l and 2.0 $\mu$g/l of Aroclor 1254 These results are discussed in more detail in Section 3.3.2.4 of this report.

### 3.2.4. Summary of nature and extent of contamination

#### *3.2.4.1. Soils*

In summary, PCB contamination was found to be limited to soils at the bottom of the North Gravel Pit. Shallow core samples collected beneath the ground water surface indicated PCB impacts ranging from 1.5 to 540 mg/kg. Subsequent deeper borings (to depths of ten feet) placed in this same area showed similar concentrations, but with a maximum concentration of 1,800 mg/kg.

In each of the four deeper borings (borings B-6 through B-9), the bottom sample was found to contain lower concentrations then the samples immediately above. As indicated in Table 3-4, depths at which the concentrations of PCBs in soils are below 10 mg/Kg were 8'-10' feet at B-6, 8'-10' feet at B-7, and 6'-8' feet at B-8. While PCB concentrations at B-9 were not below 10 mg/Kg, the concentrations had dropped from a high of

1,800 mg/Kg to a low of 160 mg/Kg at the 8'-10' depth. Soil samples collected from the five perimeter borings surrounding the area of the shallow core samples indicated detectable concentrations in only 9 of the 23 soil samples, with all detected concentrations at or below 10 mg/kg.

*3.2.4.2. **Ground water***

Ground water samples collected from monitoring wells MW-10, MW-11R, MW-17, MW-18, and MW-19 contained detectable concentrations of Aroclor 1248 during the November 1996 sampling conducted in accordance with the North Gravel Pit investigation. In addition, the second round of monitoring (September 1997) conducted as part of the short-term monitoring indicated concentrations of Aroclor 1242 and 1248 (in a resample) in MW-11R. However, the concentrations found in both monitoring programs are near the NYS Class GA standard of 0.09 $\mu$g/l, indicating that ground water has not been significantly impacted. In addition, PCBs were only detected in unfiltered samples, and not in filtered samples, indicating that PCB contamination is associated with solids suspended in the ground water. Therefore, the presence of PCBs in ground water appears to be minimal and associated with solids.

The quarterly sampling conducted since September 1997 has only exhibited one event (June 1998) where concentrations of PCBs were detected in MW-11R. PCBs were not detected in any of the other wells.
The first and third quarter monitoring in 1998 indicated no detectable concentrations of PCBs. The second quarter 1998 monitoring indicated 0.24 $\mu$g/L of Aroclor 1242 in MW-11R, but no detectable concentrations in the remaining North gravel Pit wells. The North Gravel Pit monitoring wells did not contain sufficient water to collect representative samples during the December 1998 sampling event. The March 1999 monitoring did not indicate detectable concentrations of any PCBs in the North Gravel Pit monitoring wells. The March 1999 sampling was the last event of the short-term monitoring program. The long-term program is currently being established, and will include monitoring of MW-11R.

As discussed in Section 3.2.2, several VOCs were detected in low concentrations in three rounds of ground water monitoring. However, existing data in the North Gravel Pit area does not indicate VOC concentrations in ground water exceeding NYS Class GA standards, with the exception of a principle organic contaminant exceeding the standard of 5 $\mu$g/L (1,1,1-trichloroethane at an estimated concentration of 8 $\mu$g/L in MW-11R during the June 1997 sampling event).

## 3.3. Risk analysis

### 3.3.1. Human health risk analysis

A human health risk assessment was conducted for the Ludlow landfill as part of the 1986 Remedial Investigation/Feasibility Study (O'Brien & Gere, 1986). A potential ground water pathway was identified for the landfill, but the results of ground water monitoring indicated that this pathway was incomplete. The North Gravel Pit situation is similar, with only occasional detections of PCBs in unfiltered ground water samples which are near or below the NYS Class GA standard of 0.09 $\mu$g/L.

NYSDEC's site soil cleanup objectives set forth in NYSDEC TAGM #4046, "Determination of Soil Cleanup Objectives and Cleanup Levels," (January 1994) (as discussed in Section 3.6) are adequate to address potentially unacceptable risks associated with the potentially complete exposure pathways for construction workers. The NYSDEC soil cleanup objectives are based in part on acceptable human health cancer risks ($10^{-5}$ for Class C carcinogens and $10^{-6}$ for Class A and Class B carcinogens). In addition, NYSDEC's levels are based on acceptable human health levels as calculated from reference doses (RFDs) as published in EPA's Health Effects Assessment Summary Tables (HEASTs). As noted in the TAGM, the appropriate cleanup objective is based on the criteria which produces the most stringent cleanup level. Therefore, protection for human receptors is adequately addressed by cutting potential pathways to exposure to PCB concentrations which exceed the soil cleanup objectives in the TAGM.

### 3.3.2. Fish and wildlife impact analysis

This section presents the results of a Fish and Wildlife Impact Analysis (FWIA) conducted for the North Gravel Pit. The FWIA was conducted in accordance with NYSDEC's 1994 guidance document entitled, "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites," and in response to NYSDEC's August 15, 1997 request. The objective of the FWIA is to assess potential impacts to ecological receptors, including potential impacts to off-site surface waters via contaminant transport in ground water. Specifically, Step I (Site Description) and Step II (Contaminant-Specific Impact Analysis: A - Pathway Analysis and B - Criteria-Specific Analysis) of the guidance are addressed in this section. The FWIA was performed based on information obtained from regulatory agencies; an O'Brien & Gere site reconnaissance conducted October 17, 1997; and information generated under other tasks of the Supplemental RI/FS for the site.

Consistent with the guidance, the objectives of this FWIA are to:

- describe the ecology of the Ludlow site and surrounding environs within a 0.5 mile (mi) radius of the North Gravel Pit (study area)
- identify vegetative cover types within the study area and describe the observed and associated fish and wildlife resources
- evaluate the presence of special resources including endangered, threatened or special concern (ETSC) species; regulated wetlands; significant habitats; and rare natural communities
- qualitatively describe the value of the identified resources to associated wildlife and humans
- identify potentially complete exposure pathways for ecological receptors to site constituents
- compare site-specific constituent concentrations in environmental media with applicable regulatory criteria.

The FWIA is organized into four sections as follows:

1. The Study Area Characterization comprises Step I (Site Description) of the guidance, and consists of a characterization of the covertypes of the study area based on vegetation, and identification and association of wildlife species with the covertypes. As required by the guidance, this section also discusses resources other than wildlife, such as ETSC species, significant habitats, rare natural communities and freshwater wetlands that exist within a 2 mi radius of the site (see Figure 3-6).

2. Value of Fish and Wildlife Resources is a qualitative evaluation of the general ability of the study area to provide appropriate habitat for wildlife, and provides a discussion on the use of wildlife resources within the study area by humans.

3. The Exposure Pathway Analysis comprises Steps II A and B of the guidance and provides an evaluation of the potential links between the ecological receptors and the site-related constituents in the environmental media. This section also includes the identification of the applicable regulatory criteria and a comparison of site-specific media data to the appropriate criteria.

4. FWIA Summary and Conclusions presents the findings and conclusions of the FWIA regarding ecological resources and potential ecological exposures within the study area.

***3.3.2.1. Step I - Site description (Study area characterization)***

This section is divided into subsections that describe the physical and biological components of the Ludlow site and study area. This information is used to identify the ecological covertypes of the site and study area, associate wildlife species with the covertypes, and evaluate the quality of the covertypes relative to providing the habitat components necessary for the survival of wildlife species.

Site and study area description

Chapter 1 of this report includes a description of the North Gravel Pit and its surrounding areas. Current physical conditions at the North Gravel Pit are a result of previous remediation efforts, and historical sand and gravel operations at the site. Prior to the 1990-1991 remedial work, the bottom of the North Gravel Pit was approximately 16-18 feet higher in elevation than the current grade. Although information regarding pre-disposal site conditions is not available, the original grade prior to sand and gravel excavations was presumably approximately equal to adjacent grades.

The north and south banks of the pit are sparsely vegetated, steeply sloped, and approximately 20 to 30 ft high. The eastern and western banks are also sparsely vegetated and are sloped significantly less than the north and south banks. Ground water is expressed as surface water in the base of the bowl-shaped pit and covers approximately one quarter to one half acre, depending on seasonal fluctuations in ground water elevations. The remainder of the pit's basal area consists of unvegetated soils.

The study area consists of the land area within a 0.5 mi radius of the North Gravel Pit borders. The dominant land uses within the study area are mining (sand and gravel) and agricultural. Residences, small commercial businesses, roadways and woodlots also exist within the rural study area. The following subsections describe the vegetative covertypes observed during the study area reconnaissance conducted by O'Brien & Gere.

Cover type delineation

In the context of this report, a covertype is defined as an area characterized by a distinct pattern of natural (e.g. forest) or cultural (e.g. residential) land use. Covertype designations were applied based on the dominant vegetation and other physical features observed during the study area reconnaissance and from topographic map interpretation. Covertype designations follow the ecological community descriptions presented in *Ecological Communities of New York State* (Reschke 1990). The description of each identified covertype includes a list of dominant plant species observed during the reconnaissance. Scientific names of observed floral and faunal species are presented in Table 3-8. Ecological communities within the study area consist of terrestrial, palustrine and lacustrine covertypes. Based on the state and global rankings presented in Reschke 1990, none of the covertypes within the study area represents rare ecological communities. A study area covertype map, presenting the relative location and size of the dominant covertypes of the study area, is provided as Figure 3-7.

Terrestrial covertypes

The majority of the upland communities within the study area are considered *terrestrial cultural* covertypes. This designation reflects the extent of human disturbance to the study area for land uses such as residences, roadways, agriculture, landfilling and mining. The study area contains the following *terrestrial cultural* covertypes: *cropland row crops, mine spoils, landfill/dump, rural structure exterior, mowed lawn with trees, pine plantation and paved road.* In addition to the cultural covertypes, the following natural terrestrial covertypes exist within the study area: *successional old field, successional northern hardwoods and maple-basswood rich mesic forest.* The identified covertypes are described below.

*Rural structure exterior, mowed lawn with trees, pine plantation, paved road.* These covertypes are located at various locations within the study area, interspersed with the other covertypes, and are relatively small in area. Vegetation associated with these covertypes includes species planted for ornamental landscaping and agricultural purposes. These covertypes offer little fish and wildlife value due to the lack of sufficient forage, cover and nesting/roosting areas present within them. Therefore, they will not be addressed further in the FWIA.

*Cropland/row crops, mine spoils and landfill/dump.* The larger terrestrial cover types of the study area are the result of anthropogenic activities such as farming, mining and a former landfill operation. Vegetation is typically a mono-culture (single plant species) or non-existent. The major vegetative species observed in the *cropland/row crops* Cover type was corn. Cornfields existed over large tracts mainly in the southwestern portion of the study area (located on the west side of Holman City Road). The former landfill (landfill/dump Cover type), located south of the North Gravel Pit, is currently capped; therefore, vegetative growth is controlled to favor species with shallow root growth (grasses) to stabilize but not erode the cap. Vegetative species were not observed in the active portions of the Ludlow Sand and Gravel mining operation *(mine spoils Cover type)* northeast, east and southeast of the site. The locations of these cover types are represented on Figure 3-7.

*Successional old field.* Various portions of the study area contain meadow areas, less than 10 acres in size, typical of a *successional old field* Cover type. These abandoned fields are dominated by forbs and grasses on sites that may have been historically cleared for farming or development. Characteristic flora included; goldenrod, sumac, wild carrot, aster and dogwood. These areas were bordered by either *rural structure exterior* or *successional northern hardwoods* cover types.

*Successional northern hardwoods.* This Cover type exists at various locations within the study area. The typical size of these areas is between 5 ac and 25 ac. Vegetation consists of trees ranging from 4 inches to 10 inches in diameter with a maximum height of approximately 60 ft, and numerous shrubs and herbaceous species. Canopy trees were dominated by Eastern cottonwood, black cherry, willow, and white ash, with quaking aspen and Norway spruce less common. Understory shrubs observed include: Virginia creeper, raspberry, willow, aspen, sumac and dogwood.

*Maple-basswood rich mesic forest.* This Cover type was also observed at multiple locations within the study area. Typical size of these areas is between 5 and 50 acres with trees ranging from 4 inches to 24 inches in diameter, maximum heights of approximately 80 ft, and a minimal shrub layer. Canopy tree species observed at these locations included: sugar maple, basswood, ash and locust. Understory species observed include: maple, dogwood, raspberry, trillium, blue cohosh and wood fern. It is likely additional herbaceous species existed on the forest floor; however, they were not observed due to the lateness of the season and the significant amount of organic matter on the forest floor due to deciduous trees having dropped their leaves.

<u>Palustrine and lacustrine cover types</u>
Palustrine communities consist of non-tidal perennial wetlands characterized by emergent vegetation (Reschke 1990). Lacustrine communities consist of open water situated in topographic depressions and lacking persistent emergent vegetation (Reschke 1990). Wetland and open water communities observed within the study area are described below.

*Shrub swamp.* This Cover type exists approximately 3000 ft south of the site and borders the southeastern edge of the landfill. This Cover type extends from the eastern edge of the deep emergent marsh (discussed below) to near the western border of Mohawk Road in the southern portion of the study area (Figure 3-7). Much of this area is identified as wetlands on both state and federal wetland maps (Figures 3-8 and 3-9). Total area of the *shrub swamp* Cover type is approximately 18 ac. Predominant vegetative species within the *shrub swamp* and adjacent to the surface water of the *deep emergent marsh* include red osier dogwood, alder and various grasses, sedges and mosses. The central and eastern portions of the Cover type contain additional woody species including hemlock, spruce, willow, witch hazel, button bush and yew.

*Quarry pond* The North Gravel Pit is an aquatic community of an excavated basin that was created from the earlier remedial action. Conditions of the North Gravel Pit prior to site contamination or sand and gravel operations could not be established. The Oneida County Soil and Water Conservation District (see Exhibit I) characterizes the soils in the North Gravel Pit area as "pits, sand and gravel." The surface water of the North Gravel Pit is representative of the *quarry pond* Cover type, and resulted from excavation below the ground water table. Reedgrass and cattail comprise the dominant vegetation of the soils bordering the surface water and cover approximately 25 percent of the shoreline. Submerged algae persisted in the shallower portions (<12 in) of the pond covering approximately 10 percent of the substrate. Although the banks of the pit contained miscellaneous grass species and saplings of cottonwood, bare soils and gravel were dominant.

The surface water in the North Gravel Pit covered a land area of less than one quarter acre at the time of the site reconnaissance on October 17, 1997, and was approximately 20 to 30 feet below the surrounding grade. The average depth of the water was approximately 18 in. Maximum depth could not be measured as access to the center of the ponded water was restricted by the depth and soft consistency of the fine-grained substrate. As discussed in Section 3.1.3, the elevation of the surface water is consistent with that of local ground water. Therefore, the water present in the pond is exposed ground water and may also be influenced by local surface water runoff. Additionally, the pond has no outlet. An eroded channel which drains storm water into the pit was observed on the eastern bank of the pit which drains storm water into the pit. Water quality parameters for the *quarry pond* are presented in Table 3-9. In general, water quality was sufficient to support aquatic life.

*Deep emergent marsh.* Another open water community observed within the study area is the deep emergent marsh located approximately 3000 ft south of the North Gravel Pit and at the southern extreme of the study area. This 3 ac marsh exists along the east side of Holman City Road at the southern base of the former landfill. This marsh is part of Operable Unit #2, and remedial activities which occurred at the marsh are discussed in Section 1.2.1 of this report. The marsh is bordered to the east by the shrub swamp

Cover type described above. Both the deep emergent marsh and the shrub swamp cover types are identified on the New York State Freshwater Wetland Map and the National Wetlands Inventory Map (Figures 3-8 and 3-9). The mowed lawn with trees Cover type exists at the southern edge of the marsh as part of a residence. Aquatic macrophytes found along the shores of the marsh include: cattail, sedge, dogwood and grass species.

The marsh receives runoff from the surrounding area, including the landfill surface and Holman City Road. Surface water discharges from the southwestern end of the marsh to a small (<2 ac) wetland area adjacent to an agricultural field on the west side of Holman City Road. Observed flow (discharge) to the marsh was insignificant. Average depth of the marsh is approximately 3 ft. The NYSDEC surface water classification for the *deep emergent marsh* was determined by O'Brien & Gere to be Class D, which is a default classification for isolated water bodies not otherwise classified in the regulations (6 NYCRR Part 701). Water quality parameters for the *deep emergent marsh* are presented in Table 3-9. In general, water quality was sufficient to support aquatic life.

#### *3.3.2.2. Description of fish and wildlife resources*

The presence of fish and wildlife species in the study area was evaluated during a study area reconnaissance conducted on October 17, 1997, and a literature review. Resident and transient wildlife species observed in the study area were identified based on actual sightings; audible indicators such as bird songs; or other indications such as tracks, burrows or scat. Results of the evaluation are presented below.

*Observed terrestrial wildlife.* Terrestrial wildlife observed during the study area reconnaissance consisted of birds and small mammals. Most species were observed as transient to one or more cover types. No wildlife were observed in the *mine spoils* and *landfill/dump* cover types. The most common bird and small mammal species observed were the black-capped chickadee and gray squirrel, respectively. Table 3-10 presents a list of terrestrial wildlife observed at the North Gravel Pit. Indicators of terrestrial wildlife species were not observed on-site.

*Observed aquatic wildlife.* During the study area reconnaissance, aquatic wildlife were observed in the *deep emergent marsh* and *quarry pond.* Aquatic wildlife presumably did not exist at the quarry pond prior to the 1990-1991 remedial actions.

Benthos evaluations were conducted in these open water communities via dip net. In the *deep emergent marsh*, snails, worms, creek chub, brown bullhead and an unidentified minnow species were observed in the substrate and surface water. Mallard, turkey, great blue heron and American goldfinch were observed in and/or around the *deep emergent marsh*. Additionally, raccoon tracks were observed on the shoreline of the marsh.

In the *quarry pond* of the North Gravel Pit, tadpoles and several species of benthic invertebrates were observed. Additionally, a spotted sandpiper was observed foraging in the shallow (<2 in ) water of the *quarry pond*. Table 3-10 presents a list of aquatic wildlife observed in these cover types.

*Fauna expected to inhabit study area cover types*. Due to the large areas of relatively poor quality habitat (lacking sufficient cover, forage and nesting/roosting areas) existing as the *mine spoils* and *landfill/dump* cover types, wildlife diversity is likely to be the greatest within the natural cover types of the study area existing as the *successional northern hardwoods*, *maple-basswood rich mesic forest* and *successional old field* cover types. Terrestrial amphibians and reptiles, varied avian species, small mammals and white-tailed deer are likely to inhabit the natural terrestrial and palustrine cover types of the study area. Additionally, the *cropland/row crops* Cover type may harbor assorted small mammal and avian species. A list of typical inhabitants of these cover types, as presented in the published literature, is presented as Table 3-11. It is reasonable that the listed species would frequent the respective cover types.

Access to the lacustrine cover types of the North Gravel Pit and study area is limited due to the presence of fencing and roadways adjacent to these cover types. However, avian, resident invertebrate, fish, amphibian and reptilian species are likely to inhabit the aquatic cover types within the study area and their bordering upland areas. Typical inhabitants of the aquatic cover types in the study area, as presented in the published literature, are listed in Table 3-11. It is reasonable that the listed species would frequent the respective cover types.

Special resources

Other fish and wildlife resources, such as ETSC species, significant wildlife habitats, regulated wetlands, or special surface waters that are present within 2 mi of the site were identified through contact with regulatory agencies and review of applicable published information such as state and federal wetlands maps. Letters were sent to the New York State Natural Heritage Program (NHP), NYSDEC's Fish and Wildlife Division, United States Fish and Wildlife Service (USFWS) and the New York State Office of Parks, Recreation and Historic Preservation (OPRHP) requesting information relative to the presence of special resources in the vicinity of the site. A November 5, 1997 response was received from the OPRHP (see Exhibit J) which stated that "...it is the OPRHP's opinion that your project will have No Impact upon cultural resources in or eligible for inclusion in the State and National Registers of Historic Places." Results of the special resource evaluation are presented below.

*ETSC species*. According to the USFWS, no federally listed or proposed endangered or threatened species exist within the study area (Morgan 1997). A Natural Heritage Report (NHR) on Rare Species and Ecological Communities (report), received from the NYSDEC (Mackey 1997), indicated that there were no significant wildlife habitats or special surface waters in the study area. The report indicates that the Crawe sedge, a threatened species, and Schweinitz's sedge, a rare plant species, "may possibly occur" within a 2 mi radius of the North Gravel Pit. However, the last recorded sighting of these species was in 1917 at a minimum distance of 1 mile from the North Gravel Pit. Based on the last recorded sighting of these species approximately 80 years ago at a significant distance from the North Gravel Pit, these plant species are unlikely to be affected by the site and are not further evaluated in the FWIA.

*Wetlands*. A review of the New York State (NYS) Freshwater Wetlands Maps and the USFWS National Wetland Inventory (NWI) Maps for the study area was conducted. Figures 3-8 and 3-9 contain the NYS Freshwater Wetlands and NWI habitats, respectively, located within the study area. Portions of NYS and USFWS recognized wetlands exist within the study area.

The North Gravel Pit is recognized as a palustrine/scrub-shrub/brood-leaved deciduous/seasonally flooded/saturated habitat on the NWI. It should be noted that the NWI habitat map (which does not definitely identify the presence of federal wetlands) referenced for the FWIA and Figure 3-9 were prepared from a 1982 aerial photograph. Subsequent to 1982, the vicinity was modified due to mining, landfilling and remediation activities. Therefore, habitats presented on the NWI map may not typically be reflective of current study area conditions.

The Oneida County Soil and Water Conservation District characterizes the soils in the North Gravel Pit area as "pits, sand and gravel." Based on this description, it would not appear that the soils in this area were hydric soils at the time of the commencement of remedial efforts in 1990-1991. The presence of hydric soils is one of the three mandatory criteria for identification of federally regulated wetlands. Based on the absence of hydric soils at the North Gravel Pit location, it can be concluded that the North Gravel Pit likely was not a federal wetland. This conclusion is consistent with the decision by both the USEPA (see item #1 of the 1988 USEPA

Record of Decision) and NYSDEC (see ¶ 1.10 of the ARP) to remove PCB-impacted soils in the North Gravel Pit.

The North Gravel Pit in its current state is an isolated depression, which is not hydraulically connected by surface water to the off-site wetland areas located to the northwest of the study area. Due to the likelihood that the North Gravel Pit area was not a federal wetland prior to excavation and the fact that the remedial effort at the North Gravel Pit under the Approved Remedial Plan was only postponed, pending the selection of a remedy for the residual PCB contamination, there would be no federal wetlands within the area of the North Gravel Pit to be remediated.

Observations of site-related stress

During the reconnaissance, the study area was examined for evidence of stress such as reduced vegetative growth or density. Except for the removal of vegetation to allow remedial activities to take place (*i.e.*, soil excavation), no signs of stress such as stained soils, leachate seeps, exposed waste, or effects on biota were observed on or in the vicinity of the site.

#### *3.3.2.3. Value of fish and wildlife resources*

The value of the cover types was qualitatively evaluated based on habitat requirements of identified species and field observations. Habitat requirements such as feeding preferences, home range, and cover for species identified in the study area were considered. Field observations used to evaluate habitat quality included: 1) the nature, extent, and diversity of observed wildlife; 2) the availability of suitable habitat in the study area; 3) the size of the habitat; and 4) adjacent land-use patterns.

*Value of habitat to associated fauna.* Wildlife species observed in the study area were consistent with those expected to inhabit rural terrestrial and wetland/aquatic environments. The wildlife habitat quality of the North Gravel Pit is poor and the fencing surrounding the site and intermittent human activity result in low terrestrial wildlife utilization of the site. Aquatic wildlife present in the North Gravel Pit would not have been present if the 1990-1991 remedial action had not occurred. Minimal cover would be afforded to birds and small mammals at the North Gravel Pit and there are insufficient food sources and nesting areas to make the site attractive to a high diversity of terrestrial and aquatic species. Although wildlife was observed on and in the surface water of the North Gravel Pit (see Section 3.4.2.2.), the water level fluctuations (due to ground water elevation changes and influence from surface runoff) and relatively small size of the *quarry pond* limit its ability to support aquatic wildlife. It is more likely the North

Gravel Pit would be used as a resting stop for transient fauna from more suitable cover types such as the *deep emergent marsh* and *maple-basswood rich mesic forest* cover types.

For the majority of the *terrestrial cultural* portions of the study area (excepting the *cropland/row crops* Cover type), suitable wildlife habitat to support a diverse or natural wildlife population is limited. These areas provide inadequate resources to sustain a healthy and diverse wildlife community because of the high degree of development. Food resources are limited and cover is also limited due to the lack of appropriate vegetative species. Based on these considerations, the value of habitat to associated wildlife is low in the *terrestrial cultural* cover types.

The natural terrestrial cover types including the *successional northern hardwoods, successional old field* and *maple-basswood rich mesic forest* cover types are considered higher quality habitat for a variety of wildlife species. Canopy and ground feeding species, such as songbirds (Passerines) and gray squirrel, find suitable food and cover here. Turkey and white-tailed deer may also take advantage of the food sources and available cover of these cover types. However, the relatively small sizes of these portions of the study area may be a limiting factor because of the larger home ranges of these species.

The palustrine and lacustrine communities also provide habitat for fish and wildlife species. The wetland areas in the study area provide sufficient water depth and food sources to attract aquatic furbearers such as muskrat and beaver, or waterfowl such as the wood duck and Canada goose. These communities are also suitable for aquatic invertebrates and a variety of fish, reptiles and amphibians.

*Value of resources to humans*. The wildlife resources within the study area provide little economic value to humans. The *successional northern hardwoods, successional old field* and *maple-bass wood rich mesic forest* cover types may provide sufficient area for big and small game hunting. Angling opportunities within the deep emergent marsh may exist, but access to the surface water may be limited due to property rights. Observations of plant and animal species in the natural cover types of the study area provide limited recreational opportunities, and are also limited due to property rights.

<u>Identification of applicable fish and wildlife regulatory criteria</u>
Contaminant-specific criteria applicable to the North Gravel Pit FWIA include the NYSDEC Ground Water Quality Standards (NYSDEC 1993).

### *3.3.2.4. Step II - Exposure pathway analysis*

As required by Step IIA of the FWIA guidance (Pathway Analysis), an exposure pathway analysis is presented herein. The exposure pathway evaluation identifies the means by which an ecological receptor may be exposed to stressors at or originating from a site. Exposure is defined as the contact of a receptor with a chemical. The three primary routes of exposure are inhalation, ingestion, and dermal contact. Exposure pathways are classified as either complete or incomplete. An exposure pathway is complete when a biotic receptor contacts a physical or chemical stressor under site-specific conditions. The pathway is incomplete when biotic receptors are not exposed under the specified conditions. Exposure pathways are evaluated through a review of the 1) potential source and extent of stressors at the site, 2) biotic receptors present (as described above), and 3) migration pathway between a stressor and the receptor. Information obtained through the performance of the FWIA for these parameters is presented below.

As stated in Chapter 2 of this report, potential impacts to soils, sediment, surface water, and ground water have been evaluated as part of the RI. PCBs have been detected in surface and subsurface soils, and ground water samples collected from the North Gravel Pit. Pathway-specific information is presented below.

*Surface water/ground water exposure pathway.* Aquatic invertebrates, amphibians, reptiles, resident or migratory shore and wading birds, and certain terrestrial small mammals are potential receptors of site-related constituents in water through direct contact and incidental ingestion. However, the surface water at the North Gravel Pit is actually ground water expressed as surface water. Therefore, wildlife inhabiting the North Gravel Pit are likely to contact ground water, and the ground water pathway is complete as surface water of the *quarry pond.*

As previously noted, the remedial action conducted in 1990-1991 has resulted in the current physical conditions which allow for aquatic life in the North Gravel Pit. Also, as discussed in Section 3.3, PCBs tend to adsorb to soil particles and do not readily solubilize in ground water. There is no surface outlet from the North Gravel Pit, so the only pathway to off-site surface water would be via ground water migration.

Ground water monitoring, conducted in accordance with NYSDEC requirements, indicates the presence of PCBs in ground water samples collected from onsite monitoring wells located downgradient from the North Gravel Pit. However, PCB concentrations in ground water have been near or below the NYS Class GA standard of 0.09 $\mu$g/L, and have not been detected in off-site wells. Because of the distance between the downgradient wells and Sauquoit Creek, as well as aquatic communities located approximately 4000 ft northwest of the North Gravel Pit, ground water concentrations observed at the onsite monitoring wells are unlikely to discharge to surface waters in these areas.

*Soil/Sediment exposure pathway.* Aquatic invertebrates, amphibians and reptiles frequenting the *quarry pond* are potential receptors of site-related constituents in soil through direct contact and incidental ingestion. PCBs were detected in soils of the North Gravel Pit; therefore, the soil exposure pathway is considered complete.

*Food chain exposure pathway.* Foraging raptors, ground and plant gleaning birds, migrating or resident shore birds, terrestrial and aquatic amphibians, and small mammals frequenting the North Gravel Pit could be exposed to compounds in sediments that adhere to or bioconcentrate in aquatic food sources (i.e., vegetation and soil invertebrates). Exposure through forage (vegetation, invertebrates and surface water) to ecological receptors is considered a complete exposure pathway.

*Pathway summary.* Complete exposure pathways to North Gravel Pit contaminants exist for aquatic invertebrates, aquatic vertebrates such as amphibians, and terrestrial and aquatic wildlife utilizing the quarry pond through direct contact and incidental ingestion. The aquatic pathway was created by the 1990-1991 remedial action. Additional potential receptors include small mammals able to burrow under or traverse the fence surrounding the site and birdlife potentially frequenting the pond.

There is no surface discharge from the North Gravel Pit. Ground water flows to the northwest towards off-site wetlands and surface waters. Although analytical results from onsite downgradient ground water samples (see Section 3.2.2) indicate PCB concentrations marginally above NYS GA standards, PCBs tend to adsorb to soil particles and do not readily migrate. Therefore, discharge to off-site wetlands and off-site surface waters located to the northwest is unlikely.

Criteria-specific analysis

In accordance with Step IIB of the guidance (Criteria-Specific Analysis), analytical results of water and soil samples collected from the North Gravel Pit were compared to ground water quality standards and soil guidance values. The objective of the screening is to evaluate the potential for impacts to ecological receptors as a result of direct contact with water and soils of the North Gravel Pit. Water PCB concentrations were evaluated against New York State Class GA standards for the protection of aquatic life and wildlife consumers of fish (NYSDEC 1993a). The soil PCB concentrations were evaluated against NYSDEC soil cleanup criteria, benthic aquatic life chronic toxicity sediment criteria, and wildlife bioaccumulation sediment criteria (NYSDEC 1993b). The criteria are based on the organic carbon content of the soil, which was analyzed at the site ranging from 7.4% and 13.6% (mean = 10.5%). Table 3-11 presents the comparison of site PCB media concentrations to the appropriate criteria.

In this case, PCB criteria were exceeded for soils (NYSDEC TAGM 4046), and water (NYSDEC Class GA standards). NYSDEC PCB criteria were developed to be protective of sensitive potential receptors of the specific medium.

Media PCB concentrations below criteria would be protective of potential receptors. Media PCB concentrations above criteria indicate a potential for impact, but do not indicate an actual impact. The potential for impact may require further evaluation if remedial activities do not address exposure of receptors to these media.

#### *3.3.2.5. FWIA summary and conclusions*

A summary of the findings and conclusions of the FWIA are presented below.

- The majority of the study area is highly developed, with dominant cover types classified as *cultural* (created or maintained by human activities), resulting in reduced wildlife diversity when compared to natural cover types.

- Higher quality habitats are interspersed with the *terrestrial cultural* communities and are likely to support a diverse wildlife population. Palustrine and lacustrine cover types offer low to medium quality habitat for diverse wildlife populations; however, numerous wildlife species were observed in both the *quarry pond* on-site and in the *deep emergent marsh* south of the site. Current conditions in the North Gravel Pit which supports aquatic life were apparently created by the 1990-1991 remedial action.

- No ETSC animal species, significant wildlife habitats or special surface waters were identified in the study area. Two protected plant species, the Crawe sedge and Schweinitz's sedge, have been reported by the NHP to exist within a 2 mi radius of the site. However, these plants were last reported approximately 80 years ago and are unlikely to be effected by the site because of their significant distance from the site and the unlikelihood of migration of site constituents to these areas.

- North Gravel Pit water and soil PCB concentrations exceed NYSDEC criteria for the protection of aquatic life.
- Complete exposure pathways were identified on-site for aquatic invertebrates, aquatic vertebrates such as amphibians, and terrestrial and aquatic wildlife utilizing the *quarry pond* for foraging. These exposure pathways were apparently created by the 1990-1991 remedial action.
- Downgradient off-site surface waters and wetlands would not likely be affected due to the propensity for PCBs to adsorb to soil particles. Therefore, off-site wetland or streams located to the northwest of the North Gravel Pit are unlikely to have been impacted. Therefore, off-site impacts to fish, wildlife and resources are not expected.
- Due to the presence of PCB concentrations above applicable guidance criteria, further investigation may be required to evaluate the potential risk to ecological receptors at the North Gravel Pit if remedial measures do not address complete exposure pathways.

## 3.4. Data qualifications

Following receipt of the analytical data reports, data validation was performed by Data Validation Services of North Creek, New York. Data validation reports are attached as Exhibit K.

### 3.4.1. QC excursions

Sample processing was conducted in accordance with analytical protocol requirements and with adherence to quality criteria. Only minimal qualification was necessary, and are discussed in the following sections.

#### *3.4.1.1. Ground water sampling*

*November 5, 1996 Ground Water Sampling.* Data from the first round of ground water sampling was found to be acceptable. Laboratory ID numbers and NYSDEC client ID numbers were reversed on the report form. Holding times, surrogate recoveries, accuracy and precision were within required/recommended limits. Since methylene chloride and acetone were qualified as also having been detected in the associated blank samples, these constituents were qualified as potential contamination unrelated to the site. In addition, PCB results from MW- 17 (unfiltered) were qualified as estimated ("j" qualifier flag) due to low surrogate recoveries.

*February 20, 1997 Ground Water Sampling.* Data from the second round of ground water sampling was found to be acceptable. Since methylene chloride was detected in the associated blank sample, this constituent was qualified as potential unrelated contamination.

*June 10-11, 1997 Ground Water Sampling.* Data from the third round of ground water sampling was found to be acceptable. Only minimal qualification was necessary, due to low level volatile blank contamination.

#### *3.4.1.2. Soil samples*

*January 13-14, 1997 Soil Sampling.* Data from the January 1997 soil sampling event was generally found to be acceptable. Internal chain-of-custody documentation was not maintained by Inchscape Testing Labs, the subcontractor for total organic carbon (TOC) analyses, although sample log in and analyst initials were present on the provided data. One of the equipment blanks was noted as being soil on the chain-of-custody, but was corrected upon log in at O'Brien & Gere Laboratories.

Holding times and instrument parameters for PCB analyses met protocol requirements. Due to poor correlation of individual isomer proportions and/or dual column correlations, Aroclor 1254 results from three samples (B-3 at 16'-18', B-1 at 10'-12', and B-1 at 14'-16') were qualified as being estimated. Analytical results from samples SED-03, SED-05, and matrix spikes of SED-05 may have been biased low due to separation during acid cleanup.

*September 17, 1997 Soil Sampling.* The analytical package initially submitted for this sampling event required corrections due to incorrect dilution factors. The corrected data is included in Appendix D. In the corrected data, some samples required large dilutions due to elevated concentrations of PCBs, which prohibited evaluation of surrogate recoveries and exceeded the solvency of the extraction. Therefore, the following samples were qualified as estimated results:

- B-7 (6'- 8') B-9 (0'- 2')
- B-9 (2'- 4') B-9 (4'- 6')
- B-9 (6'- 8') B-9 (8'- 10')

#### *3.4.1.3. North Gravel Pit water samples*

Data from the two ponded water samples collected as part of the FWIA was found to be acceptable, but the result for Aroclor 1242 was qualified as estimated due to poor correlation of individual congener proportions, and/or dual column correlations.

### 3.5. Site-specific evaluation with respect to potential applicable or relevant and appropriate requirements (ARARs) and to be considered (TBC) material

Applicable requirements are defined in *CERCLA Compliance with Other Laws Manual* (USEPA 1988a) as those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or circumstance at a site. Accordingly, relevant and appropriate requirements are defined as those requirements that, while not specifically applicable to a given substance or circumstance, address concerns or situations sufficiently similar that their use is well suited to that site.

Section 121 of CERCLA, as amended by SARA, requires that remedial actions comply with ARARs under federal or state environmental law at the completion of remedial action. USEPA guidance also suggests evaluation of "to be considered material" (TBCs)(USEPA 1988b). TBCs are non-promulgated advisories or guidance issued by the federal or state governments that are not legally binding but which are relevant for consideration. Three categories of ARARs are required to be considered: chemical-specific, location-specific, and action-specific.

- Chemical-specific ARARs are health-based or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. These numerical values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

- Location-specific ARARs set restrictions on activities based on the characteristics of the site or its immediate environs.

- Action-specific ARARs set controls or restrictions on particular types of remedial actions once the remedial actions have been identified as part of a remedial alternative.

A remedial alternative that does not attain all ARARs may be selected under CERCLA, provided that one or more of six waiver conditions are met, and the alternative remains protective of human health and the environment. The six waiver conditions are:

- interim measures
- greater risk to health and the environment
- technical impracticability
- equivalent standard of performance
- inconsistent application of state requirements
- fund balancing.

Potential ARARs for the North Gravel Pit are identified and described below. Evaluation of compliance with ARARs for each remedial alternative is documented in Section 4.

Remedial activities will be conducted in accordance with the Consent Judgment and the Stipulation. As such, no federal, state, or local permits will be needed.

New York State Class GA standards in 6 NYCRR Part 703 have been identified as potential chemical-specific ARARs for the North Gravel Pit.

Regulations that have been identified as potential action-specific ARARs include:

*Toxic Substances Control Act (TSCA) Regulations.* Regulations promulgated under TSCA specify treatment, storage, and disposal requirements for PCBs based on their form and concentration. These regulations are potentially applicable to remedial alternatives involving handling and disposal of excavated materials as they apply to materials containing PCBs at concentrations equal to or greater than 50 mg/kg upon excavation. Potentially applicable subparts of 40 CFR 761 include:

- 40 CFR 761.1 - Applicability
- 40 CFR 761.40 - Marking Requirements
- 40 CFR 761.45 - Marking Formats
- 40 CFR 761.60 - Disposal Requirements
- 40 CFR 761.65 - Storage for Disposal
- 40 CFR 761.75 - Chemical Waste Landfills
- 40 CFR 761.79 - Decontamination
- 40 CFR 761.125 - Requirements for PCB Spill Cleanup
- 40 CFR 761.180 - Records and Monitoring
- 40 CFR 761.207,208, 215, and 218 - Recordkeeping and Reporting.

*New York State Hazardous Waste Regulations.* PCBs at concentrations equal to or greater than 50 mg/kg are listed as a hazardous waste by New York State hazardous waste regulations in 6 NYCRR Part 371. Therefore, soil which may be removed from the site would be considered hazardous waste if PCB concentrations were 50 mg/kg or more. The following NYS hazardous waste regulations have been identified as potentially applicable, depending upon the chosen alternative:

- 6 NYCRR Part 364 - Waste Transporter Permits
- 6 NYCRR Part 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters, and Facilities
- 6 NYCRR Part 373 - Hazardous Waste Treatment, Storage, and Disposal Facility Requirements.

*State Pollutant Discharge Elimination System (SPDES).* Dewatering of the North Gravel Pit with on-site treatment and discharge, if required, would be addressed under the Consent Judgment. Procedurally, this would be done by modifying the current SPDES permit for the existing landfill leachate treatment facility to add water collected during the dewatering activities, or to add a second outfall.

*Department of Transportation (DOT) Regulations.* The following DOT regulations are potentially applicable to transportation of soil and/or water from the site:

- 49 CFR 172 Use of Hazardous Materials Tables and Communications
- 49 CFR 173 Requirements for Shipping and Packaging
- 49 CFR 174 Carriage by Rail
- 49 CFR 177 Carriage by Public Highway
- 49 CFR 178 Specifications for Packaging
- 49 CFR 179 Tank Car Specifications.

The appropriate DOT regulations would need to be met during transport of contaminated materials from the North Gravel Pit.

*Occupational Safety and Health Administration (OSHA) Regulations.* OSHA requirements for worker safety contained in 29 CFR 1910 and 29 CFR 1926 are potentially applicable for remediation activities. Construction tasks would be implemented in accordance with these requirements.

*New York State Air Quality Standards and Emission Limits.* 6 NYCRR Parts 257 and 212 set forth the potentially applicable NYS air quality standards and air quality emission limits. As PCBs are not highly volatile, and much of the soil to be managed during the remedial activities would be wet, it is not expected that a source of air pollution will be created during the remedial activities.

*New York State Waste Management Facilities Landfill Closure Criteria.* 6 NYCRR Part 360-2.15 outlines the design and construction requirements for solid waste landfill covers. These regulations may be relevant and appropriate to the cover design for the PCB-containing soil.

*NYSDEC Technical and Administrative Guidance Memorandum (TAGM): Determination of Soil Cleanup Objectives and Cleanup Levels (HWR-94-4046), January 1994* provides recommended soil cleanup objectives, and is guidance to be considered (TBC) in evaluating volumes of impacted soil to be addressed.

*USEPA OSWER Directive No. 9355.4-01 "Guidance on Remedial Actions for Superfund Sites with PCB Contamination (August 1990)* provides guidance on cleanup levels and is considered TBC in evaluating cleanup objectives.

## 3.6. Conclusions

PCB contamination in the area of the North Gravel Pit is limited to the soils located in the bottom of the pit. Perimeter soil borings located around the outside of the bottom of the pit and ground water outside of the pit have been shown not to be significantly impacted. Therefore, human health and ecological exposure pathways appear to be limited to direct contact with soils and existing standing water located at the bottom of the pit.

# 4. Supplemental feasibility study for North Gravel Pit

This chapter presents the remedial action objectives identified for the North Gravel Pit and an assessment of appropriate remedial actions. Remedial action objectives are medium-specific goals developed to protect human health and the environment. These objectives are developed based upon promulgated federal and state standards and human health and ecological risk derived values (HHRA and ERA results).

## 4.1. Objectives and overview

The objective of the Supplemental Feasibility Study is to protect human health and the environment from adverse impacts related to residual PCB-impacted soils which were detected in the Supplemental Remedial Investigation.

## 4.2. Development of alternatives

### 4.2.1. Remedial action objectives

PCB-impacted soils have been identified in the soils at the bottom of the North Gravel Pit, and are believed to have resulted from the historical disposal of PCB-contaminated waste oil. Ground water in the vicinity of the North Gravel Pit does not appear to have been significantly impacted. The following remedial action objectives were identified for the North Gravel Pit:

1. Prevent human exposure to PCBs from direct contact in the North Gravel Pit, and

2. Minimize on-site exposure of invertebrates, vertebrates, and terrestrial and aquatic wildlife using the North Gravel Pit for forage.

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To achieve these objectives, a PCB soil cleanup objective of 25 mg/Kg has been identified, to be combined with measures to prevent human or ecological contact with residual soils.

#### 4.2.2. General response actions

General response actions are medium-specific actions that satisfy the remedial action objectives. General response actions that fulfill the North Gravel Pit remedial action objectives include institutional actions, containment actions, disposal actions, and treatment actions.

*Institutional Actions.* Institutional actions may include such actions as deed restrictions, fencing to prevent access, monitoring, and operational modifications. Deed restrictions would be used to limit future activities on the site which may disrupt the contaminated areas, and/or access ground water. Some of these actions, such as fencing, have already been put in place.

Furthermore, the following restriction would apply to sites, like the Ludlow site, which are on the NYSDEC Registry of Inactive Hazardous Waste Sites:

Under 6 NYCRR § 375-1.2 (e)(2)(i), no person shall engage in any activity:

(a) that will, or that reasonably is anticipated to, prevent or interfere significantly with any proposed, ongoing, or completed program at any site listed in the Registry; or

(b) that will, or is reasonably foreseeable to, expose the public health or the environment to a significantly increased threat of harm or damage at any site listed in the Registry.

The foregoing restriction will prohibit any activity which would interfere with the proposed remedy without prior review by NYSDEC (See 6 NYCRR § 375-1.2(e)(2)(ii))

*Containment Actions.* For contaminated soils, containment actions could include using a soil cover, a clay cap, or a multimedia cap. Use of a soil cover would effectively reduce human exposure and ecological contact with PCBs in the soil, and is, therefore, potentially applicable. Use of a clay cap or multimedia cap would provide further protection against vertical migration of PCBs which could have potential impacts to ground water. The installation of a cap has been considered further in the Supplemental Feasibility Study (SFS).

*Disposal Actions.* Disposal actions for contaminated soils would involve the excavation of the material, followed by on-site treatment and replacement, or disposal off-site at a permitted disposal facility. Due to the proximity of the ground water table at the bottom of the North Gravel Pit and the fact that the impacted material is located below the ground water table, conventional excavation may not be feasible, and vacuum dredging, dewatering of the pit, or other methods of water management may be required. Dredging would also require shoring to prevent the collapse of the saturated side walls, and dewatering with treatment of the pumped water prior to discharge. The option of excavation and off-site disposal of contaminated soil has been considered further in this SFS.

*Treatment Actions.* On-site treatment of impacted soils would most likely consist of soil washing to reduce the volume of soil to be disposed off-site. As discussed in Section 2.5 of this SRI/FS, bench scale treatability tests for soil washing were not conducted because of the variability of concentrations found in the soil samples, and the difficulty in segregating soil by their respective concentrations. In addition, soil washing would require wastewater treatment with the associated SPDES permitting and monitoring. As discussed in Section 4.7.1.4., wastewater treatment at this site would likely be technically challenging and would require the construction of an on-site leach field for disposal. Treatment of impacted soil to reduce the volume for off-site disposal has not been considered further in this SFS.

Treatment of water pumped from the pit to allow excavation would most likely involve using activated carbon for treatment of PCBs. The treatment of water from construction dewatering has been considered further in this SFS.

## 4.3. Identification of volumes or areas of contamination

Site conditions, the nature and extent of contamination, potential exposure routes, and acceptable exposure levels were considered to define the volumes or areas of media to be addressed by general response actions. The area of PCB-impacted soils is approximately 0.43 acres, which is the approximate extent of the bottom of the North Gravel Pit. Based on the analytical results discussed in Chapter 4 of this report, and using the New York State PCB soil cleanup objective of 10 mg/kg (a TBC) for subsurface soils, varying depths of soils would be considered contaminated. Based on existing information, the calculated volume of PCB-contaminated soil is 2,775 $yd^3$. This volume is based on an average depth of 2 ft across three-quarters of the bottom area of the North Gravel Pit, with the depth of contamination for the remaining one-quarter of the area being 10 ft.

Not applicable

Using the TSCA spill cleanup goal of 25 mg/Kg (TSCA cleanup standard) for restricted access locations other than outdoor electrical substations (40 CFR Part 761.125(c)(3)(v)) and the OSWER directive on PCBs at CERCLA sites, the estimated volume of contaminated soil would consist of approximately 55 $yd^3$. This area represents the highest concentrations detected, and when combined with various remedial alternatives, provides a sound technical, ecological and cost-effective cleanup goal. This is further discussed in the remaining sections of this chapter.

## 4.4. Identification and screening of remedial technologies and process options

Alternatives were developed by identifying and screening potentially applicable remedial technologies and the process options for each technology. Process options were screened mainly on the basis of their technical feasibility. Infeasible process options were not considered further. The screened technologies and process options identified for the North Gravel Pit are listed in Table 4-1.

Since the North Gravel Pit is currently protected by a chain link fence with a locked gate and the site is governed by the restrictions applicable to sites on the NYSDEC Registry of Inactive Hazardous Waste Sites, some institutional controls are already in place. Screened technologies and process options that are also applicable to the North Gravel Pit are further described in detail as follows:

### 4.4.1. Containment

Capping or placement of soil cover will meet the objective of preventing human and ecological contact with PCB-impacted soils, and has been considered further in this SFS. The use of a grout curtain or sheet piling would not be sufficient for containment due to the absence of an underlying confining layer. Therefore, although sheet piling has been considered further as a component of conventional excavation, it has not been considered further as an alternative for containment. Pressure grouting has been considered further as an alternative for solidifying soils identified as being impacted and for containing impacted soils by injecting grout beneath and around identified areas.

### 4.4.2. *In situ* treatment

*In situ* biological treatment actions may involve the degradation of organic constituents. Due to the stable nature of PCBs in the environment, and the documented limited effectiveness of *in situ* biological treatment of PCBs, this treatment option is not considered further in this SFS.

#### 4.4.3. *Ex situ* treatment

For treatment of PCB soils, *ex situ* treatment may consist of soil washing to reduce the volume of contaminated media to be disposed off-site. Contaminants found in soil generally adhere to the fines, as opposed to the coarse or medium-grained materials. Therefore, separation of the fines from the other soil constituents would concentrate the bulk of the contaminants with the fines and reduce the volume of soil to be treated. Grain size analysis and PCB distribution analysis would be conducted to evaluate the feasibility of soil washing at the site. In addition, surfactants have been shown to enhance the separation process, and could be included in the analysis of the potential application to the site.

Due to the wide range of concentrations encountered in the soils, and the reported source of contamination as waste oil, soil washing would most likely not be an effective treatment option. Segregating soils of varying concentrations would be difficult, as indicated by the wide range of concentrations encountered in the sampling at the bottom of the pit. In addition, PCBs contained in an oil matrix may adhere to larger soil particles in sufficient concentrations to be of concern. Therefore, soil washing was not considered further in this SFS.

### 4.5. Evaluation of process options

Typically, the second phase of the Feasibility Study is the evaluation of process options. In this phase, alternatives are screened on effectiveness, implementability, and cost to limit the number of alternatives that will undergo a detailed analysis. Because a limited number of alternatives were developed for this Supplemental Feasibility Study, there was no evaluation of process options. Therefore, each option that was developed was further evaluated in subsequent sections.

### 4.6. Assembly of remedial alternatives

Based on the evaluation and applicability of remedial technologies and process options, the following remedial alternatives were assembled:

### 4.6.1. Alternative 1 - No action alternative

The No Action Alternative is included in the range of alternatives as required by the NCP and USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA 1988). This alternative provides a benchmark for the evaluation of action alternatives.

This general response action does not contain remedial technologies but can be used to track site conditions in the absence of remediation. The No Action Alternative is typically carried through as an alternative which is used as a basis for comparing the relative attributes of other alternatives. The No Action Alternative often includes access limitations such as deed restrictions and fencing. For the purposes of this SFS, the No Action Alternative includes maintaining the existing fencing, the addition of warning signs, the use of access restrictions. and the continuation of groundwater monitoring as part of the off-site ground water remedial response in the Consent Judgment, with the addition of three additional downgradient ground water monitoring wells..

### 4.6.2. Alternative 2 - Placement of impermeable cap

This alternative would entail the placement of clean fill into the North Gravel Pit to raise the grade sufficiently to allow proper drainage, the installation of an artificial impermeable membrane, a minimum of two feet of soil cover over the membrane, and the establishment of a vegetative cover to minimize erosion (see Figure 4-1).

The soil immediately above the impacted soil would be mounded, and a 40 mil plastic membrane would be placed over the soil to minimize the vertical movement of water through the bottom of the North Gravel Pit. Additional clean fill would be placed in the pit to raise the surface elevation to approximately 1,275 feet. This would allow any surface drainage in the area to drain through an existing culvert under the sand and gravel access road. A swale and culvert would be placed northeast of the pit to divert surface flow to the existing drainage ditch which flows to the north. If necessary, a retention basin would be constructed to regulate this drainage. Ground water monitoring would continue under the existing off-site groundwater remedy set forth under the Consent Judgment, with three additional downgradient ground water monitoring wells.

### 4.6.3. Alternative 3 - Solidification

Under this alternative, pressure grouting would be used to stabilize residual PCB-impacted soils to reduce their permeability and consolidate them into a stable mass. A working platform would be constructed by placing sufficient clean fill to raise the bottom of the North Gravel Pit above water level. Pressurized grout would then be injected in the area of the impacted soils to stabilize the soil mass. For verification sampling, one sample per 100 cu yds of material will be sampled and analyzed for leachability of PCBs.

Following the injection and sufficient curing of the grout material, additional clean fill would be placed several feet over the soil base. This soil would be mounded, and a 40 mil plastic membrane would be placed over the soil to minimize the vertical movement of water through the bottom of the North Gravel Pit. Additional clean fill would be placed in the pit to raise the surface elevation to approximately 1,275 feet, which would allow any surface drainage in the area to drain through an existing culvert under the sand and gravel access road. A swale and culvert would be placed northeast of the pit to divert surface flow to the existing drainage ditch which flows to the north. Ground water monitoring would continue under the existing off-site groundwater remedy set forth under the Consent Judgment, with the addition of two downgradient ground water monitoring wells.

#### 4.6.4. Alternative 4 - Excavation and off-site disposal

This alternative would involve the excavation and off-site disposal of soil containing residual PCB concentrations from the bottom of the North Gravel Pit. As discussed in Section 4.3 of this report, the volume to be removed is estimated to be approximately 2,775 $yd^3$. The soil would be excavated, solidified to remove free liquids, and placed in trucks for off-site disposal.

The excavation would include the installation of approximately 517 linear feet of sheet piling to a depth of 30 feet to allow excavation of three quarters of the area (see Section 4.3) to a depth of 10 feet. An additional 121 linear feet of sheet piling would be installed to a depth of 6 feet to allow excavation of the remaining area to a depth of 2 feet. An alternative to sheet piling would be the use of a grout curtain. However, this option would be more technically challenging and expensive (see Table 4-2), with no corresponding benefit over sheet piling. For verification, end point samples would be collected on a 25 foot grid.

As a deeper pool of water with steep, loose banks could represent a potential physical hazard, clean fill would be used to raise the grade to the approximate original grade. Similar to Alternative 2, a swale and culvert would be placed northeast of the pit to divert surface flow to an existing drainage ditch which flows to the north. Ground water monitoring would continue under the existing off-site groundwater remedy set forth under the Consent Judgment.

**4.6.5. Alternative 5 - Excavation to 25 mg/Kg via caissons**

Much of the area of PCB-impacted soils at the bottom of the North Gravel Pit consist of soils of low or no residual PCB concentrations. In 1990 and 1991, approximately 20,000 cy of PCB impacted material were removed from the North Gravel Pit and placed in the landfill prior to closure (see Section 1.2.3). The objective of this alternative would be to excavate soils containing identified elevated residual concentrations of PCBs, thereby providing a greater efficiency in the remedial effort. Removal of these elevated residual concentrations will be in conjunction with access restrictions, a soil cover, and continued ground water monitoring.

Under this alternative, eight foot diameter sections of pipe would be placed vertically over identified areas of soil contamination identified as exceeding the TSCA cleanup standard of 25 mg/Kg. Clean fill would be placed at the bottom of the North Gravel Pit to a sufficient depth to provide a working platform above the ground water table (see Figure 4-2). Upon completion of the working platform, sections of slightly smaller pipe would be driven vertically to preselected depths (established via previous data) within the previously placed pipe sections. Pressure grout would be injected to depths below and outside the area of the caissons to form plugs to minimize water infiltration, and to provide ballast to counteract buoyancy during excavation of the impacted soils. Additional grout would be placed in the area surrounding Boring B-9, which contains the highest concentrations of PCBs in soil. This grout would extend up to approximately 10 feet outside the caisson, and be placed to a depth of approximately 16 feet. Under this alternative, approximately 55 $yd^3$ of impacted soils would be removed for off-site disposal, with additional soils being stabilized in place. Lower pressure grout would also be used to stabilize the soils in the caissons above the plugs to be removed. An auger would then be used to remove the impacted soils for off-site disposal.

Following excavation of impacted soils, additional clean fill would be placed in the caissons and several feet over the soil base. This soil will be mounded, and a 40 mil plastic membrane will be placed over the soil to minimize the vertical movement of water through the bottom of the North Gravel Pit. Additional clean fill will be placed in the pit to raise the surface elevation to approximately 1,275 feet, which will allow any surface drainage in the area to drain through an existing culvert under the sand and gravel access road. Similar to Alternatives 2 and 3, a swale and culvert would be placed northeast of the pit to divert surface flow to an existing drainage ditch which flows to the north. Ground water monitoring would continue under the existing off-site groundwater remedy set forth under the Consent Judgment. Because of the more focused soil removal effort associated with caisson technology, one additional downgradient well would be installed.

### 4.6.6. Alternative 6 - Excavation via caissons with additional investigations near Boring B-9

Much of the area of PCB-impacted soils at the bottom of the North Gravel Pit consist of soils of low PCB concentrations. The objective of this alternative would be to use available resources to excavate soils containing elevated concentrations of PCBs. Removal of these areas would be in conjunction with access restrictions, a soil cover, and continued ground water monitoring.

This alternative would be similar to Alternative 5, except that greater emphasis would be placed in the vicinity of Boring B-9, which appears to be the area of greatest impact. Three of the six caissons (SED-4, B-7, and B-8) which would be excavated under Alternative 5 would be deleted pending additional investigation results around B-9.

Alternative 6 would allow for additional investigation around the B-9 location, which exhibited the highest concentrations of PCBs in soils, with some or all of the caissons located at SED-4, B-7, and B-8 to be placed near B-9 depending upon the results of the additional sampling. The additional investigation would consist of four additional borings (installed in accordance with the procedures outlined in the 1994 SRI/FS Work Plan), each of which would be placed approximately 15 feet away from B-9. Each boring would be placed to a depth of 16 feet, with soil samples being collected every two foot interval below the current grade via split spoon sampling.

The intent of this alternative is to allow for greater flexibility in the allocation of remedial resources by allowing the relocation of expensive caisson installations from areas marginally exceeding 25 mg/Kg to an area which may be found to be more extensively impacted. This alternative would also allow, if necessary, for the underlying plugs of caissons in close proximity to each other to overlap and for additional grout to be placed between caisson locations. Therefore, additional solidification and/or containment of the remaining soils may be provided.

Following excavation of impacted soils, additional clean fill would be placed in the caissons and several feet over the soil base. This soil will be mounded, and a 40 mil plastic membrane will be placed over the soil to minimize the vertical movement of water through the bottom of the North Gravel Pit. Additional clean fill will be placed in the pit to raise the surface elevation to approximately 1,275 feet, which will allow any surface drainage in the area to drain through an existing culvert under the sand and gravel access road. Similar to Alternatives 2 and 3, a swale and culvert would be placed northeast of the pit to divert surface flow to an existing drainage ditch which flows to the north. Ground water monitoring would continue under the existing off-site groundwater remedy set forth under the Consent Judgment, with one additional downgradient monitoring well.

## 4.7. Detailed analysis of alternatives

The detailed analysis compared the alternatives to nine evaluation criteria that encompass statutory requirements and other gauges of the overall feasibility and acceptability of remedial alternatives. The alternatives were evaluated individually against the criteria, and also comparatively against one another considering the same criteria.

The NCP *Federal Register (March* 8, 1990) categorizes nine criteria into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The two threshold criteria must be satisfied in order for an alternative to be eligible for selection. The primary balancing criteria are used to balance trade-offs among alternatives. The modifying criteria are formally considered after public comment is reviewed on the SRI/FS Report and the proposed plan. The evaluation criteria are:

- Threshold Criteria:
  - Overall protection of human health and environment
  - Compliance with ARARs
- Primary Balancing Criteria:
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume through treatment
  - Short-term effectiveness
- Implementability:
  - Cost
- Modifying Criteria:
  - State acceptance
  - Community acceptance.

Alternatives 1 through 6 were subjected to the detailed analysis. The results of the detailed analysis are discussed in this section and presented in Table 4-2.

### 4.7.1. Individual analysis of alternatives

The following subsections present a detailed discussion of each of the identified alternatives as they pertain to the evaluation criteria. The analysis of each alternative with respect to overall protection of human health and the environment evaluates whether the alternative achieves and maintains adequate protection. It describes how site risks are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. The individual analyses of each alternative with respect to this criterion are presented in Table 4-2.

#### *4.7.1.1. Alternative 1 - No action*

The No Action Alternative would involve a continuation of current access restrictions and the institution of a monitoring program. As presented in Table 4-2, the ecological assessment concludes that applicable ecological-based criteria are exceeded for water and soil in the North Gravel Pit, thereby indicating a potential for impacts to wildlife which may be in contact with this area. Similarly, soils in the bottom of the North Gravel Pit exceed the TSCA Cleanup level of 25 mg/Kg which has been selected as an ARAR for the North Gravel Pit. Since the alternative does not meet the Threshold Criteria, it also does not meet the following four criteria:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability.

With regard to the cost criteria, this alternative has the lowest cost.

#### *4.7.1.2. Alternative 2 - Capping, restoration of grade, and monitoring*

Alternative 2 involves the placement of a cap over the impacted soil, restoring the North Gravel Pit to approximate original grade to allow drainage through an existing culvert, and the institution of a monitoring program. By preventing contact between the PCB-impacted soils and humans/wildlife, this alternative would meet the criteria of protecting human health and the environment, although PCB contamination above the TSCA cleanup standard would remain. Ground water monitoring would evaluate the long-term effectiveness and permanence. Since no treatment would be provided, reductions in toxicity, mobility, or volume would not be provided through treatment, although a reduction in the exposure to toxicity would occur. The short-term effectiveness and implementability would be considered acceptable, and the cost of this alternative is the second lowest, after the "No Action" alternative.

#### *4.7.1.3. Alternative 3 - Solidification via pressure grouting*

Alternative 3 would include the solidification of PCB-impacted soils via pressure grouting, backfilling the North Gravel Pit to allow drainage through an existing culvert, and ground water monitoring. This alternative would be protective of human health and the environment by cutting exposure pathways. Strict compliance with ARARs would not be achieved, since concentrations of PCBs in the solidified matrix would exceed the TSCA cleanup standard. However, the impacted matrix would be less permeable and, therefore, less susceptible to leaching. Long-term effectiveness and permanence would be satisfactory. A reduction in mobility of contaminants would result from treatment of the impacted media with grout since the treated material will have a lower permeability and there will be a greater surface area available for PCBs to adsorb to. Short-term effectiveness of the alternative should be good. Grouting technology is a proven technology, and is readily implementable, although its specialized nature may require advance scheduling based on the limited number of contractors. The estimated cost for this alternative is the highest of the six alternatives considered, being more than twice expensive as the next highest.

#### *4.7.1.4. Alternative 4 - Conventional excavation*

Alternative 4 would protect human health and the environment by removing the main source of the PCB-impacted soils, and would also meet ARARs. This alternative would also meet the criterion for long-term effectiveness and permanence. While there would be a reduction at the site in mobility and volume of PCB-impacted soils, the reduction would not result from treatment. Since Alternatives 2 through 6 would meet the criterion of protecting human health and the environment, the short-term effectiveness of Alternative 4 would be comparable to the others.

The implementability of this alternative would be difficult due to the saturated nature of the impacted media. Dewatering would be necessary, with a SPDES-permitted discharge. However, a suitable receiving water is not available for the discharge, which would likely necessitate the construction of a subsurface leach field. The volume of water needed to dewater the North Gravel Pit may be prohibitive to the construction of an on-site leach field. The saturated environment in the excavation would also provide obstacles to management of the excavation process.

***4.7.1.5. Alternative 5 - Excavation to 25 mg/Kg via caissons***

Alternative 5 would include the excavation via caissons of preselected areas of soils which contain 25 mg/Kg or greater of PCBs, and the restoration of the approximate original grade. In addition, an area around B-9 would also be grouted to stabilize soils. Protection of human health and the environment would be achieved by cutting exposure pathways. Caissons would be placed in a manner to comply with the soil cleanup objective of 25 mg/Kg. This remedy would be expected to be effective on a long-term basis and would result in a reduction in the potential for mobility through the removal of impacted soils for off-site disposal and the solidification of some residual soils. The alternative should also be effective in the short-term. Implementability would entail the use of several common technologies combined in an innovative fashion that may require advance scheduling of appropriate subcontractors. Its cost is competitive with several other alternatives.

***4.7.1.6. Alternative 6 - Excavation via caissons with additional investigation near Boring B-9***

This alternative is similar to Alternative 5, with the exception that six additional borings will be placed in the vicinity of B-9, and (based on the results of this investigation) three of the six caissons could be relocated from areas where marginal remedial benefits would be realized to areas which would provide additional remedial benefits. As with several other alternatives, protection of human health and the environment would be protected by cutting exposure pathways. Strict compliance with the TSCA cleanup standard would not be met, but better encapsulation of some of the remaining soils would be realized by overlapping areas of stabilized soils in the B-9 location, along with the 40 mil liner to be incorporated into the cover.

The alternative is considered to be effective and permanent in the long-term, and would result in a reduction in the potential for mobility through the removal of impacted soils for off-site disposal and the solidification of some residual soils. The alternative should also be effective in the short-term. Implementability would entail the use of specialized technology and may require advance scheduling of appropriate subcontractors. The cost for this alternative is anticipated to be higher than Alternative 5 due to the additional investigation and uncertainty of caisson locations.

## 4.8. Comparative analysis of alternatives

In this section of the detailed analysis of alternatives, each of the alternatives is compared to the others using the initial seven evaluation criteria.

### 4.8.1. Overall protection of human health and the environment

The potential for risk to ecological and human receptors has been identified at the North Gravel Pit. As such, Alternative 1 does not meet the criterion for overall protection of human health and the environment. However, Alternatives 2 through 6 do meet this criterion via remedial actions which would result in incomplete pathways of exposure for both human and ecological receptors. Therefore, routes for exposure would no longer exist. Alternatives 4, 5 and 6 would further remove the source of exposure.

### 4.8.2. Compliance with ARARs

Section 3.5 evaluates potential standards and guidance criteria and lists tentatively identified ARARs and TBCs for the remedial actions proposed in this SRI/FS. The identification of ARARs and TBCs is an iterative procedure, however, that continues throughout the remedial process. As a result, a number of ARARs and TBCs listed in Section 3.5 may be eliminated once the remedial action is selected. The individual analysis of each alternative with respect to this criterion is presented in Table 4-2. As presented in this table, Alternatives 1, 2 and 3 would not comply with the TSCA cleanup standard of 25 mg/Kg. Alternatives 4, 5 and 6 would comply with the TSCA Cleanup standard. Alternatives 2 through 6 would not comply with all ARARs, but would result in incomplete exposure pathways for both human health and ecological risks. The soil exposure pathway would be eliminated and the ground water pathway would be monitored as a part of the ongoing ground water monitoring already in place. The remedial action for the existing closed Ludlow Landfill, which was chosen under the EPA ROD and implemented under the Consent Judgment, is similar to Alternatives 2 through 6 in this regard.

Alternative 1 would not immediately comply with chemical-specific ARARs of TSCA or NYSDEC PCB TAGM Soil Cleanup Objectives (a TBC). While not meeting the TSCA cleanup standard or the 10 mg/Kg PCB subsurface standard set forth in NYSDEC's TAGM #4046, Alternatives 2 and 3 would increase the depth to non-complying soils. Alternative 4 would meet both guidances, and Alternatives 5 and 6 would meet the TSCA cleanup standard of 25 mg/Kg.

Potential action-specific ARARs (OSHA requirements) would not be applicable to Alternative 1, but would be met for Alternatives 2 through 6 by following OSHA requirements during remedial action implementations.

Alternative 4 best meets the criteria for chemical and action-specific ARARs and TBCs.

### 4.8.3. Long-term effectiveness and permanence

The magnitude of residual risk from residual PCB-impacted media at the North Gravel Pit and the adequacy and reliability of controls to manage this risk are assessed for each alternative. The individual analysis of each alternative with respect to this criterion is presented in Table 4-2. As presented in this table, long-term effectiveness is not achieved by Alternative 1 because risks to humans and wildlife from PCB exposure would continue to exist. However, long-term effectiveness is achieved for Alternatives 2 through 6.

Because no controls would be implemented as part of Alternative 1, risks of human health and ecological exposure to PCB-impacted media would continue to exist; therefore, Alternative 1 does not have long-term effectiveness. As part of Alternatives 2 through 6, human health and ecological exposure pathways would no longer be complete; therefore, potential risks would be addressed. Ground water monitoring required under the Consent Judgment would be used in all alternatives to monitor potential impacts to ground water. Therefore, Alternatives 2 through 6 would best meet the criterion for long-term effectiveness and permanence, although Alternatives 2 and 3 would leave residual PCB-impacted materials in place.

### 4.8.4. Reduction in toxicity, mobility, or volume through treatment

The expected performance of treatment technologies employed in each alternative was assessed. The assessment evaluated the treatment alternative's ability to reduce the toxicity, mobility, or volume. The individual analysis of each alternative with respect to this criterion is presented in Table 4-2. Alternative 1 does not involve treatment; therefore, reduction of toxicity, mobility, or volume is not anticipated. Although Alternative 2 does not involve treatment, a reduction in toxicity would be provided by presenting a barrier to ecological and human exposure to the PCB-impacted areas. Since no significant migration of PCBs has occurred in over thirty years, the potential for future mobility of PCBs is not significant. Alternative 3 would provide a reduction in mobility via solidification of impacted soils. Alternatives 4 through 6 would result in a reduction in toxicity and volume at the North Gravel Pit by transferring the material to an off-site landfill, in addition to presenting a barrier to ecological and human exposure to the PCB-impacted soils.

### 4.8.5. Short-term effectiveness

Short-term effectiveness addresses the ability of an alternative to protect workers and the community during construction and implementation of the alternative, environmental effects resulting from implementation of each alternative, and the time required to achieve remedial objectives. The individual analysis of each alternative with respect to this criterion is presented in Table 4-2.

Because no remedial actions would occur in Alternative 1, short-term effectiveness is not applicable. In accordance with USEPA guidance, short-term effectiveness includes the evaluation of the protection of the community. Implementations of Alternatives 2 through 6 would require consideration of dust control measures and adherence to applicable OSHA safety requirements. Reduction of exposure risks to contaminants in PCB-impacted media would be achieved upon Alternative 2 through 6, all of which meet this criterion.

### 4.8.6. Implementability

The following factors are assessed relative to the criterion of implementability:

- ability to construct and operate technologies
- reliability of technologies
- ease of undertaking additional remedial action
- ability to monitor the effectiveness of each remedy
- ability to obtain necessary approvals from other agencies
- availability of services, capacities, equipment, materials and specialists.

The individual analysis of each alternative with respect to this criterion is presented in Table 4-2. There is no action to implement for Alternative 1. Alternative 2 is readily implementable. Alternative 3 involves the extensive use of subsurface grouting in a saturated environment. While not commonly applied as a remedial measure, this technology is readily implementable. Alternative 4 is not readily implementable, due to difficulties which would occur from excavating below the ground water table, and deep shoring would be required to prevent the collapse of side walls. Excavation under saturated conditions would result in considerable mixing of clean and contaminated soil, and would be difficult to control. Alternatives 5 and 6 involves several technologies typically used for construction in saturated environments similar to the bottom of the North Gravel Pit (see Exhibit L). While not typically applied to remedial actions, these technologies are readily implementable.

**4.8.7. Cost**

The objective of evaluating costs during the detailed analysis of alternatives is to make comparative analyses among alternatives based on cost. Cost estimates were prepared based on readily available vendor information, cost estimating guides, and experience with similar contaminants and technologies. Capital costs are those required to implement a remedy and include both direct and indirect capital costs. Annual operation and maintenance (O&M) costs are costs which are expected to be incurred yearly throughout implementation of the remedy, including monitoring costs. The estimated capital and O&M costs were calculated for each alternative, along with a present worth cost. Present worth cost represents the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover costs associated with the remedial action. Present worth costs were calculated for the life of the alternative at a 5% discount rate.

Detailed cost estimates for Alternatives 2 through 6 are presented in Tables 4-3 through 4-7. Because no significant costs are associated with the No Action alternative, a cost estimate was not prepared for Alternative 1. A summary of estimated costs for each alternative is presented in Table 4-2. Cost estimates are considered preliminary (+/- 30%), but are sufficiently detailed for purposes of comparing the alternatives in the SFS. Costs associated with the selected remedial alternative will be refined during the remedial design.

**4.8.8. Modifying criteria (state and community acceptance)**

The modifying criteria of state and community acceptance will be addressed in the Record of Decision (ROD) following the public comment period and implemented in accordance with the terms and conditions of the August 3, 1996 Stipulation to the Consent Judgment.

# 5. Selected remedial alternative for North Gravel Pit

The detailed analysis of the alternatives conducted in Chapter 4 compared each alternative to seven evaluation criteria that encompass ARARs, TBCs, and other gauges of the overall feasibility of remedial alternatives. The alternatives were evaluated individually against the criteria, and also comparatively against one another considering the same criteria. The detailed analysis of alternatives indicated that the six alternatives were not comparable in most areas, especially regarding overall protection of human health and the environment, reduction in toxicity, short and long-term effectiveness, and cost.

Alternative 1 has the least cost because no action is involved. However, this alternative would not reduce the potential human health or ecological risk exposure risks at the site, and therefore is not recommended.

Alternative 2 is readily implementable, would minimize potential risks to human health and the environment, and is similar to the remedial action chosen at the existing closed Ludlow Landfill (Operable Unit #1). No significant ground water impacts have been shown in the area bordering the North Gravel Pit, even though the presence of PCBs has been uncontrolled for approximately thirty years, and the alternative has the lowest estimated cost of the alternatives, other than the No Action alternative.

Alternative 3 would involve solidification of impacted soils via pressure grouting. While this alternative would lower the likelihood of contaminant migration, its cost is more than twice the next costliest alternative, and significant migration of PCBs has not been observed at the site. Alternative 4 would provide the best protection against potential impacts to human health and the environment by removing the bulk of the PCB-impacted soils. However, the North Gravel Pit was operated as an unrestricted disposal area starting approximately 30 years ago, and no significant impact to ground water was observed in the ground water monitoring conducted as part of this SRI/FS. In addition, the implementability of Alternative 4 is lower than the other alternatives, due to difficulty with controlled excavation in a saturated environment, which raises the cost of implementing the alternative.

Alternatives 5 and 6 would remove the identified areas of the most concentrated PCB impacted soils, and would allow for much greater control of the excavation process. As compared to Alternative 4, dewatering and its associated water management requirements would be minimized, and on-site treatment and disposal would not be necessary. Alternative 6 is more expensive than Alternative 5, and while more investigation would be provided around Boring B-9, Alternative 5 would provide solidification of these soils, and would also excavate other sample locations to the soil cleanup goal of 25 mg/Kg.

The recommended alternative is Alternative 5, which consists of the placement of clean fill over the bottom of the pit to allow for an acceptable working platform, excavation of selected impacted areas using caisson technology, further solidification of approximately 576 $yd^3$ of soil surrounding Boring B-9, the placement of an impermeable membrane to minimize the vertical migration of ground water through the remaining soils, and a vegetative cover to protect the cover surface. Also, in order to prevent future erosion of the cap, a swale and culvert would be placed to the northeast of the pit to divert surface drainage away from the area. Verification sampling would involve the placement of one additional ground water monitoring well. This well would be installed to bedrock, and be located near the northwest corner of the Ludlow property, near the intersection of Holman City Road and Cedar Lake Road.

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**Table 1-1.** *Summary of 1988 and 1989 ground water analytical results.*

| Sample description | Date | PCB ($\mu$g/l) | PCB filtered ($\mu$g/l) |
|---|---|---|---|
| MW-10 | 9/13/88 | ND | -- |
| | 7/12/89 | 0.09 | <0.065 |
| | 9/26/89 | <0.065 | -- |
| MW-11 | 9/13/88 | ND | -- |
| | 7/12/89 | 0.17* | <0.065 |
| | 9/26/89 | -- | -- |
| MW-12 | 9/13/88 | 5.5** | -- |
| | 7/12/89 | 10 | <0.065 |
| | 9/26/89 | 0.83 | -- |
| | 11/21/89 | 0.42 | -- |

* Duplicate sample analyzed for well MW-11. Result = 0.6 $\mu$g/l
** Analysis for Aroclor 1254 only.
ND = Not detected at the method detection limit.
-- = Not analyzed.

September 1989 samples analyzed using USEPA 608 methodology to achieve a detection limit below 0.1 ppb.

**Table 1-2.** *1991 soil boring and surface soil PCB analytical results via CLP Method 608.*

| Boring # | Grade elevation (ft.) | Sample depth (ft.) | Sample elevation (ft. AMSL) | PCB (mg/kg) |
|---|---|---|---|---|
| SB-191 | 1284.4 | 21-23 | 1262 | <1 |
| SB-291 | 1277.4 | 13-15 | 1263 | 120 |
| SB-391 | 1280.4 | 17-19 | 1262 | <1 |
| SB-491 | 1284.9 | 21-23 | 1263 | <1 |
| SB591 | 1284.4 | 21-23 | 1262 | <1 |
| SB-691 | 1283.1 | 23-25 | 1259 | <1 |
| SB-791 | 1258.0 | 1-3 | 1256 | 2 |
| SB-891 | 1258.4 | 3-5 | 1254 | 1 |
| SB-991 | 1260.8 | 5-7 | 1255 | 2 |
| SB-1091 | 1258.2 | 5-7 | 1252 | 5 |
| SB-1191 | 1281.3 | 20-22 | 1260 | 35 |
| SB-1191 | 1281.3 | 34-36 | 1246 | <1 |
| SB-1291 | 1283.9 | 21-23 | 1261 | <1 |
| SB-1391 | 1283.4 | 19-21 | 1263 | <1 |
| SB-1391 | 1283.4 | 22-24 | 1260 | <1 |
| SB-1491 | 1289.2 | 23-25 | 1265 | <1 |
| SB-1491 | 1289.2 | 27-29 | 1261 | <1 |
| SB-1591 | 1266.9 | 5-7 | 1261 | 1 |
| SB-1691 | 1284.0 | 21-23 | 1262 | <1 |
| SB-1791 | 1286.8 | 23-25 | 1263 | 1 |
| B-21 | NR | 0-0.5 | NR | 2 |
| B-22 | NR | 0-0.5 | NR | 200 |
| B-23 | NR | 0-0.5 | NR | 770 |
| B-23 | NR | 0-1 | NR | 49 |
| B-24 | NR | 0-0.5 | NR | 850 |
| B-24 | NR | 0-1 | NR | 8 |
| B-25 | NR | 0-1 | NR | 110 |
| B-26 | NR | 0-1 | NR | 44 |
| B-27 | NR | 0-1 | NR | 74 |
| B-28 | NR | 0-1 | NR | 2 |

NR - Not recorded

**Table 1-3.** *October 1991 Soil Investigation PCB analytical results (via CLP Method 608).*

| Sample ID | Aroclor 1254 (mg/kg) |
|---|---|
| NGP002 | 25 |
| NGP003 | 520 |
| NGP006 | 78 |
| NGP009 | 510 |
| NGP010 | 19 |
| NGP011 | 23 |
| NGP012 | 40 |
| NGP013 | 2000 |
| NGP014 | 68 |
| NGP015 | 2 |
| NGP016 | 240 |
| NGP017 | 690 |

**Table 2-1.** *Soil boring Installation data*

| Boring | Approximate surface elev. | Boring depth (ft) | Bottom elevation |
|---|---|---|---|
| B-1 | 1,262 | 16 | 1,246 |
| B-2 | 1,282 | 32 | 1,250 |
| B-3 | 1,264 | 20 | 1,244 |
| B-4 | 1,274 | 26 | 1,248 |
| B-5 | 1,265 | 16 | 1,249 |
| B-6 | 1,256 | 8 | 1,248 |
| B-7 | 1,256 | 8 | 1,248 |
| B-8 | 1,256 | 8 | 1,248 |
| B-9 | 1,256 | 8 | 1,248 |

**Table 3-1.** *Ground water elevation data - North Gravel Pit.*

| Monitoring well | Depth to water | 11/6/96 | Depth to water | 2/20/97 | Depth to water | 6/10 - 11/97 |
|---|---|---|---|---|---|---|
| MW-10 | 19.42 | 1258.29 | 17.40 | 1260.31 | 16.16 | 1261.55 |
| MW-11R | 22.36 | 1256.54 | 24.93 | 1258.97 | 22.97 | 1260.93 |
| MW-17 | 13.17 | 1260.74 | 10.91 | 1263.00 | 10.41 | 1263.50 |
| MW-18 | 14.98 | 1256.94 | 13.51 | 1258.35 | 12.94 | 1258.98 |
| MW-19 | 41.21 | 1256.49 | 38.79 | 1258.91 | 36.74 | 1260.96 |

**Table 3-2.** *Summary of shallow core samples - North Gravel Pit (1/14/97)*
*(All results for Aroclor 1254 in mg/kg)*

| Sample | Result |
|---|---|
| SED 01 | 16 |
| SED 02 | 260 |
| SED 03 | 13 |
| SED 04 | 38 |
| SED 05 | 23 |
| SED 06 | 540 |
| SED 07 | 22 |
| SED 08 | 1.5 |

**Table 3-3** *January 1997 perimeter soil boring results - North Gravel Pit (all results for Aroclor 1254 in mg/kg)*

| Depth (ft) | Concentration |
|---|---|
| *Boring B-1:* | |
| 4 - 6 | 1.2 |
| 10 - 12 | 4.9 |
| 14 - 16 | 0.82 |
| *Boring B-2:* | |
| 4 - 5 | 2.1 |
| 10 - 12 | 0.4 |
| 14 - 16 | 0.12 |
| 20 - 22 | <0.021 |
| 24 - 26 | <0.020 |
| 28 - 30 | <0.019 |
| *Boring B-3:* | |
| 2 - 4 | <0.018 |
| 6 - 8 | 0.057 |
| 8 - 10 | 0.30 |
| 12 - 14 | 0.67 |
| 16 - 18 | 0.60 |
| *Boring B-4:* | |
| 4 - 6 | <0.020 |
| 8 - 10 | <0.019 |
| 14 - 16 | <0.019 |
| 16 - 18 | <0.019 |
| 20 - 22 | <0.019 |
| 24 - 26 | <0.019 |
| *Boring B-5:* | |
| 0 - 2 | 10 |
| 4 - 6 | <0.021 |
| 6 - 8 | <0.020 |
| 10 -12 | <0.019 |
| 14 - 16' | <0.019 |

**Table 3-4.** *Summary of Data From September 1997 Soil Borings - North Gravel Pit (All results for Aroclor 1254 in mg/kg).*

| Boring B-6 Depth (ft) | Concentration | Boring B-7 Depth (ft) | Concentration |
|---|---|---|---|
| 0-2 | 25 | 0-2 | 0.16 |
| 2-4 | 8.5 | 2-4 | 0.85 |
| 4-6 | 15 | 4-6 | 0.66 |
| 8-10 | 0.3 | 6-8 | 49 |
| | | 8-10 | 0.24 |
| **Boring B-8 Depth (ft)** | **Concentration** | **Boring B-9 Depth (ft)** | **Concentration** |
| 0-2 | 31 | 0-2 | 750 |
| 6-8 | 7.2 | 2-4 | 750 |
| 8-10 | 1.1 | 4-6 | 1800 |
| | | 6-8 | 290 |
| | | 8-10 | 160 |

**Table 3-5.** *Ground water monitoring field data - North Gravel Pit.*

| Date/Well no. | Temperature | pH | Conductivity |
|---|---|---|---|
| ***November 6, 1996:*** | | | |
| MW-10 | 52.6°F | 7.14 | 87.5 μs |
| MW-11R | 49.2°F | 6.88 | 911μs |
| MW-17 | 50.6°F | 7.63 | 440 μs |
| MW-18 | 57.6°F | 6.30 | 1.05 μs |
| MW-19 | 48.9°F | 7.35 | 355 μs |
| ***February 20, 1997:*** | | | |
| MW-10 | 49.3°F | 6.98 | 906 μs |
| MW-11R | 48.6°F | 6.83 | 1,281 μs |
| MW-17 | 47.4°F | 7.67 | 500 μs |
| MW-18 | 47.5 °F | 7.12 | 566 μs |
| MW-19 | 49.3 °F | 7.51 | 422 μs |
| ***June 10-11, 1997:*** | | | |
| MW-10 | 54°F | 6.88 | - |
| MW-11B | 57°F | 6.89 | - |
| MW-17 | 52°F | 6.50 | - |
| MW-18 | 56°F | 7.01 | - |
| MW-19 | 54°F | 7.16 | - |

**Table 3-6.** *Summary of ground water PCB data - North Gravel Pit (in μg/L)*

| Well | 11/96 | 2/97 | 6/97 | 9/97 | Resample | 12/97 | 3/98 | 6/98 | 9/98 | 12/98 | 3/99 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-10 | ND | ND | ND | ND | - | ND | ND | ND | ND | Dry | ND |
| MW-11R | 0.39 (1248) | ND | ND | 0.13 (1242) | 0.11 (1248) | ND | ND | 0.24 (1242) | ND | Dry | ND |
| MW-17 | 0.10 | ND | ND | - | - | - | - | - | - | - | - |
| MW-18 | 0.078 | ND | ND | - | - | - | - | - | - | - | - |
| MW-19 | 0.26 | ND | ND | ND | - | ND | ND | ND | ND | Dry | ND |

Note: All results presented are for unfiltered samples. No PCBs were detected in filtered samples. Specific Aroclors are noted after concentrations.

**Table 3-7.** *Summary of ground water VOC data - North Gravel Pit (in $\mu g/L$)*

| Well/compound | 11/96 | 2/97 | 6/97 |
|---|---|---|---|
| **MW-10** | | | |
| Acetone | 4 JB | ND | 3 J |
| Methylene chloride | ND | 1 J | 2 J |
| **MW-11R** | | | |
| Methylene chloride | 2 J | ND | ND |
| Acetone | 3 JB | ND | 7 J |
| 1,1,1-Trichloroethane | 1 J | ND | 8 J |
| **MW-17** | | | |
| Methylene chloride | 2 J | ND | ND |
| Acetone | 4 JB | ND | 2 J |
| 1,1-Dichloroethane | 1 J | ND | ND |
| 1,1,1-Trichloroethane | 4 J | 2 J | 3 J |
| **MW-18** | | | |
| Acetone | ND | ND | 1 J |
| Methylene chloride | 2 J | ND | ND |
| 1,1,1-Trichloroethane | 3 J | 2 J | 2 J |
| Tetrachloroethene | 1 J | 1 J | 2 J |
| **MW-19** | | | |
| Methylene chloride | 2 J | ND | ND |
| Acetone | ND | ND | 1 J |

**Table 3-8**. *Scientific names of referenced species.*

| Common Name | Scientific Name |
| --- | --- |
| ***Plants*** | |
| Eastern hemlock | Tsuga canadensis |
| sugar maple | Acer saccharum |
| white ash | Fraxinus americana |
| willow | Salix spp. |
| raspberry | Rubus spp. |
| American basswood | Tilia americana |
| locust | Robinia sp. |
| black cherry | Prunus serotina |
| quaking aspen | Populus tremuloides |
| white birch | Betula papyrifera |
| Eastern cottonwood | Populus deltoides |
| Norway spruce | Picea abies |
| Crawe sedge | Carex crawei |
| Schweinitz's sedge | Carex schweinitzii |
| witch hazel | Hamamelis virginiana |
| buttonbush | Cephalanthus occidentalis |
| staghorn sumac | Rhus typhina |
| speckled alder | Alnus rugosa |
| Virginia creeper | Parthenocissus quinquefolia |
| sedges | Scirpus spp. |
| grasses | Grammae spp. |
| reedgrass | Phragnites spp. |
| cattails | Typha latifolia |
| red-osier dogwood | Cornus stolonifera |
| poison ivy | Rhus radicans |
| wood fern | Dryoptris |
| goldenrod | Solidago spp. |
| American yew | Taxus canadensis |
| moss | Sphagnum spp. |
| wild carrot | Daucus corota |
| aster | Aster spp. |
| trillium | Trillium spp. |
| blue cohosh | Caulophyllum thalictroides |
| ***Wildlife*** | |
| white-tailed deer | *Odocoileus virginianus* |
| muskrat | *Ondatra zibethica* |
| beaver | *Castor canadensis* |
| wood duck | Aix sponsa |
| Canada goose | Branta canadensis |

**Table 3-9.** *Water quality parameters of North Gravel Pit waters.*

| Parameter (1) | Quarry pond | Deep emergent marsh |
|---|---|---|
| pH | 5.67 | 5.74 |
| Conductivity (mS/cm) | 0.466 | 0.595 |
| Temperature (deg C) | 6.9 | 8.5 |
| Turbidity (NT units) | 40 | 27 |

Notes:

1 = dissolved oxygen measurements were discarded due to instrument failure.

Measurements conducted using a Horiba model u-10 field instrument on October 23, 1997.

**Table 3-10.** *Observed study area wildlife*

| Species | Scientific name | Location/Indicator |
|---|---|---|
| various aquatic invertebrates | *Odonata, Ephemeroptera, Coleoptera, Hemiptera* | quarry pond |
| tadpoles | *Amphibia* | quarry pond |
| creek chub | *Semotilus atromaculatus* | emergent marsh |
| brown bullhead | *Ictalurus nebulosus* | emergent marsh |
| American goldfinch | *Carduelis tristis* | shrub swamp |
| black-capped chickadee | *Parus atricapillus* | cultural areas |
| red-tailed hawk | *Buteo jamaunicensis* | transient |
| wild turkey | *Memeagris gallopavo* | old field |
| hairy woodpecker | *Picoides pubescens* | cultural areas |
| downy woodpecker | *Picoides villosus* | cultural areas |
| brown creeper | *Certhia americana* | northern hardwoods |
| American crow | *Corvus brachyrhynchos* | transient |
| blue jay | *Cyanocitta cristata* | northern hardwoods |
| song sparrow | *Melospiza melodia* | cultural areas |
| sparrow | *unidentified* | cultural areas |
| great blue heron | *Ardea herodius* | emergent marsk/track |
| mallard | *Anas platyrhynchos* | emergent marsh |
| spotted sandpiper | *Actitis macularia* | quarry pond |
| gray squirrel | *Sciurus carolinensis* | siting |
| racoon | *Procyon lotor* | emergent marsh/tracks |

**Table 3-11.** *Typical inhabitants of study area covertypes – Lacustrine and palustrine.*

**Fishes**

Central Mudminnow
Chain Pickerel
Golden Shiner
Green Sunfish
Least Killifish
Starhead Topminnow
Swamp Darter
Creek Club
Brown Bullhead

**Amphibians**

Green Frog
Lesser Siren
Mud Salamander
Pickerel Frog
Red Salamander
River Frog
Spotted Salamander
Spring Peeper
Striped Chorus Frog
Two-lined Salamander
Wood Frogs
Bullfrog

**Reptiles**

Black Swamp Snake
Brown Snake
Brown Water Snake
Cottonmouth
Flattened Musk Turtle
Green Water Snake
Mud Snake
Northern Water Snake
Razorback Musk Turtle
Slider
Timber Rattlesnake
Wood Turtle

**Birds**

Barred Owl
Black-crowned Night Heron
Great Blue Heron
Red-winged Blackbird
Pied-billed Grebe
Prothonotary Warbler
Red-bellied Woodpecker
Red-shouldered Hawk
Swamp Sparrow
Wood Duck
Least Bittern
Night Heron

**Mammals**

Black Bear
Cotton Mouse
Golden Mouse
Moose
Raccoon
Smoky Shrew
Red-backed Vole
Star-nosed Mole
White-tailed Deer

**Table 3-11.** *Typical inhabitants of study area covertypes – Old field and hardwood forest.*

**Amphibians**

American Toad
Common Gray
Treefrog
Eastern Newt
Fowler's Toad
Mountain Dusky
Salamander
Pickerel Frog
southern Leopard Frog
Spring Peeper
Tiger Salamander
Wood Frog

**Reptiles**

Broadhead Skink
Coal Skink
common Garter Snake
Common Kingsnake
Copperhead
Corn Snake
Eastern Box Turtle
Five lined Skink
Ground Skink
Milk Snake
Painted Turtle
Racer
Rat Snake
Timber Rattlesnake
Wood Turle

**Birds**

Acadian Flycatcher
American Redstart
American Robin
American Woodcock
Barred Owl
Black-and-white
Warbler
Black-billed Cuckoo
Blue-gray Gnatcatcher
Blue Jay
Broad-winged Hawk
Brown Thrasher
Cardinal
Carolina Chickadee
Cedar Waxwing
Common Crow
Copper's Hawk
Downy Woodpecker
Eastern Screech Owl
Eastern Wood-Pewee
Great Horned Owl
Hairy Woodpecker
Hooded Warbler
Kentucky Warbler
Long-eared Owl
Mourning Dove
Norther Flicker
Norther Parula
Northern Saw-whet Owl
Ovenbird
Pileated Woodpecker
Pine Warbler
Red-bellied
Woodpecker
Red-cockaded
Woodpecker
Red-eyed Vireo
Red-shouldered Hawk
Red-tailed Hawk
Rose-breasted Grosbeak
Ruby-throated
Hummingbird
Rufous-sided Towhee
Scarlet Tanager
Sharp-shinned Hawk
Summer Tanager
Tufted Titmouse
Whip-poor-will
White-breasted
Nuthatch
White-eyed Vireo
Wild Turkey
Wood Duck
Wood Thrush
Worm-eating Warbler
Yellow-breasted Chat
Yellow-throated Vireo

**Table 3-11.** *Typical Inhabitants of study area covertypes – Old field and hardwood forest. (continued)*

| **Mammals** |
|---|
| Beaver |
| Cotton Mouse |
| Deer Mouse |
| Eastern Chipmunk |
| Eastern Cottontail |
| Eastern Spotted Skunk |
| Eastern Woodrat |
| Fox Squirrel |
| Gray Fox |
| Gray Squirrel |
| Hoary Bat |
| Long-tailed Weasel |
| New England Cottontail |
| Raccoon |
| Red Fox |
| Short-Tailed Shrew |
| Striped Skunk |
| Virginia Opossum |
| White-footed Mouse |
| White-tailed Deer |
| Woodchuck |
| Woodland Vole |

Source: Reschke (1990); Chambers (1983)

**Table 3-12.** *North Gravel Pit Media Criteria Comparison.*

| Total PCBs | North Gravel Pit Water ($\mu$g/l) | | | Soil | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel Pit | Class GA | Wildlife AWQC (2) | Gravel Pit (mg/kg) | NYS TAGMs | Chronic $Sc_{og}$ ($\mu g/g_{og}$) (3) | Wildlife $Sc_{og}$ ($\mu g/g_{og}$) (4) | % Organic Carbon | Chronic SC (mg/kg) (5) | Wildlife SC (mg/kg) (6) |
| **Maximum** | 3.5 | 0.1 | .001 | 540 | 10 | 19.3 | 1.4 | 10.5 | 2.03 | 0.147 |
| **Mean** | 3.0 | | | 114 | | | | | | |

Notes:
(1) - Benthic Aquatic Life Chronic Toxicity Water Quality Criteria (NYSDEC 1993a)
(2) - Wildlife Bioaccumulation Water Quality Criteria (NYSDEC 1993a)
(3) - Organic Carbon Normalized Benthic Aquatic Life Chronic Toxicity Sediment Criteria (NYSDEC 1993b)
(4) - Organic Carbon Normalized Wildlife Accumulation Sediment Criteria (NYSDEC 1993b)
(5) - Benthic Aquatic Life Chronic Toxicity Sediment Criteria (NYSDEC 1993b)
(6) - Wildlife Accumulation Sediment Criteria (NYSDEC 1993b)

**Table 4-1.** ***Screened technologies and process options***

| General response action | Remedial technology | Process option | Description | Screening comments |
|---|---|---|---|---|
| No action | None | Not applicable | No action | Required for consideration by National Contingency Plan (NCP). |
| Institutional actions | None | Sign posting | Installation of signs warning of presence of PCB-impacted materials | Potentially applicable |
| | Use Restriction | Deed Restriction | Limit future use of the area of the North Gravel Pit. | Potentially applicable |
| | Monitoring | Ground water monitoring | Periodic ground water sampling and analysis to document ground water quality | Potentially applicable |
| Containment actions | Cover | Low permeability cover | Synthetic membrane or clay cover over residual PCB-impacted area | Would prevent vertical migration of ground water. Potentially applicable |
| | | Soil cover | Vegetated soil cover over residual PCB-impacted area to prevent human or ecological contact. | Potentially applicable |
| Removal actions | Excavation below water level via conventional methods. | Backhoes, front-end loaders, cranes, shoring, dewatering and treatment systems | Removal of soil using standard construction equipment in dewatered areas. Impacted soil would then be disposed or treated (see disposal and treatment actions). | Potentially applicable |

**Table 4-1.** ***Screened technologies and process options***

| General response action | Remedial technology | Process option | Description | Screening comments |
|---|---|---|---|---|
| Removal actions *(continued)* | Strategic excavation of predetermined areas of higher concentrations of residual PCB-impacted material. | Excavation via caisson technology. | Installation of caissons at predetermined locations, with grouted plugs at the bottom of the caisson to prevent ground water infiltration and counter buoyancy. Impacted soil would then be removed (see disposal and treatment actions). | Potentially applicable |
| Disposal actions | Commercial landfill | TSCA landfill | Solidification (if necessary) with transportation and disposal of TSCA (and NYSDEC RCRA) regulated PCB-impacted soil at a commercial permitted landfill | Potentially applicable |
| | | Subtitle D landfill | Solidification (if necessary) with transportation and disposal of non-TSCA (or NYSDEC RCRA) regulated soil at a commercial permitted landfill. | Potentially applicable for soil containing PCBs at concentrations less than 50 mg/kg. This may require additional soil characterization. |
| Treatment actions | Thermal treatment | Incineration | Combustion of PCBs in soil in mobile on-site or off-site incineration unit. | Potentially applicable for off-site thermal treatment. Volume of material to be burned would not be cost-effective for on-site thermal treatment. |
| | | *In situ* vitrification | Application of high power electrical current to transform soil into pyrolyzed mass, immobilizing PCBs. | Not feasible due to the soil water content. |

**Table 4-1.** ***Screened technologies and process options***

| General response action | Remedial technology | Process option | Description | Screening comments |
|---|---|---|---|---|
| Treament actions *(continued)* | Chemical treatment | Chemical dechlorination | Nucleophilic substitution reaction using chemical reagents to dechlorinate PCBs in soil | Not feasible due to the low volume of impacted soil to be remediated and the range of concentrations found. |
| | | Solvent extraction | Use of solvent to extract and concentrate PCBs from soil | Not feasible due to the low volume of impacted soil to be remediated and the range of concentrations found. |
| | Physical treatment | Soil washing | Aqueous-based separation of PCBs and finer-grained soil from coarser grained soil | Not feasible due to the low volume of impacted soil to be remediated and the range of concentrations found. |
| | | Solidification/ stabilization | Addition and mixing of solidification/stabilization agents to soil to immobilize PCBs | Potentially applicable |
| | Biological treatment | *In situ* | Degradation of PCBs in soil in place by enhancing conditions for naturally occurring microorganisms | Not applicable due to concentrations of PCBs found and the difficult nature of reaching degradation goals with PCBs. |
| | | *Ex situ* | Degradation of PCBs in soil by enhancing conditions for naturally occurring microorganisms via slurry-phase, composting, or landfarming methods | Not applicable due to concentrations of PCBs found and the difficult nature of reaching degradation goals with PCBs. |

Table 4-2. *Detailed analysis of remedial alternatives*

| Criteria | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 | Alternative 6 |
|---|---|---|---|---|---|---|
| | ***No Action***<br>***- Signs***<br>***- Access restrictions***<br>***- Ground water monitoring*** | ***Soil Cover***<br>***- Signs***<br>***- Access restrictions***<br>***- Soil cover***<br>***- Synthetic membrane***<br>***- Backfill to approximate original grade***<br>***- Ground water monitoring*** | ***Solidification***<br>***- Signs***<br>***- Access restrictions***<br>***- Solidification via pressure grouting***<br>***- Backfill to approximate original grade***<br>***- Ground water monitoring.*** | ***Conventional Excavation***<br>***- Signs***<br>***- Access Restrictions***<br>***- Conventional Excavation (with Cleanup Goal of 10 ppm)***<br>***- Off-Site Disposal***<br>***- Backfill to Approximate Original Grade***<br>***- Ground Water Monitoring*** | ***Coventional Caissons***<br>***- Signs***<br>***- Access Restrictions***<br>***- Excavation (with Cleanup Goal of 25 ppm) via Caissons***<br>***- Solidification around Boring B-9***<br>***- Off-Site Disposal***<br>***- Backfill to Approximate Original Grade***<br>***- Ground Water Monitoring*** | ***Nested Caissons***<br>***- Signs***<br>***- Access Restrictions***<br>***- Nested Caissons around Boring B-9***<br>***- Off-Site Disposal***<br>***- Solidification around Boring B-9 (as necessary)***<br>***- Backfill to Approximate Original Grade***<br>***- Ground Water Monitoring*** |
| **Overall Protection of Human Health and the Environment** | | | | | | |
| Protection of Human Health | Access restrictions would reduce the potential for direct contact exposure. | Soil cover would minimize direct contact with residual PCBs, minimize the potential for their vertical migration, and reduce the potential for human health exposure. Access restrictions would restrict access that could result in breaching of the integrity of the cover. The use of appropriate protective equipment during remedial activities would minimize potential threats to remedial workers. | Soil cover would prevent direct contact with residual PCB-impacted soils. Solidification would further reduce the potential for residual PCB migration via groundwater. Access restrictions would restrict access that may result in breaching of the integrity of the cover and contact with soil. The use of appropriate protective equipment during remedial activities would minimize the potential threat to remedial workers. | Excavation and transport of excavated soil to a TSCA-permitted commercial landfill would minimize direct contact with PCBs, although the contaminants would be transferred to another site. Potential hazards to humans due to transportation of PCB impacted soil for off-site disposal would be minimized via compliance with DOT requirements. The use of appropriate protective equipment during remedial activities would minimize potential threats to remedial workers. | Soil cover would prevent direct contact with residual PCB-impacted soils. Excavation and transport of excavated soil to a TSCA-permitted commercial landfill would minimize direct contact with PCBs. Potential hazards to humans due to transportation of PCB impacted soil for off-site disposal would be minimized via compliance with DOT requirements. The use of appropriate protective equipment during remedial activities would minimize potential threats to remedial workers. | Soil cover would prevent direct contact with residual PCB-impacted soils. Excavation and transport of excavated soil to a TSCA-permitted commercial landfill would minimize direct contact with PCBs. Potential hazards to humans due to transportation of PCB impacted soil for off-site disposal would be minimized via compliance with DOT requirements. The use of appropriate protective equipment during remedial activities would minimize potential threats to remedial workers. |

**Table 4-2.** *Detailed analysis of remedial alternatives*

| Criteria | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 | Alternative 6 |
|---|---|---|---|---|---|---|
| Protection of Environment | Potential ecological exposure not addressed. | Soil cover would reduce direct contact with residual PCB- impacted soil by ecological receptors and minimize the potential for the vertical migration of PCBs. | Soil cover and solidification would reduce direct contact with residual PCB-impacted soil by ecological receptors. | The majority of the source material would be removed from the site. Soil cover would reduce direct contact with remaining residual PCB-impacted soil by ecological receptors. | The removal of impacted soils, and the placement of soil cover would reduce direct contact with residual PCB-impacted soil by ecological receptors. | The removal of impacted soils, and the placement of soil cover would reduce direct contact with residual PCB-impacted soil by ecological receptors. |
| **Compliance with ARARs** | | | | | | |
| Location-Specific ARARs | None | None | None | None | None | None |
| Action-Specific ARARs | None | Particulate air quality standard would be attained through dust control. OSHA and DOH requirements would be followed during construction. | Particulate air quality standard would be attained through dust control. OSHA requirements would be followed during construction. | Impacted soil would be cleaned to the NYS Soil Cleanup Objective of 10 mg/Kg. Excavated soil would be disposed of at a TSCA-approved/RCRA permitted disposal facility. RCRA and DOT requirements would be attained during transportation. Marking and decontamination would meet TSCA requirements. RCRA and TSCA generator requirements would be followed. Particulate air quality standard would be attained through dust control. OSHA requirements would be followed during construction. | Soil would be excavated to the TSCA cleanup standard of 25 mg/Kg. Excavated soil would be disposed of at a TSCA-approved/RCRA permitted disposal facility. RCRA and DOT requirements would be attained during transportation. Marking and decontamination would meet TSCA requirements. RCRA and TSCA generator requirements would be followed. Particulate air quality standard would be attained through dust control. OSHA requirements would be followed during construction. | Soil would be excavated to the TSCA cleanup standard of 25 mg/Kg, although isolated pockets of soil with PCB concentrations marginally exceeding 25 mg/Kg may remain. Excavated soil would be disposed of at a TSCA-approved/RCRA permitted disposal facility. RCRA and DOT requirements would be attained during transportation. Marking and decontamination would meet TSCA requirements. RCRA and TSCA generator requirements would be followed. Particulate air quality standard would be attained through dust control. OSHA requirements would be followed during construction. |

Table 4-2. *Detailed analysis of remedial alternatives*

| Criteria | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 | Alternative 6 |
|---|---|---|---|---|---|---|
| **Long-Term Effectiveness and Permanence** | | | | | | |
| Magnitude of Residual Risk | Migration pathways and ecological exposures are not controlled. | Direct contact and partial ecological and human health exposure would be controlled by reducing the migration potential. Erosion and precipitation migration pathways controlled. | Direct contact and ecological exposure controlled by soil cover. Erosion and precipitation migration pathways controlled. | Direct contact and ecological exposure controlled through source removal, erosion and precipitation migration pathways controlled. | Direct contact and ecological exposure controlled through source reduction and soil cover. Erosion and precipitation migration pathways controlled. | Direct contact and ecological exposure controlled through source reduction and soil cover. Erosion and precipitation migration pathways controlled. |
| Adequacy and Reliability of Controls | Access restrictions are adequate to restrict activities resulting in contact with soil, but are not as reliable as other alternatives. | Soil cover is adequate and reliable in restricting contact with impacted soil. | Soil cover is adequate and reliable in restricting contact with impacted soil. | Soil cover is adequate and reliable in restricting contact with impacted soil. Source material would also be removed. | Soil cover is adequate and reliable in restricting contact with impacted soil. Source material would also be removed. | Soil cover is adequate and reliable in restricting contact with impacted soil. Source material would also be removed. |
| **Reduction of Toxicity, Mobility, and Volume Through Treatment** | | | | | | |
| Amount of Hazardous Materials Destroyed or Treated | There would be no reduction in volume or exposure to hazardous materials with this alternative. | Exposure to hazardous materials would be reduced, although there would be no reduction in volume. | Exposure to hazardous materials would be reduced, although there would be no reduction in volume. | A reduction in both volume and exposure would occur with this alternative at this location. | A reduction in both volume and exposure would occur with this alternative through the removal of soils in areas of high concentrations. | A reduction in both volume and exposure would occur with this alternative through the removal of soils in areas of high concentrations. |
| Degree of Expected Reductions in Toxicity, Mobility, and Volume | There would be no expected reduction in toxicity, mobility, or volume of hazardous materials with this alternative. | There would be no expected reduction in toxicity or volume of hazardous materials with this alternative, although mobility would be reduced. | There would be no reduction in volume or toxicity with this alternative, although exposure pathways would be rendered incomplete. There would be an expected reduction in mobility (which is currently low). | This alternative would result in the largest reduction in volume, and the associated reduction in toxicity and mobility. | There would be a reduction in volume of impacted soil, with a larger reduction in toxicity and mobility due to the removal of soils which have been most heavily impacted with PCBs. | There would be a reduction in volume of impacted soil, with a larger reduction in toxicity and mobility due to the removal of soils which have been most heavily impacted with PCBs. |
| Degree to Which Treatment is Irreversible | Additional treatment would be easily implemented. | Additional treatment could necessitate removal of the soil cover. | Additional treatment could necessitate removal of the soil cover. | Additional treatment for residuals with concentrations below 10 ppm could necessitate removal of the soil cover. | Additional treatment could necessitate removal of the soil cover. | Additional treatment could necessitate removal of the soil cover. |

Table 4-2. *Detailed analysis of remedial alternatives*

| Criteria | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 | Alternative 6 |
|---|---|---|---|---|---|---|
| Type and Quantity of Residuals Remaining after Treatment | Impacted residual soils would remain in their current state. | Existing impacted soils would remain, but would not be accessible from the surface and would have a reduced potential for migration. | Existing impacted soils would remain, but would be less mobile and would not be accessible from the surface. | Remaining impacted soils would contain less than 10 mg/Kg of PCBs, and would not be accessible from the surface. | Impacted soils remaining would be less than 25 mg/Kg and would not be accessible from the surface. | Impacted soils remaining would generally be less than 25 mg/Kg and would not be accessible from the surface. |
| **Short-Term Effectiveness** | | | | | | |
| Protection of Community During Remedial Actions | Community will be restricted from access to the site. Monitoring will not affect community. | Community will be restricted from access to the site and mobility will be reduced. Monitoring will not affect community. | Community will be restricted from access to the site and mobility will be reduced. Monitoring will not affect community. | Community will be restricted from access to the site and mobility will be reduced. Monitoring will not affect community. | Community will be restricted from access to the site and mobility will be reduced. Monitoring will not affect community. | Community will be restricted from access to the site and mobility will be reduced. Monitoring will not affect community. |
| Protection of Workers During Remedial Actions | None required. | Appropriate protective equipment would be utilized during remedial activities. | Appropriate protective equipment would be utilized during remedial activities. | Appropriate protective equipment would be utilized during remedial activities. | Appropriate protective equipment would be utilized during remedial activities. | Appropriate protective equipment would be utilized during remedial activities. |
| Environmental Impacts | None | Contaminant transport during construction would be minimized through appropriate methods such as equipment decontamination and dust/sediment control. | Contaminant transport during construction would be minimized through appropriate methods such as equipment decontamination and dust/sediment control. | Contaminant transport during construction would be minimized through appropriate methods such as equipment decontamination and dust/sediment control. | Contaminant transport during construction would be minimized through appropriate methods such as equipment decontamination and dust/sediment control. | Contaminant transport during construction would be minimized through appropriate methods such as equipment decontamination and dust/sediment control. |
| Time Until Remedial Action Objectives (RAOs) are Achieved | Achieving RAOs not expected. | Immediately following implementation. | Immediately following implementation. | Immediately following implementation. | Immediately following implementation. | Immediately following implementation. |

**Table 4-2.** *Detailed analysis of remedial alternatives*

| Criteria | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 | Alternative 6 |
|---|---|---|---|---|---|---|
| **Implementability** | | | | | | |
| Ability to Construct and Operate the Technology | Property owners required to provide access under consent judgement. | Soil cover is readily constructed. Property owners required to provide access under consent judgement. | Grouting of soils in saturated conditions is a specialized but implementable technology. Property owners required to provide access under consent judgement. | Excavation in a saturated environment will require shoring to stabilize the excavation sides, dewatering and wastewater treatment, solidification of soils, transportation for off-site disposal of soil, and backfilling. These are readily implementable. Property owners required to provide access under consent judgement. | Caisson and grouting technologies are specialized technologies commonly used in construction and are easily implementable. However, the concept of combining these technologies for remedial activities is not common. Property owners required to provide access under consent judgement. | Caisson and grouting technologies are specialized technologies commonly used in construction and are easily implementable. However, the concept of combining these technologies for remedial activities is not common. Property owners required to provide access under consent judgement. |
| Reliability of Technology | Access restrictions and monitoring are reliable. | Containment reliable with appropriate maintenance. Access restrictions and monitoring are reliable. | Grouting is a reliable technology. Access restrictions and monitoring are reliable. | Excavation and off-site disposal is reliable. Access restrictions and monitoring are reliable. | Caissons and grouting are reliable technologies. Access restrictions and monitoring are reliable. | Caissons and grouting are reliable technologies. Access restrictions and monitoring are reliable. |
| Ease of Undertaking Additional Remedial Actions, if Necessary | Additional remedial actions are implementable. | Additional remedial actions would not be readily implementable due to isolation of PCB-impacted residual materials by the cap. | Additional remedial actions would not be readily implementable due to isolation of PCB-impacted residual materials by the cap. | Additional remedial actions would not be readily implementable due to isolation of PCB-impacted residual materials by the cap. | Additional remedial actions would not be readily implementable due to isolation of PCB-impacted residual materials by the cap. | Additional remedial actions would not be readily implementable due to isolation of PCB-impacted residual materials by the cap. |
| Ability to Monitor Effectiveness of Remedy | Operation and maintenance activities including routine inspection, maintenance of access restriction measures, and ground water monitoring would be adequate indicators of performance. | Operation and maintenance activities including routine inspection, maintenance of access restriction measures, and ground water monitoring would be adequate indicators of performance. | Operation and maintenance activities including routine inspection, maintenance of access restriction measures, and ground water monitoring would be adequate indicators of performance. | Operation and maintenance activities including routine inspection, maintenance of access restriction measures, and ground water monitoring would be adequate indicators of performance. | Operation and maintenance activities including routine inspection, maintenance of access restriction measures, and ground water monitoring would be adequate indicators of performance. | Operation and maintenance activities including routine inspection, maintenance of access restriction measures, and ground water monitoring would be adequate indicators of performance. |

**Table 4-2.** *Detailed analysis of remedial alternatives*

| Criteria | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 | Alternative 6 |
|---|---|---|---|---|---|---|
| Availability of Off-Site Treatment, Storage and Disposal Services and Capacities | None required. | None required. | None required. | Landfill facility and capacity expected to be readily available. | Landfill facility and capacity expected to be readily available. | Landfill facility and capacity expected to be readily available. |
| Availability of Necessary Equipment, Specialists, and Materials | Inspection and maintenance personnel, sampling equipment, sampling personnel, and analytical laboratory readily available. | Construction equipment and backfill materials readily available. Inspection and maintenance personnel, sampling equipment, sampling personnel, and analytical laboratory readily available. | Pressure grouting requires specialized equipment but is available with scheduling. Construction equipment and backfill materials readily available. Inspection and maintenance personnel, sampling equipment, sampling personnel, and analytical laboratory readily available. | Excavation/construction, dewatering, water treatment and backfill materials readily available. Inspection and maintenance personnel, sampling equipment, sampling personnel, and analytical laboratory readily available. | Caisson installation and pressure grouting require specialized equipment but are readily available. Excavation/construction, and backfill materials readily available. Inspection and maintenance personnel, sampling equipment, sampling personnel, and analytical laboratory readily available | Caisson installation and pressure grouting require specialized equipment but are readily available. Excavation/construction, and backfill materials readily available. Inspection and maintenance personnel, sampling equipment, sampling personnel, and analytical laboratory readily available |
| Availability of Prospective Technologies | None required. | Applied technologies readily available. | Applied technologies readily available with scheduling. | Applied technologies readily available. | Applied technologies readily available with scheduling. | Applied technologies readily available with scheduling. |

**Table 4-2.** *Detailed analysis of remedial alternatives*

| Criteria | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 | Alternative 6 |
|---|---|---|---|---|---|---|
| **Cost** | | | | | | |
| **Capital Cost** | $0 | $991,519 | $6,843,139 | $3,001,726 ($3,053,926 if grout curtain were used.) | $1,450,451 | $1,697,432 |
| **Annual O & M Costs** | $19,500 | $30,500 | $30,500 | $15,500 | $15,500 | $15,500 |
| **Total Present Worth Costs** | $299,764 | $1,460,380 | $7,312,000 | $3,240,000 ($3,292,200 if grout curtain were used.) | $1,688,725 | $1,935,706 |
| **State Acceptance** | | | | | | |
| **Community Acceptance** | | | | | | |
| **Verification Sampling**[1] | - 3 downgradient wells<br>- 30 yr GW sampling program<br>- 5 year reviews of remedy | Same as Alternative 1, with the addition of cap monitoring and maintenance. | - Bench scale pilot test<br>- 1 sample/100 cy for leach test<br>- 2 downgradient wells<br>- 30 yr GW sampling program<br>- 5 year reviews of remedy | - End point samples to confirm 25 ppm<br>- Sampling based on 25 foot grid | - 1 downgradient well<br>- 30 yr monitoring program<br>- 5 year reviews of remedy | - 6 borings around B-9<br>- 1 dowgradient well<br>- 30 yr monitoring program<br>- 5 year reviews of remedy |
| **Constraints**[2] | None identified | None identified. | The grouting process will likely displace a significant volume of soil from the impacted area. Due to the specialized nature of the grouting operations, scheduling delays may occur. | Volume of water to be treated prohibits transportation off-site, and on-site disposal would likely require a leach field or other method of disposal. | Due to the specialized nature of the caisson and grouting operations, scheduling delays may occur, as available contractors are limited. | Due to the specialized nature of the caisson and grouting operations, scheduling delays may occur, as available contractors are limited |

Notes:
1. A description of the verification sampling, if any, needed to support the alternative.
2. A listing of the constraints/options associated with the alternative which do not necessarily fall within the other evaluation criteria.

**Table 4-3.** *Estimated costs - Altemative 2.*

| Item | Estimated quantity | Units | Unit price | Total estimated costs |
|---|---|---|---|---|
| **Direct Capital Costs:** | | | | |
| Placement of clean fill | 25,528 | CY | $8.25 | $210,606 |
| 40 mil. LLDPV | 70,000 | SF | $0.80 | $56,000 |
| 2 ft. barrier protection layer | 5,200 | CY | $27 | $140,400 |
| 0.5 ft. topsoil | 1,300 | CY | $30 | $39,000 |
| Seed and mulch | 7,800 | SY | $1 | $7,800 |
| ***Other costs:*** | | | | |
| Drainage | 1 | LS | $50,000 | $50,000 |
| Health & safety (allowance) | 1 | LS | $80,000 | $80,000 |
| Ground and sediment control | 1 | LS | $50,000 | $50,000 |
| Dust control | 1 | LS | $20,000 | $20,000 |
| Site restoration | 1 | LS | $20,000 | $20,000 |
| Mobilization/demobilization | 1 | LS | $10,000 | $10,000 |
| *Estimated Direct Capital Costs* | | | | *$683,806* |
| ***Indirect capital costs:*** | | | | |
| Contingency allowance (25%) | | | | $170,952 |
| Engineering fees (15%) | | | | $102,571 |
| Legal fees (5%) | | | | $34,190 |
| *Estimated Indirect Capital Costs* | | | | *$307,713* |
| | | | ***Total Estimated Capital Cost*** | ***$991,519*** |
| **Annual Operation and Maintenance Costs** | | | | |
| Annual Cap Maintenance | 2 | acres | $2,500 | $5,000 |
| Monthly Inspections | 12 | events | $500 | $6,000 |
| Ground Water Monitoring[1] | 4 | events | $3,500 | $18,000 |
| Annual Report | 1 | LS | $1,500 | $1,500 |
| *Total Estimated Annual Operations and Maintenance Costs* | | | | ***$30,500*** |
| ***Estimated 30 Year Present Worth Annual Operation and Maintenance (I=5%)*** | | | | ***$468,861*** |
| | | | **Total Estimated Present Worth Cost** | **$1,460,380** |

1) Assumes quarterly monitoring of five existing wells for PCBs, with letter reports.

CY = Cubic Yard
SF = Square Feet
SY = Square Yards
LS = Lump Sum

**Table 4-4.** *Estimated costs - Alternative 3*

| Item | Estimated quantity | Units | Unit price | Total estimated costs |
|---|---|---|---|---|
| **Direct Capital Costs** | | | | |
| Pressure grouting | 1 | LS | $4,000,000 | $4,000,000 |
| Placement of clean fill | 25,528 | CY | $8.25 | $210,606 |
| 40 mil LLDPV | 70,000 | SF | $0.80 | $56,000 |
| 2 ft. barrier protection layer | 5,200 | CY | $27 | $140,400 |
| 0.5 ft. topsoil | 1,300 | CY | $30 | $39,000 |
| Seed and mulch | 7,800 | SY | $1 | $7,800 |
| Pilot study | 1 | LS | $15,000 | $15,000 |
| Verification sampling | 1 | LS | $30,600 | $30,600 |
| ***Other Costs*** | | | | |
| Drainage (allowance) | 1 | LS | $50,000 | $50,000 |
| Health & safety | 1 | LS | $80,000 | $80,000 |
| Ground & sediment control | 1 | LS | $50,000 | $50,000 |
| Dust control | 1 | LS | $20,000 | $20,000 |
| Site restoration | 1 | LS | $20,000 | $20,000 |
| *Estimated Direct Capital Costs* | | | | *$4,719,406* |
| ***Indirect Capital Costs*** | | | | |
| Contingency allowance (25%) | | | | $1,179,852 |
| Engineering fees (15%) | | | | $707,911 |
| Legal fees (5%) | | | | $235,970 |
| *Estimated Indirect Capital Costs* | | | | *$2,123,733* |
| | | ***Total Estimated Capital Cost*** | | ***$6,843,139*** |
| **Annual Operation and Maintenance Costs** | | | | |
| Annual cap maintenance | 2 | Acres | $2,500 | $5,000 |
| Monthly inspections | 12 | Events | $500 | $6,000 |
| Ground water monitoring | 4 | Events | $3,500 | $18,000 |
| Annual report | 1 | LS | $1,500 | $1,500 |
| *Total Estimated Annual Operation and Maintenance Costs* | | | | *$30,500* |
| ***Estimated 30 year Present Worth Annual O & M Costs (I=5%)*** | | | | ***$468,861*** |
| **Total Estimated Present Worth Cost** | | | | **$7,312,000** |

**Table 4-5.** *Estimated costs - Alternative 4*

| Item | Estimated quantity | Units | Unit price | Total estimated cost |
|---|---|---|---|---|
| **Direct Capital Costs** | | | | |
| Sheet piling | 16,236 | SF | $20 | $324,720 |
| Excavate, and load trucks | 2,775 | CY | $10 | $27,750 |
| Transportation | 4,163 | Ton | $58 | $241,454 |
| Disposal | 4,163 | Ton | $164 | $682,732 |
| Backfill | 28,303 | CY | $8.25 | $233,500 |
| Verification samples | 1 | LS | $20,000 | $20,000 |
| Restoration of surfaces | 2 | Acre | $15,000 | $30,000 |
| ***Other Costs*** | | | | |
| Dewater material | 1 | LS | $150,000 | $150,000 |
| Drainage (allowance) | 1 | LS | $80,000 | $80,000 |
| Health & safety (allowance) | 1 | LS | $80,000 | $80,000 |
| Ground and sediment cControl | 1 | LS | $80,000 | $80,000 |
| Dust control | 1 | LS | $20,000 | $20,000 |
| Site restoration | 1 | LS | $50,000 | $50,000 |
| Mobilization/Demobilization | 1 | LS | $50,000 | $50,000 |
| *Estimated Direct Capital Costs* | | | | *$2,070,156* |
| ***Indirect Capital Costs*** | | | | |
| Contingency allowance (25%) | | | | $517,539 |
| Engineering fees (15%) | | | | $310,523 |
| Legal fees (5%) | | | | $103,508 |
| *Estimated Indirect Capital Costs* | | | | *$931,570* |
| | | ***Total Estimated Capital Cost*** | | ***$3,001,726*** |
| **Annual Operation and Maintenance Costs** | | | | |
| Ground water monitoring[1] | 4 | Events | $3,500 | $14,000 |
| Annual report | 1 | LS | $1,500 | $1,500 |
| *Total Estimated Annual Operation and Maintenance Costs* | | | | *$15,500* |
| ***Estimated 30 Year Present Worth Annual Operation and Maintenance Cost (I=50%)*** | | | | ***$238,274*** |
| | | **Total Estimated Present Worth Cost** | | **$3,240,000** |

1) Assumes quarterly monitoring of five existing wells for PCBs, with letter reports

CY = Cubic Yards
SF = Square Feet
LS = Lump Sum

**Table 4-6.** *Estimated costs - Alternative 5*

| Item | Estimated quantity | Units | Unit price | Total estimated costs |
|---|---|---|---|---|
| <u>**Direct Capital Costs**</u> | | | | |
| Install. and exc. of caissons | 1 | LS | $128,892 | $128,892 |
| Pressure grouting | 1 | LS | $377,612 | $377,612 |
| Disposal of contaminated soils | 100 | Ton | $164 | $16,400 |
| Disposal of contaminated water | 1,000 | Gallon | $8 | $8,000 |
| Placement of clean fill | 25,528 | CY | $8.25 | $210,606 |
| 40 mil LLDPV | 70,000 | SF | $0.80 | $56,000 |
| Seed and mulch | 7,800 | SY | $1 | $7,800 |
| Well installation | 1 | LS | $25,000 | $25,000 |
| ***Other Costs*** | | | | |
| Health & safety (allowance) | 1 | LS | $80,000 | $80,000 |
| Ground and sediment control | 1 | LS | $50,000 | $50,000 |
| Dust control | 1 | LS | $20,000 | $20,000 |
| Site restoration | 1 | LS | $20,000 | $20,000 |
| *Estimated Direct Capital Costs* | | | | *$1,000,310* |
| ***Indirect Capital Costs*** | | | | |
| Contingency allowance (25%) | | | | $250,078 |
| Engineering fees (15%) | | | | $150,047 |
| Legal fees (5%) | | | | $50,016 |
| *Estimated Indirect Capital Costs* | | | | *$450,141* |
| | | | ***Total Estimated Capital Cost*** | ***$1,450,451*** |
| <u>**Annual Operation and Maintenance Costs**</u> | | | | |
| Ground water monitoring | 4 | Events | $3,500 | $14,000 |
| Annual report | 1 | LS | $1,500 | $1,500 |
| *Total Estimated Annual Operations and Maintenance Costs* | | | | *$15,500* |
| ***Estimated 30 Year Present Worth Annual Operation and Maintenance (I=5%)*** | | | | ***$238,274*** |
| | | | **Total Estimated Present Worth Cost** | **$1,688,725** |

**Table 4-7.** ***Estimated costs - Alternative 6***

| Item | Estimated quantity | Units | Unit Price | Total estimated costs |
|---|---|---|---|---|
| **Direct Capital Costs** | | | | |
| Install. and exc. of caissons | 1 | LS | $138,198 | $138,198 |
| Pressure grouting | 1 | LS | $501,439 | $501,439 |
| Disposal of contaminated soils | 150 | ton | $164 | $24,600 |
| Disposal of contaminated water | 1,500 | gallon | $8 | $12,000 |
| Placement of clean fill | 25,528 | CY | $8.25 | $210,606 |
| 40 mil LLDPV | 70,000 | SF | $0.80 | $56,000 |
| Seed and mulch | 7,800 | SY | $1 | $7,800 |
| B-9 investigation | 1 | LS | $50,000 | $50,000 |
| ***Other Costs*** | | | | |
| Health & safety (allowance) | 1 | LS | $80,000 | $80,000 |
| Ground and sediment control | 1 | LS | $50,000 | $50,000 |
| Dust control | 1 | LS | $20,000 | $20,000 |
| Site restoration | 1 | LS | $20,000 | $20,000 |
| *Estimated Direct Capital Costs* | | | | *$1,170,643* |
| ***Indirect Capital Costs*** | | | | |
| Contingency allowance (25%) | | | | $292,661 |
| Engineering fees (15%) | | | | $175,596 |
| Legal fees (5%) | | | | $58,532 |
| *Estimated Indirect Capital Costs* | | | | *$526,789* |
| | | | ***Total Estimated Capital Cost*** | ***$1,697,432*** |
| **Annual Operation and Maintenance Costs** | | | | |
| Ground water monitoring | 4 | Events | $3,500 | $14,000 |
| Annual report | 1 | LS | $1,500 | $1,500 |
| *Total Estimated Annual Operations and Maintenance Costs* | | | | *$15,500* |
| ***Estimated 30 Year Present Worth Annual Operation and Maintenance (I=5%)*** | | | | ***$238,274*** |
| | | | **Total Estimated Present Worth Cost** | **$1,935,706** |