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August 18, 2006

Mr. Jesse Perez
U. S. Air Force Center for Environmental Excellence
HQ AFCEE/IWA-COR
3300 Sidney Brooks, Building 532
Brooks City-Base, TD 78235-5112

SUBJECT: Final Remedial Design Report for the Ash Landfill Operable Unit at Seneca Army Depot Activity; Contract FA8903-04-D-8675, Delivery Order 0012, CDRL A001G and A013

Dear Mr. Perez:

Parsons is pleased to submit the Final Remedial Design Report for the Ash Landfill Operable Unit at the Seneca Army Depot Activity (SEDA) in Romulus, New York. Responses to USEPA comments received on August 1 and 15, 2006 and responses to NYSDEC comments received on August 10, 2006, on the Draft Remedial Design Report for the Ash Landfill Operable Unit are included as Appendix D of the subject document. Mobilization into the field will begin the week of August 21, 2006.

This work was performed in accordance with the Scope of Work (SOW) for Contract No. FA8903-04-D-8674, Task Order No. 0012.

Parsons appreciates the opportunity to provide you with the Design Report for this work. Should you have any questions, please do not hesitate to call me at (617) 449-1405 to discuss them.

Sincerely,

Todd Heino, P.E.
Project Manager

Enclosures

cc: S. Absolom, SEDA (3 paper copies, 1 electronic copy)
K. Hoddinott, USACHPPM (2 paper copies, 1 electronic copy)
C. Boes, USAEC (1 copy, electronic and paper)
R. Battaglia, USACE, NY District (1copy, electronic and paper)
T. Battaglia, USACE, NY District (1 copy, electronic and paper)
Air Force email (letter only)

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August 18, 2006

Mr. Julio Vazquez
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Remedial Bureau A, Section C
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Mr. Mark Sergott
New York State Department of Health
Bureau of Environmental Exposure Investigation, Room 300
Flanigan Square, 547 River Street
Troy, New York 12180

SUBJECT: Final Remedial Design Report for the Ash Landfill Operable Unit at Seneca Army Depot Activity; Contract FA8903-04-D-8675, Delivery Order 0012, CDRL A001G and A013; EPA Site ID: NY0213820830 - NY Site ID: 8-50-006;

Dear Mr. Vazquez/Mr. Gupta/Mr. Sergott:

Parsons is pleased to submit the Final Remedial Design Report for the Ash Landfill Operable Unit at the Seneca Army Depot Activity (SEDA) in Romulus, New York (EPA Site ID# NY0213820830 and NY Site ID# 8-50-006). Responses to USEPA comments received on August 1 and 15, 2006 and responses to NYSDEC comments received on August 10, 2006, on the Draft Remedial Design Report for the Ash Landfill Operable Unit are included as Appendix D of the subject document. Mobilization into the field will begin the week of August 21, 2006.

Should you have any questions, please do not hesitate to call me at (617) 449-1405 to discuss them.

Sincerely,

Todd Heino, P.E.
Program Manager

Enclosures

cc:	J. Perez, AFCEE	Air Force email (letter only)	T. Battaglia, USACE, NY District
	S. Absolom, SEDA	C. Boes, USAEC	R. Battaglia, USACE, NY District
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US Army Corps of Engineers

Air Force Center for Environmental Excellence

Seneca Army Depot Activity
Romulus, New York

FINAL
REMEDIAL DESIGN REPORT
FOR THE ASH LANDFILL OPERABLE UNIT
SENECA ARMY DEPOT ACTIVITY

AFCEE CONTRACT NO. FA8903-04-D-8675
TASK ORDER NO. 0012
CDRL A001G AND A013
EPA SITE ID# NY0213820830
NY SITE ID# 8-50-006

PARSONS
AUGUST 2006

FINAL REMEDIAL DESIGN REPORT
FOR THE ASH LANDFILL OPERABLE UNIT

SENECA ARMY DEPOT ACTIVITY, ROMULUS, NEW YORK

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS CITY-BASE, TEXAS

and

SENECA ARMY DEPOT ACTIVITY
ROMULUS, NEW YORK

Prepared by:

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Contract Number FA8903-04-D-8675
Task Order No. 0012
CDRL A001G and A013
EPA SITE ID# NY0213820830
NY SITE ID# 8-50-006

August 2006

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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
AFCEE	Air Force Center for Environmental Excellence
ARAR	Applicable or Relevant and Appropriate Requirement
AWQS	Ambient Water Quality Criteria
BCT	Base Cleanup Team
BOD	Biological Oxygen Demand
BRAC	Base Realignment and Closure
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CAMP	Community Air Monitoring Plan
CAR	Corrective Action Report
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	Contaminant of Concern
COR	Contracting Officer's Representative
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
CQP	Construction Quality Plan
DCE	Dichloroethene
ES	Engineering Science, Inc.
ESI	Expanded Site Inspection
FC/MR	Field Change/Modification Request
FD	Final Design
FFA	Federal Facility Agreement
FSP	Field Sampling Plan
ft/ft	foot per foot
HSP	Health and Safety Plan
IAG	Interagency Agreement
IDW	Investigation-derived waste
IRM	Interim Removal Measure
LUC	Land Use Control
MCL	Maximum Contaminant Level
NAD	North American Datum
NAVD	North American Vertical Datum
NCFL	Non-Combustible Fill Landfill
NCR	Non-Conformance Report
NPL	National Priorities List
NTCRA	Non-Time Critical Removal Action
NWI	National Wetlands Inventory
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	Oxidation/reduction potential
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCE	Perchloroethene
PCCMP	Post-Closure Monitoring and Maintenance Plan
PD	Preliminary Design
PHSO	Program Health and Safety Officer
PM	Project Manager

ACRONYMS AND ABBREVIATIONS (CONTINUED)

POC	Point of contact
PPE	Personal Protective Equipment
PRB	Permeable Reactive Barrier
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDWP	Remedial Design Work Plan
RI	Remedial Investigation
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SEDA	Seneca Army Depot Activity
sf	square feet
SHSO	Site Health and Safety Officer
SM	Site Manager
SPDES	State Pollutant Discharge Elimination System
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TAGM	Technical and Administrative Guidance Memorandum
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TOC	Table of Contents
TSS	Total Suspended Solids
USAEHA	U.S. Army Environmental Hygiene Agency
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VC	Vinyl Chloride
VOC	Volatile Organic Compound
ZVI	Zero-Valent Iron

1.0 INTRODUCTION

1.1 Report Objectives

This remedial design report describes the approach to completing the soil and groundwater remediation at the Ash Landfill Operable Unit (OU), located at the Seneca Army Depot Activity (SEDA or the Depot) in Romulus, New York. The design includes the technical specifications and drawings that provide detail to the construction team to complete the remedial action. This document has been prepared for the Air Force Center for Environmental Excellence (AFCEE) under Contract No. FA8903-04-D-8675, Task Order No. 0012.

1.2 Site Description and Background

Since its inception in 1941, SEDA's primary mission was the receipt, storage, maintenance, and supply of military items. SEDA was proposed for the National Priorities List (NPL) in July 1989. In August 1990, SEDA was finalized and listed under Group 14 on the Federal Section of the NPL. To facilitate resolution of contamination issues at SEDA, the United States Environmental Protection Agency (USEPA), New York State Department of Environmental Conservation (NYSDEC), and the Army entered into a Federal Facilities Agreement (FFA), also known as the Interagency Agreement (IAG). This agreement stated that future investigations would be based on Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidelines, and that the Resource Conservation and Recovery Act (RCRA) was considered an Applicable or Relevant and Appropriate Requirement (ARAR) pursuant to Section 121 of CERCLA. In October 1995, SEDA was designated as a facility to be closed under the provisions of the Base Realignment and Closure (BRAC) process.

SEDA is a 10,587-acre former military facility located in Seneca County near Romulus, New York, which has been owned by the United States Government and operated by the Department of the Army since 1941. A location map for SEDA is shown in **Drawing C-1**. As shown in **Drawing C-1**, SEDA is located between Seneca Lake and Cayuga Lake in Seneca County. **Drawing C-1** also shows that SEDA is bordered by New York State Highway 96 on the east, New York State Highway 96A on the west, and sparsely populated farmland on the north and south.

The location of the Ash Landfill OU, also referred to as the Ash Landfill Operable Unit, is shown relative to SEDA in **Drawing C-1**. The Ash Landfill OU is composed of five solid waste management units (SWMUs). As shown in **Drawing C-2**, the five SWMUs that comprise the Ash Landfill OU are the Incinerator Cooling Water Pond (SEAD-3), the Ash Landfill (SEAD-6), the Non-Combustible Fill Landfill (NCFL) (SEAD-8), the Debris Piles (SEAD-14), and the Abandoned Solid Waste Incinerator Building (SEAD-15).

Prior to the development of the Ash Landfill OU, the land in this area was used for farming. From 1941 (the date SEDA was constructed) to 1974, uncontaminated trash was burned in a series of burn pits near the abandoned incinerator building (Building 2207). According to a U.S. Army Environmental Hygiene Agency (USAEHA) Interim Final Report, Groundwater Contamination Survey No. 38-26-0868-88 (July 1987), the ash from the refuse burning pits was buried in the Ash Landfill (SEAD-6) from 1941 until the late 1950's or early 1960's.

The incinerator was built in 1974. Between 1974 and 1979, materials intended for disposal were transported to the incinerator. Nearly all of the approximately 18 tons of refuse generated per week on the Depot were incinerated. The source for the refuse was domestic waste from depot activities and family housing. Large items that could not be burned were disposed of at the NCFL (SEAD-8). The NCFL has an area of approximately two acres and is located southeast of the incinerator building (immediately south of the SEDA railroad line). The NCFL was used as a disposal site for non-combustible materials, including construction debris, from 1969 until 1977.

Ash and other residue from the incinerator were temporarily disposed in an unlined cooling pond immediately north of the incinerator building. The cooling pond consisted of an unlined depression approximately 50 feet in diameter and approximately 6 to 8 feet deep. When the pond filled, the fly ash and residues were removed, transported, and buried in the adjacent ash landfill east of the cooling pond. The refuse was dumped in piles and occasionally spread and compacted. No daily or final cover was applied during operation. The active area of the Ash Landfill extended at least 500 feet north of the incinerator building, near a bend in a dirt road, based on an undated aerial photograph of the incinerator during operation. A fire destroyed the incinerator on May 8, 1979, and the landfill was subsequently closed. The landfill was apparently covered with native soils of various thicknesses but has not been closed with an engineered cover or cap. Other areas on the site were used for a grease pit and burning of debris.

Contamination

The nature and extent of the constituents of concern at the Ash Landfill OU were evaluated through a comprehensive remedial investigation (RI) program. The Ash Landfill OU was initially estimated to encompass an area of approximately 130 acres. Following the RI, the area of the Ash Landfill OU was refocused to an area of approximately 23 acres. It was determined that surface water and sediment were not media of concern and do not require remediation. During the RI, a groundwater contaminant plume, emanating from the northern corner of the Ash Landfill, was delineated. The primary constituents of concern at the Ash Landfill are volatile organic compounds (VOCs), primarily chlorinated and aromatic compounds, semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), and, to a lesser degree, metals. Release of the constituents of concern is believed to have occurred during the former activities at the Ash Landfill OU, as described above.

Soil

VOCs, specifically trichloroethene (TCE), were detected in the soil in the “Bend in the Road” area, located northwest of the Ash Landfill. Between 1994 and 1995, the Army conducted a Non-Time

Critical Removal Action (NTCRA), also known as an Interim Removal Measure (IRM), to address VOC and PAH soil contamination in areas near the “Bend in the Road”, believe to be the source of the groundwater plume. The NTCRA was successful in reducing risk due to future exposure to these soils and prevented continued leaching of VOCs to groundwater associated with this operable unit. In the years that have passed since the NTCRA, the positive benefits of the NTCRA have been observed in that the concentration of VOCs in groundwater near the original source area has decreased by two orders of magnitude. Further remediation for VOCs in the soil at the “Bend in the Road” is not required.

The other compounds of significance detected in the soils were PAHs and metals. PAHs were detected at concentrations above NYSDEC’s Technical and Administrative Guidance Memorandum (TAGM) values in the NCFL and in the various Debris Piles present around the former Ash Landfill. In general, the highest PAH concentrations were detected in the NCFL and small debris pile surface soils. The metals detected at elevated concentrations (significantly above TAGMs) in soils were copper, lead, mercury, and zinc. These elevated concentrations were found in the Ash Landfill, the NCFL, and the Debris Piles, and the highest concentrations of metals were detected at the surface of the Debris Piles. These piles are small, localized, surface features that are visibly discernable and do not extend into the subsurface.

Groundwater

The primary potential impact to human health and the environment is the groundwater plume, approximately 1,100 feet long by 625 feet wide, containing dissolved concentrations of TCE, 1,2-dichloroethene (DCE), and vinyl chloride (VC) that originated in the "Bend in the Road" area near the north western edge of the Ash Landfill. The nearest exposure points for groundwater are the three farmhouse wells, located approximately 1,250 feet from the leading edge of the plume. At least one of the farmhouse wells draws water from the till/weathered shale aquifer and the remaining two wells derive water from the bedrock aquifer. Vertically, the plume is restricted to the upper till/weathered shale aquifer and is not present in the deeper competent shale aquifer. As noted above, the source of the plume was removed by the NTCRA.

In December 1998, a 650-foot long permeable reactive zero valent iron (ZVI) wall was installed approximately 100 feet east of the railroad tracks near the property line. The wall was installed as a demonstration project to show that the reactive iron wall could be effective in reducing the concentrations of chlorinated ethenes through reductive dechlorination. In July 2005, two pilot-scale mulch biowalls were installed near the source area to demonstrate that biowalls were at least equally as effective as the ZVI wall at degrading chlorinated ethenes and their daughter products. The results of the pilot study are presented in **Section 3**.

1.3 Remedial Design Goals

Site-specific remedial action objectives were established for the Ash Landfill OU between NYSDEC, USEPA, and the Army and were listed in the Record of Decision (ROD) (Parsons, 2004) and the Remedial Design Work Plan (Parsons, 2006a) as follows:

- Mitigate exposure pathways for dermal contact and ingestion of VOCs, metals, and PAHs in soils for current and intended future site use scenarios, thereby decreasing risk to human health and ecological receptors;
- Comply with ARARs for New York State Class GA groundwater quality standards and federal Maximum Contaminant Levels (MCLs);
- Reduce and improve non-carcinogenic and cancer risk levels from contact with groundwater for current and intended future receptors; and
- Prevent exposure to off-site receptors through possible off-site migration of the VOC plume.

1.4 Summary of Remedial Design

To achieve the remedial action objected stated above, the following objectives are part of the remedial design at the Ash Landfill OU:

- Excavation and off-site disposal of Debris Piles, and establishment and maintenance of a vegetative soil cover for the Ash Landfill and the NCFL for protection of ecological receptors;
- Installation of three *in situ* permeable reactive barriers (PRBs) biowall systems, and maintenance of the proposed walls for migration control of the groundwater plume;
- Backfilling and re-grading the Incinerator Cooling Water Pond (SEAD-3);
- Development of a Contingency Plan to treat the groundwater in the event that the selected groundwater remedy is not effective;
- Land Use Controls (LUCs) to attain the remedial action objectives; and
- Completion of a review of the selected remedy every five-years (at minimum), in accordance with Section 121(c) of the CERCLA.

1.5 Report Organization

The first section of this report serves as an introduction to the Design Report. **Section 2** summarizes the remediation requirements and procedures. **Section 3** presents the basis of the groundwater remediation design. **Section 4** presents the design elements. **Section 5** presents a Field Sampling Plan (FSP). **Section 6** is the Construction Quality Plan (CQP) and **Section 7** includes the Post-Closure Monitoring and Maintenance Plan (PCMMP). **Section 8** is the Waste Management Plan. **Section 9** consists of a land use control remedial design (LUC RD) plan for the Ash Landfill. **Section 10** presents the contingency plans. **Section 11** includes the remedial action schedule and the project team organization. References are provided in **Section 12**.

Appendix A presents the Design Drawings, and **Appendix B** presents the Technical Specifications.

2.0 REMEDIATION REQUIREMENTS AND CRITERIA

2.1 Applicable or Relevant and Appropriate Requirements (ARARs)

Excavation and off-site disposal requirements and criteria include regulatory and disposal facility requirements.

2.1.1 Chemical-Specific Requirements

These requirements include the following:

- Transport and disposal of excavated soil to meet Federal and State of New York Department of Transportation requirements and also requirements based on the operation permit held by the disposal location;

- Discharge requirements based on the Seneca County Sewer District No. 2 discharge permit held by the entity to receive site groundwater from excavation dewatering, in compliance with New York State's State Pollutant Discharge Elimination System (SPDES).

2.1.2 Location-Specific Requirements

These requirements are associated with protecting existing resources potentially impacted by site remediation activities.

Based on the New York state regulated wetland maps (Geneva South, Romulus, Ovid, and Dresden quads), there are six regulated wetlands within the 2-mile study area, but none are in close proximity to the site perimeter. The closest wetland is approximately 2,000 feet northeast of the Ash Landfill OU perimeter. The other five regulated wetlands are over one mile from the site perimeter. Several small freshwater emergent wetlands were identified during the RI within the Ash Landfill OU, including one located near that "Bend in the Road". Several of these emergent wetlands may have been created by landfill excavation operations. No standing water was observed in these wetlands when they were surveyed during the RI.

A Phase I cultural resources survey was conducted in the area of the IRM at the Ash Landfill in 1994 prior to the IRM activity. As a result of the survey, one site of Native American cultural activity was found and three or four twentieth century structures were identified. The survey was entitled "Archeological Investigations, Ash Landfill Site, Seneca Army Depot Activities, 20 August 1995" and was conducted by Heritage America Ltd. They concluded that the Native American occupation site could meet National Register eligibility criteria and recommended further investigation. The survey also concluded that the twentieth century structures in the area were not likely to meet eligibility requirements for being listed on the National Register of Historic Places and recommended no further investigation. In September 2003, a boundary line and required buffer-zone of this archaeological Native American Site was established during the surveying of all significant archeological sites identified after the completion and submission of a multi-year cultural resource survey conducted at the Depot. This boundary is shown in **Drawing C-4**.

A historic farmstead was located directly east of the Ash Landfill Site between the railroad tracks and North-South Baseline Road. An assessment was completed and while materials dating back to the middle of the nineteenth century were identified, the deposits were disturbed and not associated with historic features. The farmstead was not listed as a historic site (Cooper et.al., 1999). No cultural resources were identified within the boundary of the Ash Landfill OU during this study.

Floodplain information was reviewed from the Federal Emergency Management Agency confirming that the Ash Landfill OU is not within the floodplain of a 100-year or 500-year flood. Flood insurance rate maps indicate the entire Depot is outside the 100-year floodplain.

U.S. Fish and Wildlife Service (USFWS) indicated that no federally listed or proposed endangered or threatened species under their jurisdiction are known to exist in the area of the Ash Landfill. The NYSDEC Natural Heritage Program Biological and Conservation Data System identified no known species of special concern living within the Depot property.

2.1.3 Action-Specific Requirements

A water quality certification under Section 401 of the Federal Clean Water Act is not needed for this remediation project.

A storm water discharge permit or authorization is not needed for this removal action since the area being excavated (i.e., the Debris Piles) is less than one acre in size. Soils excavated will be directly loaded to trucks and will not be stockpiled. Any water in the excavation area will be collected.

2.1.4 Notification Requirements and Status

While formal permits are not needed for a CERCLA site remediation, any applicable state or local regulatory permit requirements will be met. Such requirements include disposal requirements for off-site disposal operations as well as Seneca County Sewer District No. 2 water discharge requirements. No special local Town of Romulus requirements have been identified that will need to be met other than SEDA security procedures.

2.1.5 Access Needs During Remediation

Access is being obtained from the SEDA in order for the remediation work to be completed. The construction contractor will use this gate for access and egress to and from the site. SEDA will provide the contractor with keys to the necessary gates.

3.0 BASIS OF GROUNDWATER REMEDIATION DESIGN

3.1 Background

According to the ROD for the Ash Landfill, migration of the groundwater contaminant plume will be controlled by the installation of three *in situ* PRBs (Parsons, 2004). The ROD was written to allow flexibility in selecting the most effective medium for the PRB. Previous treatability testing supported the use of PRBs using iron filings, and a ZVI wall is currently providing migration control at the site. In the interest of identifying a medium that optimizes cost effectiveness while maintaining performance at a level equal to or better than ZVI, a different treatment medium, mulch, was evaluated for the full-scale implementation of migration control. The use of mulch in a "biowall" was evaluated because the:

- Cost of iron had tripled and the use of reactive iron was no longer cost-effective; and
- Use of mulch in reactive walls was found to be as effective as iron at other sites and had gained regulatory acceptance for treatment of chlorinated ethene plumes.

A pilot study was performed by Parsons and the Army from July 2005 to February 2006 to show that the use of mulch as the selected wall medium (i.e. biowalls) would effectively control migration of groundwater contaminants at the site.

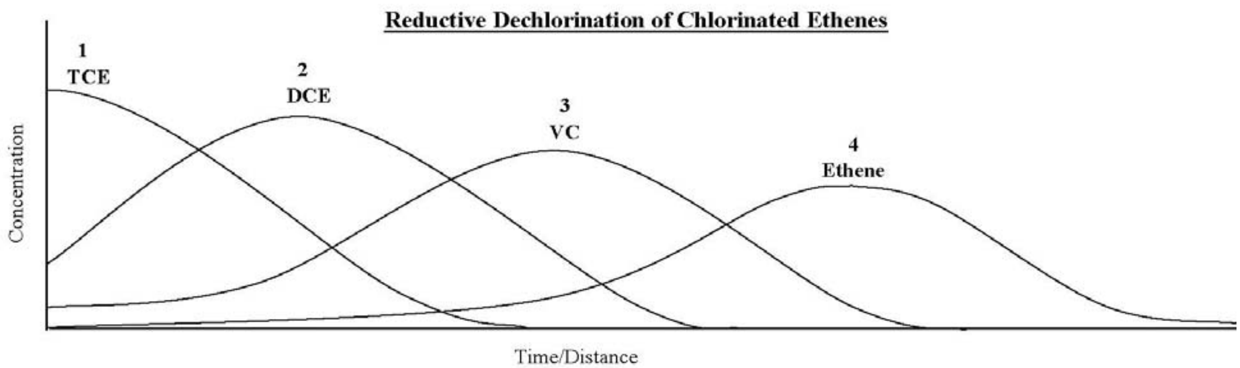
This section presents the components and findings of the mulch biowall pilot study, which serve as the basis of design for the biowalls. This information was previously presented in the "Evaluation Report for the Mulch Biowalls at the Ash Landfill" submitted as an appendix of the "Draft Remedial Design Work Plan for the Ash Landfill Operable Unit" (Parsons, 2006a,b); however, this information is summarized in this Design Report because it is needed to understand why the wall configuration, wall layout, and details have been selected.

3.1.1 Technology Description

Mulch may be used to stimulate anaerobic biodegradation of chlorinated ethenes. This substrate is mixed with coarse sand and emplaced in a trench or excavation in a permeable reactive biowall configuration. Biodegradable vegetable oils may also be added to the mulch mixture to increase the availability of soluble organic matter. This treatment method relies on the flow of groundwater under a natural hydraulic gradient through the biowall to promote contact with slowly-soluble organic matter. As the groundwater flows through the organic matter within the biowall, a treatment zone is established not only within the biowall, but downgradient of it, as the organic matter migrates with the groundwater and anaerobic microbial processes are established.

Degradation of the organic substrate by microbial processes in the subsurface provides a number of breakdown products, including metabolic acids (e.g., butyric and acetic acids). The breakdown products and acids produced by degradation of mulch in a saturated subsurface environment provide secondary fermentable substrates for generation of hydrogen, the primary electron donor utilized in anaerobic reductive dechlorination of chlorinated ethenes. Thus, a mulch biowall has the potential to stimulate reductive dechlorination of chlorinated ethenes for many years. If needed, mulch biowalls can be periodically recharged with liquid substrates (e.g., vegetable oils) to extend the life of the biowall.

The transformation of chlorinated ethenes via reductive dechlorination is shown in **Figure 3-1**. Dechlorination is sequential and concentrations of TCE and its dechlorinated products increase and decrease as depicted in the schematic below.



The schematic above shows the theoretical concentrations of TCE and its products expected during reductive dechlorination of chlorinated ethenes as outlined in the following steps:

1. TCE is the predominant contaminant source.
2. As TCE is reduced, DCE levels increase.
3. DCE decreases as it is converted to VC.
4. Finally, VC is further converted to ethene/ethane and other non-toxic by-products.

The goal of anaerobic biodegradation using biowalls is to completely degrade chlorinated ethenes to innocuous end products (e.g., ethene and ethane), without the accumulation and persistence of DCE or VC.

3.1.2 Pilot Study Description

In July 2005, two biowalls were constructed in parallel positioned perpendicular to the path of groundwater flow in the vicinity of monitoring well PT-12A as shown on **Figure 3-2**. The selected area for installation has historically shown the highest concentrations of chlorinated ethenes within the Ash Landfill VOC plume. The eastern biowall is 150 feet long and averages 11.3 feet deep, by 3 feet wide. The western biowall is 150 feet long and averages 10.7 feet deep, by 3 feet wide.

Four rounds of groundwater monitoring were completed between September 2005 and January 2006 along each of the two groundwater monitoring well transects. The full results of the pilot study are presented in a technical memorandum "Evaluation Report for the Mulch Biowalls at the Ash Landfill Site, Seneca Army Depot Activity" submitted in March 2006. This memorandum is included in **Appendix C** of this report.

Based on the results of the Ash Landfill Biowall Pilot Study, the following are the most important of the conclusions that were made:

- The reduction in concentrations of TCE through the dual biowalls is greater than 99%.
- The reduction in the concentration of total molar chlorinated ethenes through the dual biowalls is between 86 and 99%.
- Geochemical data and chlorinated ethene reduction indicates that treatment zones were established within and downgradient of the dual biowall system during the pilot study time frame (approximately 6 months).
- The molar fraction of ethene is increasing within and downgradient of the biowall system and is a positive indicator of complete dechlorination of the chlorinated ethenes present at the site. If the process resulted in the sole production of VC, ethene levels would not be increasing as measured during the third and fourth sampling rounds. The presence of VC and elevated concentrations of ethene downgradient of the biowall trenches is solid evidence that treatment zones have begun to be established downgradient of the biowall system. Destruction of contaminants is occurring beyond the installed treatment system.
- Sampling of monitoring well MW-56 located upgradient of the Farm House was conducted in October 2005. The results showed no contaminant concentrations exceeding the Class GA groundwater standards.
- The objectives of the biowall pilot study have been met. The biowall performance has been shown to be comparable, if not superior to that of the ZVI wall. In light of this information, mulch had been selected as the media for the full-scale PRBs, and the Army recommended that full-scale design of a biowall groundwater treatment system for the Ash Landfill commence.

The full results of the pilot study are presented in a technical memorandum "Evaluation Report for the Mulch Biowalls at the Ash Landfill Site Seneca Army Depot Activity" submitted to USEPA and NYSDEC in March 2006. The results presented in the Evaluation Report demonstrated that biowalls are effective at treating chlorinated ethenes at the Ash Landfill OU and are a suitable and effective technology to achieve the project remedial action objectives of preventing groundwater exceedances at the trigger monitoring well and reducing groundwater concentrations at the site until standards are met. This section uses the results and information gathered from the pilot study to address the following design issues: biowall configuration, biowall locations, biowall dimensions and mulch composition.

3.2 Biowall System Rationale

The following section describes the basis of design for the full-scale biowall system and the rationale for the design based on the results of the pilot study. The following components of the design are discussed below:

- Use of three dual biowalls vs. single biowalls;
- Location of biowalls within the plume;
- Configuration and layout of the biowall systems;
- Thickness of the walls;
- Biowall backfill material

Use of Dual Biowalls vs. Single Biowalls

The pilot study evaluated the effectiveness of the reduction of TCE and its daughter products in groundwater by flowing through a single biowall or two closely spaced walls in parallel. Results of the pilot study indicate that complete dechlorination of TCE to ethene can be achieved, but that the residence time required to lower concentrations of DCE and VC to target levels may not be achieved through a single biowall. The dual biowall system creates a continuous reaction zone between the first and second biowall. In this configuration, the first biowall in the pair serves to reduce concentrations of both TCE and native electron acceptors (e.g., sulfate). Within the second biowall, efficient reduction of DCE and VC occurs with less competition from alternate electron acceptor processes. This is more effective in stimulating complete dechlorination than single, separate biowalls where groundwater reduction-oxidation (redox) conditions rebound between widely-spaced biowalls.

In addition, the dual wall system provides added reinforcement in areas of higher localized groundwater velocities. For the full-scale system, a series of three dual-biowall systems is proposed to form multiple, sequential reaction zones. As the contaminant plume migrates through each of the biowall systems, overall contaminant mass flux will be reduced (by as much as 98 to 99 percent), and any DCE and VC leaving upgradient biowall segments will migrate through subsequent reaction zones thereby increasing the residence time necessary to reduce DCE and VC concentrations to target levels and reducing the mass flux into each subsequent reaction zone.

Location of Biowalls within the Plume

The installation of three dual biowall systems (i.e. a total of six biowalls) is designed to reduce the mass flux across each successive biowall system, and provide a redundancy for capturing any contaminant mass (i.e., DCE and VC) that may pass through the initial treatment zone. The biowall pairs will be placed near the source of the plume, as shown in **Drawing C-4**, to target the highest concentrations of chlorinated ethenes at the heart of the plume. Aggressively treating the groundwater at the source area will reduce chlorinated ethene concentrations at downgradient locations in the plume.

Since reductive dechlorination was observed in sulfate reducing and methanogenic conditions during the pilot study, TCE, DCE, and some VC will be adequately reduced during migration through the three dual biowalls, incorporated into the final design. VC is the last step in the sequential dechlorination of TCE, and may degrade at a slower rate than TCE or DCE. Therefore, it is prudent to allow several hundred feet beyond the furthest downgradient biowall system for groundwater conditions to recover to aerobic conditions where any remaining VC is readily oxidized prior to reaching the site boundary. Similarly, fermentation products such as ketones and alcohols will also oxidize well before they reach the property fence line. To this end, the design specifies that the location of the biowalls will be clustered within the eastern upgradient portion of the dissolved chlorinated ethene plume that emanates from the Ash Landfill, shown in **Drawing C-4**, in order to create an anaerobic treatment zone that will focus on degrading TCE and its immediate dechlorination products DCE and VC. An aerobic treatment zone, which can efficiently degrade any residual VC or fermentation products like ketones, is desirable and will be established in the downgradient portion of the plume, beginning approximately 350 feet east of the ZVI wall, as illustrated in the schematic **Figure 3-3**. Note that the exact sizes of the aerobic and anaerobic zones are approximate.

The maintenance of an aerobic zone between the site boundary and the most downgradient biowall shown on **Drawing C-4** is desirable to ensure that any residual concentrations of VC or biowall fermentation byproducts (i.e., ketones) are reduced by oxidation reactions. **Figure 3-3** shows that an anaerobic zone follows a biowall. There is potential that low concentrations of VC may persist as the last dechlorination product under anaerobic conditions. However, VC will be rapidly degraded under aerobic conditions as it travels through an aerobic redox recovery zone. If a biowall were located closer to the site boundary, it is possible that the anaerobic treatment zone would extend to or beyond the site boundary, and the benefits of sequential anaerobic/aerobic bioremediation would not be realized.

More aggressive mitigation of the downgradient portion of the plume (i.e. from the final dual wall system proposed to the toe of the plume) is not necessary for the following reasons:

- Aggressive treatment of the groundwater in the eastern portion of the plume will further reduce the historically low concentrations further downgradient. The pilot study demonstrated that groundwater was flowing at a rate ranging from 100 to 400 feet/year. This indicates that levels of chlorinated solvents in the groundwater at the site boundary may decrease as soon as two years after the installation of the biowalls.

- An existing treatment wall (i.e. the pilot study ZVI wall) is currently in place providing treatment of contaminants near the property fence line, and treatment effectiveness will improve as the input concentrations from upgradient areas are reduced by the three dual biowall systems.

- There have been no exceedances at the trigger well MW-56, (the off-site monitoring well) historically over 12 years of monitoring, even prior to the IRM when groundwater levels at the source were an order of magnitude higher than they are today.

Configuration and Layout of Biowalls

The proposed biowalls will be installed perpendicular to the general direction of groundwater flow within the area and will extend approximately to the chlorinated ethenes 10 ppb isocontour of the existing plume as delineated in **Drawing C-4**. The following provides the rationale for the orientation of each dual biowall system.

A1 and A2 – Source walls: The purpose of biowalls A1 and A2 is twofold: (1) to reduce the high level of TCE present in the groundwater at this location and (2) to decrease the level of electron receptors native to the aquifer, thereby "jump starting" conditions conducive to anaerobic degradation of chlorinated compounds. By placing a source of organic carbon upgradient of the biowall pilot study location, it is anticipated that better reduction of chlorinated solvents will be seen in downgradient walls, since competing electron acceptors such as dissolved oxygen and sulfates will be depleted. In addition, since anaerobic reductive dechlorination is most effective under reducing conditions that support sulfate reduction and methanogenesis (ORP lower than -200 mV), it is beneficial to reach such conditions further upgradient in the plume so that the organic carbon provided by subsequent biowalls is used more efficiently to support reductive dechlorination processes, resulting in more effective reduction of the dechlorination products DCE and VC.

The total length of biowalls A1 and A2 is approximately 370 feet each. The north end of walls A1 and A2 stop short of the emerging wetland area since there is evidence that a reducing zone has already been established in this area of the plume as seen by the chemical composition of the groundwater in MW-44A (i.e. low concentrations of TCE in the presence of higher levels of DCE and VC). The second biowall system (B1/B2) extends beyond this area to the north as discussed below. The south end of biowalls A1 and A2 covers the majority of the high concentration portion of the plume (i.e. the 1,000 µg/L chlorinated ethene isocontour), stopping short of the subsurface 6-inch water line. Biowalls A1 and A2 pivot at a point about 210 feet from the northern end in an effort to better capture the groundwater flow. This flow is predominantly to the northwest, but flows slightly more to the direct west along the southern end of the biowall alignment.

B1 and B2 – Middle walls: The purpose of biowalls B1 and B2 is to provide an added carbon source to sustain the reduction zone and maintain anaerobic conditions that were “jump started” in Biowalls A1 and A2. By having A1 and A2 in place, the chlorinated hydrocarbon loading on Biowalls B1 and B2 will be reduced and electron acceptors that compete with DCE and potentially VC (e.g. dissolved oxygen and sulfates) will be depleted. Therefore, intermediate by-products such as DCE are expected to be reduced more readily.

Biowalls B1 and B2 will be located at the existing pilot study biowall location, approximately 40 feet west of the source walls. The length of the biowalls to be constructed along B1/B2 is approximately 725 feet each. The existing biowalls will be extended to cover the entire width of the chlorinated solvent plume to the inferred 10 ppb total chlorinated ethenes isocontour. The southern end of the middle wall stops short of the ditch along West Smith Farm Road, and the northern end of the middle walls will extend 50 feet beyond the 10 ppb isocontour line. The walls intersect the branch of the 6-inch water main that runs from the eastern portion of the site. These middle walls pivot at one point. In extending north from the existing pilot study walls, the walls pivot slightly to the west to avoid wetland areas to the north where anaerobic conditions may already be established. The southern extension from the mid-point of the existing pilot study walls pivots slightly to the east to stay perpendicular to groundwater flow which appears to change direction slightly in this area of the site and also avoids the buffer zone around the archaeological Native American site identified in the area (see **Drawing C-4**). Groundwater flow in this area is more directly west than flow in the northern portion of the site.

C1 and C2 – Final Walls: Biowalls C1 and C2 are located downgradient of PT-22, approximately 325 feet west of the middle biowalls. During the pilot study, mild effects from the pilot study biowalls (the location of biowalls B1 and B2) were observed at PT-22. Therefore, by providing an added carbon source at this location, it was felt that anaerobic conditions could be sustained such that continued degradation of chlorinated solvents to inert by-products may occur. The location of walls C1 and C2 are located further west of PT-22 to stay outside of the buffer zone established around the archaeological Native American site located within this area. These two walls are expected to reduce levels of TCE and DCE to acceptable levels. Any VC that remains in the aquifer beyond biowalls C1 and C2 will encounter an aerobic zone and have adequate residence time within the aquifer to aerobically degrade prior to approaching the fence line of the site. VC degrades more rapidly under aerobic conditions. By placing the six biowalls in the eastern half of the plume, a strongly reducing anaerobic environment is established forcing TCE and DCE to form their by-products, VC and ethene and ethane. Any remaining VC, volatile fatty acids, or other fermentation products will then be able to travel the remaining length of the site in more aerobic, oxidizing conditions and deteriorate prior to reaching the fence line.

The total length of each of Biowalls C1 and C2 is approximately 575 feet. The north end of the final walls extends to 50 feet north of the 10 ppb isocontour line. MW-48 historically has had no detections of chlorinated compounds. The south end of the walls run out to just before the drainage ditch along West Smith Farm Road. The walls are south of the 6-inch water main, but do intersect the branch of the main that runs to the western portion of the site. These walls are oriented such that they are perpendicular to the groundwater flow in this area, where groundwater flow is more towards the southwest.

Biowall Thickness

Based on the results of the biowall pilot study at the site, a 3-foot trench thickness resulted in adequate establishment of a treatment zone, which was further enhanced with a second 3-foot thick biowall in series. The 3-foot thickness allows for the use of standard excavation equipment. The two segments will be placed parallel to each other, with the upgradient wall installed approximately 12 feet west (hydraulically downgradient) of the downgradient wall. This distance allows for ease in constructability of two 3-foot trenches and worked well during construction of the pilot-test biowall system.

Biowall Backfill Material

During the pilot study, vegetable oil was added to the upgradient (Eastern) biowall as a supplemental source of organic carbon to increase substrate loading. Parsons' experience with the use of vegetable oil injected directly into the subsurface indicates that vegetable oil alone is able to sustain a reactive zone for periods of 3 to 4 years or more. The use of vegetable oil is an inexpensive contingency to optimize the duration of biowall performance. Continued monitoring of the pilot biowall system may be used as an early indicator of when the full-scale system may need to be recharged.

The mulch for all biowalls will be coated with food-grade vegetable oil and then mixed with the sand prior to emplacement in the trench, because it will increase the duration of organic carbon release from the biowall.

Drawing C-5 provides a cross-section of the biowall system components along one of the well transects. Piping was added to the pilot biowall system as a contingency for recharge using fluid substrates. Piping will not be installed in the full-scale walls, since it may not be needed. Instead, direct injection using temporary direct-push injection points, which are easy to install, will be used to recharge the system, if necessary.

4.0 DESIGN ELEMENTS

This section provides a summary of design information for each aspect of the remedial action at the Ash Landfill OU: site preparation; soil remediation, including excavation and disposal of Debris Piles, backfilling the Incinerator Cooling Water Pond, and establishment and maintenance of vegetative soil covers over the Ash Landfill and the NCFL; groundwater remediation, installing *in situ* biowalls; and site restoration.

Drawings (**Appendix A**) and technical specifications (**Appendix B**) present the detailed design information that will be implemented. Confirmatory sampling and disposal characterization sampling is described in the site-specific Field Sampling Plan (FSP) in **Section 5**. The Construction Quality Plan (CQP) is included in **Section 6**, and the Post-Closure Monitoring and Maintenance Plan (PCMMP) is in **Section 7**.

4.1 Site Preparation

Site preparation will be required prior to construction activity at the Ash Landfill OU. As part of this report, the specifications are developed for the following activities:

- Mobilization details;
- Siting of staging areas for construction activities;
- Clearing requirements;
- Removing debris;
- Identification of obstructions and utilities, both overhead and underground;
- Storm water and erosion control measures, including establishing temporary silt fencing;
- Protection of monitoring wells;
- Construction of equipment and personnel decontamination area;
- Site survey;
- Site controls and security; and
- Dust control measures.

4.1.1 Mobilization and Staging Areas

The field crew and equipment will be mobilized to the site. The contractor shall submit, for the engineer's approval, the proposed plan for decontamination of personnel and equipment a minimum of five working days prior to commencement of work.

Any debris located at the Ash Landfill OU in the proposed work areas will be removed and disposed in an appropriate off-site facility with the excavated soil.

4.1.2 Clearing

The work areas at the Ash Landfill OU will be cleared to allow for equipment access. Trees and brush will be cleared from the Debris Piles, the Ash Landfill, and the NCFL in order to complete the work at those areas. Trees will be ground up and used as an organic enhancement in the 12-inch vegetative soil cover being installed over the Ash Landfill and the NCFL.

4.1.3 Identification of Obstructions and Utilities

Prior to the start of construction, all utilities, both underground and overhead, will be marked out and accounted for in the construction plan. Precautions will be taken to prevent the disruption of service due to equipment traffic in and out of the site. There are overhead electrical lines at the Ash Landfill OU, and the Contractor will use care when working in their vicinity. A 6-inch water main and a 12-inch reinforced concrete drainage pipe (RCP) run through portions of the site as shown on the site plan (**Drawing C-2**) and will be marked out prior to the commencement of work. Utility clearance and mark out will be completed by Underground Facilities Protective Organization (UGFPO) prior to the commencement of work.

4.1.4 Off-Site Borrow Pits

Soil fill consisting of either common fill, top soil, or sand will be required for the following:

- Backfilling the Incinerator Cooling Water Pond by moving the surrounding bermed material into the Pond and adding common fill to meet the natural grade;
- Placement of a 12-inch cover suitable for sustaining surrounding vegetation over the Ash Landfill (common fill and/or top soil);
- Placement of a 12-inch cover suitable for sustaining surrounding vegetation over the NCFL (common fill and/or top soil);
- Sand mixture for placement with the mulch material for the reactive walls; and
- Placement of cover over the biowalls, if required.

An off-site borrow source will be identified for this project and data will be provided certifying that the material is suitable for use as clean fill. The soil from the borrow source will comply with the borrow source specifications (Section 02223) in **Appendix B**. Specifically, analytical data from the borrow soil must be less than NYSDEC TAGMs.

The procedure to show acceptability of a borrow source for use as fill at the Ash Landfill, consistent with NYSDEC's Draft DER-10 Technical Guidance for Site Investigation and Remediation (December 2002), is as follows:

1. Contractor identifies a potential borrow source for the Ash Landfill project. Contractor provides the name of the site owner, the location where the fill was obtained, and a brief history of the site which is the source of the fill.

2. Contractor collects one representative sample from the borrow source and submits for the analysis of VOCs, SVOCs, and metals. The results are provided to the Army, USEPA and NYSDEC.

3. The analysis results are compared to the NYSDEC TAGM 4046 values.

4. If all results are lower than the requirements, the material is acceptable for use as fill or cover material. If the results are not acceptable, a new borrow source will be located and the process will be repeated. The Army will provide the comparison of borrow material results to the acceptability criteria to NYSDEC and USEPA for review prior to accepting the material onsite. The Army will consider the material approved if it meets all of the requirements as discussed above.

5. No additional borrow source samples will be required once the source is approved. The Army will monitor the incoming loads of borrow material to document that the material is free of extraneous debris or solid waste.

4.1.5 On-Site Borrow Source

On-site borrow material may also be used as fill and/or cover material. Soil generated during excavation of the biowalls will be stockpiled on-site and may be used as on-site borrow material. As stated in the "Ash Landfill Biowall Pilot Study Work Plan" (Parsons, 2005a), on-site soil with TCE concentrations less than the NYSDEC TAGM value of 0.7 mg/Kg can be used on-site as fill, grading, or cover material, and soil with concentrations of TCE greater than the TAGM value may be used as cover material over the biowall.

4.1.6 Identification of Off-Site Disposal Facilities

Non-hazardous material excavated from the Debris Piles will be managed by the earthwork contractor and will be transported to Ontario County Landfill in Flint, New York or Seneca Meadows Landfill in Waterloo, NY for disposal. If found, hazardous soil will be managed at SWM Chemical Services (LLC), 1550 Balmer Road, Model City, NY or similar permitted facility. No hazardous material has been identified at the site during the sampling events to date. It is not anticipated that there is any hazardous material at the Ash Landfill OU. In the event that hazardous waste is encountered, the material will be treated on-site to render it non-hazardous, when possible. Treatment may include stabilization to immobilize contaminants such as heavy metals. Stabilization involves mixing an additive such as cement, quick lime, fly ash, pozzolans, or a proprietary agent with the soil. The stabilization process decreases the toxicity of the metals because the metals are converted to less soluble forms. Once stabilization is complete, samples would be collected and analyzed for the TCLP parameters for which the waste is characteristically hazardous. Results will be used to render the waste non-hazardous and suitable for disposal at the Ontario County Landfill or Seneca Meadows Landfill.

4.1.7 Control of Run-on and Run-off Waters

The only subgrade excavation where run-on and run-off water will require control is during installation of the biowall trenches. The trenches will be backfilled in a timely manner and are not expected to collect significant quantities of water. Fill materials for the biowall will be stockpiled upgradient of the transects prior to excavation, providing a berm to divert surface water during installation. Because of the depth of the trenches, no surface water run-off is anticipated from the trenches.

4.1.8 Erosion and Sedimentation Control

Temporary erosion and sedimentation controls, such as silt fencing, hay bales, or soil berms, will be installed as required during operations to prevent migration of sediments and erosion. Prior to beginning any remedial work, temporary silt fencing (Specification Section 02370) will be erected, which will surround the downgradient sides of disturbed areas to prevent contaminated sediment transport. The temporary silt fencing will be maintained throughout the project and will not be removed until permanent vegetation has been re-established. In addition, storm water from upgradient locations will be routed away from exposed materials, and storm water contact of exposed material with storm water will be minimized to the extent practical. Any temporary erosion control measures will be removed following remediation so as to return drainage patterns to their general conditions prior to remediation.

4.1.9 Protection of Wetlands

Based on the New York state regulated wetland maps (Geneva South, Romulus, Ovid, and Dresden quads), there are six regulated wetlands within the 2-mile study area, but none are in close proximity to the site perimeter. The closest wetland is approximately 2,000 feet northeast of the Ash Landfill OU perimeter. The other five regulated wetlands are over one mile from the site perimeter. Several small freshwater emergent wetlands were identified during the RI within the Ash Landfill OU, including one located near that “Bend in the Road”. Measures will be taken, such as installing silt fencing, as necessary, to protect the emergent wetland areas.

4.1.10 Site Control and Security Requirements

The Ash Landfill OU is located within the Depot that is surrounded by a fence with locked gates. The Army will provide site access to the field team prior to and during construction activities. Site security is necessary to prevent exposure of unauthorized, unprotected individuals to the work area. The area immediately surrounding the work area will be clearly marked through the use of signs, barrier rope, tape, or fencing.

Site security will be enforced by the Site Health and Safety Officer (SHSO) or a designated alternate who will ensure that only authorized personnel are allowed in the work area. This person will also ensure that entry personnel have the required level of personal protective equipment (PPE), are trained under the requirements of 20 Code of Federal Regulations (CFR) 1910.120, and are on a current medical monitoring program.

All visitors to the work site are required to report to the Site Manager (SM) and/or the SHSO as soon as they arrive on-site. The presence of visitors on-site will be recorded in the field logbook, including the visitor’s name, company, date, time, and activities performed while on-site.

4.1.11 Site Health and Safety

All field activities during the remedial design will be performed in accordance with the site-specific health and safety plan (HSP), “Project Safety Plan and Site-Specific Health and Safety Plan for Remediation of the Seneca Army Depot Activity” (Parsons, 2005b) in accordance with Parsons’ Safety, Health, and Risk Program (SHARP) Manual. The construction contractor will review Parsons’ HSP and develop their own HSP written specifically for remedial design activities. The Health and Safety Plan of Action portion of this document will protect site workers through the identification, evaluation, and control of health and safety hazards.

4.2 Soil Remediation

The soil at the Ash Landfill OU will be addressed separately from the groundwater. The remedial action for soil includes the following three components: (1) Excavation and off-site disposal of the Debris Piles; (2) Installation and maintenance of a 12-inch vegetative soil cover over the Ash Landfill and the NCFL; and (3) Backfilling and re-grading of the Incinerator Cooling Water Pond. Each element is discussed individually in the three subsections below.

4.2.1 Excavation and Debris Removal

Before excavation commences, the Debris Piles will be located and staked to show their limits. Debris will be removed to the staked limits, or as directed by the engineer based on the visible presence of debris. The Debris Piles will be removed with standard construction equipment. The debris pile volume has been estimated at 770 cubic yards (cy), as shown on **Drawing C-3;** However, recent observations indicate the actual volume could be considerably less. The excavation will be complete once the Debris Piles have been removed, as determined by the Engineer. The underlying soil will not be removed unless the visual observations suggest that additional debris is present in the underlying soils.

For disposal characterization, the waste management facility requires that one composite sample will be collected from the Debris Piles and submitted for analysis, as detailed in **Section 5**. The disposal sample will be one composite of discrete grab samples from the piles. This sampling requirement is based on the waste management facility's review of the historic sampling results of the Debris Piles at the Ash Landfill OU. The disposal facility will pre-approve acceptance of the soil based on these data. The disposal characterization sampling will be completed prior to the commencement of construction activities. The disposal samples will be tested for contaminant leaching using the Toxicity Characteristic Leaching Procedure (TCLP). However unlikely, soil that fails the TCLP will be stabilized on-site and then disposed as non-hazardous waste. If the disposal sample passes the TCLP, then the soil from the excavation will be directly loaded into dump trucks and transported to and disposed in an off-site Subtitle D landfill selected by the earthwork contractor, which anticipates using either Ontario County Landfill in Flint, New York or Seneca Meadows Landfill in Waterloo, New York. It is not expected that any materials will be disposed as hazardous waste.

Debris will be directly loaded into dump trucks for transportation to the appropriate off-site waste management facility. It is not anticipated that soil will be staged prior to being transported off-site; however, in the event that temporary soil staging areas are required, soils will be temporarily placed in piles. A contingency plan presented in **Section 10** addresses soil stockpile areas in the unlikely event that they are necessary.

Any debris at the site will be disposed in an off-site landfill. A Waste Management Plan is included in **Section 8**.

The water collected from decontamination operations and run-on/run-off control will be drummed and discharged to the Seneca County Sewer District No. 2 via an on-site sanitary sewer with approval.

Contaminated materials will be "packaged" utilizing the following methods:

- Non-hazardous soil will be loaded into Department of Transportation (DOT) approved dump trucks and/or dump trailers; and

- Collected waters will be discharged via the on-site sanitary sewer.

Representatives of the transportation companies will be required to attend an orientation prior to hauling the excavated soil off-site. The orientation will cover:

- Traffic patterns
- Project safety issues
- Communication issues
- Haul and disposal procedures
- Documentation issues
- SEDA specific issues

The orientation will be summarized in a handout that will be expected to be passed along to each driver involved with the hauling activities. The transportation company will be required to document that pertinent information was delivered to each driver, or drivers will not be loaded.

Coordination of the off-site disposal activities will be done by the Site Manager. Each load will be tracked utilizing a worksheet provided to them as they arrive at SEDA. The worksheet will record:

- Transportation Company
- Arrival time/date
- Truck No.
- Trailer No.
- Driver's name
- Material to be loaded
- Site name/Excavation No.
- Time loaded
- Decon – Yes
- Tarped – Yes
- Release time
- Destination
- BOL/Manifest No

All shipments to off-site facilities will be tracked utilizing the worksheet and a Parsons-developed database. The database allows for easy cross-referencing, reporting, and quantifying.

Prior to leaving an area, each truck will be inspected and gross soils swept or brushed clean.

Water will be utilized to keep haul roads wet to control dust and VOC emissions in active areas. Polyethylene sheeting will also be utilized as a barrier on exposed material to control emissions. An air monitoring plan has been developed to protect the workers involved in the construction at the Ash Landfill OU. Public health and safety is ensured by monitoring within the work zone and creating an exclusion zone surrounding the construction area at each site. The air monitoring will be conducted in accordance with the air monitoring program outlined in Section A8 of the HSP (Parsons, 2005b). In addition, perimeter air monitoring will be conducted in accordance with the New York State Department of Health (NYSDOH) Generic Community Air Monitoring Plan (CAMP). Based on requirements specified in the NYSDOH CAMP, the perimeter air monitoring program will consist of real-time perimeter measurements for total VOCs and respirable airborne dust particulates (particulate matter less than 10 microns – PM_{10}).

4.2.2 Backfilling/Regrading the Incinerator Cooling Water Pond

The Incinerator Cooling Water Pond (SEAD-3) will be backfilled and regraded to meet surround grades. Initially, the bermed soil surrounding the Incinerator Cooling Water Pond will be pushed into the pond. Additional soil will be used to backfill the pond to meet the surrounding natural grade. Soil for backfilling will be obtained from either an on-site or off-site borrow source. Parsons will verify that the borrow soil documentation meets the TAGMs. The backfill will be placed in 1 to 2 foot lifts with required compaction. Soil compaction will be achieved by three passes of a dozer.

4.2.3 Installation of Vegetative Soil Cover

The landfill cover material will be obtained from an on-site or off-site borrow source. The cover material will be suitable for vegetative growth. The off-site or on-site borrow material may be amended with an organic top soil or mulch if the borrow soil does not appear to be contain sufficient organics to sustain growth. The goal of the landfill covers is to sustain vegetative growth that blends in with the surrounding areas. Additional material, such as mulch and tree chippings, may be added into the vegetative soil cover as an organic enhancement. A staging area for the borrow material will be established by the Engineer and the Contractor. The material will be protected with erosion and sedimentation controls to prevent sediment transport.

The limits of the landfills were defined during the RI at the Ash Landfill and are delineated on **Drawing C-3**. Twelve inches of soil cover material will be placed over the Ash Landfill and over the NCFL to the limits shown on Drawing C-3. The soil cover thickness will be verified following placement by hand digging holes to verify thickness on a 100 by 100-foot grid system. The material will be placed and soil compaction will be achieved by three passes of a dozer. The soil cover will be seeded to promote vegetation to prevent erosion.

The purpose of the cover is as a protective barrier to prevent direct contact and not as a low permeability precipitation infiltration barrier.

4.3 Groundwater Remediation – Biowalls

4.3.1 Biowall Locations

Drawing C-4 shows the proposed locations of the six biowalls at the Ash Landfill OU. The biowalls will be installed in three pairs: A1/A2, B1/B2, C1/C2. Biowalls A1 and A2 are source walls that will (1) reduce the high level of TCE present in the groundwater at this location and (2) decrease the level of electron receptors native to the aquifer (e.g., sulfates), thereby “jump starting” conditions conducive to anaerobic degradation of chlorinated compounds before reaching the middle walls. Biowalls B1 and B2, the middle walls, are extensions of the pilot study walls and extend over the entire width of the chlorinated solvent plume. These middle walls provide an added carbon source to sustain the reduction zone and maintain anaerobic conditions that were "jump started" in Biowalls A1 and A2, which allows for intermediate by-products such as DCE to be reduced more readily. Biowalls C1 and C2 provide a final source of substrate to sustain anaerobic conditions such that TCE and DCE levels are further reduced. This last biowall pair is approximately 400 feet upgradient of the site boundary. Any VC that remains in the aquifer beyond biowalls C1 and C2 will encounter an aerobic zone and have adequate residence time within the aquifer to aerobically degrade prior to approaching the fence line of the site. VC degrades more rapidly under aerobic conditions.

Table 3-1 shows the anticipated dimensions of the six biowalls that will be installed. **Section 3** provides the rationale for the placement of these biowalls. A typical cross section of a biowall pair is shown in **Drawing C-5**. Prior to excavating the biowall trenches, the location of each biowall will be staked out according to the coordinates provided on **Drawing C-4**. The walls within each pair will be spaced approximately 15 feet apart. The A1/A2 Biowalls will be situated approximately 40 feet east of the B1/B2 Biowalls (pilot study walls). The C1/C2 Biowalls will be approximately 325 feet west of the B1/B2 Biowalls.

4.3.2 Excavation

The biowalls will be excavated with standard excavating equipment. During the pilot study, the biowalls were excavated using a backhoe with a 3-foot wide bucket. The full-scale biowalls will be excavated in the same manner. During the pilot study, the excavator was able to easily excavate to a depth of 15 feet deep, scraping the competent shale in the area. As shown in **Table 3-1**, the depth to bedrock is not anticipated to be greater than that encountered during the pilot study biowall installation. Virtually no excavation water was produced due to the tight formation. Therefore, it is not anticipated that dewatering will be necessary. Trench boxes will be used to maintain the 3-foot trench width, as necessary.

Biowalls B1, B2, C1, and C2 will intercept an unused 6-inch ductile iron water main that runs east to west by the Incineration Building on the site (see Detail B on **Drawing C-5**). The water line is suspected to be located approximately 42 to 48 inches below ground surface. This line will be located using historical site plans, water valves existing at the site, and electromagnetic surveys, if necessary, prior to any excavation. The line will be marked with stakes. The section of the line that intersects Biowalls B1, B2, C1, and C2 will be isolated and drained through the hydrant located near West Patrol Road. This will be done at least one month prior to excavation of the biowall trenches so that any excess surface water has had time to run off or infiltrate. Once the biowall area is surveyed and staked and the water line is confirmed to be dry, the Contractor will install the biowalls around the 6-inch pipe in a manner such that the pipe is protected and maintained in a condition suitable for future operation, if necessary, and in such a way that no preferential groundwater flow path develops along the pipeline.

Soil excavated during the biowall installation will be placed on the side of the excavation in a windrow parallel to the biowall. The windrows will be sampled and managed as described in the Field Sampling Plan (**Section 5**). If soil results show that the soil is suitable for use as on-site backfill, the soil will be stockpiled near the Ash Cooling Pond. Soil not suitable for backfill will be placed over the biowalls.

The location and extent of the biowall will be marked with metal fence posts painted a high visibility color.

4.3.3 Mulch Backfill

Biowall installation will consist of excavating a linear trench into competent bedrock and backfilling this trench with a mixture of mulch and sand to ground surface. The mulch backfill in the Ash Landfill biowalls will be will be similar to the backfill used during the pilot study. It will consist of a mixture of shredded plant material generated during seasonal landscaping/farming operations (i.e., tree/brush removal, silage). The mulch will be stockpiled and allowed to partially compost for a minimum period of 1 week prior to installation of the biowall. The mulch for all six biowalls will be coated with food-grade vegetable oil (e.g., soybean oil) prior to mixing with sand and emplacement in the trench. The vegetable oil will be delivered to the site in either 55-gallon drums or as 220-gallon ‘totes’. In the event that it is technically difficult or infeasible to sufficiently mix the oil-coated mulch with sand, the mulch will be mixed with the sand prior to application of vegetable oil to the backfill.

The backfill mixture will be approximately 50 percent mulch and 50 percent coarse sand by volume. Poorly-graded, coarse or medium sand will be stockpiled at the site in preparation for mixing with the mulch material. Examples of commonly available sands meeting this requirement include washed block sands and washed concrete sands. The selected sand will be approved by the Engineer and must allow an acceptable permeability through the biowall. The ratio of mulch to sand is intended to maximize the amount of organic material, while still maintaining permeability within the biowall that is greater than the surrounding formation. Previous biowall installations, including the biowall pilot study, using a mixture of 50 percent mulch and 50 percent sand have shown that this mixture is optimal for balancing ease of emplacement with the long-term maintenance of biowall permeability. At this ratio, the mulch is supported by a sand matrix that minimizes compaction and maintains permeability. The mulch/sand mixture will be of sufficient permeability to allow for injection of vegetable oil, if necessary, at a later date.

The total volume of the proposed biowall trenches is approximately 4,000 cy, as calculated on **Table 3-1**. The sand component does not compact relative to the mulch component, and will fill in much of the void space of the larger mulch pieces. Therefore, 2,000 cy of sand will be used to meet a specification of 50 percent of the volume of the final mulch mixture. However, a mixing (or bulk) factor for the mulch is necessary to account for compaction and filling of the mulch pore space by sand. Based on experience, a mixing factor of 1.4 is appropriate to determine how much mulch is required to prepare the total volume of the mulch mixture. Therefore, it will take approximately 2,800 cy (2,000 cy x 1.4) of mulch to mix with 2,000 cy of sand to create a total of 4,000 cy of the mulch and sand mixture. The top of the trench (above the mulch/sand mixture) will be covered with soil from the excavation. **Table 3-1** provides the dimension of the trenches and the volume of mulch required.

Prior to mixing with sand, the mulch will be coated with vegetable oil. The drums or totes of oil will be lifted with a backhoe or crane and poured over the mulch in batches. A backhoe will then be used to mix the vegetable oil into the mulch taking care to coat all of the mulch. The total volume of vegetable oil used for the 2,800 cy of mulch required will be approximately 9,700 gallons. The addition of 9,700 gallons of vegetable oil incorporated into the 4,000 cy of mulch/sand mixture will result in approximately 3% of the pore space volume occupied by oil. This is the proportion used in the East Biowall during the pilot study testing.

Drawing C-5 provides a cross-section of the biowall system components along one of the well transects.

The field engineer will evaluate the physical characteristics of the mulch and sand used for construction of the biowall, including visual descriptions of the mulch composition, point of origin, processing, range of particle size, and any signs of compositional decay. One representative sample of sand from each source will be collected and submitted for the analyses listed in **Table 5-1**. A descriptive log of all backfill mixing, trenching, and biowall installation activities will be recorded in the field. The field logs will include photo documentation and a written log. The written log will include daily setup and breakdown times, advancement rate, problems encountered in the field and corrective measures taken, as well as any other field observations.

Parsons personnel will visually inspect the backfill mixing process to determine when the mixture is adequately homogenized. Following a visual determination of homogenization, a minimum of three grab samples will be collected and analyzed in the field for the volume and weight ratio of sand to organic material. Note that organic material included in this analysis will include both mulch and any green organic material that is added to the backfill mixture. The target volumetric mulch mixture ratio of 50 percent organic material and 50 percent sand, with an allowable variation of ± 10 percent. Weight percentage will be used as a secondary criterion for evaluating mulch mixture homogeneity, with densities of individual mulch mixture components measured in the field as wet density. A target range for mulch mixture density will then be calculated using these wet densities and the range of acceptable volume ratios.

The mulch mixture QC will be performed by collecting approximately five liters sample of the mixture and passing it through a number 6 mesh sieve (0.132 inch opening). Material passing the number 6 mesh sieve is anticipated to be mostly sand, with some fine-grained organics from the mulch material. Material retained on the number 6 mesh sieve is anticipated to primarily be organic material. The volume and weight measurements for percent passing and percent retained on the number 6 mesh sieve will be recorded in the field. If either the volumetric or weight percentage of all samples is within the tolerances described above, the mulch mixture will be accepted as sufficiently mixed for placement as the backfill material. In the event that neither the volumetric or weight percentage of one or more samples is within the acceptable range of values, the mulch mixture will be mixed again to determine if insufficient mixing is the cause of this discrepancy. In the event that continued mixing does not result in the achievement of an acceptable mixture composition, addition of the material which is lean in the mixture will be performed to achieve an acceptable mixture ratio for the backfill material.

4.3.4 Soil Cover/Capping

A 12-inch soil cover will be placed over the entire length of the biowalls as shown in **Drawing C-5**. This cover will impede surface water from preferentially flowing into the biowall. Trench spoils will be used as the cover material.

Biowalls C1 and C2 intercept a ditch that is approximately 3 feet in depth (see Detail A on **Drawings C-4** and **C-5**). Prior to excavation in this area, any water in the ditch will be dewatered and a temporary dam will be constructed upgradient to prevent water from entering the biowall excavation. The biowall will then be excavated as described above. A 12-inch soil cap will be constructed over the biowall in the area of the ditch as shown in **Drawing C-5**, Detail A to prevent surface water from infiltrating into the biowalls. Lower permeability soil will be selected from the trench spoils for this use and will be compacted with the backhoe.

4.4 Site Restoration

Prior to demobilization, the following site restoration activities will be completed:

- Backfilled areas and work areas that have been disturbed during operations will be seeded to allow re-vegetation. Vegetation serves to reduce erosion through wind or overland water flow, enhance evapotranspiration, and improve run-off water quality. A seed mixture will be selected to blend the area with natural vegetation already existing drainage ditches and swales will be protected against erosion by seeding. Specification 02990 includes seeding requirements;

- Any drainage control features such, as diversion ditches or berms, disturbed by site operations will be restored to a functioning condition;

- All equipment and materials will be demobilized;

- A final inspection and housekeeping sweep of the work areas will be completed. All trash and waste materials will be removed; and

- All field personnel and equipment will be demobilized from the site.

5.0 FIELD SAMPLING PLAN

5.1 Introduction

This Field Sampling Plan (FSP) describes the approach to conducting sampling necessary to complete the remediation at the Ash Landfill OU. The sampling proposed in this FSP has been designed to provide the information necessary (1) to characterize excavated soils for reuse; (2) to characterize sand used to construct the biowalls; and (3) to characterize off-site backfill and cover material. Project specific data quality objectives (DQOs) for sampling are described throughout this section. Groundwater sampling as part of long-term groundwater monitoring is discussed in the Post-Closure Monitoring and Maintenance Plan (PCMMP) in **Section 7** of this report. Sampling and analysis for investigation-derived waste (IDW) is presented in **Section 8** of this report.

For each type of sampling, this FSP specifies the following:

- Types of sampling required;
- Number of required samples;
- List of required analyses;
- Acceptance criteria for analytical results; and
- Sample labeling and recording system.

This FSP is supplemented by the Revised Final Generic Site-Wide Sampling and Analysis Plan, Seneca Army Depot Activity (Parsons, 2006c; hereafter referred to as the SAP). This SAP was provided to the agencies under separate cover. The SAP specifies the following:

• Data quality objectives; • Specific field sampling procedures; • Sample custody and management; • Quality control (QC) sample collection; • Analytical methods;	• Data validation; • Laboratory analytical requirements; • Data management and evaluation; • Performance assessment and system audits; and • Preventative maintenance.

5.2 Project Scope and Objectives

This project focuses on the excavation and disposal of the Debris Piles, backfilling the Incinerator Cooling Water Pond, installing the biowalls, and installing a 12-inch vegetative soil cover over the Ash Landfill and the NCFL. In order to accomplish this project, several sampling tasks are required. These sampling tasks are outlined below and the standard operating procedures (SOPs) are discussed in further detail in the SAP. The details of the field sampling requirements are presented in **Section 5.3**.

5.2.1 Disposal Characterization Sampling

For disposal characterization, the disposal facility requires that one composite sample shall be collected and submitted for analysis for each source of material to be disposed. This sampling requirement is based on the disposal facility's review of the historic sampling results at the Ash Landfill OU. The disposal facility will approve acceptance of the soil based on these data. Prior to the commencement of the excavation of the Debris Piles, one composite soil sample will be collected from the piles and analyzed for TCLP VOCs, TCLP SVOCs, TCLP metals, TCLP pesticides, TCLP herbicides, PCBs, ignitability, pH, and reactivity. The analytical results for the composite soil sample will determine whether the excavated piles at the Ash Landfill OU will be directly loaded into trucks for off-site disposal to a Subtitle D non-hazardous facility.

Additionally, if it is determined that trench spoils will require off-site disposal, one composite sample from the spoils will be submitted for analysis and approval.

5.2.2 Off-Site Sand Sampling

Off-site mulch and sand will be mixed and placed in excavated trenches to construct the biowalls. One representative sand sample from an off-site source will be collected and submitted for analysis of iron, phosphorus, and potassium using the SW846 Method 6010B (**Table 5-1**).

5.2.3 Trench Spoils Sampling

Soil excavated from the trenches will be staged in windrows parallel to each of the trenches. One sample will be collected from the trench spoils per 150 LF of biowall excavated within the 100 μg/L total chlorinated ethene contour line for groundwater. Based on **Drawing C-6**, it is anticipated that 16 samples will be collected from the trench spoils. The soil samples will be submitted for VOC analysis using the SW846 Method 8260B (**Table 5-2**). If the concentration of TCE in the soil is less than the NYSDEC TAGM value of 0.7 mg/Kg, it will be used on-site as fill, cover, or grading material, and trench spoils with TCE concentrations greater than the TAGM value may be used as cover material over the biowalls.

5.2.4 Fill Material Sampling

An off-site borrow pit will be designated as a source of fill material, including common fill and topsoil, for the project. One sample of material from the pit for each type of soil will be collected for characterization to ensure that the soil is clean. Each sample of the borrow soil will be analyzed for VOCs, SVOCs, and metals and compared to TAGM values. If these goals are not met, the off-site borrow source material will not be used as backfill. A new borrow source capable of meeting the requirements will be located.

5.2.5 Monitoring Well Installation and Monitoring

Three monitoring wells will be installed at the Ash Landfill OU. SOPs for monitoring well installation, including field screening analysis requirement, are presented in the Seneca Generic Site-Wide SAP and summarized in **Section 7**. Groundwater sampling as part of long-term groundwater monitoring is discussed in the PCMMP in **Section 7** of this report.

5.2.6 Waste Residuals

Waste residuals generated during the field sampling activities, including disposable sampling tools, plastic sheeting, and disposable personal protective equipment will be bagged and disposed in an on-site trash dumpster. Waste residuals are discussed further in **Section 8**.

5.2.7 Air Monitoring

An air monitoring plan has been developed to protect the workers involved in the construction at the Ash Landfill OU. Public health and safety is ensured by monitoring within the work zone and creating an exclusion zone surrounding the construction area at the site. The air monitoring will be conducted in accordance with the air monitoring program outlined in Section A8 of the Project Safety Plan and Site-Specific Health and Safety Plan for Remediation of the Seneca Army Depot (Parsons, 2005b). In addition, perimeter air monitoring will be conducted in accordance with the NYSDOH Generic Community Air Monitoring Plan (CAMP). Based on requirements specified in the NYSDOH CAMP, the perimeter air monitoring program will consist of real-time perimeter measurements for total VOCs and respirable airborne dust particulates (particulate matter less than 10 microns – PM_{10}).

5.3 Field Sampling Detail

This section provides a detailed description of the field sampling activities that were outlined in the previous section. Refer to the Seneca Generic Site-Wide SAP (Parsons, 2006c) for a more detailed description of the analytical program, including sample custody, sample management, and data validation. Quality control (QC) samples will be collected in accordance with the SAP.

5.3.1 Disposal Characterization Sampling

For disposal characterization, the disposal facility requires that one composite sample from each source of disposal material will be collected at the site. For example, one sample will be collected from the Debris Piles, and one sample will be collected from the trench spoils if off-site disposal is necessary. This sampling requirement is based on the disposal facility's review of the historic sampling results at the Ash Landfill OU. The disposal facility has already pre-approved acceptance of the soil based on these data. A disposal characterization sample will be collected and analyzed to determine if the excavated soils can be disposed as non-hazardous waste.

5.3.1.1 Sample Collection

One composite soil sample will be collected from the Debris Piles prior to commencement of the excavation activity. The composite sample will consist of a discrete sample from each pile. The sample will be collected following procedures outlined in the SAP and the samples will be composited into one composite soil sample. One composite sample may be collected from the trench spoils, if necessary. No field QC samples will be collected for the disposal characterization.

5.3.1.2 Sample Analysis

The composite soil sample will be submitted for TCLP VOC, TCLP SVOC, TCLP metal, TCLP pesticide, TCLP herbicide, PCB, ignitability, pH, and reactivity analyses. The corresponding analytical methods are specified in **Table 5-1**. The results will be compared with the limits used for hazardous waste identification (as specified in 40 CFR 261 and summarized in the Seneca Generic Site-Wide SAP).

5.3.1.3 Sample Designation

The disposal characterization samples from the Ash Landfill OU will be labeled as follows:

ALDW1000

AL represents Ash Landfill OU. DW designates that the sample is collected for disposal characterization. 1000 is the sample number for soil.

Sample labeling will be consistent with the SOPs specified in the Seneca Generic Site-Wide SAP. In the field, the engineer will keep a log of the sample information (e.g., sample locations and collection methods).

5.3.2 Off-Site Sand Sampling

One representative sample will be collected from each source of sand selected to be used for biowall construction for characterization purposes.

5.3.2.1 Sample Collection

One representative sample will be collected from the sand material following sample collection procedures outlined in the SAP. No field QC samples will be collected for the sand sampling.

5.3.2.2 Sample Analysis

The sand sample will be submitted for iron, phosphorus, and potassium analyses using SW846 Method 6010B. No acceptance criteria are available for the sand sample results.

5.3.2.3 Sample Designation

The sand sample will be designated as follows:

ALBW5000

AL represents Ash Landfill OU. BW designates that the sample is collected for activities associated with the biowall remediation. 5000 is the sample number for miscellaneous material (in this case sand).

5.3.3 Trench Spoils Sampling

Soil excavated from the trenches during the biowall construction will be sampled to determine the future use of the trench spoils.

5.3.3.1 Sample Collection

One sample will be collected from the trench spoils per 150 LF of biowall excavated within the 100 µg/L total chlorinated ethene contour line for groundwater. Based on **Drawing C-6**, it is anticipated that 16 samples will be collected from the trench spoils. Discrete soil samples will be collected once excavation activities have been completed for the designated biowall. Field QA/QC samples will be collected in accordance with the Seneca Generic Site-Wide SAP. The QA/QC sample requirements are presented in **Table 5-3**. In summary, one field duplicate (or one per SDG, whichever is more frequent) will be collected for the trench spoil sampling. One matrix spike/matrix spike duplicate (MS/MSD) pair will be collected for the project to evaluate potential matrix impact to the analytical results.

5.3.3.2 Sample Analysis

All trench spoil samples and field QA/QC samples will be submitted for VOC analysis using the SW846 Method 8260B (**Table 5-2**). The TCE results in the trench spoil samples will be compared with the NYSDEC TAGM value of 0.7 mg/Kg. The following table describes the fate of trench spoils based on the comparison with the NYSDEC TAGM value.

Sample Results	Acceptable Use
TCE less than NYSDEC TAGM of 0.7 mg/kg.	Soil may be used on-site for fill, cover, or grading material.
TCE greater than NYSDEC TAGM of 0.7 mg/kg.	Soil may be used as cover over the biowalls (a one-foot cover to prevent surface infiltration is required).

5.3.3.3 Sample Designation

The trench spoil sample will be designated as follows:

ALBW10016 through ALBW10027

AL represents Ash Landfill OU. BW designates that the sample is collected for activities associated with the biowall remediation. The sample numbers for soil samples will begin with 10016.

5.3.4 Fill Material Sampling

Fill material will be used to backfill the Incinerator Cooling Water Pond and to provide a 12-inch vegetative soil cover over the Ash Landfill and NCFL at the site. The fill material will be common fill for both backfilling and the covers. Topsoil may be required to increase the organic content of the common fill and allow for re-vegetation. Prior to accepting any off-site material, fill material (topsoil or common fill) will be sampled to determine if it is acceptable as clean fill, as specified in Specification 02223. The contractor will provide Parsons with data indicating that the VOC, SVOC, and metal concentrations are below TAGM values and the material is suitable for use as fill.

5.3.4.1 Sample Collection

The contractor will submit representative fill material samples and provide the analytical results for comparison to the TAGMs. One sample will be collected for each type of fill material prior to use as all fill material is expected to be from one designated source. No QA/QC samples will be collected for the fill material sampling.

5.3.4.2 Sample Analysis

The soil samples will be submitted for the following analyses:

- VOC analysis using SW846 Method 8260B,
- SVOC analysis using SW846 Method 8270C, and
- Metal analysis using SW846 Method 6010B and Method 7471A.

The sample results will be compared to TAGMs. If the concentrations exceed the TAGM values, the fill material will be rejected for the project unless approved for use by the regulatory agencies.

5.3.4.3 Sample Designation

The fill material will be designated as follows:

ALFM10000

FM indicates that the sample is fill material. 10000 is the sample number for soil.

6.0 CONSTRUCTION QUALITY PLAN

The Construction Quality Plan (CQP) describes the construction quality assurance (QA) and quality control (QC) activities to be performed during construction of the Remedial Action (RA) for the Ash Landfill OU at the Seneca Army Depot Activity. This section addresses the QA/QC procedures for site preparation, excavation, backfilling, installation of soil covers, installation of PRBs, and site restoration. QA/QC for groundwater monitoring is addressed in **Section 7** of this report and the SAP (Parsons, 2006c). This CQP has been developed to ensure that implementation of the remedial action is in compliance with the project documents, including the plans and specifications, **Appendix A** and **B**, respectively. Inspections to verify compliance with the quality requirements will be performed during all phases of construction.

The objective of this plan is to ensure that proper materials, construction techniques, methods, and procedures are implemented by the contractor and completed in accordance with project specifications. This plan provides a means to identify problems that may occur during construction and provides appropriate methods for resolution of these problems.

6.1 Construction Project Organization

Responsibilities for selection of appropriate project team members and integration of team resources to address project requirements are performed by the key team members outlined below.

Name	Title	Phone Number	Primary Location
Jesse Perez	AFCEE Contracting Officer's Representative (COR)	Office: (210) 536-5269	Off-site (Brooks-City-Base, TX)
Stephen Absolom	Seneca Army Depot Activity's Point of Contact (POC)	Office: (607) 869-1309	On-site
Thomas Battaglia	Seneca Army Depot Activity's CORR	Office: (607) 869-1353	On-site
Todd Heino	Parsons Project Manager (PM)	Office: (617) 449-1405	Off-site (Boston, MA)
Tim Mustard	Program Health and Safety Officer (PHSO)	Office: (303) 764-8810	Off-site (Denver, CO)
Tom Andrews	Site Manager (SM)	Office: (716) 633-7074 Cell: (716) 998-7473	On-site 1 to 2 days/wk Off-site (Buffalo, NY)
Beth Wasserman	Project Engineer	Office: (617) 449-1565	Off-site (Boston, MA)
Jackie Travers	Quality Assurance (QA) Manager	Office: (617) 449-1566	Off-site (Boston, MA)

Name	Title	Phone Number	Primary Location
Ben McAllister	Site Health and Safety Officer (SHSO) / QC Officer	Office: (617) 449-1592 Cell: (207) 409-6151	On-site

Parsons has dedicated, experienced, and competent personnel to manage the Ash Landfill OU remediation. Senior management and staff personnel have been selected based on their knowledge and abilities in areas of site remediation and civil construction; management and administration of environmental contracts; regulatory and technical expertise; and health, safety, and quality awareness.

Responsibilities of key personnel are described in the following subsections.

6.1.1 Project Manager (PM) / Quality Assurance (QA) Manager

The Project Manager (PM), Todd Heino, will manage the project from the Boston, Massachusetts office and will be on-site periodically during construction. Mr. Heino is the final decision authority, and will receive reports from the field from the Site Manager (SM) or the Quality Control (QC) Officer. Mr. Heino will visit the work site, as necessary, to meet with the client and review work progress. Mr. Heino's responsibilities as PM are as follows:

- Managing program administration;
- Serving as primary AFCEE/Army interface on all project issues;
- Serving as primary interface with USEPA and NYSDEC on project issues;
- Resolving conflicts with AFCEE/Army or subcontractors;
- Reviewing and submitting project documentation.

6.1.2 Site Manager (SM)

The Site Manager (SM), Tom Andrews, is directly responsible for all aspects of the contractor's performance including work assignments, approval of all contractor and subcontractor costs, and approval of all subcontracts and procurements. Mr. Andrews will be on-site one or two days a week during the construction phase of this project. Mr. Andrews shall also be responsible for the resolution of all QA issues that arise during construction. Other responsibilities of the SM include:

- Reviewing all construction documents to verify compliance with remedial action objectives;
- Developing a QA program to ensure that program objectives are met through a systematic process of QC and documentation;

- Ensuring that contractor personnel are experienced, competent, and qualified for their assigned tasks;
- Coordinating constructability review of project scoping documents;
- Coordinating with the Project Engineer and the SHSO/QC Officer in developing work plan implementation procedures during pre-construction;
- Selecting the construction subcontractors, as needed, and administration of the construction subcontracts;
- Coordinating all construction activities associated with subcontractors; and
- Coordinating with the SHSO/QC Officer to ensure that inspections, tests, and records are developed and performed adequately.

6.1.3 Project Engineer

The Project Engineer, Beth Wasserman, will support the PM in the office. It is not anticipated that Ms. Wasserman will be on-site, with the exception of an occasional visit, as necessary. The responsibilities of the Project Engineer include the following:

- Reviewing design issues;
- Modifying the design with regulators, if required;
- Reviewing analytical data to assess if results are satisfactory; and
- Preparing AFCEE and regulatory submittal documents for approval, as required.

6.1.4 Quality Assurance (QA) Manager

The QA Manager, Jackie Travers, will be responsible for all QA issues. Ms. Travers' responsibilities as QA Manager are as follows:

- Implementing the QA program, including conducting audits and/or surveillance of project and construction activities, as needed, to verify that project personnel are performing their duties in accordance with this work plan. Scope audits will include verification that project and construction activities are being properly performed and documented, and that health and safety-related or quality-related concerns, nonconformances, and deficiencies are being resolved in a satisfactory manner.

6.1.5 Site Health and Safety Officer (SHSO) & Quality Control (QC) Officer

Ben McAllister will serve in the dual role as Site Health and Safety Officer (SHSO) and as the Site Quality Control (QC) Officer. Mr. McAllister will be on-site full time and will be responsible for all daily operations. Mr. McAllister's key responsibilities are as follows:

- Implementing the work plan;
- Supervising and coordinating all activities relating to field remediation operations on a daily basis and serving as the subcontractors' primary point of contact for daily and routine operations;
- Completing daily reporting tasks and review of any daily or weekly reports;
- Requisitioning labor, materials, and equipment to perform construction activities;
- Making routine field decisions;
- Identifying problems that cannot be resolved in the field, and reporting them to the SM or PM, as appropriate;
- Communicating QA/QC policies, objectives, and procedures to project personnel and subcontractors during project meetings and informal discussions;
- Conducting sampling and QA testing;
- Monitoring, controlling, and documenting the quality of on-site construction activities;
- Verifying that QC personnel are properly qualified and trained in specified plans and testing procedures;
- Verifying and documenting that construction QC activities involving inspection, testing, and records are complete, accurate, and in accordance with site-specific documents;
- Enforcing site health and safety policies and procedures as defined in this report and in the site-specific HSP (Parsons, 2005b);
- Conducting and documenting health and safety orientation and daily meetings, as required, prior to construction;
- Determining the appropriate levels of PPE for each construction activity; and
- Overseeing construction QC operations performed by subcontractors.

Mr. McAllister will have the authority to stop work on any project activity due to nonconformance with this work plan. All on-site personnel will be encouraged to discuss any quality-related concerns with Mr. McAllister. In the event that Mr. McAllister detects or is informed of a potential nonconformance, he will investigate the matter, determine the corrective action required, document the incident, and report the incident to the SM or Project Engineer.

6.2 Inspection and Testing Requirements

A QC inspection and testing program has been developed for the remediation at the Ash Landfill OU to verify that site preparation, excavation, backfilling, installation of soil covers, installation of PRBs, and site restoration meets the project quality requirements. As detailed in **Sections 6.2.1**, **6.2.2**, and **6.2.3**, the QC inspections and testing program includes three phases of inspections for work in progress: pre-construction inspections, construction inspections, and post-construction inspections. Upon substantial completion of the work (or significant portions of the work), completion inspections will be conducted. Completion inspections are also a three-step process, consisting of the QC completion inspection, the pre-final inspection, and the final acceptance inspection. The specific on-site inspection and testing requirements are addressed in **Section 6.2.2**.

The Site QC Officer, Mr. McAllister, will have primary responsibility for conducting and documenting the QC inspections and tests described herein. In the event that QC inspection or testing results indicate nonconformance with the project specifications or this work plan, the SM will be notified of the nonconformance. Corrective action will be coordinated through the SM, and resolution of the nonconformance will be verified by Mr. McAllister, as appropriate.

6.2.1 General Requirements

The general components of inspection activities are provided below and are scheduled in the following three major phases:

1. Pre-construction;
2. Construction;
    a. Construction: Startup;
    b. Construction: In-progress;
3. Post-construction.

Specific inspection requirements for each of the major components of the remedial action are discussed in **Sections 6.2.2** and **6.2.3**.

Pre-Construction Inspections

Preparatory inspections will be performed prior to initiation of specific activities or definable features of work. This phase of inspection is conducted prior to initiating actual construction and will generally consist of the following:

- Review contract with subcontractors, if appropriate, and verify conformance to project objectives;
- Verify that materials and equipment from off-site sources have been inspected and/or tested as required;
- Verify that conformance documentation such as test results for backfill and performance data is submitted and approved prior to construction;
- Verify that QA/QC inspection procedures are in place;
- Discuss procedures for conducting the work and discuss quality concerns with project personnel who will perform the work; and
- Review potential safety and environmental hazards that may be associated with the planned activity, including the presence of buried and overhead utilities.

The results of the preparatory inspections will be documented and incorporated with the Daily QC Report.

Construction: Startup

Initial inspections will be performed during the startup of field work. This phase of inspection will generally consist of the following:

- Examine the work area to ensure that all preliminary work has been accomplished in compliance with the contract documents;
- Physically examine required materials, equipment, and storage areas to ensure conformance with contract documents;
- Observe and verify that the construction methods and quality of workmanship meet the requirements set forth in the scoping documents;
- Perform receiving inspections, if required (as described below);
- Check dimensional requirements relevant to the specific work activity and compatibility with subsequent or adjacent work; and

- Verify that safety procedures are strictly enforced and in full compliance with the HSP.

The results of all initial inspections will be documented and incorporated into the daily QC report.

Construction: In-progress

During construction, receiving inspections, periodic follow-up inspections, and work plan compliance inspections will be conducted, as indicated in the following discussion. *Receiving inspections* will be performed when materials or equipment arrive at the project site. The inspections will be performed to verify that the materials or equipment received meet project requirements and specifications, are free of defects, have not been damaged in transport, and are being properly stored at the project site. Receiving inspections will be conducted by the Site QC Officer, Mr. McAllister, and will consist of the following:

- Verification of the quantities of the materials, supplies, or equipment received;
- Visual inspection of the materials, supplies, or equipment for damages, defects, or other quality aspects;
- Acceptance of the transport manifests or other delivery documents;
- Coordination of material and/or equipment storage, if required, prior to construction or installation; and
- Inspection and laboratory sampling of imported construction materials for foreign material will be performed and conducted by the Mr. McAllister or the SM.

A qualitative judgment based on visual inspection will be made by Mr. McAllister regarding the material conformance with specifications. Mr. McAllister will document the following information regarding the received materials and/or equipment in the daily QC report:

- Types and quantities of materials and/or equipment received;
- Visual description of the materials and/or equipment; and
- Material and/or equipment storage details, including storage locations.

Follow-up inspections are conducted periodically during specific construction activities to verify that work in progress meets technical, contractual, and regulatory requirements. Follow-up inspections will be conducted no less frequently than indicated in **Sections 6.2.2** and **6.2.3**. Additional follow-up inspections may be performed to verify that any deficiencies noted have been corrected prior to the start of subsequent features of the work. Follow-up inspections will consist of the following types of inspection activities:

- Material quality testing to verify that materials being used conform with project requirements;

- Examination of the work area and QA/QC documentation to verify that all previous work has been accomplished in compliance with the project requirements;

- Placement testing to verify that materials are being placed and constructed in conformance with the plans and scoping documents; and

- Final follow-up inspections to verify that final surface grades and completed work are in compliance with the project requirements.

The results of the follow-up inspections will be documented and incorporated into the daily QC report.

Regular construction inspections will be conducted to verify compliance with the work plan and design documents. These inspections will be performed by the Mr. McAllister and/or Mr. Andrews and include the following:

- Overseeing earthwork to confirm that the removal of the Debris Piles is being performed in accordance with the design drawings and technical specifications.

- Documenting that the subcontractors are taking appropriate measures to control and minimize dust emissions and to control erosion at the site related to the subcontractors' work activities;

- Documenting that trucks and equipment are properly decontaminated, and decontamination spoils are properly managed and disposed;

- Documenting that security measures are being followed, including entry by authorized persons only, use of appropriate personnel protective equipment (PPE), protection of SEDA property, and use of locks and security measures to prevent unauthorized entry to the work site on non-business hours.

- Documenting the effective use of barricades and other temporary controls to prevent impacted storm water and construction-related runoff.

- Documenting the sampling procedure and chain-of custody procedure for all samples.

- Overseeing the placement of backfill and the soil covers with required compaction.

- Overseeing and documenting the installation of the biowalls to the correct alignment and depth; and

- Overseeing the mixing and placement of the biowall backfill material to the specifications.

For the Ash Landfill OU remedial activities, the Program Health and Safety Officer (PHSO), Tim Mustard, or the SHSO, Mr. McAllister, will conduct periodic health and safety inspections in accordance with the project HSP.

Post-Construction

Post-construction completion inspections will be conducted when the contract work, or specific definable component of the contract work, is substantially complete. Completion inspections are conducted to verify that the work is properly completed and that all specified components of the work have been constructed or installed.

Three types of completion inspections will be performed to verify that site work activities performed meet the requirements of project specifications. These inspections include:

- QC completion inspection;
- Pre-final inspection; and
- Final acceptance inspection.

The QC completion inspection will occur when the contract work is nearing substantial completion. Based on AFCEE's and the Army's concurrence that substantial completion is near, and at least five days prior to the pre-final inspection, the Site QC Officer will conduct a QC Completion Inspection. The AFCEE COR, Mr. Jesse Perez, will be notified of the inspection date so that he may participate. Upon completion of the inspection, an itemized list of work that was not properly completed, work that exhibits inferior workmanship, or work that does not conform to project requirements will be prepared. The list will also include outstanding deliverables and appropriate record documents.

The Pre-Final Inspection will be conducted immediately following completion and/or correction of all deficiencies noted during the quality control completion inspection, and following completion of all construction activities. The Site QC Officer will notify the AFCEE COR at least five days prior to conducting the Pre-Final Inspection. The notice will include assurance that all specific items previously identified in the Quality Control Completion Inspection, along with all remaining contract work, will be completed and/or corrected by the date scheduled for the Pre-Final Inspection. The Pre-Final Inspection will be conducted by the Site QC Officer and the AFCEE COR.

The Site QC Officer will notify the AFCEE COR when the work is ready for the Final Acceptance Inspection. The notice will be given to the AFCEE COR at least five days prior to the Final Acceptance Inspection and will include assurance that all specific items previously identified as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the Final Acceptance Inspection. The Site QC Officer and the AFCEE COR will conduct the Final Acceptance Inspection.

Meetings

A pre-construction meeting will be held at the site prior to beginning construction activities. AFCEE COR, SEDA's POC and COR, the PM, the SM, the SHSO, appropriate subcontractors, USEPA, and NYSDEC will be invited to attend the pre-construction meeting. This site specific CQP will be reviewed, with specific focus on methods for documenting and reporting inspection data and methods for distributing and storing documents and reports. The responsibility of each party will be reviewed and clearly understood, and the work area security and safety protocols will be transmitted to all participants. This meeting will occur after the procurement for the remedial action implementation has begun.

Progress meetings will be held on a weekly basis and chaired by the SM. The primary subcontractors must send an authorized representative to each meeting. Issues at this meeting may include the progress of work, future scheduling issues, and related topics.

Base Cleanup Team (BCT) meetings will be held as required and chaired by the regulatory agency or their representative. Parsons will attend all BCT meetings during the course of this contract. Subcontractors will not be required to attend these meetings unless requested by AFCEE, regulatory agencies, Army personnel, or Parsons. The intent of the meetings will be to provide the regulatory agency with a progress update of the project and to address any regulatory issues that might delay the progress of the work.

6.2.2 Pre-Construction Requirements

Field inspections will be performed during on-site construction activities in order to verify that all work is in conformance with the design drawings and specifications. The following subsections summarize the specific field testing and other QC requirements as components of the three phases of inspection for each of the primary work activities to be performed. Specific pre-construction inspection activities for each of the primary work activities are summarized in **Table 6-1**.

Site Preparation

Site preparation activities are listed in **Table 6-1** and include visual observations to insure that all site preparation activities are completed prior to beginning construction. Site preparation will include removing any debris in the work areas, finalizing the mark-out of the Debris Piles to be excavated, staking the locations of the biowalls including all turning points, finalizing the mark-out of the landfills to be covered, finalizing the mark-out of utility locations, confirming approval and location for site trailers, and confirming that all necessary roads are accessible and access gates are working properly.

Utility Locating and Availability of Utilities

SEDA and local utility suppliers will provide electrical service to the work area, and the contractor will be responsible for the electrical connections to the site trailer. The earthwork contractor will be responsible for obtaining potable water from either the Army or the Town of Romulus.

Prior to the start of construction, all utilities, both underground and overhead, will be marked out and accounted for in the construction plan. Precautions will be taken to prevent the disruption of service due to equipment traffic in and out of the site.

Site Surveying

Site surveying will be accomplished by a combination of visual and instrument surveying of the site and construction features. The following surveys will be provided:

- Pre-construction area survey; and
- Post-excavation survey.

The excavation areas, landfill areas, and biowall layouts will be surveyed prior to construction. All utilities and cultural resource areas will be staked. Whenever possible, 20 feet will be cleared on either side of the work area. If this is not possible, the maximum path will be cleared and work will be coordinated to ensure constructability. All utilities will be clearly marked following the clearing.

Disposal Characterization

For disposal characterization, the waste management facility requires that one composite sample will be collected from the Debris Piles and trench spoils (if necessary) and submitted for analysis, as detailed in **Section 5**. This sampling requirement is based on the waste management facility's review of the historic sampling results at the Ash Landfill. The disposal facility will pre-approve acceptance of the soil based on these data. The disposal sample will be one composite of grab samples from each of the Debris Piles. The disposal characterization sampling will be completed prior to the commencement of construction activities. The disposal samples will be tested for contaminant leaching using the TCLP. However unlikely, soil that fails the TCLP will be stabilized on-site and then disposed as non-hazardous waste. If the disposal sample passes the TCLP, then the soil from the excavation will be directly loaded into dump trucks and transported to and disposed in an off-site permitted Subtitle D landfill selected by the contractor.

6.2.3 Construction Requirements

The construction activities listed in **Table 6-2** include visual observations to ensure that equipment is operating properly and safely, site security is in place, erosion controls are maintained, backfill availability will not slow construction, health and safety monitoring is performed, and the as-built records of the trenches and landfill covers are maintained. These inspection activities will ensure that excavations, landfill covers, and biowalls are completed in accordance with the project scope of work and all components of reporting can be fully met.

Excavation

The Debris Piles will be excavated to remove the visible debris using a tracked excavator, and the excavated debris will be loaded directly onto dump trucks for off-site disposal. It is not anticipated that stockpiling of the material will be necessary.

Biowall Installation

Excavation of the biowalls will be conducted using a backhoe with a 3-foot wide bucket to depth of competent bedrock. Backfill material will be a 50:50 ratio by volume mulch and sand mixture. Mulch will be coated with food-grade vegetable oil using an excavator. The mulch/sand mixture will be placed into the trench up to ground surface. A 12-inch soil cover will be placed over the entire length of the biowalls.

Landfill Cover

Soil for covering the landfills will be obtained from an on-site or off-site borrow source. The Project Engineer will verify that the borrow soil documentation meets the TAGM concentration requirements by reviewing sampling conducted by the contractor. Mr. McAllister will observe the placement of 12 inches of approved fill material over the Ash Landfill and the NCFL. The 12-inch soil cover will consist of common fill and/or topsoil capable of sustaining vegetative growth native to the area. Additional material such as mulch may be used as an organic enhancement for the topsoil and common fill.

Observation and Inspection

Mr. McAllister will be on-site during the soil removal to confirm that the removal is conducted in accordance with the Technical Specifications. A photographic log will be maintained throughout the project to provide documentation of the process and procedure. In addition, a post-excavation survey will be performed. Mr. McAllister will visually observe all work, and he will estimate the volume of excavations and material placed for the covers and biowalls, based on the dimensions of the work.

Backfilling

The Incinerator Cooling Water Pond initially will be backfilled with the bermed material surrounding the pond, and then additional borrow soil will be placed in the pond to meet the surrounding natural grade, as necessary. Soil for backfilling the Incinerator Cooling Water Pond will be obtained from an on-site or off-site borrow source. The Project Engineer will verify that off-site borrow soil meets the TAGM concentration requirements by reviewing sampling conducted by the contractor. Mr.

McAllister will observe the placement of backfill and compaction of backfill. The Debris Piles excavation will not require backfill.

Soil Disposal

Based on soil disposal characterization conducted as part of pre-construction activities, excavated materials are expected to be directly loaded into dump trucks and transported to and disposed in an off-site Subtitle D landfill selected by the earthwork contractor, which anticipates using either Ontario County Landfill in Flint, New York or Seneca Meadows Landfill in Waterloo, New York. It is not expected that any materials will be disposed as hazardous waste. Wastes will be "packaged" by loading non-hazardous soil into DOT approved dump trucks and/or dump trailers. No hazardous soil will be shipped. If hazardous soils are encountered, they will be treated on-site and then disposed off-site as non-hazardous materials.

Erosion Control Maintenance

Temporary erosion and sedimentation controls, such as silt fencing, hay bales, or soil berms, will be installed as required during operations to prevent migration of sediments and erosion. Prior to beginning any construction work, temporary silt fencing (Specification Section 02370) will be erected, which will surround the downgradient sides of disturbed areas to prevent contaminated sediment transport. The temporary silt fencing will be maintained throughout the project and will not be removed until permanent vegetation has been re-established. In addition, storm water from upgradient locations will be routed away from exposed materials, and contact of exposed material with storm water will be minimized to the extent practical. Any temporary erosion control measures will be removed following remediation so as to return drainage patterns to their general conditions prior to remediation. The final grade is based on restoring pre-excavation slope and drainage.

Site Security

All visitors to the work site are required to report to Mr. McAllister and/or the SM upon arrival. The Ash Landfill OU will have access limiting measures in place, such as but not limited to signs, barriers, or fences. Site security is necessary to prevent exposure of unauthorized, unprotected individuals to the work area. The area immediately surrounding the work area will be clearly marked through the use of signs, barrier rope or tape, or fencing.

Site Restoration

Field inspection for site restoration activities is identified in **Table 6-3**. Inspection activities include observations to verify the final location of the excavation and to confirm that the site was properly restored. A final site survey will be conducted once construction is complete.

6.3 Subcontractor Quality Control

All subcontractors and material suppliers involved with on-site construction activities shall comply with this plan. Subcontractor personnel qualifications, technical performance levels, QA/QC procedures, acceptability levels, and documentation and submittal requirements will be clearly defined in the subcontractor's scope of work and procurement documents. The PM will review the scope of work and procurement documents to verify that all of the relevant QA/QC requirements have been adequately communicated to the subcontractor.

Each subcontractor shall identify a qualified individual within their organization to be responsible for QC and performance of QC testing. Mr. McAllister will coordinate all QC functions with the designated subcontractor QC representative. Mr. McAllister has authority over all subcontractor QC requirements. These activities will be documented on inspection reports, checklists, audit reports, field logs, or other forms appropriate to the function performed.

6.4 Quality Control Documentation

An effective QA/QC program depends on thorough monitoring of all construction activities. This is most effectively accomplished by observation and documentation during all phases of construction. Documentation shall consist of project submittals, daily QC inspection reports, weekly QC summary reports, non-conformance and corrective action reports, design and specification clarifications or modifications, photographic records, observation and testing data sheets, as-built documentation, and a summary report. This section describes the requirements of each of these aspects of the QC documentation.

6.4.1 Daily QC Inspection Reports

Mr. McAllister will prepare a Daily QC Report and submit it to the SM, who will sign it to acknowledge non-conformances and observations, and place it in the project files or begin the corrective action request. The Daily QC Reports will be submitted (daily, or at some other agreeable interval) to the AFCEE and Army contact, and will also be included as part of the weekly progress reports submitted to AFCEE and the Army.

The Daily QC Report will include the following information:

- Project name, location, and date;
- Personnel and equipment used;
- Estimated volume of excavated material shipped off-site during the day;
- Weather conditions;
- Narrative description of inspections, tests, and sampling;

- Description of kinds and types of material delivered and used;
- Narrative description of work performed, problems encountered, and corrective measures taken; and
- Record of any data or measurements collected.

6.4.2 Weekly QC Summary Reports

The Site QC Officer will draft the Weekly QC Summary Report and submit it to the SM. The SM will review the report, and then submit it to the AFCEE and Army contacts.

The Weekly QC Summary Report will include the following information:

- Date, project name, and location;
- Summary of construction-related activities;
- Summary of QC activities;
- Attached inspection reports;
- Test results;
- Volume of soil shipped for disposal;
- Volume of soil shipped for disposal to other locations (e.g., off-site, if necessary);
- Non-Conformance Reports (NCRs);
- Non-Conformance/Corrective Action Tracking Log; and
- Corrective Action Reports.

6.4.3 Non-Conformance Documents

As the Site QC Officer, Mr. McAllister will report each nonconforming item on a NCR form. The NCR form will include the information listed below:

- Name and job title of the individual who identified the non-conformance;
- Description of the non-conformance;
- Effect of non-conformance on suitability of the work for the intended purpose;
- Immediate corrective measures taken; and

- Recommended corrective action or variance/field change to the project documents.

The Site QC Officer will describe the NCR in the Daily QC Report, and then log it on the Non-Conformance/Corrective Action Tracking Log. The Site QC Officer will include the revised log in the Weekly QC Report. The SM will review this list and initiate a Corrective Action Report (CAR) if a non-conformance is not satisfactorily corrected in a timely manner. The CAR will include the following and will be signed by all responsible parties:

- Summary of the affected project requirements;
- The nature of the non-conformance;
- The corrective action to be taken;
- Action items/responsibilities for each affected individual;
- A schedule for completion of the corrective action; and
- Recommendations for preventing recurrence of the problem.

The PM will review unresolved CARs and take appropriate measures to ensure that the corrective actions are completed on schedule. The Site QC Officer will conduct an inspection to verify that the CAR is resolved, update the Non-Conformance/Corrective Action Tracking Log, and document the resolution in the Daily and Weekly QC Reports.

6.4.4 Design and Specification Clarifications or Modifications

The need to address design and specification changes or scope changes may arise. In such cases, the PM will notify the AFCEE COR. A design, specification, or scope of field change that will impact the project or its cost must be approved by the PM and the AFCEE COR before it is implemented. Approvals by these parties may be obtained concurrently, if possible. Approval of USEPA/NYSDEC may be necessary if the proposed change may effect the projects ability to achieve the performance objectives or impact the project goals. To approve a change, a Field Change/Modification Request (FC/MR) form will first be completed by the PM and then submitted to AFCEE. A standard FC/MR form will be completed which includes the following information:

- Date of request/order;
- FC/MR number;
- Name of originator of request/order;
- Summary of existing requirements;

- Description of requested/ordered changes in the affected requirements in sufficient detail for cost, schedule, and technical evaluation;

- Description of estimated cost impact of change; and

- Approval signatures of the PM and the AFCEE COR.

The PM will establish and maintain an FC/MR Log to track dates of requests, approvals, and completions.

6.4.5 Photographic Documentation

All phases of construction will be documented with photographs taken by QA/QC personnel. All photographs will be identified as to location, time, date, and initials of the person taking the photograph.

6.4.6 As-Built Drawings

The Site QC Officer will establish and maintain a set of project drawings in the project office for the purpose of noting changes. Changes will be noted in red ink or pencil and referenced to the approved FC/MRs. New drawings will be added to the set if required for major or extensive changes. Copies of all FC/MRs, change orders, notes, sketches, and memoranda will be available for reference in the project field office. As-built drawings will be available for review in the project field office at all times.

6.4.7 Summary Reporting

At the completion of construction, a Remedy Implementation Report will be issued. This report will include a description of the construction activities, QC testing results, waste disposal records, copies of the field reports, and as-built drawings.

7.0 POST-CLOSURE MONITORING AND MAINTENANCE PLAN

This section presents a Post-Closure Monitoring and Maintenance Plan (PCMMP) for long-term groundwater monitoring and operations and maintenance of the biowalls and landfill areas. Long-term groundwater monitoring includes plume performance monitoring and biowall process monitoring. Operations and maintenance activities include vegetative cover maintenance, inspections for the landfills, and organic substrate recharge for the biowalls.

The remainder of this PCMMP provides the following:

- Overview of site conditions, including site hydrogeology and contaminant distribution (**Section 7.1**);
- General information on the biowall enhanced bioremediation process (**Section 7.2**);
- Description of the monitoring plan and protocols, including monitoring frequency and a monitoring exit strategy (**Section 7.2** and **Section 7.3**);
- Vegetative cover maintenance and inspection requirements (**Section 7.4**);
- Organic substrate recharge evaluation and procedure (**Section 7.4**); and
- Reporting requirements (**Section 7.5**).

7.1 Site Conditions

7.1.1 Hydrogeology

The depth to water at the Ash Landfill Site varies from between 2.15 feet and 6.70 feet below ground surface (bgs). Results of groundwater contour mapping indicate that shallow groundwater flow is towards the west (**Figure 7-1**) with a horizontal hydraulic gradient range of 0.02ft/ft to 0.05ft/ft in the till/weathered shale zone.

Hydraulic conductivities at the Ash Landfill were found to range from 2.0 x 10^{-5} cm/sec to 2.5 x10^{-4} cm/sec in shale/weathered bedrock based on slug testing in October and December 2005.

7.1.2 Contaminant Distribution

The primary COCs at the Ash Landfill are VOCs, specifically chlorinated ethenes (namely TCE and DCE) in groundwater. The primary impact to the groundwater is a VOC plume (chlorinated ethenes) that originates from the Ash Landfill (see **Figure 7-1**). The chlorinated ethene plume is approximately 1,250 feet long. Concentrations of TCE, cis-DCE, and VC currently exceed NYSDEC AWQS for Class GA water.

7.2 Long-Term Groundwater Monitoring

Groundwater monitoring will be performed as part of the Ash Landfill OU post-closure operations. Groundwater monitoring is required since contaminant concentrations in the groundwater at the site currently exceed applicable groundwater standards.

Two types of long-term groundwater monitoring are presented in this section: plume performance monitoring and biowall process monitoring. Performance monitoring will be conducted to measure groundwater contaminant concentrations and the effectiveness of the biowalls remedy for the Ash landfill OU. The objectives of performance monitoring are as follows:

- Confirm that there are no exceedances of COC groundwater standards at the trigger monitoring well MW-56;
- Document the effectiveness of the biowalls to remediate and attenuate the chlorinated ethene plume; and
- Confirm that groundwater concentrations throughout the plume are decreasing to eventually meet GA standards.

Biowall process monitoring will be conducted at the pilot-scale biowall and at a location within the furthest downgradient full-scale biowall to determine if, and when, any needed maintenance activities should be performed. The objectives of biowall process monitoring for operations and maintenance (O&M) activities are as follows:

- Monitor the long-term performance and sustainability of the biowalls;
- Monitor substrate depletion and chemical and geochemical conditions under which the effectiveness of the biowalls may decline; and
- Determine if, and when, the biowalls need maintenance (i.e., need to be recharged with additional organic substrate).

The pilot biowall system offers a unique opportunity to evaluate biowall performance and sustainability approximately one year in advance of the full-scale biowalls as they mature. This will allow for planning and maintenance of the full-scale biowall system before its effectiveness declines to undesirable levels.

7.2.1 Background

One of the purposes for groundwater monitoring is to demonstrate that exposure to off-site receptors through potential off-site migration of the VOC plume is not occurring, and that the plume is being attenuated by the operation of the biowall system. Numerous natural processes contribute to the reduction in dissolved phase contamination concentrations over distance and time, often referred to as natural attenuation. These processes include sorption, dilution, dispersion, volatilization, and biodegradation. Of these, biodegradation is of primary interest because this process actually destroys the contaminant, and because it is the process being stimulated construction of the biowalls.

Numerous laboratory and field studies have shown that many organic compounds are readily biodegraded via naturally occurring processes. Chlorinated ethenes biodegrade under anaerobic conditions through a process referred to as reductive dechlorination. Some chlorinated ethenes (e.g., VC) can also be biodegraded via direct aerobic oxidation (aerobic conditions).

Geochemical data concerning potential electron acceptors, electron donors, and biodegradation by-products can be used to show that organic compounds are biodegrading in saturated soil and groundwater. Depressed concentrations, as compared to background, of electron acceptors such as nitrate, oxygen, and sulfate that are used by microorganisms to facilitate the oxidation of VOCs within groundwater are geochemical indicators that VOCs are biodegrading. Similarly, elevated concentrations of biodegradation byproducts, such as iron II, in groundwater are also geochemical indicators that compounds are biodegrading. Depressed oxidation/reduction potential (ORP) may also indicate the occurrence of biodegradation.

Biodegradation of chlorinated organics requires the presence of natural or anthropogenic carbon to create the conditions (anaerobic, low redox potential) necessary to stimulate reductive dechlorination of the more chlorinated solvents such as perchloroethene (PCE) and TCE. Dechlorination products of these compounds (cis-DCE and VC) can also be dechlorinated under highly reducing conditions or directly oxidized under aerobic or mildly anaerobic conditions. Therefore, indicators of conditions appropriate for reductive dechlorination should include those parameters that measure the groundwater redox state, as well as the presence of parent compounds and their dechlorination products.

Based on the data collected to date, contaminant concentrations at the Ash Landfill OU appear to be stable or decreasing naturally. However, natural attenuation alone may not be sufficient to reduce groundwater contaminant concentrations to below the site-specific cleanup goals within an acceptable time period. Based on a review of natural groundwater chemistry, there is a lack of organic substrate (electron donor) to stimulate reductive dechlorination. A pilot-scale biowall system using mulch and vegetable oil as a source of organic carbon has been successful in stimulating the sequential dechlorination of TCE to the innocuous end product of ethene. A full-scale application of the technology is proposed, and the following sections describe the monitoring strategy and protocols that will be used to document the performance of the remedy to meet the remedial design objectives for the Ash Landfill OU.

7.2.2 Monitoring Strategy

At the Ash Landfill OU, there are two sets of groundwater monitoring wells that will be sampled simultaneously. One set is for performance monitoring of the plume (i.e., regulatory compliance) and incorporates on-site wells and one off-site well; and the second set is for process monitoring of the biowall system. The first set is intended to demonstrate compliance with requirements of the ROD. The performance monitoring wells will monitor the migration and size of the plume, in addition to whether contaminant concentrations are diminishing and approaching groundwater standards. The performance monitoring wells include a trigger well (MW-56) located downgradient and outside of the VOC plume beyond the SEDA boundary. The trigger well is used primarily to show that the plume is not migrating and that there is no risk of exposure to off-site receptors.

The second set of wells, the biowall process monitoring wells, is used to monitor the operation and effectiveness of the biowall remedy, in particular to monitor for the first occurrence of substrate depletion and to evaluate if, and when, the initial maintenance (i.e., recharge) of the biowall system is required. Substrate recharge is discussed further in **Section 7.4.4** in the Operation and Maintenance section.

7.2.3 Monitoring Well Locations

Table 7-1 provides a summary of the wells and analytical protocols that will be monitored at the site, and **Figure 7-2** illustrates the Ash Landfill monitoring well locations. The rationale for monitoring each of these wells is described in **Table 7-2**.

Plume Performance Monitoring

Existing monitoring wells PT-18, MWT-22, PT-22, PT-17, MWT-7, and PT-24 will be used for long-term plume performance monitoring. In addition, two new wells (MWT-24 and MWT-25) are proposed along the axis of the plume to further document reductions in contaminant concentrations and overall attenuation of the plume. Monitoring well MW-56, a trigger well, is the off-site performance monitoring well that will be used to document that no exceedances have been detected at the trigger well.

Biowall Process Monitoring

Select monitoring wells along the North Transect of the pilot biowall (MWT-12R, MWT-13, MWT-15, and MWT-17R) will be monitored to allow for planning and maintenance of the full-scale biowall system. A new monitoring well (MWT-23) is proposed for installation within the furthest downgradient biowall to measure the process and potential depletion of substrate within the full-scale biowall system.

7.2.4 Monitoring Frequency

After the first year of monitoring and annually thereafter, the list of wells to be monitored will be reviewed and modified according to the decision flow diagram, **Figure 7-3**. At that time, any additional wells that are determined to no longer be necessary will be abandoned in accordance with the well abandonment procedure outlined in “Monitoring Well Abandonment Work Plan” (Parsons, 2005d). The wells in each monitoring program (on-site and off-site plume performance monitoring or biowall process monitoring) are addressed in separate sections of **Figure 7-3**.

Off-Site Performance Monitoring

The off-site plume well, MW-56, will be monitored semi-annually during the first year of sampling, and the sampling frequency will decrease to annual monitoring once a decreasing trend for COCs in the on-site plume wells has been established, as defined in the On-site Plume Performance Monitoring discussion below.

On-Site Plume Performance Monitoring

As indicated in **Figure 7-3**, the on-site plume performance wells (PT-18, MWT-25, MWT-22, PT-22, PT-17, MWT-24, MWT-7, and PT-24) will be sampled quarterly for the first year. After the first year of monitoring, semi-annual monitoring of the on-site plume performance wells will be conducted until it is shown that there is a decreasing trend for COCs in the groundwater, which allows for a sampling frequency reduction to annual monitoring, as illustrated in **Figure 7-3**. A decreasing trend in the on-site plume wells will be defined based on a graphical or statistical analysis of the data. For example, data points will be plotted and a best fit line (linear regression) will be graphed. The slope of the best fit line is representative of the trend in concentration; a negative slope indicates a decreasing trend in COC concentrations. A decreasing COC trend indicates that the potential for contaminants to migrate and negatively impact groundwater further downgradient is decreasing, and that the plume is being effectively managed by the remedy. Any evaluation of trends in contaminant concentrations will take into account that historic data at the Ash Landfill shows that there are seasonal fluctuations in contaminant concentrations. Semi-annual monitoring during wet and dry seasons is appropriate until it is established in which season maximum concentrations are observed. Annual monitoring would occur in the season of maximum concentrations. Historically, higher concentrations have been observed during lower groundwater levels that occur in the summer months.

As long as the decreasing trend persists, annual monitoring of the plume performance wells will continue. Monitoring of both the on-site plume performance wells and the off-site sentinel well will stop when GA standards for the COCs are achieved during two successive rounds of sampling the on-site plume wells.

Biowall Process Monitoring

The monitoring frequency for the biowall process wells (MWT-12R, MWT-13, MWT-15, MWT-17R, and MWT-23) is addressed on the right-hand side of **Figure 7-3**. Like the on-site plume performance wells, the biowall process wells will be sampled quarterly for the first year. Subsequently, the biowall process wells will be sampled semi-annually to determine if recharge of the biowalls is required. A detailed discussion of recharge and the recharge evaluation is provided in **Section 7.4.4**. Once the first recharge of the biowalls is completed, the majority of the biowall process wells (MWT-12R, MWT-13, and MWT-17R) will be eliminated from the long-term monitoring program. After the first recharge, the wells located in the downgradient Biowalls B2 and C2, MWT-15 and MWT-23 respectively, will be retained and included in the on-site plume performance monitoring program to supplement data that will be used to determine whether additional biowall recharge is required (see **Section 7.4.4**).

The exact sampling frequency for each well will depend on the sampling results from previous monitoring rounds. The decision diagrams in **Figure 7-3** provide a road map for determining the sampling requirements for each year of long-term monitoring based on existing data. An example of the number of wells that would be sampled each year according to the decision diagrams in **Figure 7-3** is presented in **Table 7-3**. The assumptions listed in **Table 7-3** and the associated sampling frequencies are hypothetical and lay out a possible projection of the number of samples required over the next 10 years.

7.2.5 Groundwater Sampling

A summary of the groundwater wells and parameters that will be monitored at the site are listed in **Table 7-1**. For all monitoring wells, groundwater samples will be analyzed for VOCs by USEPA SW846 Method 8260B and basic groundwater geochemistry will be measured in the field to include dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductivity, pH, and temperature. The data quality objectives for each of these parameters are listed **Table 7-4.**

In addition, the process monitoring wells will be analyzed for biogeochemical parameters to evaluate the amount of soluble substrate in groundwater, the prevailing redox state, and the predominant terminal electron accepting processes (TEAPs) that are occurring at each monitoring location. These additional parameters include the following:

• Total Organic Carbon (TOC); • Methane/Ethane/Ethene; • Sulfate;	• Ferrous Iron, and • Manganese.

Table 7-4 details the monitoring purpose for each of these parameters.

All samples will be collected using low flow sampling techniques. Sampling procedure, sample handling and custody, holding times, and collection of field parameters will be conducted in accordance with the SAP (Parsons, 2006c). Additional QC samples will be collected, as specified in the SAP.

7.3 Groundwater Sampling Procedures

The SAP for the SEDA (Parsons, 2006c) presents the Quality Assurance Program Plan and Field Sampling Plan, and should be consulted for further information on the following general procedures to be followed during all monitoring and maintenance activities at the Ash Landfill Site including:

- Quality Control Activities;
- Field Sampling Procedures;
- Sample Handling and Custody;
- Screening Analytical Methods;
- Data Analytical Methods;
- Data Management and Evaluation;
- Performance Assessment;
- Equipment Maintenance;
- Corrective Actions; and
- Certification Requirements.

7.4 Operations and Maintenance

Biowalls are passive systems that rely on the flow of groundwater and migration of dissolved contaminants through a wall installed perpendicular to groundwater flow. This section contains procedures for maintenance of the Ash Landfill OU, including general site inspections, inspections of the vegetative covers installed over the landfills, maintenance of the monitoring wells, and operation of the biowalls.

7.4.1 Routine Inspections

The Ash Landfill OU will be inspected during each monitoring event to ensure site integrity. The following will be inspected during these sampling events that occur at least annually:

- Establishment and maintenance of the Ash Landfill vegetative cover;
- Conditions of biowall trenches (e.g., settlement and compaction); and
- Condition of groundwater monitoring wells.

Any problems identified during the routine inspections should be noted in the field notebook. These problems should be corrected or disclosed to the SEDA POC as soon as possible.

7.4.2 Vegetative Soil Cover Maintenance

The cover will be monitored for signs of significant erosion to ensure that the underlying soils are not exposed to the environment. The cover will be inspected to ensure that vegetation is in place and that the 12-inch vegetative cover has not been compromised. The inspection will look for breaching of the protective covering.

7.4.3 Groundwater Monitoring Well Maintenance

Monitoring wells which are damaged such that representative groundwater samples cannot be obtained will be repaired or replaced. Repair measures will be based on case-specific evaluations. Any well damaged beyond repair or rendered inoperative will be replaced with a new well of similar depth and construction. Any locks or caps that have been damaged will be replaced.

7.4.4 Permeable Reactive Barrier Operations – Organic Substrate Recharge

Operation of the biowalls includes monitoring to determine whether any maintenance (i.e., recharge of organic substrate) is required. A reduction in dechlorination efficiency that can be tied to substrate depletion and changes in biogeochemistry can be used to plan for recharge of the full-scale biowall system before its performance may decline.

If necessary, the biowalls may be recharged by direct injection of a slow-release vegetable oil substrate. The permeability and uniformity of materials within the biowalls allows for use of direct-push techniques to readily distribute the substrate along a biowall transect. The mulch/sand fill will not require replacement or excavation.

Initial Recharge Evaluation

Determining the need to recharge a biowall segment requires a review of chemical concentrations and geochemical parameters by an experienced professional. A specific, absolute set of conditions or parameter values are not appropriate to determine the need to recharge. Rather, a lines-of-evidence approach will be used that correlates a decrease in the efficiency of the system to degrade chloroethenes to geochemical evidence that indicates the cause is due to substrate depletion.

The following parameters will be evaluated on an annual basis using at least two consecutive rounds of sampling data in order to determine if recharge of the biowalls is necessary:

a. COC concentrations in the wall will be evaluated. If COC concentrations have rebounded by greater than 50% for any single sampling event, this will indicate that recharge should be considered. Concentrations within the biowalls, not at downgradient locations, will be used to make this evaluation so that the effectiveness of the wall itself is being measured without the interference of effects such as desorption and mixing.

b. Geochemical parameters, specifically ORP, TOC, and DO, in the wall will be evaluated. Benchmark values will be used initially to evaluate anaerobic conditions in the groundwater. These benchmarks are:

- ORP < -100 mV
- TOC > 20 mg/L
- DO < 1.0 mg/L

Parameters described in (a) and (b) above are intended to be used as guidelines and will be considered in the evaluation if, and when, a depletion of bioavailable organic substrate results in a rebound in geochemical redox conditions under which effective biodegradation does not occur.

Indirect Recharge Evaluation

As discussed in **Section 7.2.4**, most of the biowall process wells will be eliminated from the long-term monitoring program after the biowalls are recharged once, and at that time two wells, MWT-15 and MWT-23, which are located in downgradient biowalls B2 and C2, respectively, will be added to the on-site plume performance monitoring program. The decision diagram in **Figure 7-3** shows that after the first recharge, the data are reviewed every year to determine if the COCs have maintained their decreasing trend, as defined on the decision diagram and in **Section 7.2.4**. If it is determined that there is an increasing trend, an indirect recharge evaluation will be conducted. The evaluation will review the chemical and geochemical data and determine if the contaminant increase is a result of poor biowall performance or due to other issues, such as but not limited to seasonal variations, recent precipitation events, and/or desorption. As stated in the initial recharge evaluation discussion above, a rebound in concentrations of COCs of 50% in MWT-15 and MWT-23 in two consecutive monitoring rounds is a major indication that recharge is needed. Once this COC rebound is observed, the geochemical parameter concentrations at MWT-15 and MWT-23 will be reviewed. In addition, conditions at the other plume performance wells will be reviewed and compared to the conditions observed at those wells at the time that the initial recharge was required. The Army will determine if similar conditions in the well provide further proof that carbon source recharge is needed again.

Not all biowall transects may require recharging at any given time. Performance monitoring of wells along the axis of the plume will be used to determine areas where the effectiveness of the biowall transects may be declining.

7.5 Reporting

There will be two levels of reporting for the monitoring activities at the Ash Landfill OU. Interim reports will be prepared and submitted following each monitoring event, and there will be an annual summary report. The interim reports will be presented in letter format. Both the interim reports and the annual report will include all groundwater monitoring field data, analytical data, and brief text summarizing the monitoring event as well as any maintenance activities conducted during the monitoring period. They will be submitted to the USEPA and NYSDEC for informational purposes.

The annual report will present groundwater trends, confirm whether enhanced bioremediation and/or natural attenuation of the plume is occurring, and recommend modifications to the monitoring program as appropriate. The annual report will contain summaries of the groundwater data, including time concentration plots for key monitoring wells. Modifications to the monitoring program may include changes to the sampling frequency, the number of analytical parameters, and the number of monitoring wells included in the sampling program. Recommendations for reducing groundwater monitoring efforts will be based on the groundwater concentrations and analysis of natural attenuation at the site. The annual report will be submitted to the USEPA and NYSDEC for review and approval.

8.0 WASTE MANAGEMENT PLAN

Investigation-derived waste (IDW) will include equipment decontamination water and PPE. Soils from the excavation areas and water recovered from the excavation, run-on, or run-off are managed independently from IDW, as discussed in **Section 4.2**.

Since it is not anticipated that hazardous material will be encountered during the construction activities, any water used for decontamination can be collected and containerized for disposal to the Seneca County Sewer District No. 2.

Expendable sampling equipment, if needed, and materials that may be generated during field activities (e.g., PPE) will be bagged and disposed of in a trash dumpster located on-site. Miscellaneous trash generated during field activities (e.g., empty sand bags) also will be placed in the dumpster.

9.0 LAND USE CONTROL REMEDIAL DESIGN

This section is reserved pending further determination.

10.0 CONTINGENCY PLAN

10.1 Introduction

This section presents a Contingency Plan for the remedial activities to be performed at the Ash Landfill Site. The Contingency Plan addresses those actions that are required if some components of the remediation plan presented in **Section 4** require modification. The contingency plan for the Ash Landfill Site has been prepared to address a groundwater treatment alternative in the event that groundwater conditions downgradient of the recommended remedial action described above exceed trigger values. This plan also addresses temporary soil stockpile areas and substrate addition to the biowalls.

10.2 Groundwater Treatment Alternative

Compliance and sentry wells that will be used to determine whether a contingency remedy is required are included in the PCMMP (**Section 7**). Evidence that a contingency is required includes the presence of cis-DCE or VC at the off-site sentry well location (MW-56) at concentrations above regulatory compliance levels.

If concentrations of chlorinated ethenese exceed groundwater standards for two consecutive monitoring rounds at the trigger well MW-56, the contingency plan for groundwater will be implemented. Air sparging is the contingency plan. As sequential reductive dechlorination of TCE occurs, each successive dechlorination product (cis-DCE and VC) is increasingly volatile and subject to oxidation under mildly anaerobic conditions (i.e., anaerobic oxidation of DCE and VC under iron or manganese reducing conditions) or aerobic conditions (aerobic oxidation of VC). Therefore, air sparging is the most effective contingency remedy to strip (volatize) these dechlorination products from groundwater or to stimulate further biodegradation through oxidation reactions. Air sparging could be accomplished in a permeable trench excavated to the top of the competent bedrock.

An air sparging trench can be readily installed at the site using conventional construction techniques. The trench would be located as far downgradient as possible from the biowall reaction zones to allow for groundwater chemistry to recover from highly anaerobic conditions near the biowalls to a more natural state. The presence of excessive levels of organic carbon or soluble forms of reduced iron may interfere with operation of the sparge trench. Therefore, the air sparging contingency trench would be located downgradient of the biowall system, near the SEDA property boundary but upgradient of the existing ZVI wall, as shown in **Figure 10-1**. The air sparging trench would be designed after the decision is made that it is required.

10.3 On-Site Excavated Material Stockpiles

As discussed in **Section 4.2**, all excavated debris will be loaded directly into dump trucks for transportation to the appropriate off-site waste management facility. Though it is not anticipated, at times, it may be necessary to temporarily stockpile debris on-site prior to loading. As a contingency, on-site areas have been designated as potential temporary soil stockpile areas. The areas are shown on **Drawing C-3**. The stockpiles are located within the limits of work and erosion and stormwater controls will be used in these areas.

In the event that temporary stockpiles are necessary, excavated materials will be staged in the temporary stockpile areas. The staging areas will be constructed of a pushed up 12-inch earthen berm surrounding the stockpile area covered with 6 mil polyethylene sheeting. Each individual pile will be covered with polyethylene sheeting to prevent erosion by wind or rain.

10.4 Substrate Addition to Biowalls

Part of the monitoring and maintenance of the biowalls is determining whether recharging the biowalls with an organic substrate (i.e., vegetable oil) is needed to provide additional organic source material to the biowalls. A complete discussion on recharging the biowalls is included in the PCMMP in **Section 7.4.4**.

11.0 REMEDIAL ACTION SCHEDULE AND ORGANIZATION

11.1 Schedule

A schedule for the remedial design is presented as **Figure 11-1**. The schedule allows 30 days for the Army, NYSDEC, and USEPA to review and provide comments on the design documents. It also allows 14 days for Parsons to incorporate comments into the design documents. The construction bidding process will begin immediately after approval. This schedule will be updated on a continuing basis. The current schedule projects the commencement of construction activities in the August 2006. This schedule would allow for construction during favorable drier weather conditions and would meet the Army's land transfer goals.

11.2 Organization

The various tasks outlined herein are being implemented by the Army with Parsons as its remediation engineer. Parsons will provide constant site oversight during the remedial action.

Parsons will use the design documentation herein to hire a construction subcontractor, a laboratory subcontractor, and a surveying subcontractor. The overall construction quality assurance program, as identified in the Construction Quality Plan (**Section 6**) will be implemented directly by Parsons.

Each work effort at the Ash Landfill is overseen and reviewed by USEPA, NYSDEC, and NYSDOH. The project organization is summarized below:

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12 REFERENCES

Cooper, Judy Hennessee; Cooper, Eben S; Cooper, Jared B., 1999. Intensive Cultural Resources Survey of 4,192 Acres at Seneca Army Depot Activity, Seneca County, New York. Prepared for Geo-Marine, Inc. August 1999.

Oberon, S.J., 1995. Archaeological Investigations, Ash Landfill Site, Seneca Army Depot Activities, Town of Romulus, Seneca County, New York. Heritage America, Ltd., Middletown, New York., Submitted to the U.S. Army Corps of Engineers, New York District.

Parsons, 1994. Remedial Investigation Report at the Ash Landfill Site, Final. July 1994.

Parsons, 1996. Feasibility Study Report, Ash Landfill, Seneca Army Depot Activity, Final. 1996

Parsons, 2000. Feasibility Memorandum for Groundwater Remediation Alternatives Using Zero Valence Iron Continuous Reactive Wall at the Ash Landfill, Draft. August 2000.

Parsons, 2002. Proposed Plan for the Ash Landfill, Final. December 2002.

Parsons, 2004. Record of Decision for the Ash Landfill Operable Unit, Final. July 2004.

Parsons, 2005a. Ash landfill Biowall Pilot Study Work Plan at the Seneca Army Depot Activity, Final. May 2005.

Parsons, 2005b. Project Safety Plan and Site-Specific Health and Safety Plan for Remediation of the Seneca Army Depot Activity. Final. May 2005.

Parsons, 2005d. Monitoring Well Abandonment Work Plan for the Seneca Army Depot. May 2005.

Parsons, 2005d. Accident Prevention Plan and Generic Site-Wide Health and Safety Plan for the Seneca Army Depot Activity. Revised Final. March 2005.

Parsons, 2006a. Draft Remedial Design Work Plan for the Ash Landfill Site at Seneca Army Depot Activity. March 2006.

Parsons, 2006c. Sampling and Analysis Plan for the Seneca Army Depot Activity. Revised Final. April 2006.

Parsons, 2006b. Evaluation Report for the Mulch Biowalls at the Ash Landfill Site Seneca Army Depot Activity. March 2006.

USEPA, 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water. EPA/600/R-98/128. September 1998.

Malcolm Pirnie. 1996. *Groundwater Monitoring Well Decommissioning Procedures*. Prepared for New York State Department of Environmental Conservation.

USEPA, 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water. EPA/600/R-98/128. September 1998.

Table 3-1
Dimensions of Proposed Biowalls
Ash Landfill Remedial Design
Seneca Army Depot Activity

Wall ID	Length (ft)	Width (ft)	Average Depth (based on RI data)[1] (ft)	Depth for Estimate (ft)	Volume of Wall (Mulch Mixture) (cy)
A1	370	3	6.9	11	452
A2	370	3	6.9	11	452
B1 [2]	695	3	8.6	11	849
B2 [2]	695	3	8.6	11	849
C1	575	3	10.3	11	703
C2	575	3	10.3	11	703
TOTAL	3,280				4,009

Note:
1) Basis of depth is from the boring logs presented in Appendix C of the Remedial Investigation (RI). As a conservative estimate, a depth of 11 ft is used to determine the volume of mulch mixture.
2) Length excludes 30 foot pilot study portion of the wall length.

To get a 50:50 ratio of sand to mulch by volume sand volume will be 50% - 2,004 cy
Mulch volume will be 40 percent greater to allow for mixing (sand settlement within mulch volume). 2,004 cy*1.4 = 2,806 cy mulch

Table 5-1
Field Sampling Matrix
Ash Landfill Remedial Design
Seneca Army Depot Activity

Sample Type	Sampling Frequency	Analytical Requirements (Method)	Acceptance Criteria
Disposal Characterization	1 composite sample from Debris Piles	TCLP VOCs (SW846 Method 1311 + 8260B) TCLP SVOCs (SW846 Method 1311 + 8270C) TCLP Metals (SW846 Method 1311 + 6010B/7470A) TCLP Pesticides (SW846 Method 1311 + 8081) PCBs (SW846 Method 8082A) 1 field duplicated for VOCs (SW846 Method 8260B) 1 MS/MSD for VOCs (SW846 Method 8260B) Ignitability (SW846 Method 1030 or 1010A) pH (SW846 Method 9045D) Reactivity (SW846 - Section 7.3)	RCRA definition of non-hazardous material [1]
Sand	1 sample prior to use for each source of sand	Iron/Phosphorus/ Potassium (SW846 Method 6010B) Percent Solids (EPA Method 160.3)	For informational purposes
Trench Spoils	1 samples per 150 LF of biowall between the groundwater total chlorinated ethene 100 ug/L contour line	VOCs (SW846 Method 8260B)	TCE less than 0.7 mg/Kg (NYSDEC TAGM)
Off-Site Fill/Cover Material	1 sample prior to use	VOCs (SW846 Method 8260B) SVOCs (SW846 Method 8270C) Metals (SW846 Method 6010B, 7471A)	NYSDEC TAGMs

1. Acceptance criteria are listed in 40CFR261.23 and 40CFR261.24 and summarized in the Seneca Generic Site-Wide SAP (Parsons, 2006).

Table 5-2
Field Quality Assurance/Quality Control Sample Requirement
Ash Landfill Remedial Design
Seneca Army Depot Activity

Sample Type	Sampling Frequency	Field Quality Assurance/Quality Control Sample Requirement
Disposal Characterization	1 composite sample from Debris Piles	Not Required
Sand	1 sample prior to use for each source of sand	Not Required
Trench Spoils	1 samples per 150 LF of biowall between the groundwater total chlorinated ethene 100 ug/L contour line	1 field duplicate for VOCs (SW846 Method 8260B) 1 MS/MSD for VOCs (SW846 Method 8260B)
Off-Site Fill/Cover Material	1 sample prior to use	Not Required

TABLE 6-1
PRE-CONSTRUCTION INSPECTION ACTIVITIES FOR REMOVAL ACTION
Ash Landfill Construction Quality Plan
SENECA ARMY DEPOT ACTIVITY, NEW YORK

Preparatory Inspection Activity	Method	Frequency	Acceptance Criteria
Survey and Work Area Layout	Site Survey – Survey of Debris Piles, landfill cover areas, and biowall trench alignments and marked with grade stakes.	Once after final design	Establish grade stakes along the Debris Piles, landfill boundaries, and biowall alignments according to the design drawings. Grade stakes shall be placed at the start and termination of each linear section, at 50-foot intervals along each linear segment, at 20-foot intervals along curves, and at any change in boundary direction not in a curve.
Work Area Clearing	Visual	Once within the work area prior to work in that area.	Confirm that the landfills, Debris Piles, and trench alignments have been cleared of obstructions and that equipment can operate in the area with no obstructions.
Utility Mark Out	Call UGFPO and consult As-Built drawings provided by the facility	Once prior to commencing excavation.	Confirm all subsurface and overhead utilities are clearly marked and that the work take the utilities into consideration.
Off- Site Access / Egress Approval	Visual	Once prior to commencing construction	Confirm approval for use of off-site roads for contaminated soil transportation. Confirm that all access gates are working properly.
Job Site Trailer and Lay-Down Approval	Visual	Once prior to start of construction	Confirm approval and location for site trailer and lay-down area and availability of electrical power with Owner.
Demarcation of Monitoring Wells	Site Survey – Survey in monitoring wells.	Once prior to construction.	Establish grade stakes at locations according to the design drawings and place visible barriers to prevent damage.
Equipment Examinations	Visual	Once upon arrival at site.	Determine that equipment type and size conform to project specifications and record information in field book. Determine that equipment conforms to OSHA safety requirements. Determine that equipment is in working order and is not leaking oil or fuel in quantities sufficient to be classified as a spill.
Material Disposal Acceptance	TCLP Analytical	1 composite sample per source area	The waste management facility requires that for each source of material to be disposed, one composite sample be collected and submitted for analysis, based on the waste management facility's review of the historic sampling. For disposal as non-hazardous material, samples must pass TCLP.
Fill Material Acceptance	VOC, SVOC, and Metals Analysis	1 initial sample for each type of soil	Compliance with TAGM values.

TABLE 6-2
CONSTRUCTION INSPECTION ACTIVITIES FOR REMOVAL ACTION
Ash Landfill Construction Quality Plan
SENECA ARMY DEPOT ACTIVITY, NEW YORK

Construction Inspection Activity	Method	Frequency	Acceptance Criteria
Air Monitoring	Photo Ionization Detector with 11.7 electron Volt (eV) lamp in worker breathing zone	During start-up and construction.	Readings below 1 ppm per the HSP Section 8 (HSP).
Construction Methods Observation	Visual	During start-up and construction.	Ensure that the methods conform to standard construction practices and the worker safety is always a primary consideration.
Removal of Debris	Visual	Every Debris Pile and landfill.	The extent of the excavation will be based on visual observation of debris removal and the depth will be recorded in the field log for each 30'x30' excavated area.
Depth of trench excavation	Tape measure	Every 10 feet	Ensure that bottom of trench extends to bedrock.
Site Security	Visual	Daily during construction.	Confirm that any open excavation is fenced off and the base perimeter is secure.
Backfill of Cooling Pond	Visual	Every lift of backfill	Clean backfill will be placed in the excavation in 1 to 2 foot lifts and compaction as specified in the design.
Cover Landfills	Tape measure	Every 10,000 SF	Backfill material will be placed over the landfill in 1 foot lifts and compaction as specified in the design. Test holes will be dug on a 100-foot by 100-foot grid pattern to show the 1-foot cover depth.
Mulch/Sand Mixture	Sieve	Once for 5 liters	The target volumetric mulch mixture ratio of 50% organic material and 50% sand, with an allowable variation of ± 10%. Weight % will be used as a secondary criterion for evaluating mulch mixture homogeneity, with densities of individual mulch mixture components measured in the field as wet density. A target range for mulch mixture density will then be calculated using these wet densities and the range of acceptable volume ratios.
Erosion Control Maintenance	Visual	During start-up and construction	Ensure no migration of sediments and erosion.
Location of areas of work	Site Survey	Once at each Debris Pile, landfill, Cooling Pond, and biowalls after the work is completed	Survey the final location of each are of work for position and elevation.

TABLE 6-3
POST-CONSTRUCTION ACTIVITIES FOR REMOVAL ACTION
Ash Landfill Construction Quality Plan
SENECA ARMY DEPOT ACTIVITY, NEW YORK

Follow-Up Inspection Activity	Method	Frequency	Acceptance Criteria
Site Restoration	Visual	Once for each landfill after installation of the cover has been completed.	To ensure that the covered areas are seeded.

TABLE 7-1
Monitoring Well Sampling Summary
Ash Landfill Remedial Design Report
Seneca Army Depot Activity

Well ID	**Groundwater Field Parameters**	**Frequency**[1]	**Monitoring Purpose**
On-Site Plume Performance Monitoring			
PT-17 PT-18 PT-22 PT-24 MWT-7 MWT-15[2] MWT-22 MWT-23[2] MWT-24 (new) MWT-25 (new)	VOCs, field parameters for DO, ORP, specific conductance, pH, and temperature only	Quarterly monitoring in Year 1. Semi-annual or annual monitoring thereafter – Refer to the Decision Flow Diagram (**Figure 7-3**).	Compliance wells – monitor groundwater quality to document that groundwater concentrations throughout the plume are declining to reduce the toxicity of the contaminant plume. After the biowalls are recharged once, MWT-15 and MWT-23 will be added to the plume performance monitoring program to provide additional monitoring results that will be used in the indirect recharge evaluation.
Off-Site Performance Monitoring			
MW-56	VOCs, field parameters for DO, ORP, specific conductance, pH, and temperature only	Semi-annual or annual – Refer to the Decision Flow Diagram (**Figure 7-3**).	Sentry well – monitor groundwater quality to document that no off-site migration of plume occurs (well MW-56).
Biowall Process Monitoring			
MWT-12R MWT-13 MWT-15 MWT-17R MWT-23 (new)	VOCs, biogeochemical parameters (listed in Table 6-3)[3]	Quarterly monitoring in Year 1, followed by semi-annual monitoring until the biowalls are recharged.	Select wells along the North Transect of the pilot biowall. These wells will be used to document potential depletion of substrate and the ability of the biowall to sustain reductive dechlorination over time. Any reduction in efficiency of the pilot biowall due to substrate depletion will be used as a trigger to determine whether or when the full-scale system (using new well MWT-23) needs maintenance (i.e., additional substrate or amendments).

Notes:

1. Quarterly sampling will be conducted for the first year. The sampling frequency will be reviewed and reassessed in the monitoring report after one year, as indicated on the Decision Flow Diagram, **Figure 7-3**.
2. After the biowalls are recharged once, two wells from the biowall process monitoring group (MWT-15 and MWT-23) will be added to the plume performance monitoring program to provide additional monitoring results that will be used in the indirect recharge evaluation.
3. Biogeochemical parameters include total organic carbon (TOC), methane, ethene/ethane, sulfate, ferrous iron, manganese, dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, specific conductivity, and temperature (see Table 6-3).

Table 7-2
Well by Well Monitoring Rationale
Ash Landfill Remedial Design Report
Seneca Army Depot Activity

Well ID	**Monitoring Rationale**
On-Site Plume Performance Monitoring	
PT-17	Located approximately 150 feet downgradient of System C1-C2, this well monitors performance of Biowall System C1-C2 and provides information on recovery of redox conditions downgradient of this last biowall.
PT-18	Monitors groundwater quality in the Ash Landfill and provides information on groundwater quality upgradient of Biowall System A1-A2.
PT-22	Monitors performance of Biowall System B1-B2 and provides information on upgradient groundwater quality to System C1-C2
PT-24	Monitors groundwater quality downgradient of the ZVI wall and immediately upgradient of the SEDA property boundary to document the overall performance of biowall system.
MWT-7	Historic well located immediately downgradient of the zero valent iron (ZVI) wall and upgradient of the SEDA property boundary to document the overall performance of biowall system.
MWT-22	Historic well monitors groundwater quality along the axis of the plume after passing through the first two biowall systems.
MWT-24 (new)	Installed approximately 170 feet downgradient of System C1-C2, this well monitors performance of Biowall System C1-C2 and provides information on recovery of redox conditions downgradient of this last biowall transect.
MWT-25 (new)	Monitors groundwater quality immediately upgradient of Biowall System A1-A2.
Biowall Process Monitoring	
MWT-12R	An upgradient monitoring well to the pilot biowall, this well will be used primarily to document changes in contaminant distribution and biogeochemistry entering the pilot biowall. In addition, data from this well will document the performance of Biowall System A1-A2. (See **Figure 7-2**).
MWT-13 MWT-15	Located within the pilot biowall along the North Transect, these wells will be used to evaluate substrate depletion and ability of the pilot biowall system to sustain reductive dechlorination. Using TOC as an indicator of substrate depletion, the level of TOC and changes in geochemistry at which a loss of dechlorination efficiency is observed will serve as a trigger and early warning that maintenance of the full-scale biowall system may be required.
MWT-17R	Located downgradient of the pilot biowall along the North Transect, this well will be used to evaluate the performance of the pilot biowall system.
MWT-23 (new)	Installed within Biowall C2, this well will be used to evaluate the performance of the full-scale biowall system, and will serve to evaluate substrate depletion with the full-scale system.
Off-Site Performance Monitoring	
MW-56	Sentry well used for regulatory compliance to document that the contaminant plume has not migrated off site.

Table 7-3
Probable Sampling Plan for the Next 10 Years
Ash Landfill Remedial Design
Seneca Army Depot Activity, Romulus, NY

			Off-Site	**On-Site**										**PRB**					**TOTAL**
Year	Sampling Events	Assumptions	MW-56	PT-17	PT-18	PT-22	PT-24	MWT-7	MWT-15	MWT-22	MWT-23	MWT-24	MWT-26	MWT-12R	MWT-13	MWT-15 (1)	MWT-17R	MWT-23 (1)	
1	Off-site Wells: Semi-annual; On-Site Wells: Quarterly; PRB Wells: Quarterly.		2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	62
2	Off-site Wells: Semi-annual; On-Site Wells: Semi-annual; PRB Wells: Semi-Annual.	Decreasing Trend Not Yet Established; Recharge not required	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	32
3	Off-site Wells: Annual; On-Site Wells: Annual; PRB Wells: Semi-Annual.	Decreasing Trend Established; Recharge not required	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	21
4	Off-site Wells: Annual; On-Site Wells: Annual; PRB Wells: Semi-Annual.	Decreasing Trend Established; Recharge not required	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	21
5	Off-site Wells: Semi-annual; On-Site Wells: Semi-annual; PRB Wells: Semi-Annual.	Increasing Trend Observed; Recharge Required	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	19
6	Off-site Wells: Annual; On-Site Wells: Annual; PRB Wells: None	Recharge Performed; Decreasing Trend Established	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	14
7	Off-site Wells: Annual; On-Site Wells: Annual; PRB Wells: None	Decreasing Trend Established; Recharge not required	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	14
8	Off-site Wells: Annual; On-Site Wells: Annual; PRB Wells: None	Decreasing Trend Established; Recharge not required	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	14
9	Off-site Wells: Annual; On-Site Wells: Annual; PRB Wells: None	Decreasing Trend Established; Recharge not required	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	14
10	Off-site Wells: Annual; On-Site Wells: Annual; PRB Wells: None	Decreasing Trend Established; Recharge not required	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	14

Notes
(1) Wells will be included in the On-Site Plume Monitoring Program after first recharge event.
(2) The sampling frequency listed above is based on the stated assumptions and the decision diagram in **Figure 7-3**. The actual sampling frequency will be determined each year based on **Figure 7-3**.

TABLE 7-4
Groundwater Data Quality Objectives
Ash Landfill Remedial Design Report
Seneca Army Depot Activity

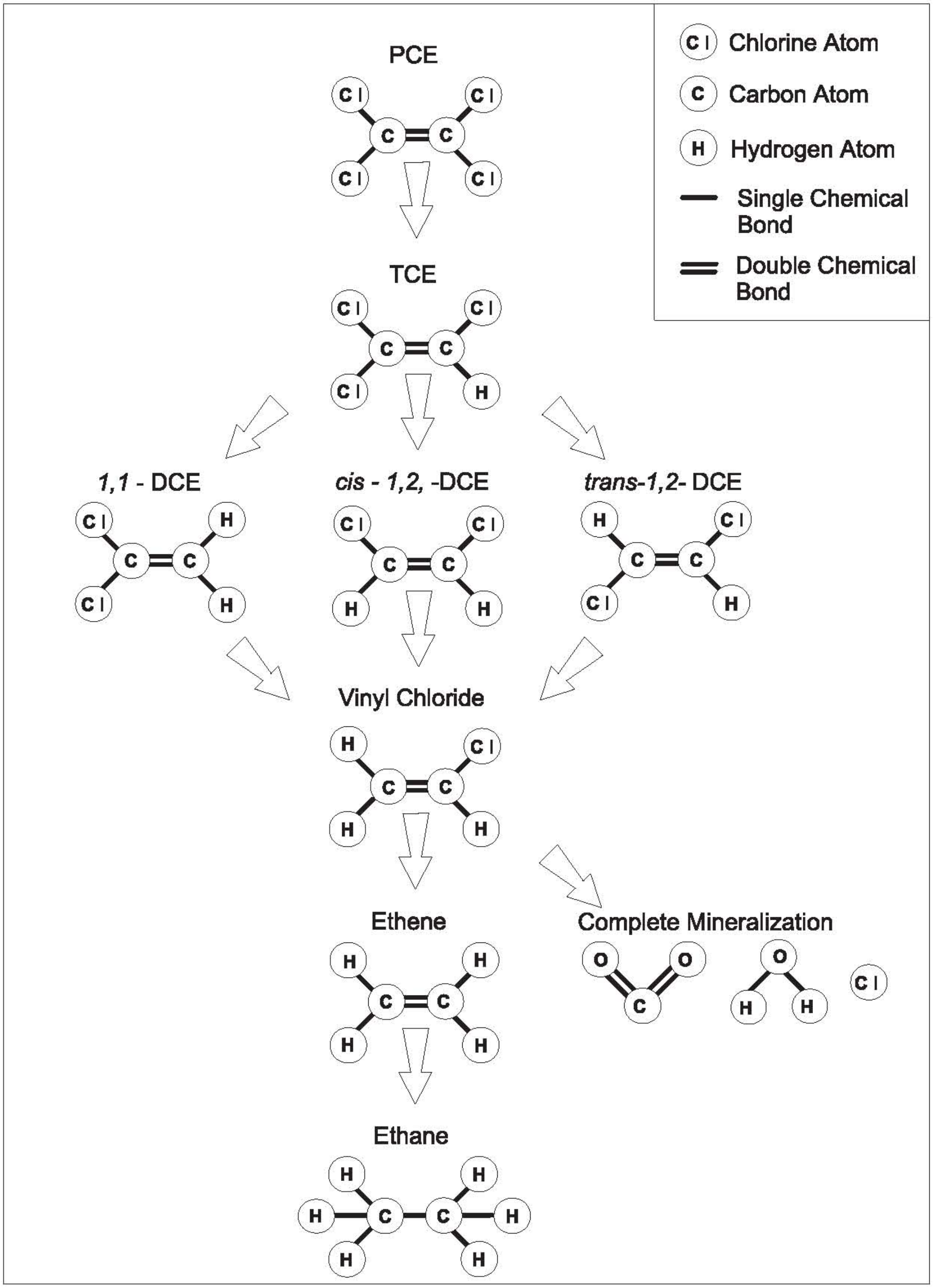
Groundwater Analyte/ Parameter	**Suggested Analytical Method**	**Location of Analysis**	**Monitoring Purpose**
VOCs	SW846 Method 8260B	Laboratory	Measure of VOCs in groundwater. Basis for measuring remedy performance.
Total Organic Carbon	SW846 Method 9060A	Laboratory	A measure of the amount of soluble organic carbon available to stimulate anaerobic biodegradation processes. In conjunction with contaminant and geochemical indicators of redox conditions, may be used to determine when biowalls require recharging.
Methane/Ethane/ Ethene	RSK-175 or EPA Method 8015D	Laboratory	Methane provides evidence of strongly reducing conditions. Ethene and ethene provide measure of innocuous dechlorination end products.
Sulfate	EPA Method 300.1 or SW846 Method 9056	Laboratory	Used as an electron acceptor; changes in its concentration may provide evidence of activities of sulfate reducing bacteria.
Ferrous Iron	Hach Colorimetric Method 8146	Field	Soluble ferrous iron is produced by reduction of ferric iron minerals by iron reducing bacteria; ferric iron is used as an electron acceptor.
Manganese	Hach Colorimetric Method 8034	Field	Soluble Manganese (II) iron is produced by reduction of manganese (IV) minerals by manganese reducing bacteria; manganese iron is used as an electron acceptor.
Dissolved Oxygen	Dissolved Oxygen Meter	Field	Indicator of aerobic environments; used as a competing electron acceptor.

(continued)

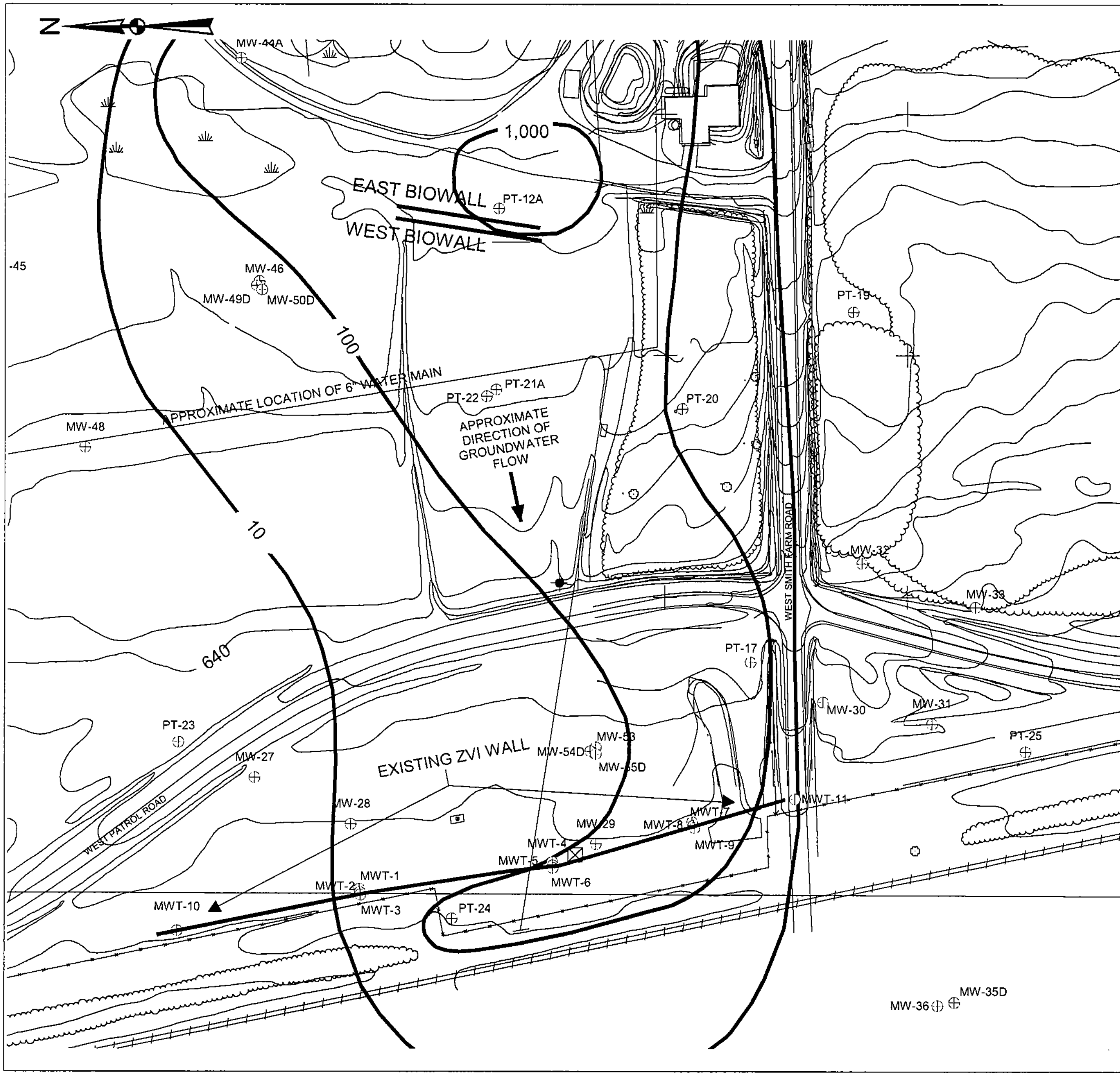
TABLE 7-4 (continued)
Groundwater Data Quality Objectives
Ash Landfill Remedial Design Report
Seneca Army Depot Activity

Redox potential	Millivolt Meter	Field	Measure of oxidation-reduction potential of the environment; ranges from +500 mV for aerobic environments to -500 mV for anaerobic environments.
pH	pH Meter	Field	Measurement of suitability of environment to support wide range of microbial species; activity tends to be reduced outside of a pH range of 6 to 8.
Specific Conductance	Conductivity Meter	Field	Stabilization parameter for groundwater monitoring.
Temperature	Temperature	Field	Stabilization parameter for groundwater monitoring.

Figure 3-1
Reductive Dechlorination of Chlorinated Ethenes
Ash Landfill Remedial Design
Seneca Army Depot Activity



(USEPA, 1998)



PARSONS

SENECA ARMY DEPOT ACTIVITY

ASH LANDFILL BIOWALL PILOT STUDY

ENVIRONMENTAL ENGINEERING	744538-01000

FIGURE 3-2
APPROXIMATE LOCATION OF BIOWALLS AND TOTAL CHLORINATED ETHENES IN GROUNDWATER

SCALE: 1" = 150'	MARCH 2006

O:\Seneca\Ash_lf\Ash RD WP\ash_rd_wp.apr\Fig 2-Ash base Plume & Biowall

LEGEND

- Anaerobic Zone
- Aerobic Zone
- Groundwater isocontour (ug/L) —100—

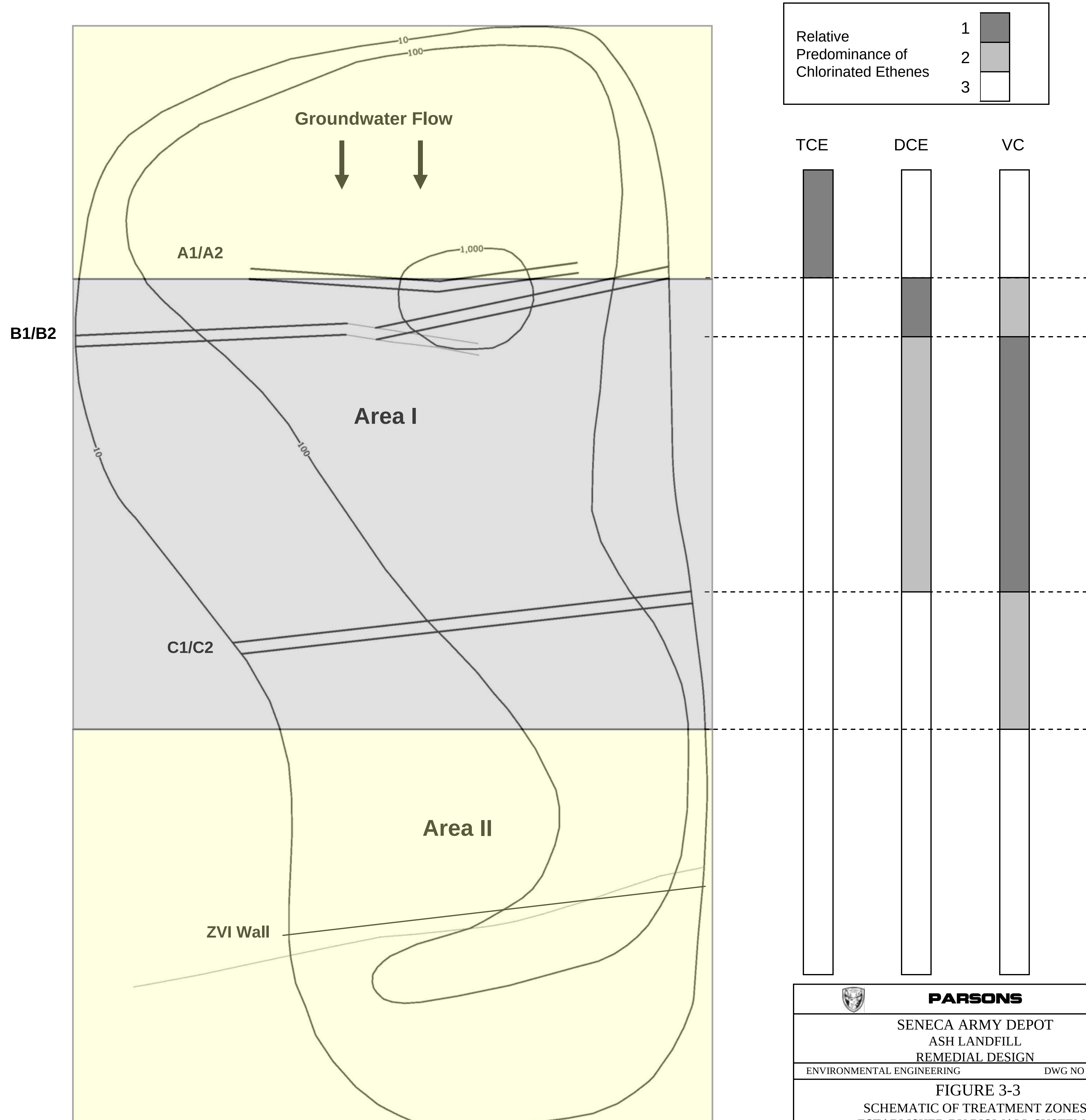
Area I: Anaerobic Zone

A1/A2 Source Wall:
- Located at highest concentrations of TCE and competing electron acceptors in groundwater.
- Levels of TCE are reduced to ND.
- DCE and VC are formed as TCE decreases, with significant reduction of DCE.
- Levels of competing electron acceptors, such as oxygen and sulfates, are depleted or reduced.

B1/B2 Middle Walls:
- Extension of pilot study walls across plume.
- Adds carbon source to maintain anaerobic zone.
- Levels of DCE and VC decrease.

C1/C2 Final Walls:
- Located approximately 325 ft downgradient of B1/B2.
- Observations made during pilot study indicated a need to recharge substrate source at this location to maintain anaerobic conditions.
- DCE and VC continue to be reduced.
- Continue anaerobic zone to destroy residual or sorbed TCE and DCE, and any residual VC.
- Potential that low levels of VC and fermentation products may persist.

Area II: Aerobic Zone
- Oxidize any remaining VC
- Oxidize any remaining fermentation products (i.e., alcohols or ketones).



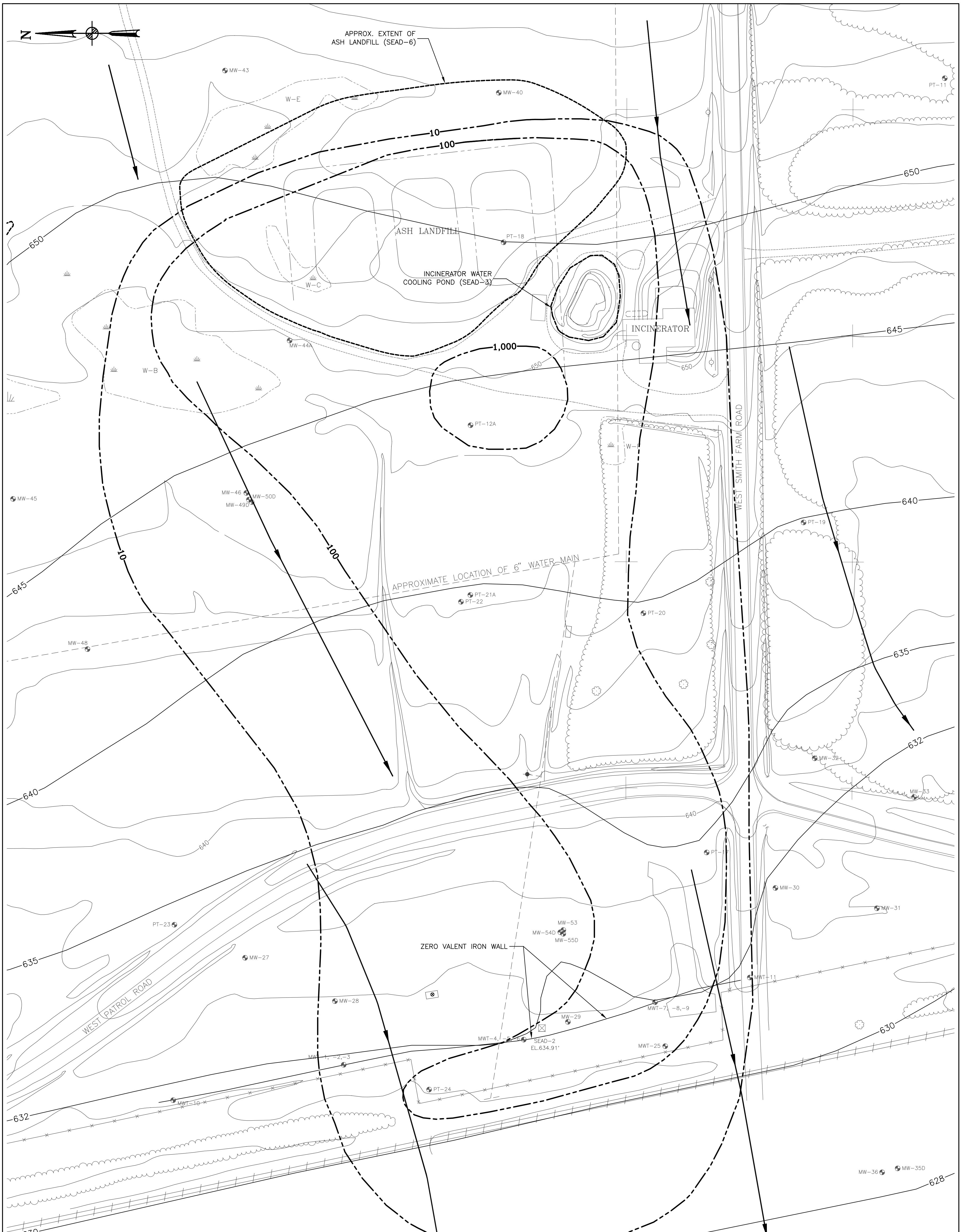
PARSONS

SENECA ARMY DEPOT
ASH LANDFILL
REMEDIAL DESIGN

ENVIRONMENTAL ENGINEERING DWG NO 744538-01400

FIGURE 3-3
SCHEMATIC OF TREATMENT ZONES ESTABLISHED BY BIOWALL SYSTEMS

NOT TO SCALE JUNE 2006



NOTES:

1. GROUNDWATER MEASUREMENTS TAKEN ON AUGUST 23, 2004.
2. GROUNDWATER ELEVATION CONTOURS BASED ON CONDITIONS AT THE TIME OF MEASUREMENT. GROUNDWATER CONDITIONS AT OTHER TIMES MAY VARY.

MW-56

LEGEND:

- PAVED ROAD
- DIRT ROAD
- GROUND CONTOUR AND ELEVATION
- TREE
- WETLAND & DESIGNATION
- APPROXIMATE LIMITS OF WORK
- RAILROAD TRACKS
- BRUSH
- CHAIN LINK FENCE
- UTILITY POLE
- APPROXIMATE LOCATION OF FIRE HYDRANT
- FUEL OR UNDERGROUND STORAGE TANK
- SURVEY MONUMENT (SEAD-1 EL.630.90')
- WATER MAIN
- EXISTING TREATMENT WALL
- GROUNDWATER FLOW DIRECTION
- EXISTING GROUNDWATER CONTOURS (650)
- GROUNDWATER ISOCONTOUR (UG/L) (10)
- MONITORING WELL AND DESIGNATION (PT-22)

PARSONS

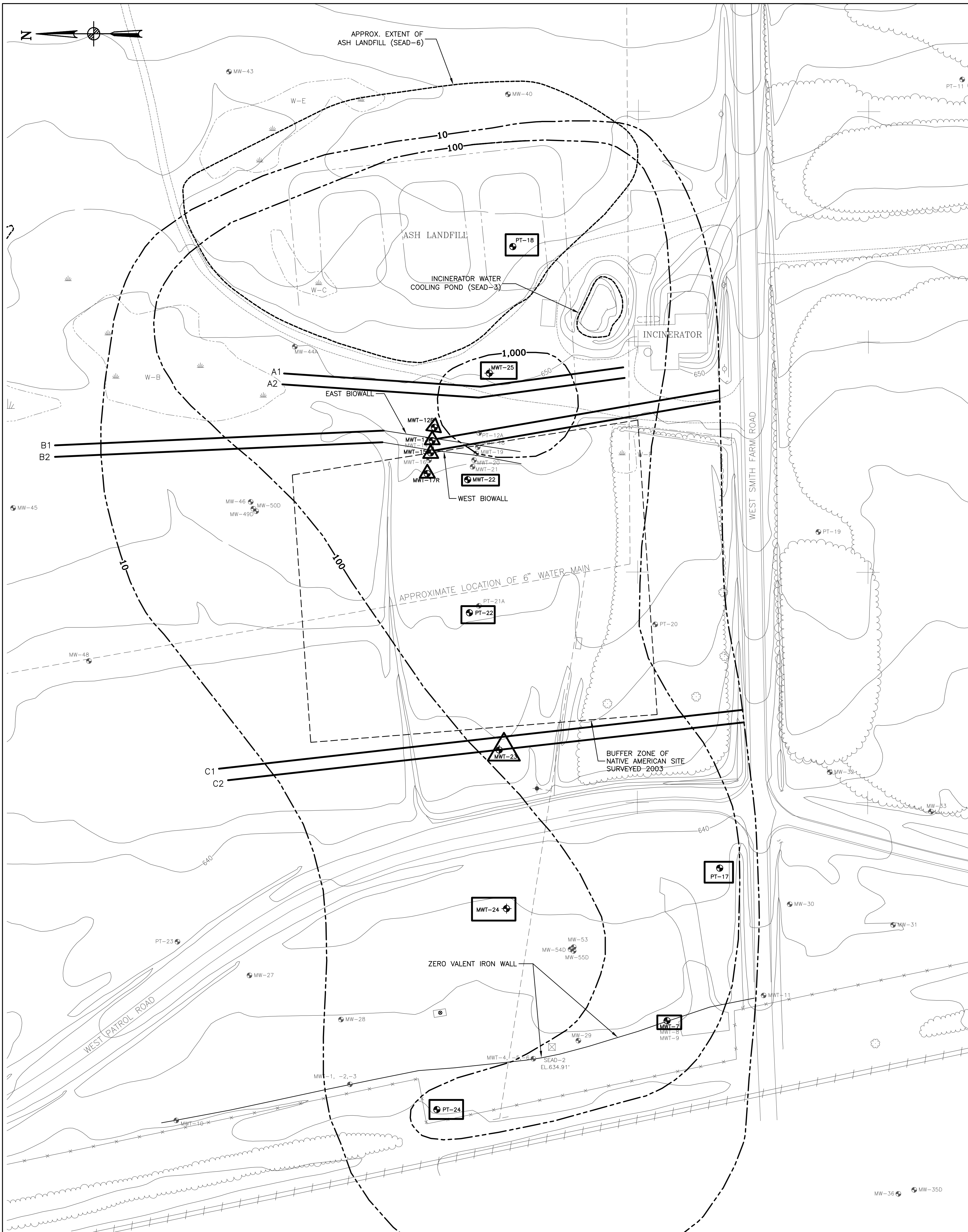
CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
ASH LANDFILL

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	744538-01400

FIGURE 7-1
GROUNDWATER CONTOURS AND FLOW DIRECTION – AUGUST 23, 2004

SCALE	DATE	REV
1" = 50'	MAY 2006	–

P:\PIT\Projects\Seneca PBC I\Remedial Design\Ash Landfill\Preliminary Design\Cad\Figure 7-1.dwg



NOTES:

1. GROUNDWATER MEASUREMENTS TAKEN ON AUGUST 23, 2004.
2. GROUNDWATER ELEVATION CONTOURS BASED ON CONDITIONS AT THE TIME OF MEASUREMENT. GROUNDWATER CONDITIONS AT OTHER TIMES MAY VARY.
3. BOLD MONITORING WELLS DENOTE WELLS INCLUDED IN THE LONG-TERM MONITORING PROGRAM.

50 0 50 100
(feet)

MW-56

LEGEND:

- PAVED ROAD
- DIRT ROAD
- GROUND CONTOUR AND ELEVATION (650)
- TREE
- WETLAND & DESIGNATION (W-B)
- APPROXIMATE LIMITS OF WORK
- RAILROAD TRACKS
- BRUSH
- CHAIN LINK FENCE
- UTILITY POLE
- APPROXIMATE LOCATION OF FIRE HYDRANT
- WATER MAIN
- PROPOSED BIOWALL
- EXISTING TREATMENT WALL
- GROUNDWATER ISOCONTOUR (UG/L) (10)
- ARCHEOLOGICAL SITE BUFFER ZONE (USACE, 2003)
- MONITORING WELL AND DESIGNATION (PT-22)
- PROPOSED MONITORING WELL (MWT-24)
- OFF-SITE PERFORMANCE MONITORING WELL IN L.T.M. PROGRAM (MW-56)
- ON-SITE PLUME PERFORMANCE MONITORING WELL IN L.T.M. PROGRAM (PT-22)
- BIOWALL PROCESS MONITORING WELL IN L.T.M. PROGRAM (MWT-12R)

PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT
ASH LANDFILL
REMEDIAL DESIGN

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	744538-01400

FIGURE 7-2
PROPOSED LONG-TERM MONITORING WELL LOCATIONS

SCALE	DATE	REV
1" = 100'	JUNE 2006	–

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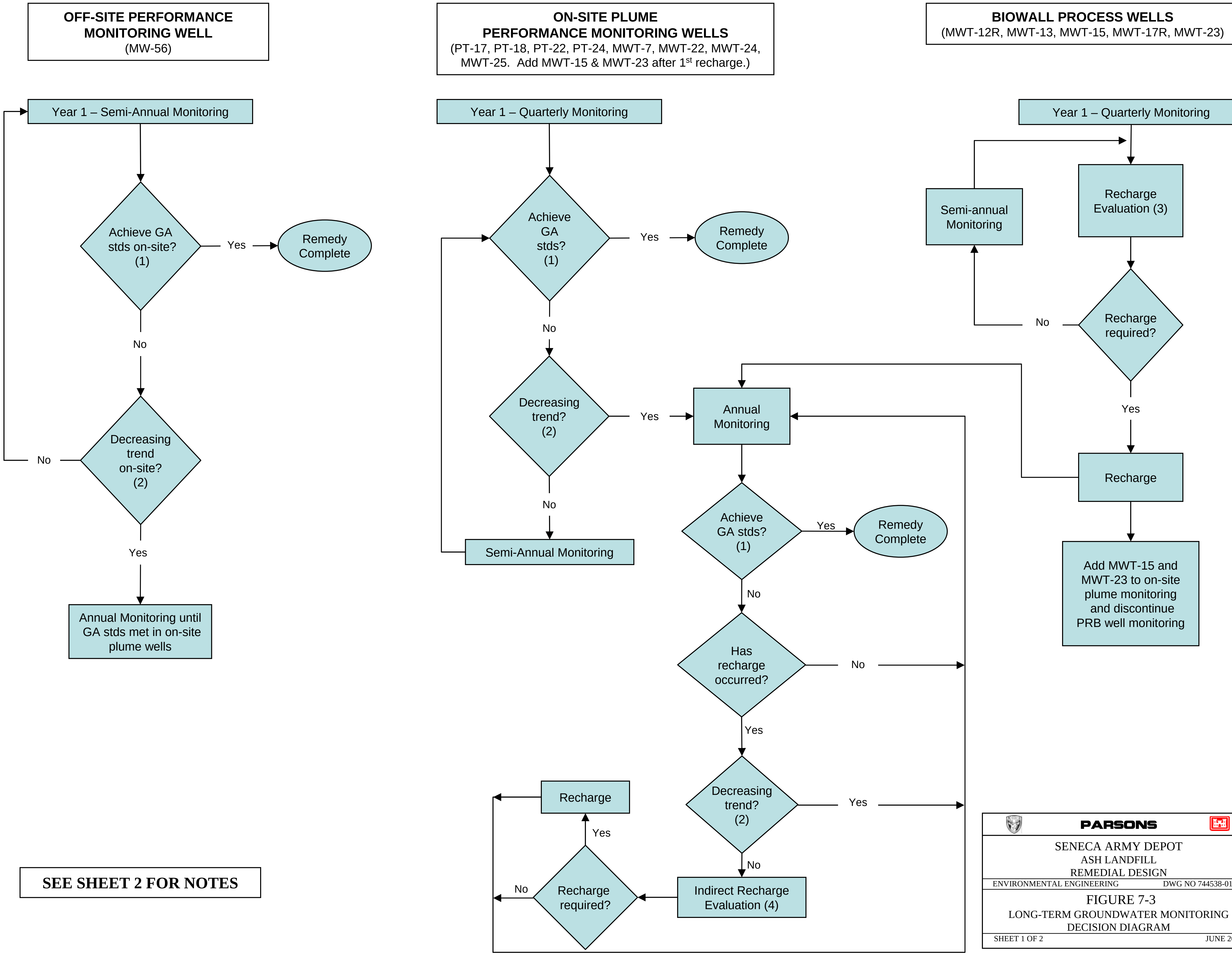


SEE SHEET 2 FOR NOTES

PARSONS

SENECA ARMY DEPOT
ASH LANDFILL
REMEDIAL DESIGN

ENVIRONMENTAL ENGINEERING DWG NO 744538-01400

FIGURE 7-3
LONG-TERM GROUNDWATER MONITORING DECISION DIAGRAM

SHEET 1 OF 2 JUNE 2006

NOTES:

1. **Achieving GA Stds:** The condition of achieving GA standards applies to achieving groundwater standards for all COCs in all of the On-Site Plume Wells. If GA standards are achieved in the On-Site Plume Wells for two successive monitoring events, then the remedy is complete and no further monitoring is required at the site.

2. **Decreasing Trend:** After each year of sampling, the Army will review the results to determine if the chemical concentrations of the COCs are increasing, decreasing, or are unchanged. Graphical and statistical analyses will be used as the basis for this determination. For example, data points will be plotted and a best fit line (linear regression) will be graphed. The slope of the best fit line is representative of the trend in concentration; a negative slope indicates a decreasing trend in COC concentrations. A decreasing COC trend indicates that the potential for contaminants to migrate and negatively impact groundwater further downgradient is decreasing, and that the plume is being effectively managed by the remedy. Any evaluation of trends in contaminant concentrations will take into account that historic data at the Ash Landfill shows that there are seasonal fluctuations in contaminant concentrations. Semi-annual monitoring during wet and dry seasons is appropriate until it is established in which season maximum concentrations are observed. Annual monitoring would occur in the season of maximum concentrations.

3. **Recharge Evaluation:**

• Determining the need to recharge a biowall segment requires a review of chemical concentrations and geochemical parameters by an experienced professional. A specific, absolute set of conditions or parameter values are not appropriate to determine the need to recharge. Rather, a lines-of-evidence approach will be used that correlates a decrease in the efficiency of the system to degrade chloroethenes to geochemical evidence that indicates the cause is due to substrate depletion.

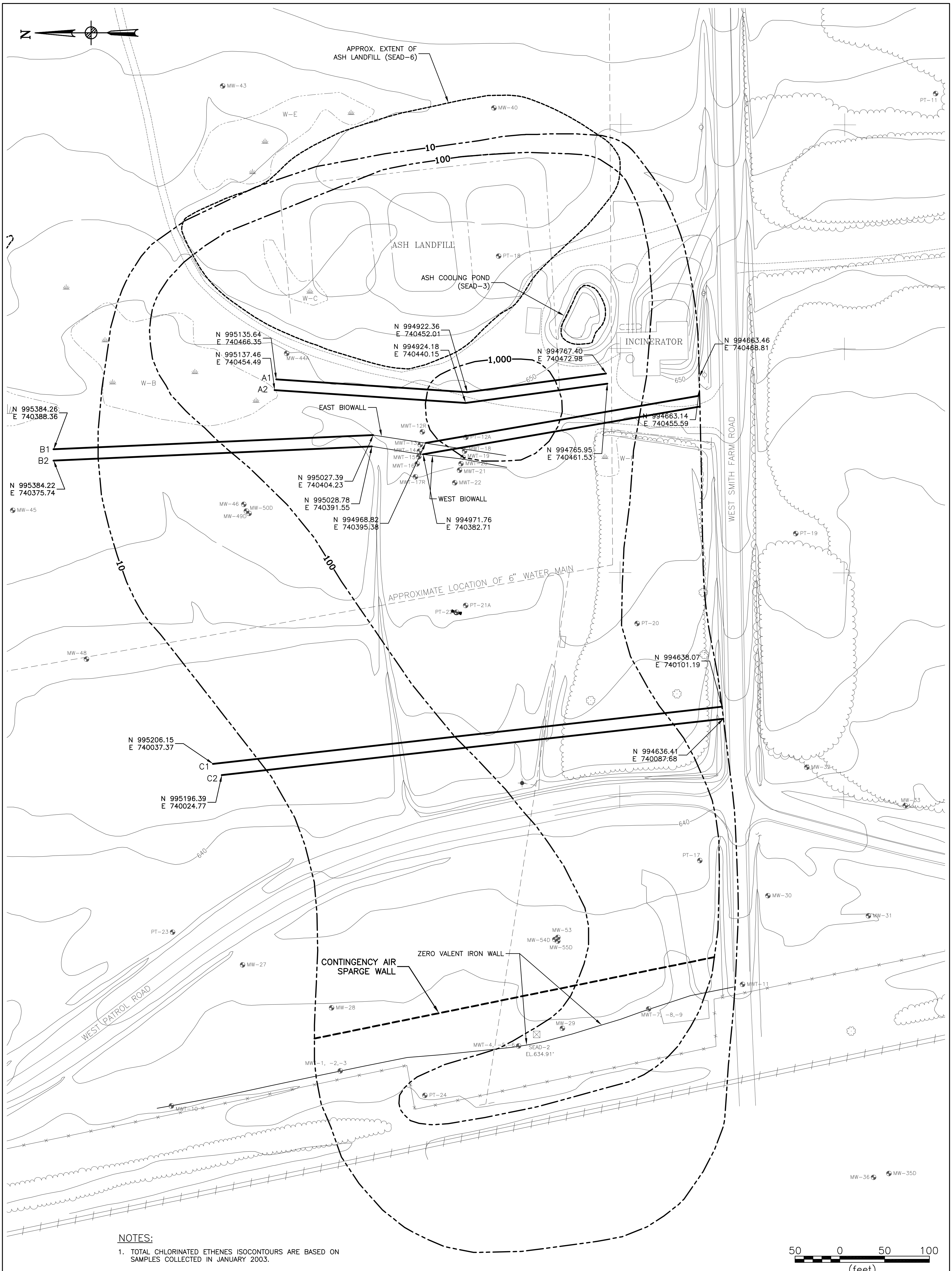
• The following parameters will be evaluated on an annual basis using at least two consecutive rounds of sampling data in order to determine if recharge of the biowalls is necessary:

a. COC concentrations in the wall. If COC concentrations have rebounded by greater than 50% for any single sampling event, this will indicate that recharge should be considered. Concentrations within the biowalls, not at downgradient locations, will be used to make this evaluation so that the effectiveness of the wall itself is being measured without the interference of effects such as desorption and mixing.

b. Geochemical parameters, specifically ORP, TOC, and DO, in the wall. Benchmark values will be used initially to evaluate anaerobic conditions in the groundwater. These benchmarks are:
- ORP < -100 Mv
- TOC > 20 mg/L
- DO < 1.0 mg/L

Parameters described in a and b above are intended to be used as guidelines and will be considered in the evaluation if, and when, a depletion of bioavailable organic substrate results in a rebound in geochemical redox conditions under which effective biodegradation does not occur.

4. **Indirect Recharge Evaluation**: Once the biowalls are recharged the first time, an indirect recharge evaluation will be conducted if an increasing trend in COC concentrations is observed in the plume performance monitoring wells. An increasing trend is a positive slope on the best-fit line, described in *Note 2* above. Two biowall monitoring wells, MWT-15 and MWT-23, will be added to the Plume Performance Monitoring program after the first recharge is completed. The evaluation will review the chemical and geochemical data and determine if the contaminant increase is a result of poor biowall performance or due to other issues, such as seasonal variations, recent precipitation events, desorption, etc. As stated in Note 2, a rebound in concentrations of COCs of 50% in MWT-15 and MWT-23 in two consecutive monitoring rounds is a major indication that recharge is needed. Once this COC rebound is observed, the geochemical parameter concentrations at MWT-15 and MWT-23 will be reviewed. In addition, conditions at the other plume performance wells will be reviewed and compared to the conditions observed at those wells at the time that the initial recharge was required. The Army will determine if similar conditions in the well provide further proof that carbon source recharge is needed again.



NOTES:

1. TOTAL CHLORINATED ETHENES ISOCONTOURS ARE BASED ON SAMPLES COLLECTED IN JANUARY 2003.

LEGEND:

- PAVED ROAD
- DIRT ROAD
- GROUND CONTOUR AND ELEVATION
- TREE
- WETLAND & DESIGNATION
- MONITORING WELL AND DESIGNATION
- RAILROAD TRACKS
- BRUSH
- CHAIN LINK FENCE
- UTILITY POLE
- APPROXIMATE LOCATION OF FIRE HYDRANT
- FUEL OR UNDERGROUND STORAGE TANK
- SURVEY MONUMENT (SEAD-1 EL.630.90')
- WATER MAIN
- PROPOSED BIOWALL
- EXISTING TREATMENT WALL
- GROUNDWATER ISOCONTOUR (UG/L)
- CONTINGENCY AIR SPARGE WALL

PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT
ASH LANDFILL
REMEDIAL DESIGN

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	744538-01400

FIGURE 10-1
LOCATION OF CONTINGENCY AIR SPARGING WALL

SCALE	DATE	REV
1" = 50'	JUNE 2006	–

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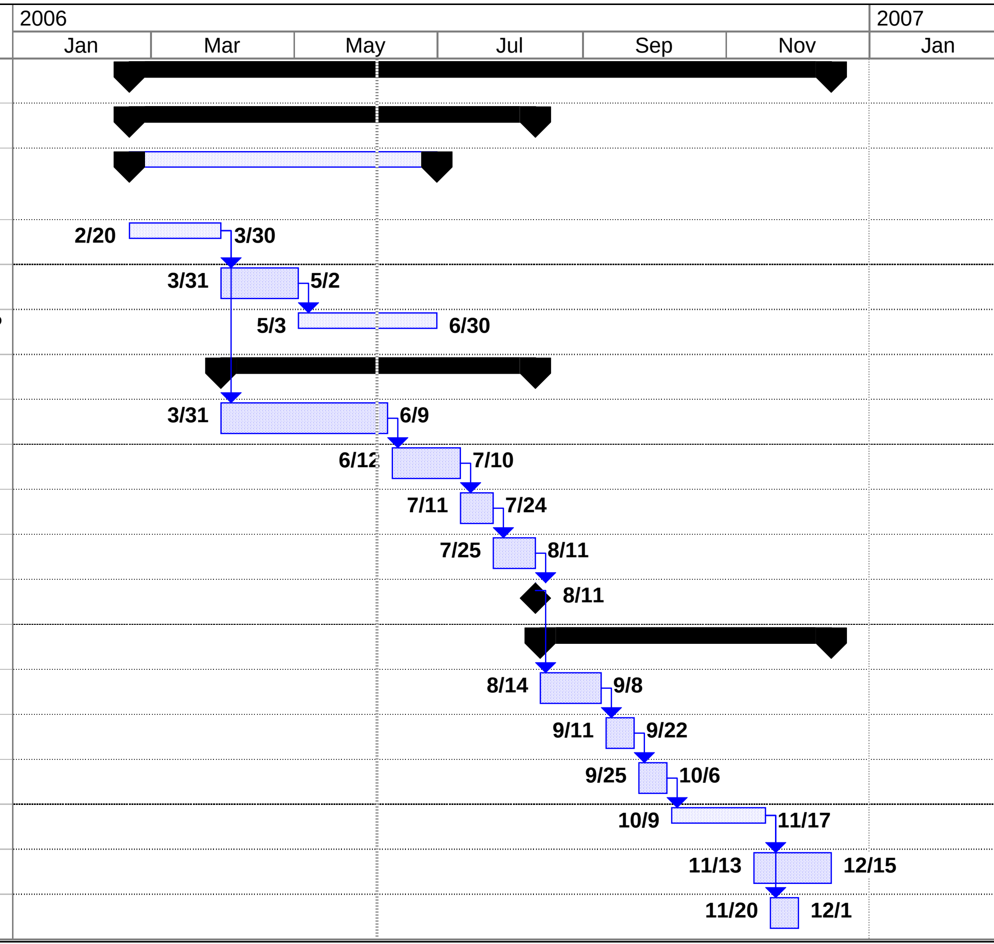
Figure 11-1
Remedial Design Schedule
Ash Landfill Remedial Design
Seneca Army Depot Activity, Romulus, New York

ID	Task Name
1	**Remediation of the Ash Landfill OU**
2	**Remedial Design WPs and Design**
3	**Remedial Design Work Plan (CDRL A004)**
4	Prepare Draft Design Work Plan
5	Army/Regulator Review of Draft WP
6	Final Work Plan Approved and Submittal of Response to Comments on Draft WP
7	**Remedial Design Ash Landfill OU (CDRL A001E,G, A013)**
8	Prepare and Submit Draft Design
9	Regulator Review of Draft Design
10	Prepare Final Design (FD)
11	Regulator Review of FD
12	Final RD Approved
13	**Remedial Action for Ash Landfill OU**
14	Mobilization
15	Complete Debris Pile Removal & Backfill Pond
16	Construct NCFL & Ash Landfill Covers
17	Reactive Wall Installation
18	Install New Monitoring Wells Ash Landfill OU
19	Demobilization



Project: SEAD 25 and 26 Remediation
Date: Mon 6/5/06

Task		Rolled Up Task		External Tasks	
Progress		Rolled Up Milestone		Project Summary	
Milestone		Rolled Up Progress		Group By Summary	
Summary		Split		Deadline	

PREPARED FOR:

AIR FORCE CENTER OF ENVIRONMENTAL EXCELLENCE

REMEDIAL DESIGN FOR
THE ASH LANDFILL OPERABLE UNIT
SENECA ARMY DEPOT
ROMULUS, NEW YORK

DRAFT DESIGN DRAWINGS
(JUNE 2006)

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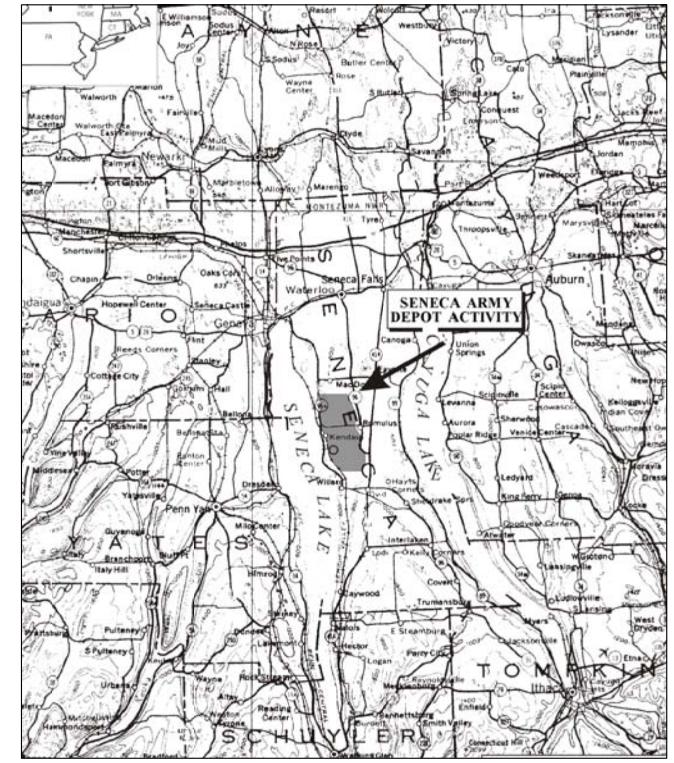

LOCATION MAP

DRAWING LIST

SHEET NO.	REVISION NO.	DESCRIPTION
C-1		TITLE SHEET
C-2		EXISTING CONDITIONS PLAN
C-3		SOIL REMEDIATION: EXCAVATION AND GRADING PLAN
C-4		GROUNDWATER REMEDIATION: BIOWALLS LAYOUT
C-5		DETAILS

SITE PLAN

NTS

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PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT
ASH LANDFILL
REMEDIAL DESIGN

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	744538-01400

C-1
TITLE SHEET

SCALE	DATE	REV
NA	JUNE 2006	-

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LEGEND:

- PAVED ROAD
- DIRT ROAD
- GROUND CONTOUR AND ELEVATION
- TREE
- WETLAND & DESIGNATION
- BRUSH
- CHAIN LINK FENCE
- UTILITY POLE
- APPROXIMATE LOCATION OF FIRE HYDRANT
- FUEL OR UNDERGROUND STORAGE TANK
- SURVEY MONUMENT (SEAD-1 EL.630.90')
- MONITORING WELL AND DESIGNATION (PT-22)
- RAILROAD TRACKS
- WATER MAIN

100 0 100 200
(feet)

PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT

ASH LANDFILL
REMEDIAL DESIGN

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	744538-01400

C-2

EXISTING CONDITIONS
PLAN

SCALE	DATE	REV
1" = 200'	JUNE 2006	-

LEGEND:

- PAVED ROAD
- DIRT ROAD
- GROUND CONTOUR AND ELEVATION (650)
- TREE
- WETLAND & DESIGNATION (W-B)
- BRUSH
- CHAIN LINK FENCE
- UTILITY POLE
- APPROXIMATE LOCATION OF FIRE HYDRANT
- FUEL OR UNDERGROUND STORAGE TANK
- SURVEY MONUMENT (SEAD-1 EL.630.90')
- MONITORING WELL AND DESIGNATION (PT-22)
- RAILROAD TRACKS
- WATER MAIN

NOTES:

1. REMOVE ALL DEBRIS IN WORK AREAS.
2. CUT TREES AND BRUSH FROM THE LANDFILLS AND THE COOLING POND PRIOR TO COVERING OR BACKFILLING, RESPECTIVELY.
3. THE DEBRIS PILES SHALL BE EXCAVATED UNTIL ALL VISIBLE DEBRIS ARE REMOVED, BASED ON THE ENGINEERS VISUAL OBSERVATION. THE GENERAL AREAS WHERE THE DEBRIS PILES ARE PRESENT ARE SHOWN.
4. INCINERATOR COOLING WATER POND SHALL BE BACKFILLED WITH APPROVED FILL MATERIAL TO MEET THE SURROUNDING GRADE.
5. TWELVE INCH SOIL COVER CAPABLE OF SUSTAINING VEGETATIVE GROWTH SHALL BE PLACED OVER THE ASH LANDFILL AND THE NCFL. THE COVER SHALL BE SEEDED TO PROMOTE VEGETATIVE GROWTH AND PREVENT EROSION. LIMITS OF THE COVERS ARE SHOWN ON THIS DRAWING.

100 0 100 200
(feet)

PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT

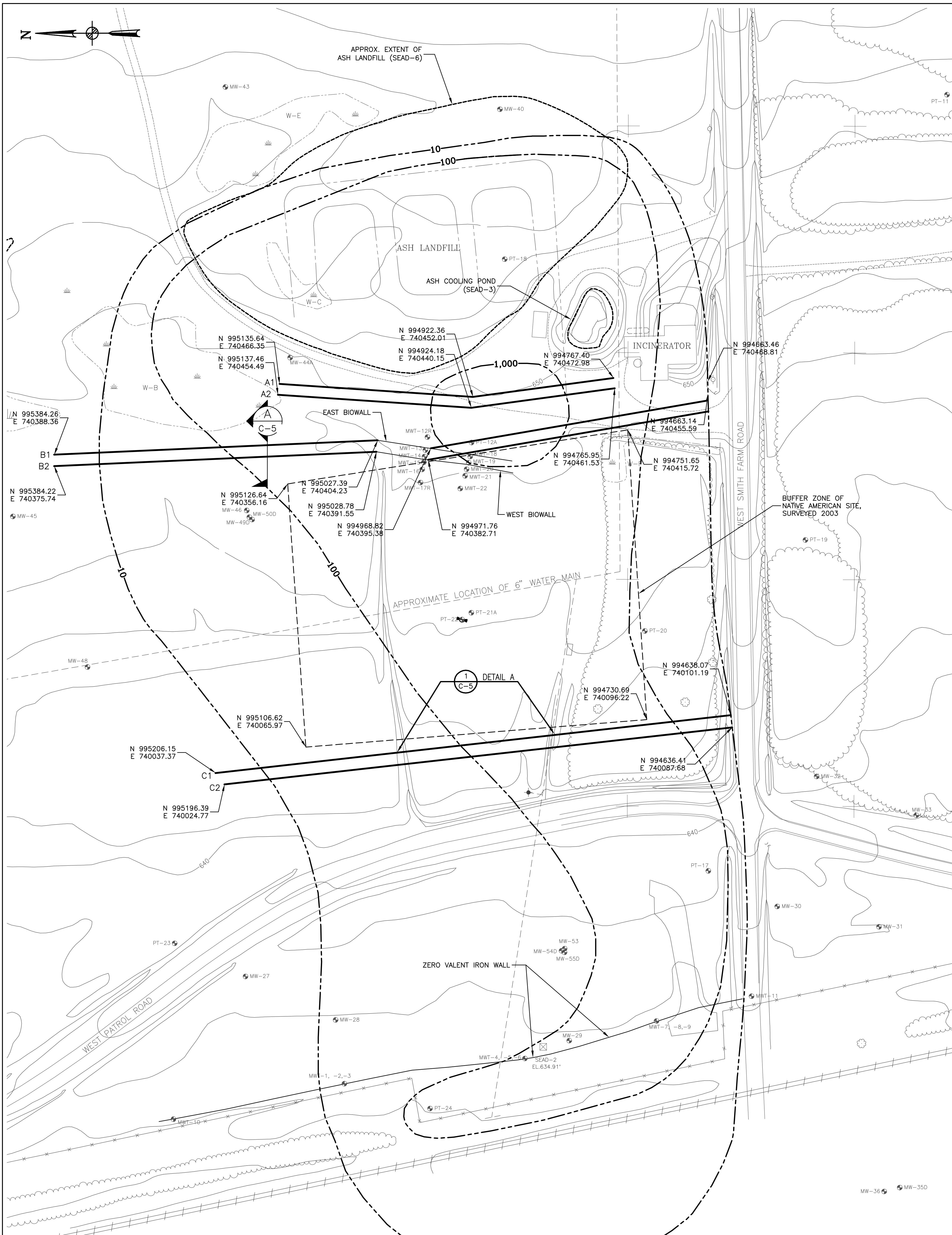
ASH LANDFILL
REMEDIAL DESIGN

DEPT.	Dwg. No.
ENVIRONMENTAL ENGINEERING	744538-01400

C-3

SOIL REMEDIATION:
EXCAVATION AND GRADING PLAN

SCALE	DATE	REV
1" = 200'	JUNE 2006	–



NOTES:

1. TOTAL CHLORINATED ETHENES ISOCONTOURS ARE BASED ON SAMPLES COLLECTED IN JANUARY 2003.

50 0 50 100
(feet)

LEGEND:

PAVED ROAD	BRUSH	WATER MAIN	
DIRT ROAD	CHAIN LINK FENCE	PROPOSED BIOWALL	
GROUND CONTOUR AND ELEVATION (650)	UTILITY POLE	EXISTING TREATMENT WALL	
TREE	APPROXIMATE LOCATION OF FIRE HYDRANT	GROUNDWATER ISOCONTOUR (UG/L) (10)	
WETLAND & DESIGNATION (W-B)	FUEL OR UNDERGROUND STORAGE TANK	ARCHEOLOGICAL SITE BUFFER ZONE (USACE, 2003)	
MONITORING WELL AND DESIGNATION (PT-22)	SURVEY MONUMENT (SEAD-1 EL.630.90')		
RAILROAD TRACKS			

SENECA ARMY DEPOT ACTIVITY

PARSONS

CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
ASH LANDFILL
REMEDIAL DESIGN

DEPT. ENVIRONMENTAL ENGINEERING
Dwg. No. 744538-01400

C-4
GROUNDWATER REMEDIATION:
BIOWALLS LAYOUT

SCALE 1" = 100'
DATE JUNE 2006
REV –

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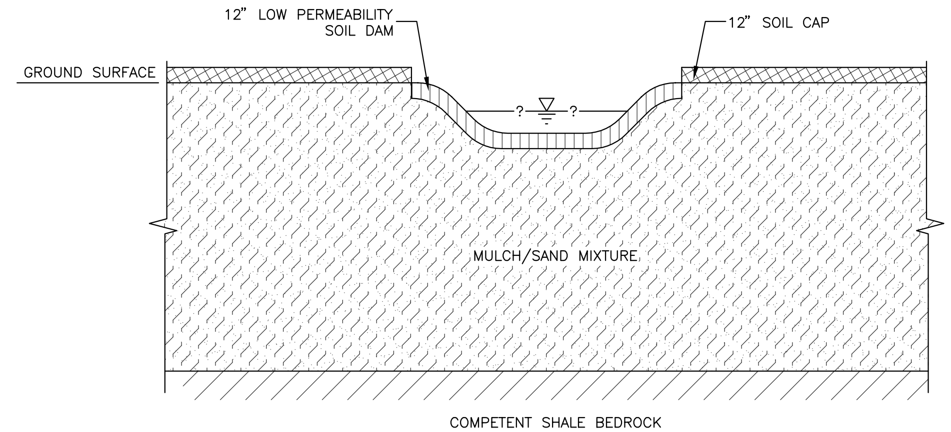


DETAIL A – BIOWALL INSTALLATION IN AREA OF DRAINAGE DITCH (1 / C–4)

N.T.S.

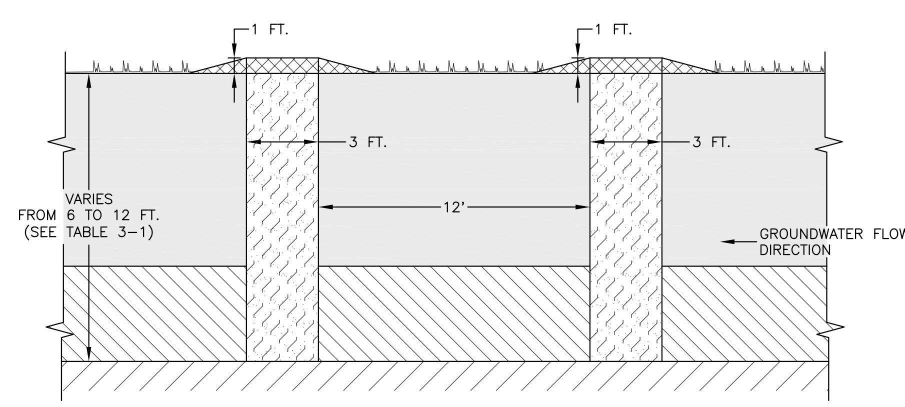
LEGEND:

- BACKFILL
- MULCH/SAND MIXTURE COATED WITH SOYBEAN OIL
- COMPETENT BEDROCK
- WEATHERED SHALE
- TILL
- LOW PERMEABILITY MATERIAL

Table 3-1
Dimensions of Proposed Biowalls
Ash Landfill Remedial Design
Seneca Army Depot Activity

Wall ID	Length (ft)	Width (ft)	Average Depth (based on RI data) [1] (ft)	Volume of Wall (Mulch Mixture) (cy)
A1	370	3	6.9	284
A2	370	3	6.9	284
B1 [2]	645	3	8.6	616
B2 [2]	645	3	8.6	616
C1	525	3	10.3	601
C2	525	3	10.3	601
TOTAL				3,002

Note:
1) Basis of depth is from the boring logs presented in Appendix C of the Remedial Investigation (RI).
2) Length excludes 30 foot pilot study portion of the wall length.



SECTION A – BIOWALL PAIRS

N.T.S.

PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT
ASH LANDFILL
REMEDIAL DESIGN

DEPT. ENVIRONMENTAL ENGINEERING	Dwg. No. 744538–01400

C–5
DETAILS

SCALE NA	DATE JUNE 2006	REV –

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SECTION 01010

SUMMARY OF WORK

PART I GENERAL

1.01 PROJECT DESCRIPTION

A. Work under this contract includes the excavation of the Debris Piles, backfilling the Incinerator Cooling Water Pond, installation of vegetative soil covers over the Ash Landfill and the Non-Combustible Fill Landfill (NCFL), installation of the six permeable reactive barriers (biowalls), and site restoration at the Ash Landfill Operable Unit at the Seneca Army Depot Activity in Romulus, New York.

1.02 PROJECT SCOPE OF WORK

A. The contractor shall furnish all labor, materials, equipment, and incidentals required and complete the work in its entirety as shown on the drawings and as specified herein.

B. The work required under this contract includes, but is not necessarily limited to, the following:

1. Project startup, including mobilization to the site;

2. Obtain all necessary permits;

3. Develop, implement and maintain a site-specific Health and Safety Plan;

4. Survey the Debris Piles, biowalls layout, and landfill areas;

5. Install temporary sediment and erosion protection measures;

6. Clear the site;

7. Excavate the Debris Piles, covering an area up to 0.2 acres ;

8. Load excavated materials and transport to off-site disposal facility;

9. Backfill the Incinerator Cooling Water Pond (approximately 0.05 acres);

10. Install 12-inch vegetative soil covers over the Ash Landfill and the NCFL (approximately 2.2 acres and 3.4 acres, respectively);

11. Install six mulch biowalls to treat the groundwater (totaling 3,280 linear feet);

12. Seed the soil covers over the landfills; and

13. Demobilize.

1.03 DEFINITIONS

A. For the purposes of these Technical Specifications, Drawings, and other contract documents, the following definitions apply:

1. Owner: The Army

2. Engineer: Owner’s Representative or Engineer (Parsons)

3. Contractor: The individual, firm partnership, or corporation designated as the Contractor in these contract documents

4. Vendor: The individual, firm, partnership, or corporation selected to supply certain major system equipment components

B. Term “provide” or “provided” shall mean “furnish, install in-place” and demonstrate to the satisfaction of the Engineer and in accordance with these plans and specifications.

C. The term “demonstrate” shall mean “to prove that the item of Work in question fulfills the requirements of the Drawings and Specifications to the satisfaction of the Engineer”.

1.04 CONTRACTORS USE OF PREMISES

A. The entrance to the site is through the main gate located on Route 96.

B. The Contractor shall notify the Engineer 7 days prior to the commencement of work.

END OF SECTION

SECTION 01011

ENGINEER'S DRAWINGS

PART 1 GENERAL

1.01 DIMENSIONS

A. If the Contractor discovers any discrepancies between the physical condition of the work and the drawings, he shall immediately notify the Engineer. Any work performed after such discovery without the agreement of the Engineer shall be at the Contractor's risk and expense.

1.02 CONTRACT DRAWINGS

A. The following Drawings are hereby included as part of the Contract Documents.

- Drawing C-1 Title Sheet
- Drawing C-2 Existing Conditions Plan
- Drawing C-3 Soil Remediation: Excavation and Grading Plan
- Drawing C-4 Groundwater Remediation: Biowalls Layout
- Drawing C-5 Details

END OF SECTION

SECTION 01039

COORDINATION AND MEETINGS

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section describes the coordination and meetings that the Contractor shall comply with for the duration of the project.

1.02 PRE-CONSTRUCTION MEETING

A. A pre-construction meeting will be held at the site after all required permit approvals are obtained and after the contract has been awarded to the Contractor. The Contractor shall attend this meeting.

B. The purpose of the pre-construction meeting is to review in detail the operating concepts and the existing site conditions that will guide the project. The meeting will define, assign, and schedule the required submissions, key tasks to be performed, and the reporting plan to be implemented. Prior to the meeting, the Contractor shall submit a construction schedule and personnel list. After the meeting, the Contractor shall submit a revised construction schedule and personnel list, as necessary. Additional items to be addressed include Health & Safety, Submittals, and Environmental Protection.

C. At a minimum, the Contractor's Superintendent, Quality Control Officer, and Safety personnel shall be in attendance.

1.03 WEEKLY CONSTRUCTION MEETING

A. The Engineer shall conduct progress meetings to review the progress of the work, schedule, and budget. The Contractor's attendance shall be mandatory.

B. The meetings will be documented by the Engineer and copies of the meeting minutes will be distribute to the Contractor.

C. Progress meetings shall be held at least once a week, at which time the weekly progress report will be reviewed.

1.04 WEEKLY PROGRESS REPORTS

A. The Contractor shall provide written weekly progress reports to the Engineer outlining the current status of the work, budget status, budget impacts, unexpected conditions, updated schedule, and any information pertinent to the progress of the work. The Engineer will keep Daily Field Reports and submit Weekly Field Reports to the Engineer.

1.05 COORDINATION

A. The Contractor shall fully cooperate with all other Contractors and Subcontractors and shall assist in incorporating the work of other trades where necessary or required.

B. The Contractor shall fully cooperate with the Engineer and shall assist obtaining all samples for quality assurance testing.

C. All on-site work shall be coordinated by the Contractor, with the approval of the Owner.

D. Contractor shall submit a list of all personnel to be used on the project to the Engineer for coordination. Security badges will not be provided to contractor personnel; however, the Contractor shall insure all employees have contractor issued identification while on the installation.

E. The annual deer harvest will occur within the depot limits on dates to be named in November and December 2006. No work will occur during the deer harvest. The harvest will not be conducted within the work area and should not affect the construction schedule. During the construction period at the end of each week, the contractor shall also notify the Engineer regarding what work is intended for the following week. The Engineer may stop work at any time when an imminent danger/serious safety violation is found.

F. Site, facility, and utility access shall be coordinated through the appropriate utility authority in the Town of Romulus.

G. All key Contractor personnel proposed for the project and accepted by the Owner shall not be removed or re-assigned from the Project without the approval of the Owner or the Engineer.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01046

CONTROL OF WORK

PART 1 GENERAL

1.01 MATERIALS

A. Furnish materials and equipment which will be efficient, appropriate, and large enough to secure a satisfactory quality of work and a rate of progress which will ensure the completion of the work within the time stipulated in the Contract. If at any time such materials appear to the Engineer to be inefficient, inappropriate, or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, he/she may order the Contractor to increase the efficiency, change the character, or increase the materials and equipment, and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his/her obligations to secure the quality of the work and rate of progress required.

1.02 PRIVATE LAND

A. Do not enter or occupy private land outside the property boundary or easements, except by written permission of the Owner and the Engineer.

1.03 OPEN EXCAVATIONS

A. Excavations shall conform to the requirements of the OSHA Standards and Interpretations, Subpart P – Excavation, Trenching and Shoring.

B. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights, and other means to prevent accidents to persons and damage to property. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer.

C. Take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles, which could be dangerous to the public, shall be marked.

1.04 MAINTENANCE OF TRAFFIC

A. All work shall be completed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, the Contractor shall repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the Owner.

B. Take precautions to prevent injury to the public due to open trenches.

1.05 CARE AND PROTECTION OF PROPERTY

A. Be responsible for the preservation of all public and private property and use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition similar or equal to that existing before the damage was done, or he shall make good the damage in other manner acceptable to the Owner.

B. The Contractor shall obtain an agreement with the Town of Romulus and the Owner and repair and restore the road to its original condition after construction.

1.06 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

A. Assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to building, utilities in the street, gas pipes, water pipes, fences, monitoring wells, hydrants, sewers, drains, and electric and telephone cables that are not specifically required to be demolished, removed, or disposed, whether or not they are shown on the Drawings. Carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operations shall be repaired by the Contractor at the Contractor's expense.

B. Assistance will be given to the Contractor by the Owner in determining the location of existing services.

C. Contractors shall contact Underground Facilities Protection Organization (UGFPO) at 1-800-962-7962 prior to any earthwork operations or excavation.

1.07 CLEANUP AND DISPOSAL OF EXCESS MATERIALS

A. During the course of the work, keep the site of operations in as clean and neat a condition as is possible. Trash generated by the Contractor as a result of work performed shall be picked up and placed in containers that are emptied on a regular schedule. On completion, all areas shall be clean and natural looking to the maximum extent possible. Signs of temporary construction and activities necessary for construction of the permanent work shall be removed.

B. All trash generated by the Contractor will be transported and disposed of in a manner that complies with federal, state, and local requirements by the Town of Romulus and the Owner. The Owner will maintain a copy of any state and/or local permits or licenses that reflect such agency's approval and compliance with applicable solid waste disposal regulations. The permits or licenses and the location of the disposal area shall be provided prior to transporting any waste material.

C. Fueling and lubricating of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spills and evaporation. Lubricants and waste oil shall be disposed of by the Contractor at his expense, in accordance with approved procedures meeting federal, state, and local regulations.

D. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, the Contractor and its subcontractors shall comply with all applicable Federal, State and local laws and regulations concerning waste material disposal as well as the specific requirements stated in this Section and elsewhere in the Specifications.

E. The Contractor is advised that the disposal of excess excavated material in wetlands, stream corridors, and plains is strictly prohibited even if the permission of the Owner is obtained. Any violation of this restriction by the Contractor or any person employed by the Contractor will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. Therefore, the Contractor will be required to remove the fill at his/her own expense and restore the area impacted.

1.08 RESTORATION

A. Restore all areas outside limit of work as shown on the Drawings, to conditions that existed prior to construction.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01100

HEALTH AND SAFETY REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Contractor is responsible for implementation and enforcement of safe work practices including, but not limited to, personnel exposure to waste and gases; use of shoring, materials handling, operation of equipment; and safety of public during progress of Work.

1.02 APPLICABLE REGULATIONS

A. Contractor shall plan for, and ensure that, all personnel comply with the basic provisions of OSHA Health and Safety Standards (29 CFR 1920) and General Construction Standards (29 CFR 1926), and any applicable local, state, and federal regulations related to worker health and safety. Workers directly involved in waste regrading or trenching operations shall meet applicable requirements of OSHA Hazardous Waste Operations and Emergency Response, Final Rule (29 CFR 1910).

1.03 OPERATIONS AND EQUIPMENT SAFETY

A. Contractor shall initiate, maintain, and supervise safety precautions and programs in connection with Work. Take necessary precautions for safety of employees on Project site and other persons that may be affected by Project.

B. Contractor’s duties and responsibilities for safety in connection with Work shall continue until such time as Work is complete and the Owner or the Engineer has issued notice to Contractor that Work is complete.

1.04 HEALTH AND SAFETY PLAN

A. Contractor shall implement and enforce health and safety requirements and shall take necessary precautions and provide protection for the following:

1. Personnel working on or visiting Project site, irrespective of employer.

2. Work and materials or equipment to be incorporated in Work area on or off site.

3. Other property at or adjacent to Project site.

4. Public exposed to job related operations or potential release of toxic or hazardous materials.

B. Contractor shall prepare a site-specific health and safety plan (HSP) in accordance with Parsons’ Safety, Health, and Risk Program (SHARP) Manual. Contractor is solely responsible for adequacy of HSP's preparation, monitoring, management, and enforcement. At a minimum, Contractor's HSP shall address the following:

1. Site description and history.

2. Project activities and coordination with other Contractors.

3. Hazard evaluation.

4. On-site safety responsibilities.

5. Work zones.

6. Personnel training.

7. Atmospheric monitoring (if required).

8. Personal protection, clothing, and equipment.

9. Emergency procedures.

C. The HSP shall be submitted in accordance with Section 01350 prior to the start of work for approval by the Engineer. Work shall not commence without the Engineer’s approval. Any delay in work due to lack of approved HSP shall be the responsibility of the Contractor.

D. The Contractor shall make arrangements for all emergency services. The Owner does not have these services available from its staff.

E. If the Engineer observes situations, which appear to have potential for immediate and serious injury to persons, the Engineer may warn persons who appear to be affected by such situations. Such warnings, if issued, shall be given based on general humanitarian concerns, and the Engineer will not, by issuance of any such warning, assume any responsibility to issue future warnings or any general responsibility for protection of persons affected by Work.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01110

ENVIRONMENTAL PROTECTION PROCEDURES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, and equipment to perform all work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this Section, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.

B. The control of environmental pollution requires consideration of air, water, and land, and involves management of noise and solid waste, as well as other pollutants.

C. Schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. Provide erosion control measures such as diversion channels, berms, staked hay bales, silt curtains, seeding or other special surface treatments as are required to prevent transport of silt. All erosion control measures shall be in place in an area prior to any construction activity in that area.

D. This Section is intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.

E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the applicable State and local laws and regulations.

1.02 APPLICABLE REGULATIONS

A. Comply with all applicable Federal, State and local laws and regulations concerning environmental pollution control and abatement.

1.03 NOTIFICATIONS

A. The Engineer will notify the Contractor in writing of any non-compliance with the foregoing provisions or of any environmentally objectional acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the Contractor in writing, through the Engineer, of any non-compliance with State or local requirements. After receipt of such notice from the Engineer or from the regulatory agency through the Engineer, immediately take corrective action. Such notice, when delivered to the Contractor or his authorized representative at the site of the work, shall be deemed sufficient for this purpose. If the Contractor fails or refuses to comply promptly, the Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.

1.04 IMPLEMENTATION

A. Prior to commencement of the work, meet with the Engineer to develop mutual understanding relative to compliance with these provisions and administration of the environmental pollution control program.

B. Remove temporary environmental control features, when approved by the Engineer, and incorporate permanent control features into the project at the earliest practicable time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EROSION CONTROL

A. Provide positive means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures, such as hay check dams and other equivalent techniques, shall be used as appropriate. Flow of surface water into work areas shall be prevented as much as is practical. Berms around construction area shall also be used to shed away water resulting from dewatering of excavated areas. At the completion of the work, ditches used for erosion control shall be backfilled and the ground surface restored to original condition.

3.02 PROTECTION OF STREAMS AND SURFACE WATERS

A. Take all precautions to prevent, or reduce to a minimum, any damage to any stream or surface water from pollution by debris, sediment, or other material, or from the manipulation of equipment and/or materials in or near such streams or surface water. Water that has been used for washing or processing, or that contains oils or sediments that will reduce the quality of the water in the stream or surface water shall not be directly returned to the stream or surface water. Divert such waters, through a settling basin or filter before being directed into streams or surface waters, as approved by the Engineer.

B. Take all preventative measures to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with State and Federal Regulation and as approved by the Engineer.

3.03 PROTECTION OF LAND RESOURCES

A. Restore land resources within the project boundaries and outside the limits of permanent work to a condition, after completion of construction, that will appear to be natural and not detract from the appearance of the project. Confine all construction activities to areas shown on the Drawings.

B. Outside of areas requiring earthwork for the construction of the new facilities, do not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer.

C. Before beginning operations near them, protect trees that may possibly be defaced, bruised, injured, or otherwise damaged by the construction equipment or other operations, by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly.

D. Any trees or other landscape features scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to their original condition. The Engineer will decide the method of restoration to be used and whether damaged trees shall be treated and healed or removed and disposed of.

1. All scars on trees caused by equipment, construction operations, or by the removal of limbs larger than 1-inch in diameter shall be coated as soon as possible with an approved tree wound dressing. Experienced workmen shall perform all trimming or pruning in an approved manner with saws or pruning shears. Tree trimming with axes will not be permitted.

2. Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer, shall be immediately removed or replaced.

E. The location of the Contractor's temporary storage and other construction buildings shall be cleared as shown on the Drawings and approved by the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Drawings showing storage facilities shall be submitted for approval of the Engineer.

F. If the Contractor proposes to construct temporary roads or embankments and excavations for plant and/or work areas, he shall submit the following for approval at least ten days prior to scheduled start of such temporary work.

1. A layout of all temporary roads, excavations, embankments, and drainage to be constructed within the work area.

2. Details of temporary road construction.

G. Remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess waste materials, or any other vestiges of construction as directed by the Engineer. It is anticipated that excavation, filling, and plowing of roadways will be required to restore the area to near natural conditions, which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and seeded as described in Section 02990, or as approved by the Engineer.

3.04 PROTECTION OF AIR QUALITY

A. Burning – The use of burning at the project site for the disposal of refuse and debris will not be permitted.

B. Dust Control

1. Maintain all excavations, embankment, stockpiles, access roads, plant sites, waste areas, borrow areas and all other work areas within or without the project boundaries free from dust which could cause the standards for air pollution to be exceeded and which would cause a hazard or nuisance to others, as approved by the Engineer.

2. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the Engineer.

3. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor shall have sufficient competent equipment on the job to accomplish this. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer.

3.05 NOISE AND ODOR CONTROL

A. Make every effort to minimize noises caused by the construction operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with Federal and State regulations.

B. Conduct work in a manner to minimize odors to residences in the vicinity of work. If odors become a problem, as determined by the Engineer, provide an odor control material or procedure acceptable to the Engineer.

3.06 LITTER CONTROL

Provide litter control to keep exposed waste from blowing off-site. Collect litter present on site and dispose. Maintain site free of litter generated by Contractor's employees.

3.07 USE OF CHEMICALS

A. Chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall be approved by USEPA, U.S. Department of Agriculture, or any other applicable regulatory agency.

B. Use and dispose of chemicals and residues in compliance with manufacturer's instructions and applicable regulations.

3.08 FUEL AND LUBRICANTS

A. Comply with local, state and federal regulations concerning transportation and storage of fuels and lubricants.

B. Fuel storage area and fuel equipment shall be approved by the Engineer prior to installation.

C. Report spills or leaks from fueling equipment or construction equipment to the Engineer and cleanup as required.

D. The Engineer may require Contractor to remove damaged or leaking equipment from Project site.

END OF SECTION

SECTION 01350

SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. This section specifies the general methods and requirements of submissions and distributions applicable to Shop Drawings, Product Data, and Samples. Detailed submittal requirements are specified in the technical sections.

B. All submittals shall be clearly identified by reference to specification section number, paragraph, Drawing number, or detail as applicable. Submittals shall be clear and legible and of sufficient size for presentation of data and information.

1.02 SUBMITTAL OF CONTRACTOR FURNISHED SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

A. Shop Drawings

1. Shop drawings, as specified in the individual Sections, include custom-prepared data, such as fabrication and erection/installation (working) drawings, schedule information, setting diagrams, actual shop work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual systems or equipment inspection and test reports, including performance curves and certifications, as applicable to the Work.

2. Within fifteen (15) calendar days after signing of Agreement, Contractor shall submit to the Owner four (4) sets of Shop Drawings to the Owner for review. The Shop Drawings shall be subject to approval by the Owner and the Engineer.

3. Where correct fabrication of the Work depends upon field measurements or confirmation, such measurements shall be made and noted on the Shop Drawings prior to being submitted.

4. All drawings submitted, including transparencies, shall be clear with sharply defined line work and legible printing to the satisfaction of the Owner. Failure to comply with this requirement will be cause for the rejection of the drawings without review.

5. All Shop Drawings submitted by Subcontractors shall be sent directly to the Contractor for review. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials. The Contractor shall review all Subcontractors' Shop Drawings regarding measurements, size of members, materials, and details to make sure that they conform to the intent of the Drawings and related Sections. The Contractor shall return Shop Drawings found to be inaccurate or otherwise in error to the Subcontractor for correction before submission thereof.

6. When Contractor utilizes computer-aided tools, such as CAD, to prepare the physical arrangement drawings, the Owner requires the submittal of drawings in electronic form in addition to the hard copy formats specified elsewhere herein. The Owner's sole use of this information will be to incorporate Equipment outlines in Contractor's general arrangements and other physical drawings.

7. All Shop Drawings of equipment shall bear the seal of certification of the Vendor and/or Manufacturer.

B. Product Data

1. Product data, as specified in the individual Sections, include standard prepared data for manufactured products (sometimes referred to as catalog data), such as manufacturer's product specification and installation instructions, availability of colors and patterns, manufacturer's printed statements of compliance and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instruction and recommended spare-parts listing and printed product warranties, as applicable to the work.

2. Within fifteen (15) calendar days after signing of Agreement, Contractor shall submit to the Owner three (3) sets of the proposed product list for review by the Engineer. The list shall be subject to approval by the Engineer.

3. Prior to submission, Contractor shall check all product data. Product data submission shall be accompanied by specific written indication that Contractor has reviewed the submission and has clearly identified the material, its supplier, and has included all pertinent data such as catalog numbers, and the use for which the sample or product data is intended.

C. Samples

1. Samples, as specified in the individual Sections, include physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols and units of work to be used by the Engineer for independent inspection and testing, as applicable to the work.

2. Within fifteen (15) calendar days after signing of Agreement, Contractor shall submit to the Owner one (1) set of samples, as required by the Drawings and Specifications for the Engineer's review.

3. On site and laboratory testing shall be performed as specified in the specifications. Test results shall be submitted to the Engineer for review within five (5) calendar days of receipt of results, but no later than 30 days after sample is collected for testing or as specified in the individual sections.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Review Shop Drawings, Product Data and Samples, including those by Subcontractors, prior to submission to determine and verify the following:

1. Field measurements
2. Field construction criteria
3. Catalog numbers and similar data
4. Conformance with related Sections

B. Each Shop Drawing, Sample, and Product Data submitted by the Contractor shall have affixed to it the following Certification Statement including the contractor's company name and signed by the Contractor. "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all contract requirements." Shop Drawings and Product Data sheets 11-inch x 17-inch and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The cover sheet shall fully describe the packaged data and include a listing of all items within the package.

C. Notify the Owner in writing, at the time of submittal, of any deviation in the submittals from the requirements of the Contract Documents.

D. The review and approval of Shop Drawings, Samples, or Product Data by the Engineer shall not relieve the Contractor from the responsibility for the fulfillment of the terms of the Contract. The Contractor and the Owner assume all risks of error and omission and the Engineer will therefore have no responsibility.

E. No portion of the work requiring a Shop Drawing, Sample, or Product Data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved Shop Drawings and Data shall be at the Contractor's risk. The Owner and Engineer will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

F. Project work, materials, fabrication, and installation shall conform with approved Shop Drawings, applicable Samples, and Product Data.

1.04 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule and in such sequence as to cause no delay in the Work or in the work of any other contractor.

B. Each submittal, appropriately coded, will be returned with 30 working days following receipt of submittal by the Owner.

C. Number of submittals required:

1. Shop Drawings: Four copies.

2. Product Data: Three copies.

3. Samples: Submit the number stated in the respective Sections.

D. Submittals shall contain:

1. The date of submission and the dates of any previous submissions.

2. The Project title and number.

3. Contractor identification.

4. The name of:

a. Contractor

b. Supplier

c. Manufacturer

5. Identification of the product, with the section number, page and paragraph(s).

6. Field dimensions, clearly identified as such.

7. Relation to adjacent or critical features of the work or materials.

8. Applicable standards, such as ASTM or Federal Standards numbers.

9. Identification of deviations from Contract Documents.

10. Identification of revisions on resubmittals.

11. A blank space suitably sized for Contractor and Engineer stamps.

12. Where calculations are required to be submitted by the Contractor, the calculations shall have been checked by a qualified individual other than the preparer. The submitted calculations shall clearly show the names of the preparer and of the checker.

1.05 REVIEW OF CONTRACTOR FURNISHED SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

A. The review of Shop Drawings, Product Data, and Samples will be for the general conformance with the design concept and Contract Documents. They shall not be construed as:

1. Permitting any departure from the Contract requirements;

2. Relieving the Contractor of responsibility for any errors, including details, dimensions, and materials; and

3. Approving departures from details furnished by the Engineer, except as otherwise provided herein.

B. Review of the Shop Drawings by the Owner and the Engineer shall be general only and shall not relieve Contractor in any way from his responsibility for proper detailing of the design furnished by the Engineer, satisfactory construction, compliance with the specifications and applicable codes, or for errors or omissions of any kind in the final installed work.

C. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing the work in a safe manner.

D. If the Shop Drawings, Product Data, or Samples as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of Owner and to be so minor as not to involve a change in Contract Price or Contract Time, the Engineer may return the reviewed drawings without noting an exception.

E. Two copies of the submittals will be returned to the Contractor under one of the following codes:

Code 1 – "APPROVED" is assigned when there are no notations or comments on submittal. When returned under this code the Contractor may immediately proceed with the Work or release the equipment and/or material for manufacture.

Code 2 – "APPROVED AS NOTED" is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may immediately proceed with the work or release the equipment and/or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 – "APPROVED AS NOTED/CONFIRM" is assigned when a confirmation of the notations and comments IS required by the Contractor. The Contractor may, at his own risk, proceed with the Work or release the equipment and/or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Owner within 15 calendar days of the date of the Owner transmittal requiring the confirmation.

Code 4 – "APPROVED AS NOTED/RESUBMIT" is assigned when notations and comments are extensive enough to resubmit the package. The Contractor may, at his own risk, proceed with the Work or release the equipment and/or material for manufacture; however, all notations and comments must be incorporated into the final product. This resubmittal is to address all comments, omissions, and non-conforming items that were noted. Resubmittal is to be received by the Owner within 15 calendar days of the date of the Owner's transmittal requiring the resubmittal.

Code 5 – "NOT APPROVED"- is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor shall not proceed with the work but shall resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Code 6 – "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal, which provide additional data to aid the Contractor.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

F. Resubmittals shall be made in the same manner, with the same number of copies, as the original submittal. On resubmittals the Contractor shall identify all revisions made to the submittals, either in writing on the letter of transmittal or on the Shop Drawings by use of revision triangles or other similar methods. The resubmittal shall clearly respond to each comment made by the Engineer and Owner on the previous submission. Additionally, the Contractor shall direct specific attention to any revisions made other than the corrections requested by the Engineer and the Owner on previous submissions. Where exceptions are taken to the marked revisions, the Contractor shall state his reasons for omitting and/or modifying the marked revisions in his transmittal letter.

G. Partial submittals may not be reviewed. The Owner through the Engineer will judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor and will be considered "Not Approved" until resubmitted. The Owner may at his option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.

H. Repetitive Review

1. Shop drawings and other submittals will be reviewed no more than twice at the Owner's expense. All subsequent reviews will be performed at times convenient to the Engineer and at the Contractor's expense, based on the Engineer's then prevailing rates. The contractor shall reimburse the Owner for all such fees invoiced to the Owner by the Engineer. Submittals are required until approved.

2. Any need for more than one resubmission, or any other delay in obtaining Engineer's review of submittals, will not entitle Contractor to extension of the contract Time.

I. If the Contractor considers any correction indicated on the Shop Drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof at least 7 working days prior to release for manufacture.

J. When the Shop Drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Owner or the Engineer.

K. Installation will not be considered complete under "terms of payment" of the general conditions of the Contract until all of the required Shop Drawings, Product Data, and Samples have been received and approved.

1.06 DOCUMENT DISTRIBUTION

A. All project documentation and correspondence shall be sent to the Owner.

1.07 CONSTRUCTION SCHEDULE

A. The Contractor shall submit a construction schedule within fifteen (15) calendar days after signing of Agreement. The schedule shall state the expected number of days needed to complete the entire project, and each individual project task.

B. The Contractor shall submit revised schedules as substantial variations are identified and required by the Owner.

C. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the start and finish dates and duration. Presentation shall be neat and accurate utilizing MS Project© or comparable project tracking software package.

D. The Contractor shall check with the Owner regarding the Owner-furnished equipment delivery dates, progress of construction by Others and to schedule the arrival of his materials, equipment and labor at the site so as to properly coordinate his and the work by Others. There will be no extra compensation for extra work, which the Contractor must perform due to his failure to coordinate his work and the work of others.

1.08 PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

A. If specifically required in other Sections, submit a P.E. Certification for each item required.

1.09 PROPOSED SUBCONTRACTOR LIST

A. The Contractor shall submit a complete list of Subcontractors, with name, address, and experience within fifteen (15) calendar days after signing of Agreement.

B. No work on the Contract shall commence until the Owner in writing has approved all the proposed Subcontractors.

C. If the Contractor plans to use a subcontractor that is not on the original subcontractor list submitted with their cost estimate, the Contractor may propose in writing an alternative Subcontractor or additional Subcontractors for the Owner or Engineer's approval.

D. No work on the Contract shall commence until the Owner in writing has approved all the proposed Subcontractors.

1.10 AS-BUILT DRAWINGS

A. The Contractor shall furnish drawings with all technical information (including Product Data, Vendor's instructions, and certificates) and all field modifications clearly indicate to the Owner. All information necessary for the generation of as-built drawings shall be provided by the Contractor within fifteen (15) calendar days of substantial completion of construction.

1.11 HEALTH AND SAFETY PLAN

A. The Contractor shall prepare a construction Health and Safety Plan and submit the plan to the Owner and Engineer for review and comments at least 14 days prior to the start of work. The Contractor shall address the Owner and Engineer's comments and resubmit the plan, as necessary. The Contractor shall complete the plan in accordance with the site-specific Health and Safety Plan, OSHA, NYSDEC, county, and local government requirements.

B. No work shall commence at the site until the plan has been approved and is in place.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.01 QUALITY CONTROL OF INSTALLATION

The Contractor shall:

A. Monitor quality control over products, services, site conditions, and workmanship to produce work of specified quality.

B. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

C. Perform work by persons qualified to produce workmanship of specified quality.

D. During freezing or inclement weather, or other adverse conditions, no work shall be performed except that which can be performed in a manner, which will ensure first class construction throughout.

1.02 WORKMANSHIP

A. The intent of these Technical Specifications is to describe definitely and fully the character of materials and workmanship required with regard to all ordinary features, and to require first-class work and material in all particulars.

B. For any unexpected features arising during the progress of the work and not fully covered herein, the specifications shall be interpreted by the Owner to require first-class work and materials; and such interpretation shall be accepted by the Contractor.

C. All labor shall be performed in the best and most workmanlike manner by mechanics skilled in their respective trades. The standards of the work required throughout shall be of such grade as will bring only first-class results.

1.03 SUBSTANDARD WORK

A. The Contractor guarantees for a period of at least one year from the date of substantial completion of the Work that the completed Work is free from all defects due to faulty materials, equipment, or workmanship and that he shall promptly make whatever adjustments or corrections which may be necessary by such defects, including repairs of any damage to other parts of the system resulting from such defects. In the event that the Contractor fails to make adjustments, repairs, corrections or other work made necessary by such defects, the Owner may do so and charge the Contractor the cost incurred.

1.04 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to current reference standards by contract documents date of issue, except where specified date is established by Code.

C. Obtain copies of standards when required by contract documents.

D. Should specified reference standards conflict with contract documents, request clarification from the Owner before proceeding.

E. The contractual relationship of the parties to the Contract shall not be altered from the contract documents by mention or inference otherwise in any reference document.

1.05 FIELD INSPECTION OF CONTRACTOR'S WORK

A. The Engineer will provide daily inspection of the Contractor's work, which will ensure that the work is being performed in accordance with the Drawings and specifications such that the end product will be in conformance with the Drawings and specifications.

B. The Contractor and its subcontractors are responsible for complete conformance to the Drawings and specifications for all work performed on the project.

C. The Contractor will provide ample opportunity for safe and easy access to the inspectors for proper inspection of the work.

D. The Contractor will inform the Engineer in advance of periods when the Contractor does not intend to work due to, but not limited to, inability to obtain materials or equipment or expected inclement weather. If ample warning is not given to the Engineer and unnecessary trips are made to the field, funds will be deducted from monies due to the Contractor to reimburse the Engineer for his/her time.

1.06 ON SITE AND LABORATORY TESTING

A. The Engineer shall be responsible for collecting samples and conducting tests related to identification of borrow source materials in order to meet the specifications.

1.07 VENDOR'S FIELD SERVICES AND REPORTS

A. When stated in individual specification sections, the Contractor is responsible for coordinating required material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces, conditions of installation, quality of workmanship, testing, as applicable, and to initiate instructions when necessary.

B. Contractor shall report to the Owner observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to Vendor's written instructions.

C. Submit report under provisions of Section 01350 (Submittals) within 30 calendar days of observation to the Owner for review.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 TEMPORARY CONSTRUCTION FACILITIES

A. The Contractor shall provide and pay for the provisions of a temporary construction office (trailer) to be used by on-site Contractor personnel only,

B. The location of the Contractor's office (trailer) may be setup up within the limit of the Ash Landfill Operable Unit at the Contractor's discretion.

C. Contractor shall park their vehicles in locations as directed by the Owner.

1.02 TELEPHONE

A. The Contractor will make arrangements with the local telephone company to provide and maintain telephone and facsimile service for the duration of the Work, if needed.

1.03 SANITARY FACILITIES

A. The Contractor shall provide and pay for temporary toilet facilities for the office personnel in addition to facilities for field personnel conforming to state and local health and sanitation regulations in sufficient number for use of the Contractor's, Owner's, Engineer's and subcontractor's personnel.

B. The Contractor shall maintain the facilities daily in clean and sanitary conditions.

1.04 WATER

A. Contractor shall provide all water necessary to complete the work, including drinking water for the Engineer and Owner.

1.05 TEMPORARY ELECTRICAL POWER AND LIGHTING

A. The Contractor shall provide all temporary electricity and lighting, including poles, transformers, and meters. All temporary distribution materials and installation shall conform to the requirements of the National Electrical Code and any applicable local codes.

B. Provide and maintain lamps, wiring, switches, sockets, and similar equipment required for temporary lighting and power tools.

C. Temporary lighting shall be sufficient to enable Contractor to complete Work and enable Owner or the Engineer to observe work as it is being performed. Illumination shall meet or exceed state code requirements.

D. Contractor shall provide and pay for electrical energy required for temporary heating and cooling of the temporary construction offices.

1.06 CONSTRUCTION SIGNS

A. The Engineer shall provide signs at the office indicating the Contractor's and Engineer's name.

B. The Engineer shall provide directional signs to direct traffic into and within the site. The signs shall be relocated as Work progresses.

C. The Engineer shall design the signs and sign posts to withstand 60 mile per hour wind velocity.

D. The Engineer shall maintain the signs and signposts and repair as necessary. The Contractor shall remove signs and supports at completion of the Project and restore the area.

E. The number, size, and text of construction signs displayed at the jobsite shall be subject to review, prior to installation, by the Owner.

F. Owner furnished signs may be provided at the Owner's discretion at no cost to the Contractor. The Engineer is responsible for maintaining the sign at the site.

1.07 SECURITY

A. The Contractor shall assume sole responsibility for security at the site for the entire duration of the Work. The Owner will not provide site security.

B. The Contractor shall take at all times such usual and ordinary precautions as may be required to protect all materials, equipment and completed work that are susceptible to damage by sabotage or vandalism and that would cause loss of life or property, or would endanger the work of this or other contracts in connection with this project, or which would effect a substantial delay in the completion of the work of this or other contracts.

C. The Contractor shall make provisions to exclude all unauthorized persons from the vicinity of his construction operations.

1.08 SNOW REMOVAL

A. The Owner shall provide snow removal to gain access to the sites.

B. The Contractor shall be required to remove snow from the work area, should it be necessary. In the event of a major snowfall, the Contractor shall coordinate with the Owner for timely access as may be needed.

1.09 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. The Contractor shall remove temporary utilities, equipment, facilities, and materials prior to demobilization from the site.

B. The Contractor shall clean and repair damage caused by installation or use of temporary work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02100

CLEARING

PART 1 GENERAL

1.01 DESCRIPTION

A. Remove shrubs, brush, trees, and other objectionable materials within the Debris Piles, the Incinerator Cooling Water Pond, the Ash Landfill, and the NCFL, as shown on the Drawings. Chip the above-grade portions of trees and brush for erosion control measures and spread on-site. Leave stumps and grindings in place.

B. Work Included in this Section. Principal items are:

1. Protection and preservation of trees and vegetation outside the clearing limits.

2. Cutting of above-grade timber, if any.

C. Related Work Specified in Other Sections.

1. Section 02219 - Contaminated Soil Excavation and Disposal

2. Section 02370 - Erosion Control

1.02 CODE REQUIREMENTS AND ENVIRONMENTAL SAFEGUARDS

Accomplish disposal of material removed from site in accordance with applicable Federal, State, and local regulations. Comply with regulations to prevent pollution of air and water.

1.03 SITE INVESTIGATIONS

Carefully examine the site to determine the full extent, nature, and location of work required to conform with the Drawings and Specifications. Bring any inaccuracies or discrepancies between the Drawings and Specifications to the Engineer’s attention in order to clarify the exact nature of the Work to be performed.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 CLEARING.

A Remove all vegetation, brush, shrubs, logs, and boulders within the Project area. Backfill holes outside of planned work areas resulting from the removal of underground structures and roots that extend below finished grade with unclassified fill or backfill.

B. Immediately restore or replace any damaged items.

C Above-Grade Material: Cut above-grade timber within 12 inches of grade. Grind timber into smaller pieces to be used as an organic enhancement in the 12-inch vegetative soil cover being installed over the Ash Landfill and the NCFL.

D. Below-Grade Material: Below grade material will remain in place.

E. Do not burn any materials on-site.

3.02 TOPSOIL REMOVAL

None required. Topsoil within the limits of the Debris Piles will be removed with the debris and loaded directly onto a truck for off-site disposal. Reuse of site topsoil for site grading or backfilling is not permitted. A 12-inch vegetative soil cover will be installed over the Ash Landfill and the NCFL; therefore, topsoil within the limits of the landfill will stay in place.

3.03 GUARANTEE

Guarantee that Work performed under this Section will not permanently damage trees, shrubs, turf, or plants designated to remain, or other adjacent work or facilities. If damage resulting from operations appears during a period up to 12 months after completion of the project, replace damaged items.

END OF SECTION 02100

SECTION 02140

CONSTRUCTION WATER MANAGEMENT

PART 1 GENERAL

1.1 WORK INCLUDED

A. Handling, storage, treatment (if necessary), and disposal of all construction water and associated residual sediments generated during construction in accordance with all applicable local, State, and Federal regulations.

B. The Contractor is to obtain (if necessary) and operate within all required local, State, and Federal permits and requirements required to implement the proposed construction water management plan. Any and all civil, criminal, and monetary penalties associated with non-compliance in any regard shall be the responsibility of the Contractor.

C. Provide materials and equipment required for handling, storage, treatment, and disposal of construction water in accordance with the Engineer-approved construction water management procedures.

D. The Engineer will perform all specified and necessary sampling and analyses to insure compliance with required permits and applicable laws and regulations.

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 02219 – Contaminated Materials Excavation and Disposal

C. Section 02370 – Erosion Control

1.3 APPLICABLE CODES, STANDARDS, AND SPECIFICATIONS

A. The Contractor shall comply with applicable federal, state, and local applicable codes, ordinances, regulations, statues and standards.

1.4 DEFINITIONS

A. Construction water: Construction water shall be defined as the following:

1. Groundwater or surface water entering excavations or trenches.

2. Liquids generated during decontamination activities.

3. Surface water resulting from precipitation during construction which has come in contact with potentially contaminated soils, sediment, fill, or debris, except from potentially contaminated soil, sediment, fill, or debris which is in place and undisturbed.

4. Water or other liquids, which have come into contact with potentially exposed contaminated soils, sediment, or debris, in addition to that resulting from precipitation.

B. Construction Water does not include water contacting non-disturbed excavation areas. This water shall be diverted from the excavation area as required to minimize the potential for contact with the construction operations.

PART 2 PRODUCTS

2.1 GENERAL

A. Construction Water Management Procedures

1. The acceptable methods of handling construction water are limited to collection and:

   a. Discharge to Seneca County Sewer District No. 2 via on-site sanitary sewer, after analytical testing results are reviewed and approved by Engineer.

2. The acceptable methods of handling sediment generated by the Contractor's management of construction water are limited to:

   a. Collection, dewatering, and disposal off-site with excavated soil.

3. Appropriate treatment prior to discharging to the sewer shall result in effluent that is non-hazardous according to 6 NYCRR Part 371.

B. Facilities

1. The Contractor shall provide methods, means, and facilities required to manage construction water and residuals generated during construction water management.

C. Equipment

1. The Contractor shall provide equipment and personnel to manage construction water.

PART 3 EXECUTION

3.1 GENERAL

A. Contractor shall be responsible for estimating the quantity and quality of construction water expected for this project based on the existing site conditions.

B. It shall be the responsibility of the Contractor to investigate and comply with all applicable Federal, State, and local laws and regulations governing the handling, storage and disposal of construction water. All construction water shall be disposed of in a manner which meets applicable permit requirements, laws, and regulations.

C. The Contractor shall obtain all required permits, manifests, and approvals required for the handling, storage, transport, treatment, and disposal of construction water and residuals generated during construction water management.

D. Any sampling and analyses necessary to protect the health and welfare of the Contractor's employees and/or agents and/or to characterize collected water, treated water, or residuals shall remain the sole responsibility of the Contractor.

E. Construction water shall be handled using equipment compatible with anticipated contaminants which may be present.

3.2 DISCHARGE TO ON-SITE SEWER

A. No construction water shall be discharged to sewer unless it meets applicable effluent limits (Class GA Standards).

B. On-site treatment facilities will include provisions for "batch" treatment. Treated waters shall be tested (on a per batch basis) to demonstrate compliance with the effluent limits prior to on-site discharge.

C. Testing required for on-site discharge shall be the responsibility of the Engineer.

3.3 OFF-SITE DISPOSAL OF WASTES

A. Contractor shall characterize construction water related wastes and any settled solids or other residuals as necessary for off-site disposal.

B. Contractor shall dispose of water related wastes with excavated soil in designated off-site facility.

C. Contractor shall dispose of wastes designated for off-site disposal within 90 days of filling the container.

D. Contractor shall mark, label, placard, package, and manifest wastes in accordance with applicable codes, regulations, and statues.

3.4 MINIMIZATION OF CONSTRUCTION WATER

A. The Contractor shall make every effort to minimize the generation of construction water and associated sediment and sludges. Methods to minimize generation of construction water include, but are not limited to:

1. Erection of temporary berms using existing soil located at least 25 feet outside of the planned excavation areas or using clean approved borrow soil.

2. Use of low permeability tarpaulin or suitable means to cover exposed contaminated areas and materials.

3 Limiting the amount of exposed contaminated areas.

4. Grading to control run-on and run-off.

END OF SECTION

SECTION 02219

CONTAMINATED MATERIALS EXCAVATION AND DISPOSAL

PART 1 GENERAL

1.01 DESCRIPTION

A. The work specified in this section consists of the labor, equipment, tools, materials, and services needed to perform the excavation and disposal of contaminated materials (i.e., soils and debris) in the Debris Piles as described herein, shown on the Contract Drawings, or directed by the Engineer

B. Related Sections:

1. Section 02100 – Clearing

2. Section 02140 – Construction Water Management

3. Section 02370 – Erosion Control

1.02 SUBMITTALS

A. Name, location, and a copy of the operating permit for off-site disposal facilities to be utilized. Statement of acceptability from disposal facilities for each material to be received.

B. Procedures, materials, and equipment to be used for the excavation, transportation, and disposal of contaminated materials. Include a spill contingency plan as part of this submittal. Do not begin soil excavation work until the Engineer has approved this submittal.

1.03 REFERENCES

None.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum. Review subsurface investigation reports and other available site information.

B. Protect plants, lawns, and other features that have been designated on the Contract Drawings to remain.

C. Protect control points, bench marks, existing structures, features, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic. Repair or replace damaged items.

D. Prior to the start of construction, notify the appropriate organizations, and have staked or marked underground utilities. Contractors shall contact Underground Facilities Protection Organization (UGFPO) at 1-800-962-7962 prior to any earthwork operations or excavation. Utilities include, but are not limited to water, gas, electric, telephone, cable, storm sewer, sanitary sewers, laterals, and services. If utility locations indicate a possible interference, or points of connection to existing facilities need to be identified, perform exploratory excavations to determine the utilities' location and elevation. Provide the utility owner with results from exploratory excavations for review. Allow the Engineer sufficient time to review exploratory excavation results and evaluate if changes are required to the design prior to start of construction.

E. Maintain existing manholes, catch basins, and other utility structures above and below grade in their pre-work condition. Promptly remove any material or debris entering same due to the operation.

F. Establish exclusion zones for work areas in accordance with the HSP.

G. Engineer will survey and stake the corners of the Debris Piles according to the Contract Drawings or the Engineer.

3.02 EXCAVATION

A. Protect adjacent structures that may be damaged by excavation work, including but not limited to utilities, monitoring wells, and pipe chases. Repair or replace any structure damaged as a result of operations.

B. Excavate until debris is visibly removed, based on the determination of the engineer. Refer to the Contract Drawings as a reference. Do not over-excavate any area without prior approval from the Engineer. Stop excavating if bedrock is encountered.

C. Excavations shall not interfere with the normal 45-degree bearing splay of foundations. Do not undercut excavation faces.

D. Remove lumped subsoil, boulders, and rock under 1 cubic yard in size.

F. Notify the Engineer of unexpected subsurface conditions, or of questionable soils encountered at required subgrade elevations, and discontinue work in the area until notified to resume work.

G. Place excavated material directly in dump truck for off-site disposal, or as designated by the Engineer.

H. Perform excavation in a manner that prevents migration of contaminants to clean areas. Remove and dispose of contamination that spreads beyond the existing contamination limits in accordance with this section.

I. Grade the excavation perimeter to provide continuous drainage and prevent ponding. Direct surface water away from excavation areas. Remove and handle surface water and groundwater seepage that collect in disturbed excavation areas known to contain contaminated material in accordance with Section 02140.

J. Transport excavated materials in accordance with Federal, State and Local requirements and in a manner that prevents spills and the spread of contamination. No free liquids will be allowed. All materials should be drained prior to loading into trucks. All trucks will be covered.

K. Do not exceed legal load limits for truck weight.

L. Stop work immediately and notify the Engineer if hazardous materials (i.e., drums, etc.) are encountered during excavation. Do not proceed with removal of hazardous materials without prior approval from the Engineer unless an emergency situation requiring immediate action exists.

M. Decontaminate equipment used for excavation of contaminated materials prior to reuse on clean material. Decontaminate equipment between distinct areas of excavation if directed by the Engineer.

3.03 PROTECTION OF EXCAVATIONS

A. Prevent cave-ins or loose soil from falling into excavation.

B. Properly and legally maintain excavations while they are open and exposed. Install and maintain sufficient and suitable barricades, warning lights, flood lights, signs, etc., to protect life and property until the excavation has been graded to a safe and satisfactory condition.

C. Make excavations in accordance with the Contractor's HSP.

3.04 DISPOSAL

A. A permitted off-site disposal facility for excavated materials will be selected by the earthwork Contractor, which anticipates using either Ontario County Landfill in Flint, New York or Seneca Meadows Landfill in Waterloo, New York, or equivalent.

END OF SECTION

SECTION 02221

BIOWALL EXCAVATION AND BACKFILLING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish all materials, labor and equipment and perform all operations required for excavating, dewatering, trenching, filling, backfilling, and grading as indicated on the Drawings, as specified herein, and as evidently required to complete the work.

B. Related work specified in other sections:
   1. Section 02223 - Backfilling

1.02 CODES AND STANDARDS

A. Current editions or revisions of the following standards as of the effective date of the Contract shall govern, unless specifically noted otherwise herein or on the Drawings.

   1. Occupational Safety and Health Administration (OSHA) Construction Standards for Excavations, 29 CFR Part 1926, Subpart P.

   2. United States EPA, Test Methods for Solid Waste (USEPA SW846).

      a. Target Compound List (TCL)
         1. Volatile Organic Compounds (VOCs) - Method 8260

1.03 SUBMITTALS

A. Submit the following items to the Contractor no less than 14 days prior to construction unless otherwise specified:

   1. Chemical and geotechnical test results for representative sample of fill materials. See Article 2.01 B, C, and G.

   2. Samples of fill materials. See Article 2.01 E.

1.04 PROJECT CONDITIONS

A. No work shall commence until all required permits have been obtained.

B. Perform work in accordance with all city, state and federal regulations, codes, standards, and permits. Comply with all safety ordinances applicable at the site, including current OSHA regulations.

C. Dust and Dirt Control - Perform the work so as to prevent the nuisance of dust in surrounding areas. Maintain haul routes, and use water, approved chemicals, or other materials to keep dust down. Furnish all materials and equipment required to control dust.

Clean all parking lot paving, walks, and roads on and off site that become dirty or littered due to the excavation and filling work.

D. Erosion Control - Take all necessary precautions to minimize soil erosion and perform any required work to prevent silting of adjacent drainage facilities or properties. Conform to all local, state, and federal erosion control laws and regulations.

E. Hazardous Materials - Hazardous materials or contaminated soils may be present at low concentrations at the site. Take precautions to prevent inhalation of dust during dry conditions, including dust suppression and use of dust masks. Notify the Contractor immediately if suspected hazardous materials or contaminated soils are encountered during the excavation work. Do not under any circumstances remove any suspected hazardous material or contaminated soil from the site without written authorization from the Contractor.

F. Excavation Near Existing Utilities

1. A six-inch water main which runs through the proposed location for the biowalls identified on Drawing C-4. It will be the responsibility of the Contractor to confirm presence of this water main and accurately locate it. Contractor shall excavate around the portion of the water main which intersects the trench, and backfill around the water main, supporting it as necessary. If it is necessary to cut the water main, the Subcontractor will cut the pipe without damage to the pipe in place and will reconnect the pipe once the work has been completed. The line shall be drained prior to excavation work in the area to prevent any flooding in the area should the line break. The water line is suspected to be 42 to 48 inches below ground surface.

2. The six-inch water main described above is the only known utility within the work area, but the completeness or accuracy of this information is not guaranteed. In advance of normal machine excavation, location of active services shall be investigated and the expected location marked. It shall be the responsibility of the Subcontractor to contact the appropriate utility company and UGFPO at least 72 hours in advance of any excavation to have utility locations marked out. As the excavation approaches these services and other expected pipes, conduits or other underground structures, digging by machinery shall be discontinued and the excavation shall be done by means of hand tools. In no case shall machine excavation be utilized in the vicinity of piping containing combustible or hazardous fluids or gases; hand digging only shall be employed.

3. Notify the Contractor immediately if unforeseen interference with existing underground piping or structure is encountered.

4. All water, gas, or other pipes, mains, services, conduits or fixtures which may be uncovered or interfered with during any excavations made in connection with this Contract shall be properly supported and maintained in position, unless otherwise indicated by the Contractor. Any such lines must also be supported during construction of the continuous reactive trench. Backfill shall be installed around foreign utilities in such a manner as to maintain support and prevent settlement. The reinforced concrete pipe shown on the Drawings may be removed or partially removed during the work and does not need to be repaired or replaced.

5. No alterations or interferences shall be made with any existing underground utilities except at the direction of the Contractor. Permission for any such alterations will be obtained by the Contractor. Cost of any such alterations to existing utilities will be paid for by the Owner in accordance with the terms and conditions of the Contract.

G. Employ all possible methods necessary to minimize noise caused by construction equipment. Such methods shall conform to local noise abatement ordinances.

PART 2 PRODUCTS

2.01 MATERIALS

A. Common Fill Requirements

Common fill shall not contain frozen soil, snow, ice, roots, sticks, timber, trash, cinders, topsoil (except for topsoil fill specified), organic materials, or other objectionable materials which may be compressible or which prevent satisfactory compaction.

B. Sand Fill for Mixing with Mulch for Biowall

1. Poorly graded, coarse or medium-grained sand, free from calcareous grains or material must be obtained from the borrow source. The backfill mixture will be approximately 50 percent mulch and 50 percent coarse sand by volume. The ratio of mulch to sand is intended to maximize the amount of organic material, while still maintaining a permeability within the biowall that is greater than the surrounding formation. Because sand fills much of the void space in the mulch, a mixing factor of 1.4 is used to determine the volume of mulch. It will take approximately 2,000 cy of sand and 2,800 cy of mulch for 3,280 LF of biowalls.

C. Mulch

1. The mulch backfill in the Ash Landfill biowalls will be a mixture of shredded plant material generated during seasonal landscaping/farming operations (i.e., tree/brush removal, silage).

2. The mulch will be stockpiled and allowed to partially compost for a minimum period of 1 week prior to installation of the biowall.

3. A minimum of 2,800 cy of mulch will be required for 3,280 LF of biowalls.

D. Vegetable Oil

1. Food-grade vegetable oil (e.g., soybean oil) will be delivered to the site in either 55-gallon drums or as 220-gallon ‘totes’. A total of 9,700 gallons of oil will be required to occupy 3 percent of the pore space volume of the 4,000 cy of sand/mulch mixture.

E. Trench Excavation Equipment

Equipment used for the installation of the biowall shall be a backhoe with a 3-foot wide bucket. Equipment shall be capable of excavating a nominal 3 foot-wide trench, performed below the water table in generally unconsolidated materials. Installation with this type of equipment can typically be performed without dewatering. Therefore, dewatering is not anticipated to occur during construction of the permeable treatment wall. The equipment shall be able to reach at least 1 foot deeper than the maximum depth anticipated, 15 feet.

PART 3 EXECUTION

3.01 EXCAVATION

A. General

A trench will be excavated down to competent bedrock, which is anticipated to be no greater than 15 feet. A trench box will be used to maintain the stability of the trench until it is backfilled.

B. Classification. - All material is anticipated to be common excavation, which is defined as material removable by means of mechanical excavation equipment or by pick and shovel.

C. Unexpected Conditions. - Notify the Contractor immediately of unexpected subsurface conditions, and discontinue work in that area until notified by the Contractor to resume work.

D. When excavating under, around or adjacent to underground services, protect the services against exposure and damage by the excavating equipment. Support all exposed services as required.

E. Excavated Material - The material shall be excavated and stockpiled on the side of the excavated trench in a windrow parallel to the biowall. Samples of the excavated material from the trench will be collected and analyzed as described in Section 3.06 below. If soil results indicate that the soil is suitable for use as on-site fill, this soil will be consolidated and transported to the Ash Cooling Pond. A berm (of hay bales or other suitable material) shall be constructed to provide erosion control. The stockpile shall be covered with a tarp and the cover shall be secured.

3.02 FILLING AND BACKFILLING

A. General Requirements

1. Place and compact designated fill and backfill materials in the manner and to the limits specified herein and on the Drawings.

2. Do not place fill or backfill material on surfaces that are below water, muddy, or frozen.

3. Do not leave debris, wood, or other foreign matter in the spaces to be backfilled.

4. Slowly and carefully place fill and backfill in uniform horizontal lifts of the specified thickness.

B. Mixing sand and mulch for biowall fill

1. The mulch will be coated with food-grade vegetable oil prior to mixing with sand and emplacement in the trench. In the event that it is technically difficult or infeasible to sufficiently mix the oil-coated mulch with sand, the mulch will be mixed with the sand prior to application of vegetable oil to the backfill.

2. To achieve a 50:50 ratio of mulch to sand by volume, 2,800 cy of mulch and 2,000 cy of sand will be mixed using a dozer to create approximately 4,000 cy of the mixture for 3,280 LF of biowalls.

3. The target volumetric mulch mixture ratio is 50 percent organic material and 50 percent sand, with an allowable variation of ± 10 percent. Weight percentage will be used as a secondary criterion for evaluating mulch mixture homogeneity, with densities of individual mulch mixture components measured in the field as wet density. The mulch mixture QC will be performed by collecting approximately five liters sample of the mixture and passing it through a number 6 mesh sieve (0.132 inch opening). Material passing the number 6 mesh sieve is anticipated to be mostly sand, with some fine-grained organics from the mulch material. Material retained on the number 6 mesh sieve is anticipated to primarily be organic material. The volume and weight measurements for percent passing and percent retained on the number 6 mesh sieve will be recorded in the field. If either the volumetric or weight percentage of all samples is within the tolerances described above, the mulch mixture will be accepted as sufficiently mixed for placement as the backfill material. In the event that neither the volumetric or weight percentage of one or more samples is within the acceptable range of values, the mulch mixture will be mixed again to determine if insufficient mixing is the cause of this discrepancy. In the event that continued mixing does not result in the achievement of an acceptable mixture composition, addition of the material which is lean in the mixture will be performed to achieve an acceptable mixture ratio for the backfill material.

4. The mulch/sand mixture will be backfilled into the trenches to ground surface as continuously as possible. Efforts will be made to minimize the length of time the trench is open.

5. No compaction is required for the sand/mulch mixture.

C. Topsoil

1. Twelve inches of fill will be placed over the entire length of each biowall as a cover. Trench spoils may be used as the source of the cover material if approved by the Engineer based on testing results.

3.06 TESTING

A. Testing of Backfill Materials – One sample of each source of sand used in the backfill mixture will be submitted to a laboratory for analysis of iron, phosphorus, and potassium using USEPA SW846 Method 6010B.

B. VOC Analyses – Approximately one sample of trench spoils per 150 LF of biowall excavated between the 100 ppb plume contour lines (Drawing C-4) shall be collected and submitted to a laboratory for analysis of trichloroethene using USEPA SW846 Method 8260B. This sampling frequency will result in approximately 16 samples.

3.07 DISPOSAL OF EXCESS MATERIAL

A. Excavated soil in excess of fill shall be disposed of on the Owner's property at locations as directed by the Contractor. The material shall be spread and graded as directed.

3.8 CLEANUP

A. Remove all trash and debris resulting from the excavation and filling work from the site.

END OF SECTION

SECTION 02223

BACKFILLING

PART 1 GENERAL

1.01 DESCRIPTION

The work specified in this section consists of the labor, equipment, tools, materials, and services needed to perform backfilling as described herein or shown on the Contract Drawings.

A. Work included in this section:

1. Analytical/geotechnical testing of imported backfill materials prior to placement and compaction.

2. Site filling and backfilling.

3. Classification of materials.

B. Related sections:

1. Section 02219 – Contaminated Materials Excavation and Disposal

3. Section 02228 - Compaction

4. Section 02990 – Finish Grading and Seeding

1.02 SUBMITTALS

A. Required initial chemical results for each material proposed, The name and owner of the borrow source provided to the engineer 14 days prior to construction. Materials must be approved by the Engineer prior to use.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D2487 - Test Method for Classification of Soil for Engineering Purposes.

B. Environmental Protection Agency (EPA) Test Methods for Evaluating Solid Waste (SW)

1. EPA SW846 Method 8260B – Volatile Organic Compounds (VOCs) by Gas Chromatography/Mass Spectrometry (GC/MS).

2. EPA SW846 Method 8270C – Semivolatile Organic Compounds (SVOCs) by Gas Chromatography/Mass Spectrometry (GC/MS).

3. EPA SW846 Method 6010B – Metals by Inductively Coupled Plasma-Atomic Emission Spectrometry.

4. EPA SW846 Method 7471 – Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique).

1.04 QUALITY ASSURANCE

A. The Owner and the Engineer reserve the right to inspect proposed sources of off-site materials and to order tests of the materials to ascertain its quality and particle size. Engage an approved testing laboratory to perform such tests, and submit certified test results.

B. Do not use materials until approval is obtained from the Engineer. Use material from approved sources.

PART 2 PRODUCTS

2.01 OFF-SITE MATERIALS

A. Acceptability of off-site material follows procedure consistent with NYSDEC's Draft DER-10 Technical Guidance for Site Investigation and Remediation (December 2002).

1. Contractor identifies a potential off-site borrow source and provides the name of the site owner, the location where the fill/cover material was obtained, and a brief history of the site which is the source of the material. Fill is natural material from approved off-site sources, free from trash, debris, deleterious materials, snow, or ice.

2. Contractor collects one representative sample from the borrow source and submits it for the analysis of metals, VOCs, and SVOCs. The results are provided to the Engineer, USEPA, and NYSDEC.

3. Analytical results are compared to NYSDEC TAGMs.

4. If all results are lower than the requirements, the material is acceptable for use as backfill for the Incinerator Cooling Water Pond or as cover over the landfills. If the results are not acceptable, a new borrow source will be located and the process will be repeated. The Owner will provide the comparison of backfill results to the acceptability criteria to NYSDEC and USEPA for review prior to accepting the material onsite. The Owner will consider the material approved if it meets all of the requirements as discussed above.

5. No additional borrow source samples will be required once the source is approved. The Army will monitor the incoming loads of backfill to document that the fill is free of extraneous debris or solid waste.

B. Natural material from approved off-site sources, free from trash, debris, deleterious materials, snow, or ice.

C. Material free of hazardous wastes, hazardous substances, meeting the NYSDEC TAGMs.

D. Materials classified in ASTM D 2487 as GW, GP, GC, SW, SP, and SC that are free from roots and other organic matter, trash, debris, frozen materials, and stone larger than 2 inch in any dimension.

PART 3 EXECUTION

3.01 GENERAL BACKFILLING REQUIREMENTS

A. Verify that fill materials are acceptable.

B. Confirm with the Engineer that confirmatory samples have been analyzed and are acceptable prior to backfilling.

C. Backfill the Incinerator Cooling Water Pond to match natural surrounding grades.

D. Repair or replace settlement in the finished work in accordance with this Section.

F. Place and compact fill materials in continuous layers to meet appropriate requirements of Section 02228 - Compaction.

G. Remove surplus backfill materials from site and/or place in an accepted area.

3.02 TESTING

A. Collect and analyze one sample prior to acceptance as the borrow source. The sample will be analyzed for VOCs (EPA Method SW846 8260B), SVOCs (EPA Method SW846 8270C), Metals (EPA Method SW846 6010B including Mercury 7471), and classification of soil (ASTM D-2487).

END OF SECTION

SECTION 02228

COMPACTION

PART 1 GENERAL

1.01 SUMMARY

A. Work included in this section:

1. Placement and compaction of imported backfill materials and relocated site materials.

B. Related Sections:

1. Section 02219 - Contaminated Materials Excavation and Disposal

2. Section 02223 - Backfilling

3. Section 02990 - Finish Grading and Seeding

1.02 SUBMITTALS

None.

1.03 REFERENCES

None.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 COMPACTION

A. Backfill soil for the Incinerator Water Cooling Pond shall be placed in maximum of 2 foot loose lifts prior to compaction. Each lift shall be compacted prior to placing the next lift. Compaction shall be achieved by three passes of a dozer or other equipment with suitable ground pressure.

B. Backfill soil shall be placed over the Ash Landfill and the NCFL in maximum of 1 foot loose lifts prior to compaction. Each lift shall be compacted prior to placing the next lift. Compaction shall be achieved by three passes of a dozer or other equipment with suitable ground pressure.

3.02 QUALITY ASSURANCE/QUALITY CONTROL

A. The Contractor shall ensure that the backfilled and covered areas have been compacted to meet final grades prior to demobilizing from the site.

3.03 PROTECTION

A. Do not compact a layer of fill on snow, ice, or frozen soil. Remove unsatisfactory materials prior to compacting fill.

END OF SECTION

SECTION 02370

EROSION CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

The work specified in this section consists of the labor, equipment, tools, materials, and services needed to accomplish erosion control measures during and following construction as described herein, shown on the Contract Drawings.

A. Work included in this section:

1. Installation of temporary erosion control measures.

2. Controlling erosion from contaminated soil stockpiles, if any.

3. Inspection of erosion control measures during and after significant rainfall.

4. Repairing failed erosion control measures.

5. Removing and disposing of sediment deposits in a manner that does not result in additional erosion or pollution.

6. Removal of temporary erosion control measures once construction and permanent stabilization is complete.

B. Related Sections:

1. Section 02219 – Contaminated Materials Excavation and Disposal

2. Section 02223 - Backfilling

3. Section 02228 - Compaction

4. Section 02990 - Finish Grading and Seeding

1.02 PERFORMANCE REQUIREMENTS

A. Observe government policy established by United States Environmental Protection Agency (USEPA).

B. Conform to all erosion and sedimentation control measures established by the State of New York.

C. Temporary erosion and sediment control measures shall be installed as one of the first steps in construction, shall be maintained throughout the construction period, and shall not be removed until permanent cover is completely established and stabilized, with Engineer's approval.

1.03 SUBMITTALS

A. Product Data. Provide product data for each component to be used in erosion and sediment control.

PART 2 PRODUCTS

2.01 MATERIALS

A. Straw Bales

1. Shall be securely tied.

B. Silt Fence

1. Mirafi "Envirofence" or equivalent.

2. Rexius Ecoberm or equivalent.

C. Stakes and Fasteners

1. Shall be two rebar or two wood stakes for each hay/straw bale.

D. Oil Sorbents

1. Booms – New Pig Spaghetti Boom or equal shall be used.

2. Socks – New Pig Skimmer Socks or equal shall be used.

2.02 METHODS

A. Sediment Barriers - Sediment barriers shall be straw bales, stone, silt fences, ecoberms, or other approved materials that will prevent migration of silts and sediment to different areas.

B. Temporary Diversion Ditches – Temporary diversion ditches shall be installed by the Contractor to control surface water and minimize construction water.

C. Oil Sorbent Booms/Socks - Oil sorbent booms/socks shall be installed to contain oil sheens emanating from waste materials, if any. Keep a supply of clean oil sorbent booms/socks on-site at all times and install within one hour after discovery of a sheen.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. It is the Contractor's responsibility to implement and maintain erosion and sedimentation control measures to effectively minimize erosion and sedimentation.

B. Earthmoving activities shall be conducted in such a manner as to minimize erosion and sedimentation.

C. Install erosion and sedimentation control measures in accordance with manufacturer recommendations.

D. Erosion and sedimentation control measures shall be inspected by the Engineer and Contractor daily. Repairs shall be made as soon as practical.

E. Employ, construct, and maintain all temporary erosion and sediment control measures in accordance with *New York Guidelines for Urban Erosion & Sediment Control***.**

3.02 SPECIAL CONDITIONS

A. Prohibited construction practices include, but are not limited to, the following:

1. Dumping of spoil material into any stream corridor, any wetlands, any surface waters, at unspecified locations, or locations not expressly approved by Engineer.

2. Indiscriminate, arbitrary, or capricious operation of equipment in any stream corridors, any wetlands, or any surface waters.

3. Pumping of silt-laden water from trenches or other excavations into any surface waters, any stream corridors or wetlands, or locations not expressly approved by Engineer.

4. Disposal of trees, brush, and other debris in stream corridors, wetlands, surface water, unspecified locations, or locations not expressly approved by Engineer.

5. Permanent or unspecified alteration of the flow line of any stream.

3.03 ADJUSTMENT OF PRACTICES

A. If the planned measures do not result in effective control of erosion and sediment runoff to the satisfaction of the regulatory agencies having jurisdiction over the project, the Contractor shall immediately adjust his program and/or institute additional measures so as to eliminate excessive erosion and sediment-runoff.

B. If the Contractor fails or refuses to comply promptly, the Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor.

END OF SECTION

SECTION 02990

FINISH GRADING AND SEEDING

PART 1 GENERAL

1.01 SUMMARY

A. The work specified herein includes the material, equipment, labor, and services necessary to final grade and seed on the vegetative cover over the Ash Landfill and the NCFL and repair disturbed and/or damaged areas.

B. Related Sections:

1. Section 02370 - Erosion Control

1.02 SUBMITTALS

A. Materials and Products:

1. Grass Seed Vendors Certificate: Seed vendor's certified statement for the grass seed mixture required, stating common name, percentage by weight, and percentages of purity and germination.

2. Hydroseeding: Data concerning hydroseeding equipment (if used) including material application rates.

B. Installer - Name of subcontractors (if used) and Qualification Statements.

C. Manufacturer's Certification - Certify that products meet or exceed specified requirements.

1.03 REFERENCES

None.

1.04 QUALITY ASSURANCE

A. Label seed in accordance with USDA Rules and Regulations under the Federal Seed Act and applicable State seed laws. Furnish seed in sealed bags or containers bearing the date of the last germination which shall be less than six (6) months prior to commencement of planting operations. Inspect seeding material upon arrival at the job site. Remove unacceptable material from the job site. Seed shall be from same or previous year's crop. Each variety of seed shall have a purity of more than 85%, a percentage of germination more than 90%, a weed content of less than 1%, and contain no noxious weeds.

PART 2 PRODUCTS

2.01 GRASS SEED

A. A seed mixture beneficial to wildlife, as recommended by the US Fish and Wildlife Service, consisting of the following proportions or equal approved by the Owner:

Common Name	Species	Pounds per Acre
White Clover	*Trifolium repens*	5
Lancer perennial pea	*Lathyrus latifolius*	5
Perennial ryegrass	*Lolium perenne*	10
Timothy grass	*Phleum pratense*	10
Orchard grass	*Dactylis glomerata*	10
Smooth bromegrass	*Bromus intermis*	10

PART 3 EXECUTION

3.01 APPLICATION PROCEDURES

A. Ash Landfill and NCFL covers and disturbed surfaces outside the work limits that have been disturbed or damaged during completion of the work shall be final graded to pre-existing grades reseeded.

3.02 SEEDING

A. Apply seed mixture uniformly on the prepared surface with a hand or mechanical spreader. Lightly rake and roll seed into the surface.

B. Apply hydroseed (optional) uniformly on the prepared surface.

3.03 WARRANTY

A. One year warranty period for seed from the date of substantial completion or correction period. Maintain as necessary including repairs, re-seeding, so that an acceptable grass stand is established. The Engineer will provide approval and direction during the one-year warranty period.

END OF SECTION

TECHNICAL MEMORANDUM

Date: March 31, 2006 (Revised July 21, 2006)

To: Julio Vazquez, USEPA
Kuldeep Gupta, NYSDEC
Charlotte Bethoney, NYSDOH

From: Todd Heino, Parsons; Jackie Travers, Parsons

Subject: Final Evaluation Report for the Mulch Biowalls at the Ash Landfill Site, Seneca Army Depot Activity, Romulus, New York

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This Evaluation Report assesses the monitoring results for enhanced *in-situ* bioremediation of chlorinated solvents via two mulch biowalls at the Ash Landfill at Seneca Army Depot Activity, Romulus, New York. In accordance with the Record of Decision (ROD) for this site, the selected remedy includes installation of three in situ permeable reactive walls for the treatment of groundwater. The use of reactive walls containing zero-valent iron (ZVI) has been assessed at the site in the past (Parsons, 2000). This Evaluation Report assesses the performance of reactive walls containing mulch to enhance biodegradation. The performance of the mulch biowalls is compared to the performance of the ZVI wall, as outlined in the Ash Landfill Biowall Pilot Study Work Plan (Parsons, 2005).

This Report summarizes data collected by Parsons for the four rounds of sampling in September, 2005, October, 2005, December, 2005 and January 2006. Two permeable mulch biowalls were installed in July 2005 in accordance with the Ash Landfill Biowall Pilot Study Work Plan (Parsons, May 2005).

1 INTRODUCTION

Solid-phase organic substrates used to stimulate anaerobic biodegradation of chlorinated ethenes include plant mulch and compost. Mulch may be composted prior to emplacement, or the mulch may be mixed with another source of compost, to provide active microbial populations for further degradation of the substrate in the subsurface. Mulch is primarily composed of cellulose and lignin, but “green” plant material is incorporated to provide a source of nitrogen and nutrients for microbial growth. These substrates are mixed with coarse sand and emplaced in a trench or excavation in a permeable reactive biowall configuration. Biodegradable vegetable oils may also be added to the mulch mixture to increase the availability of soluble organic matter. This treatment method relies on the flow of groundwater under a natural hydraulic gradient through the biowall to promote contact with slowly-soluble organic matter. As the groundwater flows through the organic matter within the biowall, a treatment zone is established not only within the biowall, but downgradient of it, as the organic matter migrates with the groundwater and microbial processes are established.

Degradation of the organic substrate by microbial processes in the subsurface provides a number of breakdown products, including metabolic acids (e.g., butyric and acetic acids). The breakdown products and acids produced by degradation of mulch in a saturated subsurface environment provide secondary fermentable substrates for generation of hydrogen, the primary electron donor utilized in anaerobic reductive dechlorination of chlorinated ethenes. Thus, a mulch biowall has the potential to stimulate reductive dechlorination of chlorinated ethenes for many years. If needed, mulch biowalls can be periodically recharged with liquid substrates (e.g., vegetable oils) to extend the life of the biowall. Vegetable oil is a substrate that is readily available to microorganisms as a carbon source to enable them to establish and continually develop their population. Used in combination with the mulch, it has the potential to increase the duration of organic carbon release. In addition to the application at Seneca Army Depot, mulch biowalls for degradation of chlorinated ethenes also have been installed at Altus AFB, Oklahoma, Offutt AFB, Nebraska (Haas et al., 2000 and 2003; Aziz et al., 2001 and 2003), F.E. Warren AFB, Wyoming (Parsons, 2004), and Naval Weapons Industrial Reserve Plant, McGregor, Texas (Cowan, 2000).

Reductive dechlorination is the most important process for natural biodegradation of the more highly chlorinated solvents (EPA, 1998) and is shown in **Figure 1**. Complete dechlorination of TCE and the other chlorinated solvents present in the groundwater is the goal of anaerobic biodegradation using the mulch biowall technology.

1.1 Objective

Two parallel permeable mulch biowalls were installed at the Ash Landfill site at the Seneca Army Depot in July 2005 to stimulate anaerobic biodegradation of chlorinated ethenes in groundwater on a pilot-scale level. In particular, the two biowalls were installed across the path of groundwater flow near the TCE plume source to demonstrate that a mulch biowall would be equally as effective as a permeable reactive iron (ZVI) wall in promoting the *in-situ* bioremediation of trichloroethene (TCE) and *cis*-1,2-dichloroethene (cDCE) in groundwater (see **Figure 2**). The objective of the future full-scale biowall application is to treat a shallow groundwater plume contaminated with TCE, cDCE and VC in order to prevent off-depot migration. The biowall is composed of shredded leaves, bark and wood mulch, and sand (to maintain permeability). The mulch and compost substrates are intended to be used as solid-phase, long-term carbon sources to stimulate anaerobic degradation of chlorinated ethenes.

Two parallel walls were installed to represent two separate scenarios. Each individual wall could be assessed on its own with the most upgradient wall treating the highest concentration groundwater and the second wall treating lower concentrations. Secondly, the walls could be assessed as a dual wall system.

Specifically, the pilot study was performed to demonstrate the following:

- Achievement of similar reduction of concentrations of TCE within the biowall as was demonstrated for the ZVI PRB described in the Feasibility Memorandum (Parsons, 2000).

- A reduction in total molar concentrations of chlorinated ethenes in the biowalls and at monitoring locations downgradient of the biowalls. One metric used to evaluate biowall effectiveness in meeting this performance objective was to demonstrate that the treatment efficiency achieved by the biowalls was equal to or greater than the percent molar reductions observed for the ZVI pilot-scale treatability study. The method used to evaluate this metric was to compare total molar chlorinated ethene concentrations at upgradient monitoring wells with those observed within the second biowall at downgradient monitoring wells. This is a slight change from the pilot study work plan in that the walls were evaluated as a dual wall system rather than individually. Results from this biowall pilot study were compared to the molar reduction results that were calculated from concentration measurements performed over time from monitoring wells in and around the ZVI PRB.

- That the biowalls create a treatment zone within and downgradient of the trenches that is favorable to the long-term enhancement of degradation of TCE and its regulated intermediate degradation products, *cis*-1,2-DCE, *trans*-1,2-DCE and VC. This performance objective was demonstrated through the evaluation of the groundwater geochemical conditions that are created within and downgradient of the biowall, and comparison of these conditions to sites where other biowalls have been installed. The long-term goal of constructing multiple biowalls is to degrade chlorinated ethenes to concentrations below the NYSDEC GA standards.

- That no chlorinated solvents will exceed NYSDEC GA Standards at the Farm House west of the site at any time during the estimated remediation timeframe.

- Evaluate biowall design criteria (e.g., organic carbon generation, degradation rates, residence time) and constructability issues (e.g. trenching techniques, trench stability, oil application, and subsurface pipe placement) required for effective long-term operation.

This report shows that the pilot study objectives have been met and the Army intends on submitting a remedial design work plan incorporating this technology.

1.2 Scope of Work

Site-specific activities conducted at the Ash Landfill in support of the enhanced bioremediation field application include:

- Installation from July 18 to July 22, 2005 of two parallel 150-foot-long, by 11-foot-deep, by 3.0-foot-wide mulch biowalls composed of shredded leaf, bark and wood mulch, and sand. The mulch/sand mixture in the easternmost wall was coated with soybean oil prior to placement in the trench;

- Installation of 11 groundwater monitoring wells on August 11, August 12 and August 22, 2005;

- Post-installation sampling of groundwater at the newly installed monitoring wells and existing monitoring well PT-12A in September 7-12, 2005 (Round 1), October 24-26, 2005 (Round 2), December 12-16, 2005 (Round 3) and January 24-28, 2006 (Round 4); and

- Aquifer testing (hydraulic conductivity) of the newly installed monitoring wells.

Groundwater samples were collected after installation of the biowall and were analyzed for chlorinated solvents and their dechlorination products, dissolved oxygen (DO), nitrate, nitrite, ferrous iron, manganese, sulfate, sulfide, carbon dioxide, methane, ethane, ethene, oxidation-reduction potential (ORP), alkalinity, pH, temperature, specific conductance, total organic carbon (TOC), volatile fatty acids (VFAs), and chloride.

2 SITE DESCRIPTION

The Ash Landfill site was initially estimated to encompass an area of approximately 130 acres. This larger area was investigated to ensure that no previously unknown waste disposal areas were overlooked. Following the remedial investigation, the area of the Ash Landfill site was refocused to an area of approximately 23 acres. This area is comprised of five Solid Waste Management Units (SWMUs) including: Incinerator Cooling Water Pond (SEAD-3), the Ash Landfill (SEAD-6), the Non-Combustible Fill Landfill (NCFL) (SEAD-8), the Refuse Burning Pits (SEAD-14), and the Abandoned Solid Waste Incinerator Building (SEAD-15). The Debris Piles are located near SEAD-14. The Ash Landfill (SEAD-6) also includes a groundwater plume that emanates from the northern western side of the landfill area. The groundwater plume extends 1,100 feet from the original source area to the western depot property line. The plume consists of chlorinated ethenes (TCE, DCE, etc.).

An RI/FS investigation was completed in 1996. A Non-Time Critical Removal Action (NTCRA), also known as an Interim Removal Measure (IRM), was conducted by the Army between August 1994 and June 1995, under the requirements of the CERCLA to remove the source area. This source removal action involved the excavation of 63,000 cubic yards of soil and treatment using Low Temperature Thermal Desorption. The surface area involved approximately 1.5 acres.

The IRM thermal treatment project provided a positive benefit for the long-term remedial action by eliminating continued leaching of VOCs into groundwater and preventing further exposure to humans and wildlife. In the several years that have passed since the IRM, the positive benefits of the IRM have been observed as the concentration of groundwater in this area has decreased over 100-fold.

A zero valence iron (ZVI) treatability study was performed between 1998 and 2001 and showed that the permeable wall would degrade chlorinated ethenes. Based on good performance data from the ZVI treatability study, a 650 foot by 15 foot by 14-inch wide trench was excavated near the depot property line and backfilled with a 50/50 mix of zero valent iron and sand. A performance monitoring well network was sampled and analyzed from 1999 to 2004 to assess the performance of the wall. A ROD for this site was subsequently issued in February 2005 and included the use of permeable walls as migration control for the groundwater contamination on site.

The site is underlain by a broad north-to-south trending series of rock terraces covered by a mantle of glacial till. As part of the Appalachian Plateau, the region is underlain by a tectonically undisturbed sequence of Paleozoic rocks consisting of shales, sandstones, conglomerates, limestones and dolostones. At the Ash Landfill site, these rocks (the Ludlowville Formation) are characterized by gray, calcareous shales and mudstones and thin limestones with numerous zones of abundant invertebrate fossils. Locally, the shale is soft, gray, and fissile. Pleistocene age (Late Wisconsin age, 20,000 years before present [bp]) till deposits overlie the shales, which have a thin (2 to 3 feet) weathered zone at the top. The till matrix varies locally, but generally consists of unsorted silt, clay, sand, and gravel. At the Ash Landfill Operable Unit, the thickness of the till generally ranges from 4 to 15 feet. At the location of the biowalls, the thickness of the till and weathered shale is approximately 10 to 15 feet.

Groundwater is present in both the shallow till/weathered shale and in the deeper competent shale. In both water-bearing units, the predominant direction of groundwater flow is to the west, toward Seneca Lake. Based on the historical data, the wells at the Ash Landfill site exhibit rhythmic, seasonal water table and saturated thickness fluctuations. The saturated interval is at its thinnest (generally between 1 and 3 feet thick) in the month of September and is the thickest (generally between 6 and 8.5 feet thick) between the months of December and March.

The average linear velocity of the groundwater in the till/weathered shale was calculated during the RI using the following parameters: 1) an average hydraulic conductivity of 4.5×10^{-4} centimeters per second (cm/sec) (1.28 feet per day [ft/day]), 2) an estimated effective porosity of 15% (0.15) to 20% (0.20), and 3) a groundwater gradient of 1.95×10^{-2} foot per foot (ft/ft) (Parsons Engineering Science, Inc. [ES], 1994a). The average linear velocity was calculated to 0.166 ft/day or 60.7 feet per year (ft/yr) at 15% effective porosity and 0.125 ft/day or 45.5 ft/yr at 20% effective porosity. The actual velocity on-site may be locally influenced by more permeable zones possibly associated with differences in the actual porosity of the till/weathered shale.

The average linear velocity of the groundwater in the competent shale was calculated using the following parameters: 1) an average hydraulic conductivity of 3.73×10^{-5} cm/sec (0.106 ft/day), 2) an estimated effective porosity of 6.75% (0.0675), and 3) a groundwater gradient of 2.5×10^{-2} ft/ft. An average linear velocity of 3.9×10^{-2} ft/day or 14.3 ft/yr was calculated for the competent shale.

TCE and the dichloroethene isomer cDCE are the most prevalent chlorinated ethenes in both extent and concentration in groundwater at the Ash Landfill. The area extent of TCE based on groundwater samples collected in January 2000 is illustrated in **Figure 2**. Subsequent monitoring has shown little change since then. The TCE plume originates from the Ash Landfill and extends west approximately 1,000 feet to the Depot's western boundary. Concentrations of total chlorinated ethenes in January ranged up to 2,088 micrograms per liter (µg/L). The plume is bounded to the west by the monitoring well (MW-56) located on the adjacent property as evidenced by historic sampling. The plume is currently controlled by the 650 foot long permeable reactive wall installed upgradient of the depot property line.

3 BIOWALL CONSTRUCTION

Two biowalls were constructed perpendicular to the path of groundwater flow in the vicinity of monitoring well PT-12A as shown on **Figure 2**. The selected area for installation has shown the highest concentrations of chlorinated ethenes. The biowalls were constructed to demonstrate the technology could be as effective as the existing zero-valent iron wall in reducing chlorinated ethene concentrations. The eastern biowall is 150-foot-long and averages 11.3 feet deep, by 3-foot-wide. The western biowall is 150-foot-long and averages 10.7 feet deep, by 3-foot-wide. The walls were installed 15 feet apart by Sessler Wrecking of Waterloo, New York. A total mix of 200 cubic yards of shredded mulch and 150 cubic yards of sand was backfilled in the trenches to form the biowalls. The mulch/sand mix for the western biowall was coated with 880 gallons of soybean oil prior to placement to evaluate if it would enhance the effectiveness of the mulch mixture. Additionally, a 3-inch HDPE pipe was installed in the western biowall for future injection of soybean oil if required. The mulch consisted of shredded plant material (a mix of whole deciduous and evergreen trees).

An excavator was employed to excavate the trench for the biowall. The excavator utilized rock teeth to properly key the bottom of the trench through the fractured bedrock into the competent bedrock. The backfill material was placed in the trench using a loader. Soil generated during excavation of the biowalls was piled next to the installed biowall. The final disposition of the soil will be dependent on the TCE concentrations as discussed in the pilot study work plan. The location and extent of the biowall is marked with metal fence posts painted a high visibility color.

Following construction of the biowall, 11 groundwater monitoring wells were installed to form two monitoring well transects. One existing well PT-12A was used as the upgradient well for one of the transects. Groundwater monitoring wells were installed along two transects perpendicular to the biowalls. Wells were installed 15 feet upgradient of the eastern wall, within the footprint of each biowall, between the walls and at distances of 7.5 and 15 feet downgradient (to the west) of the biowalls. These points are used to monitor groundwater geochemical indicators and contaminant concentrations within, between and downgradient of the biowall. **Figure 3** shows the relative locations of the monitoring wells within the two transects.

4 MONITORING RESULTS

Monitoring results from the four rounds of sampling are presented in the following subsections on hydrogeology, groundwater geochemistry, substrate and electron donor distribution, and degradation of chlorinated ethenes. The results are intended to show that the biowalls have altered groundwater geochemistry to promote reductive dechlorination of chlorinated ethenes. Two transects of monitoring wells are located along the path of groundwater flow, perpendicular to the two biowall trenches (**Figure 3**). The northern flow path (North Transect) consists of wells MWT-12R through MWT-17R. The southern flow path (South Transect) consists of wells PT-12A and MWT-18 through MWT-22. Monitoring points MWT-13, MWT-15, MWT-18 and MWT-20 are located within the biowalls. In addition to these wells, monitoring well MW-39 was sampled between the second and third round on December 1, 2005 to better assess background at the site outside of the plume. Monitoring well PT-22 was also sampled on this date and was added to the last two rounds of sampling to assess affects of the biowall further downgradient of the biowalls (approximately 150 feet downgradient of the biowalls). **Table 1** summarizes the monitoring wells sampled and the dates they were sampled.

Based on the changes in geochemistry observed at these two wells, the biological reaction zone is continuous between the two biowalls and the dual biowalls are intended to operate as a biowall "system." Therefore, groundwater quality exiting the biowall system (i.e., within or immediately downgradient of the west biowall) is the best indicator of the biowall system performance.

4.1 Hydrogeology

Groundwater elevations were measured during each sampling event and are summarized on **Table 2**. It should be noted that the ground was completely saturated during the October 2005 sampling round. **Figure 3** contours the groundwater potentiometric surface for September 1, 2005 (Round 1)**.** Depth to groundwater within the eastern biowall ranged from approximately 2.15 to 6.70 feet bgs. Depth to groundwater within the western biowall ranged from approximately 2.45 to 7.35 feet bgs. The depth of the eastern trench averages 11.3 feet bgs and the depth of the western trench is an average of 10.7 feet bgs. Therefore, the saturated thickness within the two biowall trenches ranges from 3.3 to 9.1 feet at any given time, depending on seasonal changes in groundwater levels due to recharge from precipitation. Seasonal fluctuations of the groundwater table are not expected to adversely impact the biowall performance. Since the biowall is underground and not exposed to the atmosphere, moisture will be retained sustaining the biomass that makes it effective. As described in Section 2, glacial till consists of unsorted silt, clay, sand and gravel to depths of 4 to 15 feet and overlies 2 to 3 feet of weathered shale and competent rock. The biowalls were installed to extend to the top of the competent shale (bedrock) surface. The biowall trenches do not intercept the entire width of the chlorinated ethene groundwater plume as the trenches were installed as a pilot study only. Therefore, mixing of treated groundwater from the biowall and contaminated groundwater downgradient of the biowall trench will occur to some degree. Monitoring results for well locations more than 10 feet downgradient of the biowall should be evaluated with the understanding that not all of the groundwater at those monitoring locations may have passed through the biowall. Results for wells MWT-13, MWT-15, MWT-18 and MWT-20, located within the biowall trenches, are the most representative of the degree to which the biowalls are effective in remediating chlorinated ethenes in groundwater passing through the biowall trenches.

The groundwater surface slopes northwest toward Seneca Lake, with horizontal hydraulic gradients ranging from 0.03 ft/ft to 0.05 ft/ft along the North Transect and ranging from 0.02 ft/ft to 0.03 ft/ft along the South Transect. Rising head slug tests for the wells in the North and South Transects were conducted between October and December 2005, and the results were analyzed to calculate hydraulic conductivity.

Hydraulic conductivity in the till/weathered shale formation ranges from 5.1E-5 to 1.6E-4 cm/sec in the North Transect and ranges from 2.0E-5 to 2.5E-4 cm/sec in the South Transect. The hydraulic conductivities in the biowall were one order of magnitude greater than those in the till/weathered shale formation, ranging from 1.9E-3 to 2.8E-3 cm/sec in the North Transect and ranging from 1.0E-3 to 7.3E-3 cm/sec in the South Transect. This range of hydraulic conductivities falls within the historical range of values calculated for this site during the RI.

Using the calculated hydraulic conductivities derived from the slug test data, the horizontal hydraulic gradients, and an estimated effective porosity of 15 percent, the advective velocities of groundwater flow in the till/weathered shale formation exiting the biowalls were calculated and range from approximately 0.028 to 0.071 ft/day (10 to 26 ft/yr) in the North Transect and range from approximately 0.010 to 0.14 ft/day (4 to 53 ft/yr) in the South Transect. The velocities of groundwater exiting the east biowall along each transect were calculated by considering the hydraulic gradient between the monitoring wells at the western edge of the biowall (MWT-13 and MWT-18) and the monitoring wells immediately downgradient of the east biowall (MWT-14 and MWT-19).

Table 3 shows a comparison of linear velocities derived from the RI slug test data, the biowall-specific 2005 slug test data, and the geochemical parameter monitoring. Observations of geochemical parameters monitored over the duration of the test indicate that linear velocities may be greater than slug test results indicate (see **Attachment A**). Based on the time it took for chemical parameters to be observed at the downgradient wells, it appears that flow through the North Transect may be on the order of 100 ft/yr. Flow through the South Transect may be between 200 and 400 ft/year.

Slug tests measure a hydraulic response to an induced change in groundwater elevation within a single well. This response reflects the conductivity of the entire saturated portion of the well screen interval. Sediments within the screened interval may vary significantly, and the calculated hydraulic conductivity should be considered an "average" for the range of sediments present. Sediments within the glacial till at the Ash Landfill site may consist of clay, silt, or sand. Published values for hydraulic conductivity in glacial tills or for sediments of similar grain size often range over 2 to 3 orders of magnitude or more (**Table 3**). Therefore, groundwater flow along horizons of differing sediment lithologies may also vary by an order of magnitude or more.

The higher velocities of groundwater flow based on observation of geochemical indicator parameters at downgradient monitoring locations are representative of horizons of greater permeability. These higher velocities are about an order of magnitude higher than those derived from slug test results, are well within the range of what may be expected in glacial sediments, and are therefore considered to be conservative estimates of groundwater velocity when considering such factors as residence time. As a conservative measure, future biowall design will be based on maximum rates of groundwater flow, versus an average rate alone.

Based on the highest groundwater velocities calculated above, the most conservative residence time through the biowall system (approximately 18 feet) would be 66 days for the North Transect and between 16 and 33 days for the South Transect. Since these advective velocities are based on the highest velocities observed, they do not account for the effects of a higher effective porosity with the biowall itself and do not account for sorption of contaminants onto soil, these residence times are considered conservative; actual residence times may be higher.

4.2 Groundwater Geochemistry

Biodegradation causes measurable changes in groundwater geochemistry that can be used to evaluate the effectiveness of substrate addition in stimulating biodegradation. For anaerobic reductive dechlorination to be an efficient process, the groundwater typically must be sulfate-reducing or methanogenic. Thus, groundwater in which anaerobic reductive dechlorination is occurring should have the following geochemical signature:

- Depleted concentrations of dissolved oxygen (DO), nitrate, and sulfate;
- Elevated concentrations of ferrous iron, manganese, methane, carbon dioxide, chloride, and alkalinity; and
- Reduced oxidation reduction potential (ORP).

Selected geochemical parameters are shown on **Table 4** (attached). Comparison of geochemical parameters for biowall locations MWT-13 and MWT-18 (East Biowall) and MWT-15 and MWT-20 (West Biowall) to locations outside the biowall are summarized below.

Dissolved Oxygen. Dissolved oxygen is the most favored electron acceptor used by microbes for the biodegradation of organic carbon, and its presence can inhibit the biodegradation of chlorinated ethenes. With the exception of one well between the walls in one round (MWT-19), DO levels are already depleted (less than 2 milligrams per liter [mg/L]) in the study area. In the last round of sampling (January, 2006), concentrations of DO were less than 0.30 mg/L at all sample locations up to 150 feet downgradient of the biowalls.

Oxidation-Reduction Potential. Oxidation-reduction potential (ORP) indicates the level of electron activity and indicates the tendency for the groundwater to accept or transfer electrons. Low ORP, less than -100 millivolts (mV), is typically required for anaerobic reductive dechlorination to occur. Through the first two rounds of sampling, ORP upgradient of the biowall has ranged from 10 to 100 mV, indicating background conditions are only mildly anoxic. Within the east and west biowalls, ORP has been lowered to a range of –137 mV to –220 mV. These levels of ORP indicate conditions are sufficiently reducing within the biowalls to support sulfate reduction, methanogenesis, and anaerobic reductive dechlorination. By January 2006, all monitoring locations downgradient of the biowalls (to a distance of 22.5 feet) are less than -100 mV, indicating that highly reducing conditions are present over a large area downgradient of both biowalls as well. In PT-22, the monitoring location 150 feet downgradient of the biowalls, the ORP changed from 57 mV to -91 mV over the course of the study (between November 2005 and January 2006).

Ferrous Iron. Ferric iron (III) may be used as an electron acceptor during anaerobic biodegradation of organic carbon. During this process, iron (III) is reduced to soluble ferrous iron (II), which can be measured in groundwater samples. An increase in the concentration of iron (II) is an indicator of anaerobic iron reduction. Concentrations of iron (II) upgradient of the biowall are less than 0.41 mg/L. Within the biowall, concentrations of iron (II) are elevated, with a maximum concentration of 5.1 mg/L measured at location MWT-15 in October 2005. Several readings of iron (II) were reported as >3.3 mg/L due to the upper detection limit of the field reagent used. The elevated concentrations are maintained in all downgradient locations. Elevated concentrations were not evident in PT-22, 150 feet downgradient of the biowalls. Iron (II) levels remain close to background at this location.

Sulfate. Sulfate is used as an electron acceptor during sulfate reduction, competing with anaerobic reductive dechlorination for available substrate (electron donor). Sulfate levels lower than 20 mg/L are desired to prevent inhibition of reductive dechlorination of chlorinated ethenes. Sulfate levels upgradient of the biowalls but within the footprint of the plume range from 325 to 903 mg/L. By the second round of sampling, the levels of sulfate were depleted to non-detect levels within the biowalls, except for the January ’06 round in MWT-15 (33.2 mg/L). Depletion of sulfate in the North Transect has been more evident than in the South Transect. For example, sulfate levels have decreased in MWT-14 (631 mg/L to 51.9 mg/L), MWT-16 (345 mg/L to 27.8 mg/L), and MWT-17R (408 mg/L to 58.5 mg/L). The levels of sulfate in the wells downgradient along the South Transect have only shown comparable decreases within 7.5 feet downgradient of the biowalls. Levels of sulfate 22.5 feet downgradient of the biowalls in MWT-22 have remained consistent throughout the pilot study (between 278 and 370 mg/L). Further downgradient at PT-22 (150 feet), sulfate levels have decreased slightly from 110 to 78 mg/L between December 2005 and January 2006.

Methane. The presence of methane in groundwater is indicative of strongly reducing methanogenic conditions. An increase in the concentrations of methane is an indication that reducing conditions are optimal for anaerobic reductive dechlorination to occur. Methane concentrations in the two upgradient wells range from 0.001 mg/L to 0.15 mg/L. Concentrations of methane measured in the biowalls were elevated at 3.1 mg/L to 8.1 mg/L in September 2005, and increased to 14 mg/L to 28 mg/L in January 2006. Methane levels in the downgradient wells (1.0 mg/L to 11 mg/L) are significantly higher than upgradient wells for the October 2005 through January 2006 sampling rounds. In PT-22, 150 feet downgradient of the walls, levels of methane have increased from 0.11 mg/L in early December 2005 to 0.97 mg/L in January 2006. Historical data indicates that methane has been non-detect in this well in previous sampling events (2003-2004). There is an increase in the level of methanogenic activity within the biowalls, as well as downgradient over time.

4.3 Substrate Distribution and Electron Donors

The distribution of soluble organic substrate in groundwater is reflected in levels of total organic carbon (TOC) and metabolic acids (**Table 5**) measured in groundwater. The presence of organic substrate is necessary to fuel anaerobic degradation processes, including reductive dechlorination.

Total Organic Carbon. Carbon is an energy source for anaerobic bacteria and drives reductive dechlorination. Generally, during the first three rounds of sampling, TOC concentrations in the wells within the biowalls (86.7 mg/L to 1,990 mg/L) are two orders of magnitude higher than upgradient of the biowalls (2.6 mg/L to 7.3 mg/L). Levels within the biowalls decreased during the third and fourth sampling rounds. For example, levels of TOC decreased from 1,990 mg/L in MWT-18 to 4.2 mg/L and from 951 mg/L in MWT-20 to 24.8 mg/L. However, levels remain sufficient (>20 mg/L) to maintain sulfate reducing and methanogenic conditions. TOC levels are also much higher in the wells downgradient of the walls ranging from 29.8 mg/L to 35.5 mg/L in the January 2006 sampling round of wells located 22.5 feet downgradient (MWT-22 and MWT-17R).

Metabolic Acids. Metabolic acids, or volatile fatty acids (VFAs), are produced during the biodegradation of organic substrates (e.g., produced by sulfate reducers). An increase in metabolic acids is an indication that microbial activity has been stimulated. These metabolic acids may be further fermented to produce molecular hydrogen, the primary electron donor utilized during reductive dechlorination of chlorinated ethenes. Metabolic acids (**Table 5**) measured are comprised primarily of acetic, pentanoic, propionic, and butyric acids. Total metabolic acids were less than 1.74 mg/L in the upgradient wells. Total metabolic acid concentrations increased to between 60 mg/L to 7,926 mg/L within the biowalls. In the South Transect downgradient wells, metabolic acid concentrations ranged from 316 to 820 mg/L in September 2005, and decreased to between 4 and 34 mg/L in January 2006. In the North Transect, concentrations ranged from 91 to 161 mg/L in October 2005, and decreased to between 8 to 23 mg/L in January 2006. The decrease in metabolic acid production over time correlates to the decrease in TOC concentrations over time.

In summary, levels of TOC and metabolic acids were highly elevated immediately after installation of the biowall. This is likely due to the rapid dissolution of the soluble portion of organic matter that was present in the mulch and vegetable oil added to the biowall trenches. Levels of TOC and metabolic acids appear to be stabilizing to more sustainable levels. In addition, as the microbial community grows it is capable of utilizing the available organic carbon more rapidly and less organic carbon migrates out of the immediate biowall treatment zone. It is not yet known what levels of substrate the biowall will be able to sustain over the expected design life-cycle of 5 years or more, or what threshold concentrations are required to sustain effective reductive dechlorination. As of January 2006, the effectiveness of the biowall system continues to increase with time (**Section 4.4**) as the microbial community adapts to anaerobic conditions.

4.4 Degradation of Chlorinated Ethenes

Table 6 (attached) summarizes chlorinated ethenes detected in groundwater during the monitoring period of the Ash Landfill biowall pilot study. The first round of groundwater sampling was performed approximately 6 weeks after installation of the biowall. While true "baseline" conditions for the wells located in the trenches and downgradient were not obtained, data from upgradient wells PT-12A and MWT-12R can be used to infer "baseline" conditions immediately upgradient of the biowall.

Trends in Chlorinated Ethene Concentrations

The primary contaminants detected at the site include TCE, cDCE, and vinyl chloride (VC). During the four sampling rounds, upgradient concentrations of TCE ranged from 400 μg/L to 860 μg/L, and upgradient concentrations of cDCE ranged from 310 μg/L to 980 μg/L. Concentrations of VC detected upgradient of the biowall system ranged from <1.2 to 24 μg/L in the South Transect (PT-12A) to 64 to 86 μg/L in the North Transect (MWT-12R). Lower concentrations (less than 25 μg/L) of *trans*-1,2-DCE, 1,1-DCE, 1,1-DCA, and acetone have also been detected in upgradient monitoring locations PT-12A and MWT-12R.

During Rounds 1 and 2, the ratio of TCE to cDCE in the groundwater changed significantly where treatment was occurring. The average cDCE/TCE ratio in the upgradient wells is 1:1 with approximately equal concentrations of TCE and cDCE. Within the two biowalls, the ratio increases to an average of 56:1 where TCE is only detected in one of eight samples. The change in ratio of TCE to DCE is a clear indication that TCE is being degraded to DCE.

As of the second monitoring event in October 2005, a trend of decreasing TCE was observed at all monitoring locations for the biowall network. Concentrations of TCE in the wells within and downgradient of the biowalls continued to decrease even further from September to December 2005, and remained relatively stable from December 2005 to January 2006. In January 2006, concentrations of TCE have decreased to non-detect in the four monitoring wells located within the biowalls and the TCE concentrations in the downgradient monitoring wells have been lowered to concentrations ranging from 2.9 to 25 μg/L. The biowall has significantly reduced the overall toxicity of the groundwater within the biowall treatment zone.

Total Molar Concentrations of Chlorinated Ethenes

The total molar concentration of chlorinated ethenes within the second (western) biowall relative to the upgradient locations are shown in **Table 7A**. The total molar concentrations are calculated by dividing the concentrations of PCE, TCE, DCE and VC by their molecular weight and then summing the results. Percent reductions in total molar concentrations of chloroethenes over time along the northern and southern flow paths have ranged from approximately 86 to 99 percent. A reduction in total molar concentrations shows that the chlorinated ethenes are not simply being converted from one chlorinated ethene to another, and that true reduction to non-toxic degradation products (e.g., ethene) is occurring. Total molar concentrations would be expected to remain constant if TCE was simply being transformed to cDCE without any additional degradation of cDCE. However, total molar concentrations of chloroethenes are clearly depleted within the biowalls. A decrease in total molar concentrations is observed along the North Transect both in the biowall and downgradient of the wall, as shown in **Table 7B**, indicating that a treatment zone has been established in this area. An increase in total molar concentration downgradient of the biowall along the South Transect (as shown in **Table 7B**) may be (i) due to the continued desorption of chlorinated ethenes from downgradient soils or (ii) due to the mixing with untreated groundwater. Less chlorinated compounds are more soluble and less hydrophobic. For example, in the dechlorination sequence of TCE to DCE, solubility goes from 1,100 mg/L for TCE to 3,500 mg/L for cis-DCE (**Table 8**). The organic carbon partition coefficients (K_{oc}), which defines the distribution of chlorinated ethene mass between the sorbed and aqueous phases, also decreases as the level of chlorination decreases. As anaerobic dechlorination proceeds, each successive dechlorination product is more soluble and less susceptible to adsorption than the previous compounds in the sequence. This tendency may result in an increase in aqueous-phase concentrations of less-chlorinated dechlorination products (Payne et al., 2001; Sorenson, 2003).

However, while the transformation of TCE to DCE may result in a temporal accumulation of cDCE in some locations, there remains a significant overall loss of chlorinated ethene mass (greater than 98 percent within the biowalls relative to upgradient locations) as shown in the mass flux calculations provided in **Attachment B**.

Mass Flux and Estimate of Sorbed Mass

An evaluation of contaminant mass flux through the biowall system serves as a measure of system performance in treating contaminant mass. By calculating the mass flux of soluble contaminant that enters the dual biowall system and by comparing that to the mass flux of soluble contaminant exiting the second biowall (western wall), the mass reduction of contamination is demonstrated. **Attachment B** provides the calculations for the mass flux of soluble contaminant entering and exiting each transect of the biowall. The mass flux is calculated using the concentration of each chlorinated ethene multiplied by the volume of water estimated to pass through the trench during a given time period. Based on the calculations in **Attachment B**, the mass reduction of chlorinated ethenes through the dual biowall system is between 98% for the South Transect and over 99% for the North Transect.

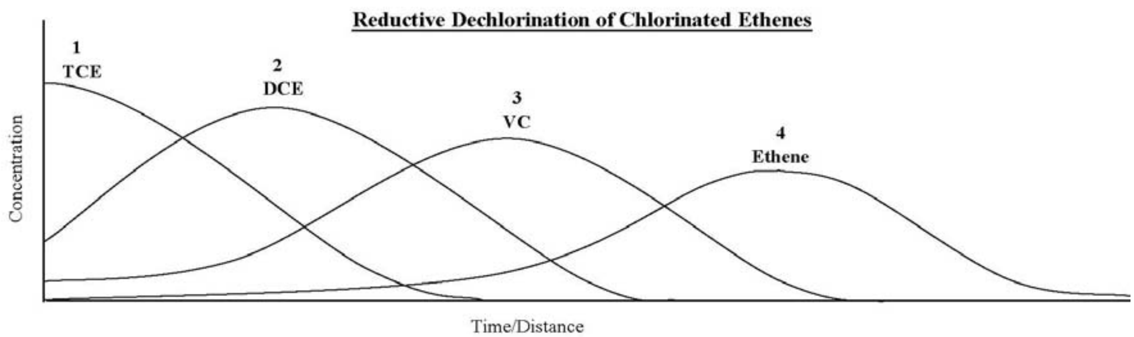
It should also be noted that a reduction in concentrations of TCE downgradient of the biowall would also result in desorption of TCE from the soil matrix. Based on the mass flux calculations shown in **Attachment B**, ten times as much contaminant mass may be sorbed to the soil as is dissolved in the groundwater. It is possible that at least a portion of the rebound in concentrations of cDCE downgradient of the biowall is simply due to desorption of TCE and transformation to cDCE. Similarly, mixing of the highly anaerobic groundwater and untreated groundwater may also cause partial transformation of TCE to cDCE downgradient of the biowall. Because of the affects of desorption and mixing downgradient of the biowall trenches, the concentrations of chlorinated ethenes within the biowall (wells, MWT-15 and MWT-20) are the most meaningful indicators of biowall performance.

Evidence of Sequential Reductive Dechlorination

Observing the relative concentrations of TCE and the by-products generated during reductive dechlorination, progression of the biodegradation process is evident within the Ash Landfill biowall system. The figure below shows the theoretical phased concentrations expected during reductive dechlorination of chlorinated ethenes as outlined in the following steps:

1. TCE is the predominant contaminant source.
2. As TCE is reduced, DCE levels increase.
3. DCE decreases as it is converted to vinyl chloride (VC).
4. Finally, VC is further converted to ethene and other non-toxic by-products.

These four steps are noted on the schematic below.



Figures 4 through **7** show the percent of total chlorinated ethenes (including ethene and ethane) as a function of distance along the biowall transects for Round 2 data and Round 4 data. The four steps outlined above are shown on the figures to indicate the phase of the dechlorination process that dominates. **Figures 4** and **5** show a snapshot of the dechlorination process for the North Transect during Rounds 2 and 4. Reductive dechlorination has proceeded through steps 1 (TCE predominates), 2 (conversion to DCE), and 3 (conversion to VC) during Round 2. In observing the Round 4 data in **Figure 5**, it is clear that the biowall system has matured and that step four (conversion of VC to ethene) is occurring not only within the dual biowall system, but also downgradient of it. A similar trend is seen in **Figures 6** and **7** for the South Transect. The presence of VC downgradient of the biowall system is convincing evidence that treatment zones have begun to be established downgradient of the biowall system. Destruction of contaminants is occurring beyond the installed biowall system.

The production of ethene is a positive indicator of complete dechlorination of the chlorinated ethenes present at the site. If the process resulted in the sole production of VC, ethene levels would not be increasing as measured during the third and fourth sampling rounds. The trends described above can also be shown on a point-by-point basis along both treatment transects. **Attachment C** provides additional graphical analysis of these data at the various locations along both transects.

In observing the fraction of total ethenes over time at certain points within the North and South Transects, it is evident that the reaction zone within the South Transect is effective but is developing at a slower rate than in the North Transect. **Figures 8** through **11** show the fraction of total ethenes over time for monitoring wells MWT-13, MWT-16, MWT-18 and MWT-21. When comparing the fraction of total ethenes in the wells within the first wall (MWT-13 and MWT-18) and in the first downgradient wells (MWT-16 and MWT-21), the observed phase of reductive dechlorination is approximately 40 to 50 days behind in the South Transect. In other words, the progress seen at 190 days in the South Transect was observed at about 140 days in the North Transect.

4.5 Other Compounds

The tables presented in **Attachment D** list all of the detected VOC compounds in all biowall performance monitoring wells. **Table 6** shows concentrations of acetone, 2-butanone and 2-hexanone in addition to chlorinated compounds of concern. Ketones have been detected in the monitoring wells located within the biowalls at concentrations up to 9,300 µg/L for 2-butanone at location MWT-13 in October 2005. These compounds, produced by fermentation reactions, are not anticipated to be stable outside of the highly reducing conditions established within and immediately downgradient of the biowall trenches. They readily degrade in aerobic conditions and decrease as the levels of TOC and metabolic acids decrease. Concentrations of these compounds decreased by over an order of magnitude (to 750 µg/L or less) in downgradient locations at 7.5 feet from the west biowall. Furthermore, concentrations of these compounds were between non-detect and 14 J µg/L at 22.5 feet downgradient of the biowalls in January, and concentrations were non-detect at the furthest downgradient well (PT-22, 150 feet from the biowalls) monitored in January 2006. Over the five month study, these ketones have decreased in locations downgradient of the biowall as shown in **Figures 12 through 15**. They have never been detected in PT-22, 150 feet downgradient of the biowall system. Therefore, it is not anticipated that these compounds will adversely impact groundwater quality outside of the immediate biowall treatment zone.

5 PERFORMANCE ANALYSIS

5.1 Objectives of the Biowall Pilot Test

The Ash Landfill Biowall Pilot Test Work Plan (Parsons, May 2005) outlined five performance objectives that were developed to evaluate the effectiveness of the biowalls. The evaluation of these five objectives is the basis of mulch as the media selected for the reactive walls for the groundwater operable unit as required in the Record of Decision for this site (January, 2005).

The objectives outlined in the Biowall Pilot Study Work Plan and the assessment of this objective using the data collected to date discussed below:

Objective	Assessment to Date
1. Achieve similar reduction of concentrations of TCE within each biowall as was demonstrated for the ZVI PRB.	As shown in **Table 7A**, TCE concentration reduction is greater than 99% when comparing the upgradient wells to the wells within the West Biowall. As shown in **Table 9A**, TCE concentration reduction was between 75-99.9% in the ZVI PRB,(comparing the upgradient well to the well within the wall). Overall, the TCE reduction is better consistently in the biowalls.
2. Demonstrate a reduction in total molar chlorinated ethene concentrations in the biowalls and at monitoring locations downgradient of the biowalls that is equal to or greater than that achieved in the ZVI PRB.	As shown in **Table 7A**, the total molar chlorinated ethene reduction is between 86 and 99% when comparing the upgradient wells to the wells within the West Biowall. As shown in **Table 9B**, the total molar chlorinated ethene reduction in the ZVI PRB (comparing the upgradient well to the well within the wall) was between 35-99.4%. Overall, results are better within the biowall.

Objective	Assessment to Date
3. Demonstrate that the biowalls create a treatment zone within and downgradient of the trenches that is favorable to the long-term enhancement of degradation of TCE and its regulated intermediate degradation products.	Zones have already been created within and downgradient of the biowalls. Geochemical data shown in **Table 10** and discussed in this section indicate the presence of these zones. Good chlorinated ethene destruction already observed downgradient of the system in the North Transect as shown in **Table 7B**. Degradation of chlorinated ethenes is occurring in the South Transect at a somewhat slower rate, however, geochemical parameters and trends indicate increased degradation will occur as well.
4. Demonstrate that no chlorinated solvents will exceed NYSDEC GA Standards at the Farm House west of the site at any time during the estimated remediation timeframe.	Sampling of monitoring well MW-56 located upgradient of the Farm House was conducted in Round 2. The results showed no contaminant concentrations exceeding the Class GA groundwater standards. Historic sampling has shown that the wells further downgradient at the farm house are not impacted by chlorinated ethenes. ROD-required monitoring and contingency plan will assure that this Farm House remains unaffected.
5. Evaluate biowall design criteria (e.g., organic carbon generation, degradation rates, residence time) and constructability issues (e.g. trenching techniques, trench stability, oil application, and subsurface pipe placement) required for effective long-term operation.	Sufficient data has been collected during the biowall pilot study to evaluate design parameters in the Remedial Design Report. The location and number of walls, dimensions of the walls, and application of oil will be fully evaluated in this report.

5.2 Discussion of Objectives

As shown in the table above, assessment of the objectives indicates that the use of mulch as the reactive media within the walls is satisfactory.

Objective 1: Achieve similar reduction of concentrations of TCE within each individual biowall as was demonstrated for the ZVI PRB described in the Feasibility Memorandum (Parsons, 2000).

Assessment of Objective 1**:** As shown in **Table 7A**, TCE concentration reduction is greater than 99% when comparing the upgradient wells to the wells within the West Biowall. Reduction in the North Transect has been slightly greater than reduction in the South Transect, although reduction in the South Transect improved during the last sampling round (from 96 to 99%) for the East Biowall. Faster flow rates through the South Transect may be responsible for the lag in reduction efficiency, but results show that this will improve over time.

As shown in **Table 9A**, TCE concentration reduction was between 75-99.9% in the ZVI PRB. Data from the treatability study for the ZVI wall were used in this assessment (1999/2000).

Overall, reduction of TCE concentrations is similar if not better in the biowall.

Objective 2: Demonstrate a reduction in total molar concentrations of chlorinated ethenes in the biowalls and at monitoring locations downgradient of the biowalls. Total molar chlorinated ethene concentrations were calculated and used to assess the treatment efficiency of the biowalls. Concentrations of chlorinated ethenes plus vinyl chloride were converted to their molar equivalents and added together. Total molar chlorinated ethene concentrations at upgradient monitoring wells were compared with those observed in the West Biowall and at downgradient monitoring wells. Results from this biowall pilot study were compared to the molar reduction results that were calculated from concentration measurements performed over time from monitoring wells in and around the ZVI PRB.

Assessment of Objective 2: As shown in **Table 7A**, the total molar chlorinated ethene reduction is between 86 and 99% when comparing the upgradient wells MWT-12R and PT-12A to the wells in the West Biowall (MWT-15 and MWT-20). During the last round of sampling, between 97 and 99% reduction in chlorinated ethenes was observed in both transects. As shown in **Table 9A**, the total molar chlorinated ethene reduction in the ZVI PRB was between 35-99.4%. Reduction is equal to if not greater in the biowalls than the ZVI PRB.

Downgradient of the biowalls, the reduction of total molar chlorinated ethenes varies as shown in **Table 7B**. In the North Transect, reduction immediately downgradient in MWT-16 and further downgradient in MWT-17R ranged from 83 to 92% during the last round of sampling. In the South Transect, the percent reduction does not yet reflect what is occurring within the Western biowall. During the last sampling round, the percent reduction of chlorinated ethenes was between 5 and 18%. As explained in **Section 4.4**, an increase in total molar concentration downgradient of the biowall within the South Transect may be (i) due to the continued desorption of chlorinated ethenes from downgradient soils, or (ii) due to the mixing with untreated groundwater. Less chlorinated compounds are more soluble and less hydrophobic. For example, in the dechlorination sequence of TCE to DCE, solubility goes from 1,100 mg/L for TCE to 3,500 mg/L for cis-DCE (**Table 8**). The organic carbon partition coefficients (K_{oc}), which defines the distribution of chlorinated ethene mass between the sorbed and aqueous phases, also decreases as the level of chlorination decreases. As anaerobic dechlorination proceeds, each successive dechlorination product is more soluble and less susceptible to adsorption than the previous compounds in the sequence. This tendency may result in an increase in aqueous-phase concentrations of chlorinated compounds having fewer chlorine atoms (Payne et al., 2001; Sorenson, 2003).

However, while the transformation of TCE to DCE may result in a temporal accumulation of cDCE in some locations, there remains a significant overall loss of chlorinated ethene mass (greater than 98 percent within the biowalls relative to upgradient locations) as shown in the mass flux calculations provided in **Attachment B**.

Based on the data collected during the ZVI wall pilot study (1999/2000), total molar chlorinated ethene reduction downgradient of the ZVI wall ranged from 41 to 91% (2.5 feet from the biowall). Using the most recent rounds of monitoring results at the ZVI wall (2004), total molar chlorinated ethene reduction ranged from -19 to 79 %. During this round, an increase in total molar chlorinated ethenes was observed in the southern transect of the ZVI wall. This may have been due to desorption of chlorinated ethenes from the soil matrix downgradient of the ZVI wall. These results are shown in **Table 9B**.

One difference between the ZVI wall and the biowall system is the size of the treatment zone. The ZVI wall relies on contact between chlorinated ethenes within the groundwater and an iron matrix of a fixed width. The treatment zone, therefore, is limited to the width of the trench containing the ZVI matrix. In the biowall system, the treatment zone extends beyond the installed width of the biowall. As the TOC migrates out of the installed biowall, a treatment zone is established beyond the wall width. In addition, desorption of the chlorinated ethene mass is enhanced. This increases the effectiveness of the biowall by enhancing the mass transfer of chlorinated ethenes to the aqueous phase, where they are subject to biodegradation processes. The physical and chemical properties of chlorinated ethenes affect many of these processes, and a summary of their properties are listed on **Table 8**. Enhanced dissolution or desorption occurs from several processes, including creating more soluble dechlorination compounds and affecting interfacial tension. More chlorinated ethenes go into solution downgradient of the biowall and treatment of these newly dissolved chlorinated ethenes continues to occur due to the extension of the treatment zone.

Objective 3: Demonstrate that the biowalls create a treatment zone within and downgradient of the trenches that is favorable to the long-term enhancement of degradation of TCE and its regulated intermediate degradation products, *cis*-1,2-DCE and *trans*-1,2-DCE and VC.

***Assessment of Objective 3*:** Parameters indicative of chlorinated compound reduction were reviewed. Levels indicate that zones within and downgradient of the biowalls have been established. Depressed oxygen, nitrate, and sulfate levels indicate that these electron receptors are being exhausted making chlorinated compounds a more favorable electron receptor (leading to its eventual destruction) (EPA, 1998). Increases in carbon dioxide, methane, volatile fatty acids, alkalinity and chlorides indicate that enhanced reductive dechlorination processes are occurring (EPA, 1998).

Figures 4 through **7** show the changes in the fraction of total ethenes from the upgradient wells (MWT-12R and PT-12A) to the most downgradient wells (MW-17R and MWT-22) for Round 2 data and Round 4 data in the North and South Transects. The four sequential dechlorination steps outlined in **Section 4** are shown on the figures to indicate the phase of the dechlorination process that dominates. **Figures 4** and **6** show a snapshot of the dechlorination process for the North and South Transects during Round 2. Reductive dechlorination has proceeded through steps 1 (TCE predominates), 2 (conversion to DCE), and 3 (conversion to VC). In observing the Round 4 data (**Figures 5** and **7**), it is clear that the biowall system has matured and that step four (conversion of VC) is occurring within the biowall system as well as downgradient of the system. The production of ethene is a very positive indicator of complete dechlorination of the chlorinated ethenes present at the site. Ethene and ethane are not only being produced within the biowall system but also in the wells downgradient of the system. If the process resulted in the sole production of VC, ethene levels would not be increasing as they are during the third and fourth sampling rounds. An adequate reaction zone has been established to degrade DCE and VC and this zone extends beyond the biowall system itself.

Objective 4: Demonstrate that no chlorinated solvents will exceed NYSDEC GA Standards at the Farm House west of the site at any time during the estimated remediation timeframe.

Assessment of Objective 4: Sampling conducted in Round 2 included MW-56 located upgradient of the Farm House (1,250 feet upgradient). This well remains unaffected by chlorinated solvents and therefore downgradient wells may be considered unaffected. ROD-required monitoring and contingency plan requirements will assure that down gradient receptors remain unaffected.

Objective 5: Evaluate biowall design criteria (e.g., organic carbon generation, degradation rates, residence time) and constructability issues (e.g. trenching techniques, trench stability, oil application, and subsurface pipe placement) required for effective long-term operation.

Assessment of Objective 5: Based on the results of the biowall study, the following design criteria will be assessed in the Remedial Design Report for this project:

- Trench constructability;
- The number, dimensions and location of the Biowalls to provide adequate coverage of the plume and adequate retention time to meet remedial action objectives.
- Production of other by-products, (e.g. ketones) and any adverse effects downgradient.
- The use and frequency of application of vegetable oil in the process.

Sufficient data has been collected during the pilot study to make a reasonable assessment of the above parameters for the purposes of full scale design.

6 SUMMARY AND PATH FORWARD

Based on the results of the Ash Landfill Biowall Pilot Study, the following conclusions are summarized below:

- TCE concentration reduction between the upgradient wells and the wells within the second biowall (West Biowall) is greater than 99%.
- The total molar chlorinated ethene reduction between the upgradient wells and the wells within the second biowall (West Biowall) is between 86 and 99%.
- Geochemical data and chlorinated ethene reduction indicates that treatment zones have already been established within and downgradient of the dual biowall system. Development of this treatment zone within the South Transect, although present, is lagging the development in the North Transect by about 40 to 50 days.
- The molar fraction of ethene is increasing within and downgradient of the biowall system and is a positive indicator of complete dechlorination of the chlorinated ethenes present at the site. If the process resulted in the sole production of VC, ethene levels would not be increasing as measured during the third and fourth sampling rounds. The presence of VC downgradient of the biowall system is solid evidence that treatment zones have begun to be established downgradient of the biowall system. Destruction of contaminants is occurring beyond the installed treatment system.
- Based on mass flux calculations (**Attachment B)**, ten times as much contaminant mass may be sorbed to the soil as is dissolved in the groundwater. It is possible that at least a portion of the rebound in concentrations of cDCE downgradient of the biowall is simply due to desorption of TCE and transformation to cDCE.
- Observations of geochemical parameters monitored over the duration of the test indicate that advective velocities may be greater than slug test results indicate. Based on the time it took for chemical parameters to be observed at the downgradient wells, it appears that flow through the North Transect may be on the order of 100 ft/yr. Flow through the South Transect may be between 200 and 400 ft/year. Based on these velocities, the residence time through the biowall system (approximately 18 feet) would be 66 days for the North Transect and between 16 and 33 days for the South Transect.
- Sampling of monitoring well MW-56 located upgradient of the Farm House was conducted in Round 2. The results showed no contaminant concentrations exceeding the Class GA groundwater standards.
- Certain ketones are being produced as a result of fermentation reactions within the biowalls. These readily degrade in aerobic conditions and the magnitude of the concentrations of acetone, 2-butanone and 2-hexanone within the biowall anaerobic reaction zone are

decreasing as the levels of TOC and metabolic acids decrease. These ketones have not been detected in the groundwater 150 feet downgradient of the biowalls. Therefore, it is not anticipated that these compounds will adversely impact groundwater quality outside of the immediate biowall treatment zone.

- Sufficient design information has been acquired during the pilot study to proceed with full-scale design.

The five objectives of the biowall pilot study have been met as outlined in **Section 5**. The biowall performance has been shown to be comparable, if not superior to that of the ZVI wall. In light of this information, the Army recommends that full-scale design of a biowall groundwater treatment system for the Ash Landfill commence.

7 REFERENCES

Aziz, C.E., Hampton, M.M., Schipper, M., and P. Haas. 2001. Organic Mulch Biowall Treatment of Chlorinated Solvent-Impacted Groundwater. *Proceedings of the Sixth International Symposium on In-Situ and On-Site Bioremediation, San Diego, California*. Vol. 6(8):73-78. Battelle Press, Columbus, Ohio. June.

Aziz, C.E., M.R. Schipper, and J. Hansen. 2003. *Pilot-Scale Mulch Biowall, Building 301, Offutt AFB, NE*. Case study prepared for the Air Force Center for Environmental Excellence, San Antonio, Texas.

Cowan, D. 2000. Innovative Abatement and Remediation of Perchlorate at McGregor, Texas Weapons Plant Site. *Soil Sediment & Groundwater*, June/July, pp. 25-26.

Domenico, P .A., and F. W. Schwartz. 1990. *Physical and Chemical Hydrogeology*. John Wiley and Sons. New York, NY

Haas, P.E., P. Cork, C.E. Aziz, and M. Hampton. 2000. In Situ Biowall Containing Organic Mulch Promotes Chlorinated Solvent Bioremediation. *Proceedings of the Second International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California*, Vol. 4:71-76. Battelle Press, Columbus, Ohio. May.

Haas, P., J. Gonzales, P. Cork, and B. Henry. 2003. Remedial Performance of Organic Mulch Biowalls at Two Geochemically Distinct Sites. *Proceedings of the 2003 AFCEE Technology Transfer Workshop, San Antonio, Texas*. Air Force Center for Environmental Excellence. February.

Kennedy, L.G., and J. Everett. 2003. *Aqueous and Mineral Intrinsic Bioremediation Analyses (AMIBA) of the Pine Bark Mulch Permeable Barrier at Altus Air Force Base SMU-7 (OU-1).* Draft Report prepared for the Air Force Center for Environmental Excellence, San Antonio, Texas. November.

Lovley, D.R., F.H. Chapelle, and J.C. Woodward. 1994. Use of Dissolved H_2 Concentrations to Determine Distribution of Microbially Catalyzed Redox Reactions in Anoxic Groundwater. *Environmental Science and Technology*, Vol. 28(7):1205-1210.

Parsons Infrastructure & Technology Group, Inc. (Parsons). 2004. *Final Treatability Study Work Plan for Bioremediation of Chlorinated Solvents Using a Permeable Reactive Biowall, Zone D Groundwater, F.E. Warren Air Force Base, Wyoming*. Prepared for the Air Force Center for Environmental Excellence, Brooks City-Base, Texas. June.

Parsons. 2003. *Final Work Plan for a Bioreactor Demonstration at Landfill 3 and Site SS-17, Altus AFB, Oklahoma*. Prepared for The Environmental Security Technology Certification Program and Altus AFB, Oklahoma. Revision 1, September.

Parsons. 2002. *Final Work Plan For In-Situ Bioremediation Of Chlorinated Aliphatic Hydrocarbons Using A Permeable Reactive Biowall Operable Unit 1, Altus Air Force Base, Oklahoma*. Prepared for the Air Force Center For Environmental Excellence, Technology Transfer Division, San Antonio, Texas. April.

Payne, F.C., Suthersan, S.S., Lenzo, F.Z., and Burdick, J.S. 2001. Mobilization of Sorbed-Phase Chlorinated Alkenes in Enhanced Reductive Dechlorination. *In: Proceedings of the Sixth International In Situ and On-Site Bioremediation Symposium.* Battelle Press. 6(2):53-60.

Robertson, W.D. D.W. Blowes, C.J. Ptacek, and J.A. Cherry. 2000. Long-Term Performance of In Situ Reactive Barriers for Nitrate Remediation. *Ground Water*. Vol. 38(5):689-695.

Sorenson, K.S. 2003. Enhanced Bioremediation for Treatment of Chlorinated Solvent Residual Source Areas. In: S.M. Henry and S.D. Warner (Eds.), *Chlorinated Solvent and DNAPL Remediation: Innovative Strategies for Cleanup.* ACS Symposium Series. Vol. 837: 119-131.

TABLES

Table 1
Summary of Monitoring Wells and Sampling Dates
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Round	**Round 1**	**Round 2**		**Round 3**	**Round 4**
Date	Sept. 7-12, 2005	Oct. 24-26, 2005	Dec. 1, 2005	Dec. 12-16, 2005	Jan. 24-28, 2006
North Transect					
MWT-12R	X	X		X	X
MWT-13	X	X		X	X
MWT-14	X	X		X	X
MWT-15	X	X		X	X
MWT-16	X	X		X	X
MWT-17	X	X		X	X
South Transect					
PT-12A	X	X		X	X
MWT-18	X	X		X	X
MWT-19	X	X		X	X
MWT-20	X	X		X	X
MWT-21	X	X		X	X
MWT-22	X	X		X	X
Upgradient Outside of Plume (1)					
MW-39			X	X	
150 feet Downgradient of Biowall (2)					
PT-22			X	X	X
1,250 Feet Upgradient of Farm House (3)					
MW-56		X			

(1) MW-39, a well upgradient of the plume, was sampled to obtain background geochemical parameters for the site outside of the plume. These were needed for comparison purposes at the site and were not originally outlined in the pilot study work plan (Parsons, 2005).

(2) Because the wells furthest downgradient in the pilot study transects (MWT-17R and MWT-22) were showing signs that enhanced biodegradation was beginning to occur after the Round 2, PT-22 (a well further downgradient) was sampled to assess effects further downgradien This well was not part of the monitoring plan as outlined in the pilot study work plan (Parsons, 2005).

(3) MW-56 is the off-site well near the Farm House, downgradient of the biowalls. This well was sampled to determine that the downgradient well remains unaffected by the VOC groundwater plume.

TABLE 2
SUMMARY OF GROUNDWATER ELEVATIONS
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Well/Borehole Identification	Date	Screened Interval (feet bgs)[a/]	Ground Surface (feet amsl)[b/]	Elevation Datum (toc) (feet amsl)	Depth to Water (feet btoc)[c/]	Groundwater Elevation (feet amsl)
Northern Flow Path						
MWT-12R	7-Sep-05	3.9 - 8.9	649.0	651.09	6.80	644.29
	24-Oct-05				2.45	648.64
	12-Dec-05				3.91	647.18
	26-Jan-06				2.80	648.29
MWT-13	7-Sep-05	4.65 - 9.65	648.5	650.83	6.70	644.13
	24-Oct-05				2.15	648.68
	12-Dec-05				3.80	647.03
	26-Jan-06				2.70	648.13
MWT-14	7-Sep-05	4.8 - 9.8	648.8	650.93	7.00	643.93
	24-Oct-05				2.60	648.33
	12-Dec-05				4.25	646.68
	26-Jan-06				3.15	647.78
MWT-15	7-Sep-05	5.25 - 10.25	648.9	651.13	7.35	643.78
	24-Oct-05				2.90	648.23
	12-Dec-05				4.74	646.39
	26-Jan-06				3.55	647.58
MWT-16	7-Sep-05	4.8 - 9.8	648.4	650.61	7.10	643.51
	24-Oct-05				2.75	647.86
	12-Dec-05				4.68	645.93
	26-Jan-06				3.50	647.11
MWT-17R	7-Sep-05	5.4 - 10.4	648.1	650.28	6.95	643.33
	24-Oct-05				2.80	647.48
	12-Dec-05				4.75	645.53
	26-Jan-06				3.55	646.73

TABLE 2
SUMMARY OF GROUNDWATER ELEVATIONS
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Well/Borehole Identification	Date	Screened Interval (feet bgs)[a/]	Ground Surface (feet amsl)[b/]	Elevation Datum (toc) (feet amsl)	Depth to Water (feet btoc)[c/]	Groundwater Elevation (feet amsl)
			(continued)			
Southern Flow Path						
PT-12A	7-Sep-05	4.8 - 9.8	648.7	651.13	6.80	644.33
	24-Oct-05				2.65	648.48
	12-Dec-05				4.12	647.01
	26-Jan-06				3.05	648.08
MWT-18	7-Sep-05	5.4 - 10.4	648.5	650.72	6.45	644.27
	24-Oct-05				2.20	648.52
	12-Dec-05				4.02	646.70
	26-Jan-06				2.75	647.97
MWT-19	7-Sep-05	4.0 - 9.0	648.5	650.65	6.45	644.20
	24-Oct-05				2.40	648.25
	12-Dec-05				4.16	646.49
	26-Jan-06				3.00	647.65
MWT-20	7-Sep-05	5.05 - 10.05	648.8	650.67	6.65	644.02
	24-Oct-05				2.45	648.22
	12-Dec-05				4.25	646.42
	26-Jan-06				3.10	647.57
MWT-21	7-Sep-05	4.35 - 9.35	648.3	650.58	6.70	643.88
	24-Oct-05				2.50	648.08
	12-Dec-05				4.35	646.23
	26-Jan-06				3.10	647.48
MWT-22	7-Sep-05	7.45 - 12.45	648.2	650.66	7.15	643.51
	24-Oct-05				2.53	648.13
	12-Dec-05				5.25	645.41
	26-Jan-06				3.85	646.81

toc = top of casing

[a/] feet bgs indicates feet below ground surface.

[b/] feet amsl indicates elevation in feet above mean sea level.

[c/] feet btoc indicates depth in feet below top of casing.

[d/] NM indicates datum not measured.

Table 3
Range of Hydraulic Conductivities and Linear Velocities for the Ash Landfill
Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

	RI Slug Test Data[1]	2005 Slug Test Data[2]	Geochemical Parameters[3]	Published Values[4]			
				Till	Fine Sand	Silt	Clay
Range of Hydraulic Conductivity, k (cm/sec)	3.9×10^{-5} - 5.3×10^{-4}	2.0×10^{-5} - 2.5×10^{-4}	NA	10^{-10}- 2×10^{-4}	2×10^{-5} - 2×10^{-2}	1×10^{-7} - 2×10^{-3}	1×10^{-9} - 4.7×10^{-7}
Porosity	15%	15%	NA	NA	NA	NA	NA
Gradient (ft/ft)	0.020	0.019-0.049	NA	NA	NA	NA	NA
Linear velocity (ft/year)	45.5 - 60.7	4 - 52	100 - 400	NA	NA	NA	NA

Notes:
1. Values derived from slug testing data of 8 wells from Remedial Investigation (1991)
2. Values derived from slug testing data of wells surrounding biowall based on slug testing data
3. The linear velocity was based on the time it took for certain geochemical parameters to travel a specified distance; the value was not calculated based on a hydraulic conductivity.
4. Domenico, P .A., and F. W. Schwartz. 1990. Physical and Chemical Hydrogeology. John Wiley and Sons. New York, NY.
NA - Not applicable

TABLE 4
GROUNDWATER GEOCHEMICAL DATA
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Sample Location		Dissolved Oxygen (mg/L)	pH (SU)	Oxidation Reduction Potential (mV)	Turbidity (NTU)	Specific Conductance (mS/cm)	Temperature ^{o}C	Manganese (mg/L)	Sulfide (mg/L)	Ferrous Iron (mg/L)	Carbon Dioxide (mg/L)	Alkalinity (mg/L)	Chloride (mg/L)	Nitrate (mg/L-N)	Nitrite (mg/L-N)	Sulfate (mg/L)	Total Organic Carbon (mg/L)	Methane (ug/L)	Ethane (ug/L)	Ethene (ug/L)
MW-39	02-Dec-05	0.31	7.19	76	19.4	0.68	10.7	0	0.05	0.11	400	212	2.8	<0.05	<0.05	27.2	<1.0	0.79	0.006 J	<0.025
(Background)	16-Dec-05	0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PT-22	02-Dec-05	1.0	6.98	57	-2.6	0.812	9.85	1.4	0.02	4	1030	413	19.4	<0.05	<0.05	110	7.8	110	0.017 J	10
(150' Downgrad of	16-Dec-05	0.08	7	-44	8.2	1.34	10.15	0.8	0.01	0.1	981	649	26.6	<0.05	<0.05	88.8	13.4	990	0.14	45
the walls)	24-Jan-06	0.1	7.28	-91	0.2	0.922	7	1.5	0.01	0.17	380	472	16.9	NA	NA	78.3	6.9	970	0.3	30
South Transect																				
PT-12A	07-Sep-05	0.96	7.14	50	0	1.04	18.5	0.3	0	0.04	0.24	313	44.2	0.98	<0.05	325	4.7	1.1	0.1	0.066
(15' Upgradient)	24-Oct-05	0	6.88	32	60	1.36	13.1	0.5	0	0.17	222	420	38	0.98	<0.05	390	4	11.0	0.17	0.18
	12-Dec-05	0.41	7.03	84	7.6	1.38	9.66	0.3	0.01	0.3	152	306	49	<0.05	<0.05	515	2.6	15.0	0.15	0.2
	24-Jan-06	0.39	7.25	93	0.3	1.51	7	1.1	0	0.16	380	320	40.3	NA	NA	585	4.2	26	0.18	0.25
MWT-18	07-Sep-05	1.25	6.57	-178	90.1	4.3	22.9	22*	15.4	4.7	100	2630	128	<0.05	<0.05	71.7	1990	4600	0.52	0.55
(in western wall)	24-Oct-05	0	6.44	-177	102	2.89	16.1	22*	0.19	2.51	980	1700	4.2	<0.05	<0.05	<2.0	777	14000	0.054	0.084
	12-Dec-05	0.1	6.62	-137	116.3	3.56	10.8	22*	0.15	2.49	998	1420	73.4	<0.05	<0.05	<10	918	11000	0.039	0.72
	24-Jan-06	0.06	6.62	-151	76	3.51	8.2	22*	0.26	3.11	1000*	1430	105	NA	NA	<4.0	4.2	19000	0.29	2.7
MWT-19	07-Sep-05	2.19	7.74	-145	0	2.3	22	12.4	0.05	5.1	76.2	846	92.8	<0.05	<0.05	492	208	98	0.18	0.46
(between walls)	24-Oct-05	0	6.79	-226	134	1.79	14.31	5.6	0.04	3.30*	602	940	70.7	<0.05	<0.05	150	42.4	1100	0.29	0.67
	12-Dec-05	0.74	7	-114	9.1	2.12	7.99	3	0.03	2.04	764	999	85.9	<0.05	<0.05	148	48	2100	0.37	7.5
	24-Jan-06	0.06	6.91	-256	30.3	2.11	7.6	7.4	0.07	3.30*	1000*	1145	83.8	NA	NA	80.3	74.05	3850	0.55	115
MWT-20	07-Sep-05	0.12	7.7	-197	80	3.38	22.2	13.2	0.54	2.73	48	2480	73.4	<0.05	<0.05	<2.0	951	7700	0.04	0.22
(in eastern wall)	24-Oct-05	1.07	7.22	-212	127	3.09	17.04	11.9	0.3	3.30*	434	2350	31.3	<0.05	<0.05	<2.0	268	13000	0.01J	0.54
	12-Dec-05	0.07	6.76	-149	389	2.77	10.18	22*	0.14	2.47	938	917	47.2	<0.05	<0.05	<4.0	173	12000	0.042	11
	24-Jan-06	0.07	6.76	-171	53.2	2.48	7	22*	0.11	3.3*	986	995	31.2	NA	NA	<4.0	24.8	18000	0.35	16
MWT-21	07-Sep-05	0.44	7.85	-245	9.1	2.17	19.8	15.8	0.632	4.1	19	118	85.2	<0.05	<0.05	443	165	1000	0.45	0.78
(7.5' downgradient)	24-Oct-05	1.22	7.19	-275	29.5	2.17	15.41	9.4	0.11	3.30*	410	1090	54.6	<0.05	<0.05	156	113	3300	0.26	1.7
	12-Dec-05	0.04	6.8	-235	40.2	2.37	9.3	0.6	-	2.06	936	1500	59.8	<0.05	<0.05	199	70.1	6100	0.38	83
	24-Jan-06	0.1	8.02	-273	34	2.16	7.3	10.9	0.28	2.41	920	940	37.3	NA	NA	114	53.5	11,000	0.85	100
MWT-22	07-Sep-05	0.45	8.1	-180	32.2	2.31	17.8	22	0.269	4.73	15	1030	154	<0.05	<0.05	278	361	1300	1.7	3.4
(22.5' downgradient)	24-Oct-05	1.28	7.35	-228	30	2.07	13.6	6.1	0.04	2.68	484	1115	110	<0.05	<0.05	296	33.2	1900	1.2	3.5
	12-Dec-05	0.04	6.82	-206	20	2.15	9	0.7	0.06	2.27	996	861	78.6	<0.05	<0.05	282	34.5	1900	1.2	95
	24-Jan-06	0.15	6.72	-104	60	2.03	8.3	6.1	0.05	2.3	722	731	63.5	NA	NA	370	35.5	2300	1.2	93

TABLE 4
GROUNDWATER GEOCHEMICAL DATA
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Sample Location		Dissolved Oxygen (mg/L)	pH (SU)	Oxidation Reduction Potential (mV)	Turbidity (NTU)	Specific Conductance (mS/cm)	Temperature ^{o}C	Manganese (mg/L)	Sulfide (mg/L)	Ferrous Iron (mg/L)	Carbon Dioxide (mg/L)	Alkalinity (mg/L)	Chloride (mg/L)	Nitrate (mg/L-N)	Nitrite (mg/L-N)	Sulfate (mg/L)	Total Organic Carbon (mg/L)	Methane (ug/L)	Ethane (ug/L)	Ethene (ug/L)
North Transect																				
MWT-12R	07-Sep-05	1.67	7.32	10	0	1.54	22.1	1	0.01	0.41	19	304	108.1	0.11	<0.05	732	7.3	23	0.35	1.52
(15' Upgradient)	24-Oct-05	0	6.86	27	1	2.08	13.65	0.8	0.01	0.05	340	800	120	<0.05	<0.05	767	4.9	97	0.63	2.25
	12-Dec-05	0.84	6.92	36	16.1	1.94	8.43	1	0.1	0.22	<500	301	116	<0.05	<0.05	903	3.7	140	1.3	3.6
	24-Jan-06	0.56	6.95	54	0.73	2.09	7.4	1	0.03	0	656	296	169	NA	NA	741	3.8	150	0.85	2.7
MWT-13	07-Sep-05	0	6.01	-220	90	6.44	20.5	22*	0.61	0.01	115	183	199	<0.05	<0.05	<20	296	3100	0.5	0.93
(in western wall)	24-Oct-05	0	6.47	-158	85.5	4.38	15.38	22	0.24	2.81	1000	2530	13.2	<0.05	<0.05	<2.0	1310	10000	0.11	0.15
	12-Dec-05	0.06	6.55	-169	492	3.16	10.55	22*	0.2	3.15	3370	10 U	66	<0.05	<0.05	<4.0	588	12000	<0.025	0.8
	24-Jan-06	0.11	6.54	-150	47.5	3.29	7.4	22*	0.19	3.30*	1000*	731	97.4	NA	NA	<4.0	298	14000	0.078	6.8
MWT-14	07-Sep-05	0	6.72	-177	0	2.96	21.1	22*	0.1	0.04	19.2	1240	139	<0.05	<0.05	631	610	31	0.15	0.26
(between walls)	24-Oct-05	1.08	7.19	-252	39.1	2.66	14.83	22*	0.11	3.30*	1000	1450	65.9	<0.05	<0.05	69.9	432	6100	0.1	0.34
	12-Dec-05	0.17	6.3	-165	342	2.43	11.5	22*	0.13	3.30*	2750	1170	77.6	<0.05	<0.05	53.8	275	14000	0.22	89
	24-Jan-06	0.15	6.59	-113	220	2.61	6.7	22*	0.18	2.7	1000*	879	61.3	NA	NA	51.9	209	14000	2.4	190
MWT-15	07-Sep-05	0	6.9	-199	63	3.88	20.6	22*	0.31	5.1	57	2020	106	<0.05	<0.05	<4.0	1060	8100	0.031	0.28
(in eastern wall)	24-Oct-05	1.05	7.27	-206	53.1	3.21	16.48	17.6	0.16	2.81	960	1900	6.5	<0.05	<0.05	<2.0	267	10000	<0.008	1.9
	12-Dec-05	0.06	6.28	-159	266	1.87	11.08	22*	0.14	2.61	-	774	31	<0.05	<0.05	<10.0	86.7	17000	0.99	16
	24-Jan-06	0.16	6.76	-150	200	1.56	6.5	22*	0.09	2.44	1000*	515	22.1	NA	NA	33.2	46.6	28000	4.3	15
MWT-16	07-Sep-05	1.7	7.1	-119	0	1.55	20.4	1	0.3	0.83	16	551	75.4	0.76	<0.05	345	63.5	23	0.081	0.14
(7.5' downgradient)	24-Oct-05	1.35	7.13	-175	52.2	2.28	14.4	7.3	0.13	2.24	1018	1300	6.7	<0.05	<0.05	2	204	4800	0.19	2.2
	12-Dec-05	0	6.45	-160	61.2	1.94	10.69	22*	0.14	3.30*	1082	1050	57	<0.05	<0.05	16.9	88.6	6200	0.68	72
	24-Jan-06	0.18	6.65	-128	37	2.1	7.9	22*	0.02	2.58	966	929	38.7	NA	NA	27.8	51.7	11000	5.3	120
MWT-17R	07-Sep-05	1.25	7.28	60	0	1.3	20.7	0.1	0.7	0	25	351	62.8	0.84	<0.05	408	9.3	1.1	0.085	0.21
(22.5' downgradient)	24-Oct-05	0	6.75	-27	25.5	1.8	13.8	5.2	0.1	0.2	544	1005	37.8	0.34	<0.05	80.5	111	1000	0.049	0.58
	12-Dec-05	0	6.39	-126	93.9	1.72	8.7	3.3	0.08	0.8	820	1180	37.8	<0.05	<0.05	43.8	63.8	4700	0.38	42
	24-Jan-06	0.29	7.56	-156	22.4	1.64	6.7	15.2	0.07	3.30*	960	781	23.7	NA	NA	58.5	29.8	7300	1.4	51

* Over the limit of the test reagent
- Parameter could not be measured

TABLE 5
VOLATILE FATTY ACIDS IN GROUNDWATER
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Sample Location		Acetic Acid (mg/L)	Butyric Acid (mg/L)	Hexanoic Acid (mg/L)	Pentanoic Acid (mg/L)	Propionic Acid (mg/L)	Pyruvic Acid (mg/L)	Total VFAs (mg/L)	Total Organic Carbon (mg/L)
South Transect									
PT-12A	07-Sep-05	0.129	<0.07	<0.1	<0.07	<0.07	<0.07	0.129	4.7
(15' Upgradient)	24-Oct-05	0.177	<0.07	<0.07	<0.07	<0.07	<0.07	0.177	4
	12-Dec-05	0.068	<0.07	<0.1	<0.07	<0.07	<0.07	0.068	2.6
	24-Jan-06	0.048	<0.07	<0.1	<0.07	<0.07	<0.07	0.048	4.2
MWT-18	07-Sep-05	1820	296	62	244	1190	<70	3612	1990
(in western wall)	24-Oct-05	66.2	27.5	NA	81.5	794	<0.07	969	777
	12-Dec-05	99.1	16.4	<10	13.7	1030	<7	1159.2	918
	24-Jan-06	483	18.5	1.28	14.2	497	<0.7	1014	726
MWT-19	07-Sep-05	148	25.8	<10	21.7	204	<7	399.5	208
(between walls)	24-Oct-05	40.6	1.63	NA	1.92	71.5	<0.07	115.6	42.4
	12-Dec-05	15.7	0.94	<0.1	0.348	32.2	<0.07	49.2	48
	24-Jan-06	52.9	0.9	<0.1	0.4	28.1	<0.7	82.3	74.1
MWT-20	07-Sep-05	76.5	21.8	<10	36.4	313	<7	447.7	951
(in eastern wall)	24-Oct-05	51.1	1.16	NA	0.212	48.8	<0.07	101.3	268
	12-Dec-05	48.5	0.873	<0.1	0.256	16.9	<0.07	66.5	173
	24-Jan-06	292	2.05	0.116	<0.7	29	<0.7	323.2	24.8
MWT-21	07-Sep-05	192	8.32	<10	10.5	105	<7	315.8	165
(7.5' downgradient)	24-Oct-05	45.2	<0.7	NA	<0.7	18.8	<0.7	64	113
	12-Dec-05	26.7	0.484	<0.1	<0.7	3.04	<0.7	30.2	70.1
	24-Jan-06	33.2	0.36	<0.1	<0.07	<0.07	<0.07	33.6	53.5
MWT-22	07-Sep-05	521	18.1	<0.1	21	260	<7	820.1	361
(22.5' downgradient)	24-Oct-05	78.6	0.979	NA	1.02	29.9	<0.07	110.5	33.2
	12-Dec-05	28.5	0.683	<0.1	0.928	9.89	<0.07	40.0	34.5
	24-Jan-06	3.6	0.1	<0.1	<0.07	0.429	<0.07	4.1	35.5
North Transect									
MWT-12R	07-Sep-05	0.592	<0.07	<0.1	<0.07	<0.07	<0.07	0.592	7.3
(15' Upgradient)	24-Oct-05	1.39	0.07	NA	<0.07	0.28	<0.07	1.74	4.9
	12-Dec-05	0.064	<0.07	<0.1	<0.07	<0.07	<0.07	0.064	3.7
	24-Jan-06	0.208	<0.07	<0.1	<0.07	<0.07	<0.07	0.208	3.8
MWT-13	07-Sep-05	4520	462	<100	364	2580	<70	7926	296
(in western wall)	24-Oct-05	82.9	<70	NA	144	3890	11.2	4128.1	1310
	12-Dec-05	200	9.85	<1	8.73	622	<7	840.58	588
	24-Jan-06	498	16.3	1.21	6.39	201	<7	722.9	298
MWT-14	07-Sep-05	710	79.6	<10	67.5	502	<7	1359	610
(between walls)	24-Oct-05	342	8.91	NA	31.1	406	<7	788.01	432
	12-Dec-05	139	5.66	<1	2.9	265	<0.7	412.56	275
	24-Jan-06	211	3.82	<0.1	1.26	78.9	<0.7	295	209
MWT-15	07-Sep-05	106	42.4	<10	73	1040	<7	1261	1060
(in eastern wall)	24-Oct-05	49.3	<0.7	NA	<0.7	47.9	<0.07	97.2	267
	12-Dec-05	65.7	0.374	<0.1	<0.07	17	<0.07	83.1	86.7
	24-Jan-06	54.6	<0.7	<0.1	<0.7	5.43	<0.7	60.03	46.6
MWT-16	07-Sep-05	37.4	<7	<0.1	<7	53.6	<7	91	63.5
(7.5' downgradient)	24-Oct-05	66.6	1.7	NA	0.8	92.2	<0.07	161.3	204
	12-Dec-05	49.7	0.428	<0.1	<0.07	9.3	<0.07	59.4	88.6
	24-Jan-06	22.6	0.16	<0.1	<0.07	<7	<0.07	22.76	51.7
MWT-17R	07-Sep-05	0.065J	0.098	<0.1	<0.07	<0.07	<0.07	0.163	9.3
(22.5' downgradient)	24-Oct-05	48.7	0.7J	NA	0.317	41.2	<0.7	90.9	111
	12-Dec-05	31	0.136	<0.1	<0.07	<7	<0.07	31.1	63.8
	24-Jan-06	7.61	<0.07	<0.1	<0.07	<7	<0.07	7.61	29.8
MWT-22A	07-Sep-05	NA	NA	NA	NA	NA	NA	NA	NA
	24-Oct-05	NA	NA	NA	NA	NA	NA	NA	NA
	12-Dec-05								
	24-Jan-06	0.059	<0.07	<0.1	<0.07	<0.07	<0.07	0.059	6.9

TABLE 6
VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Sample Identification	Sample Date	PCE ug/L	TCE ug/L	1,1-DCE ug/L	*cis*-1,2-DCE ug/L	*trans*-1,2-DCE ug/L	VC ug/L	1,1-DCA ug/L	Acetone ug/L	2-Butanone ug/L	2-Hexanone ug/L
South Transect											
PT-12A	07-Sep-05	50 U	860	50 U	910	50 U	50 U	50 U	50 U	50 U	50 U
(15' Upgradient)	24-Oct-05	1 U	730	1.3	800	11	24	1 U	5 U	5 U	5 U
	12-Dec-05	1 U	385	0.55 J	315	4.9	8.2	1 U	5 U	5 U	5 U
	24-Jan-06	1 U	530	1 U	400	5.6	19	1 U	50 U	50 U	13 J
MWT-18	07-Sep-05	50 U	28 J	50 U	120	50 U	50 U	50 U	1200 J	2500 J	27 J
(in western wall)	24-Oct-05	20 U	20 U	20 U	190	20 U	20 U	20 U	3000	4400	100 U
	12-Dec-05	5 U	5 U	5 U	230	5 U	23	5 U	4700 J	7600	49
	24-Jan-06	20 U	20 U	20 U	150	20 U	26	20 U	1800	5800	100 U
MWT-19	07-Sep-05	10 U	110	2 J	1300	13	17	10 U	370	600	4 J
(between walls)	24-Oct-05	5 U	33	5 U	1600	21	18	5 U	190	200	25 U
	12-Dec-05	5 U	17	2.1 J	1000	17	140 J	5 U	180	330	25 U
	24-Jan-06	1U	22	1.4	870	20	345	1 U	170 J	455 J	5.7 J
MWT-20	07-Sep-05	250 U	250 U	250 U	160 J	250 U	250 U	250 U	3200	1700	250 U
(in eastern wall)	24-Oct-05	5 U	5 U	5 U	160	2.9 J	16	5 U	270 J	990 J	34
	12-Dec-05	5 U	5 U	5 U	13	2.2 J	13 J	5 U	200	260	25 U
	24-Jan-06	1 U	1 U	1 U	8.4	1.8	9.1	1 U	410 J	660	17 J
MWT-21	07-Sep-05	100 U	98 J	100 U	1200	100 U	100 U	100 U	250	270	100 U
(7.5' downgradient)	24-Oct-05	1 U	45	2.4 J	1400	38	69	1 U	350 J	310 J	6
	12-Dec-05	5 U	20	5 U	570	22	180	5 U	73	66	25 U
	24-Jan-06	1 U	18	0.74 J	470	20	180	1 U	130 J	110 J	5 UJ
MWT-22	07-Sep-05	100 U	100 U	100 U	1000	100 U	100 U	100 U	400	480	100 U
(22.5' downgradient)	24-Oct-05	5 U	25	5 U	1100	17	170	5 U	340	310	25 U
	12-Dec-05	5 U	12	5 U	360	11	140	5 U	66	89	25 U
	24-Jan-06	1 U	25	0.72 J	430	13	140	1 U	14 J	12 J	5 UJ
North Transect											
MWT-12R	07-Sep-05	80 U	705	80 U	965	80 U	86	80 U	80 U	80 U	80 U
(15' Upgradient)	24-Oct-05	1 U	725	2.7	895	23	85	1 U	3.5 J	5 U	5 U
	12-Dec-05	1 U	760	2.9	980	21	64	1 U	3.8 J	5 U	5 U
	24-Jan-06	1 U	540	2.3	650	17	67	1 U	5.6 J	5 UJ	5 UJ
MWT-13	07-Sep-05	250 U	250 U	250 U	320	250 U	250 U	250 U	1600	2700	250 U
(in western wall)	24-Oct-05	20 U	20 U	20 U	410	20 U	20 U	20 U	8000	9300	100 U
	12-Dec-05	10 U	10 U	10 U	220	10 U	41	10 U	4900	6000	62
	24-Jan-06	1 U	1 U	1 U	52	1.9	55	1 U	1600	2000	38 J
MWT-14	07-Sep-05	50 U	170	50 U	1000	50 U	50 U	50 U	660	910	50 U
(between walls)	24-Oct-05	10 U	10 U	10 U	1600	22	10	10 U	2800	2900	50 U
	12-Dec-05	10 U	10 U	10 U	550	15	230	10 U	2300	2800	36 J
	24-Jan-06	1 U	2	1 U	140	11	340	1 U	770	930	17 J
MWT-15	07-Sep-05	50 U	50 U	50 U	170	50 U	50 U	50 U	3400	820	50 U
(in eastern wall)	24-Oct-05	20 U	20 U	20 U	140	20 U	36	20 U	140	690	100 U
	12-Dec-05	5 U	5 U	5 U	15	2.6 J	10	5 U	130	140	25 U
	24-Jan-06	1 U	1 U	1 U	3.1	2.2	5	1 U	55 J	33 J	5 UJ
MWT-16	07-Sep-05	20 U	70	20 U	160	20 U	20 U	20 U	270	120	20 U
(7.5' downgradient)	24-Oct-05	20 U	9.5 J	20 U	380	20 U	51	20 U	740	750	100 U
	12-Dec-05	5 U	2.5 J	5 U	58	5.3	31	5 U	85	210	25 U
	24-Jan-06	1 U	2.9	1 U	43	5.4	31	1 U	24 J	15 J	5 UJ
MWT-17R	07-Sep-05	10 U	33	10 U	59	10 U	10 U	10 U	10 U	10 U	10 U
(22.5' downgradient)	24-Oct-05	1 U	16	1 U	380	5.9	19	1 U	430 J	290 J	3.6 J
	12-Dec-05	5 U	4.8 J	5 U	120	4.4 J	42	5 U	79	180	25 U
	24-Jan-06	1 U	12	1 U	97	4.2	60	1 U	11	6.2	5 U
Downgradient Well											
PT-22	01-Dec-05	1 U	46	1 U	120	2.3	17	1 U	5 UJ	5 UJ	5 UJ
	12-Dec-05	1 U	42	1 U	160 J	3.8	30	1 U	3.8 J	5 U	5 U
	24-Jan-06	1 U	37	1 U	110	2.6	26	1 U	5 UJ	5 UJ	5 UJ
MW-56 (off-site well)	24-Oct-05	1 U	1 U	1 U	1.8	1 U	1 U	1 U	4.3 J	5 U	5 U

Note:
1) Sample duplicate pairs were collected for MWT-12R in Sep-05 and Oct-05, for PT-12A in Dec-05, and MWT-19 for Jan-06 sampling events. Non-detected values were reported at full value. If an analyte was detected in the sample but not detected in the duplicate (or vice versa), the non-detect value was taken at half and averaged with the detected value.

TABLE 7A
PERCENT REDUCTIONS OF TCE AND TOTAL CHLOROETHENES
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Reductions in Concentration of TCE [a/]

	Northern Flow Path			**Southern Flow Path**		
Date	TCE MWT-12R (µg/L)[b/]	TCE MWT-15 (µg/L)	Percent Reduction TCE	TCE PT-12A (µg/L)	TCE MWT-20 (µg/L)	Percent Reduction TCE
September-05	705	<1.6	**99.9%**	860	<8.1	**99.5%**
October-05	725	<10	**99.3%**	730	<2.5	**99.8%**
December-05	760	<5	**99.7%**	400	<5	**99.4%**
January-06	540	<1	**99.9%**	530	<1	**99.9%**

Reductions in Molar Concentration of Total Chloroethenes

	Northern Flow Path			**Southern Flow Path**		
Date	Total Molar Chlorethenes MWT-12R (nmol/L)[c/]	Total Molar Chlorethenes MWT-15 (nmol/L)c/	Percent Reduction Total Molar Chloroethenes	Total Molar Chlorethenes PT-12A (nmol/L)[c/]	Total Molar Chlorethenes MWT-20 (nmol/L)c/	Percent Reduction Total Molar Chloroethenes
September-05	16,731	1,791	**89.3%**	15,964	1,838	**88.5%**
October-05	16,190	2,192	**86.5%**	14,321	1,966	**86.3%**
December-05	17,167	401	**97.7%**	6,370	425	**93.3%**
January-06	12,089	147	**98.8%**	8,530	263	**96.9%**

[a/] TCE = trichloroethene

[b/] µg/L = micrograms per liter.

[c/] nmol/L = nanomoles per liter.

TABLE 7B
PERCENT REDUCTIONS OF TCE AND TOTAL CHLOROETHENES
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Northern Flow Path - Downgradient

Reductions in Concentration of TCE [a/]

	Immediately Downgradient			Further Downgradient		
Date	TCE MWT-12R (µg/L)[b/]	TCE MWT-16 (µg/L)	Percent Reduction TCE	TCE MWT-12R (µg/L)[b/]	TCE MWT-17R (µg/L)	Percent Reduction TCE
September-05	705	70	**90.1%**	705	33	**95.3%**
October-05	725	9.5	**98.7%**	725	16	**97.8%**
December-05	760	<5	**99.7%**	760	4.8	**99.4%**
January-06	540	2.9	**99.5%**	540	12	**97.8%**

Reductions in Molar Concentration of Total Chloroethenes

	Immediately Downgradient			Further Downgradient		
Date	Total Molar Chlorethenes MWT-12R (nmol/L)[c/]	Total Molar Chlorethenes MWT-16 (nmol/L)	Percent Reduction Total Molar Chloroethenes	Total Molar Chlorethenes MWT-12R (nmol/L)[c/]	Total Molar Chlorethenes MWT-17R (nmol/L)	Percent Reduction Total Molar Chloroethenes
September-05	16,731	2,196	**86.9%**	16,731	866	**94.8%**
October-05	16,190	4,942	**69.5%**	16,190	4,411	**72.8%**
December-05	17,167	1,209	**93.0%**	17,167	2,033	**88.2%**
January-06	12,089	1,026	**91.5%**	12,089	2,103	**82.6%**

[a/] TCE = trichloroethene
[b/] µg/L = micrograms per liter.
[c/] nmol/L = nanomoles per liter.

TABLE 7B
PERCENT REDUCTIONS OF TCE AND TOTAL CHLOROETHENES
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Southern Flow Path - Downgradient

Reductions in Concentration of TCE [a]

Date	Immediately Downgradient			Immediately Downgradient		
	TCE PT-12A (µg/L)	TCE MWT-21 (µg/L)	Percent Reduction TCE	TCE PT-12A (µg/L)	TCE MWT-22 (µg/L)	Percent Reduction TCE
September-05	860	98	**88.6%**	860	<3.2	**99.8%**
October-05	730	45	**93.8%**	730	25	**96.6%**
December-05	385	20	**94.8%**	385	12	**96.9%**
January-06	530	18	**96.6%**	530	25	**95.3%**

Reductions in Molar Concentration of Total Chloroethenes

Date	Immediately Downgradient			Further Downgradient		
	Total Molar Chlorethenes PT-12A (nmol/L)[c]	Total Molar Chlorethenes MWT-21 (nmol/L)	Percent Reduction Total Molar Chloroethenes	Total Molar Chlorethenes PT-12A (nmol/L)[c]	Total Molar Chlorethenes MWT-22 (nmol/L)	Percent Reduction Total Molar Chloroethenes
September-05	15,964	13,187	**17.4%**	15,964	10,391	**34.9%**
October-05	14,321	16,307	**-13.9%**	14,321	14,453	**-0.9%**
December-05	6,370	9,180	**-44.1%**	6,370	6,199	**2.7%**
January-06	8,530	8,082	**5.2%**	8,530	7,011	**17.8%**

[a] TCE = trichloroethene

[b] µg/L = micrograms per liter.

[c] nmol/L = nanomoles per liter.

Table 8
Characteristics of Chlorinated Aliphatic Hydrocarbons and Dechlorination Products
Ash Landfill Mulch Biowall
Seneca Army Depot Activity, Romulus, NY

Compound	Molecular Formula	Molecular Weight (g/mol)[a/]	Density (g/mL @ approx. 20 to 25 °C)[b/]	Henry's Law Constant (atm-m^3/mol)[e/]	Solubility (mg/L @ approx. 20 to 25 °C)[c/]	Vapor Pressure (mm Hg @ 20 °C)[d/]	Octanol/Water Partition Coefficient (log Kow)[f/]	Octanol/Carbon Partition Coefficient (log Koc)[g/]
Chloroethenes								
Trichloroethene (TCE)	C_2HCl_3	131.4 (1)	1.46 (1)	0.0072 (2)	1,100 (3)	60.0 (3)	2.42 (4)	2.03 (5)
cis-1,2- Dichloroethene (*cis*-DCE)	$C_2H_2Cl_2$	96.94 (1)	1.28 (1)	0.0030 (2)	3,500 (3)	200 (6)	0.70	1.65 (7)
trans-1,2- Dichloroethene (*trans*-DCE)	$C_2H_2Cl_2$	96.94 (1)	1.26 (1)	0.0073 (2)	6,300 (4)	340 (6)	2.06 (7)	1.77 (5)
1,1-Dichloroethene (1,1-DCE)	$C_2H_2Cl_2$	96.94 (1)	1.22 (1)	0.021 (2)	2,250 (5)	500 (3)	2.13 (4)	1.81 (5)
Vinyl Chloride (VC)	C_2H_3Cl	62.51 (1)	Gas	0.218 (2)	1,100 (3)	2,660 (3)	0.60 (4)	1.23 (5)
Ethene	C_2H_4	28.05 (1)	Gas	8.60 (7)	131 (7)	30,800 (7)	1.13 (8)	2.48 (7)
Chloroethanes								
1,1,1-Trichloroethane (1,1,1-TCA)	$C_2H_3Cl_3$	133.4 (1)	1.34 (1)	0.0133 (2)	4,400 (3)	100 (3)	2.47 (4)	2.02 (5)
1,1,2-Trichloroethane (1,1,2-TCA)	$C_2H_3Cl_3$	133.4 (1)	1.44 (1)	0.0012 (7)	4,500 (3)	19 (3)	2.18 (4)	1.75 (5)
1,1-Dichloroethane (1,1-DCA)	$C_2H_4Cl_2$	98.96 (1)	1.18 (1)	0.0043 (2)	5,500 (3)	180 (3)	1.78 (4)	1.48 (5)
1,2-Dichloroethane (1,2-DCA)	$C_2H_4Cl_2$	98.96 (1)	1.24 (1)	0.00098 (6)	8,690 (3)	61 (3)	1.48 (4)	1.28 (5)
Chloroethane (CA)	C_2H_5Cl	64.51 (1)	Gas	0.0094 (2)	5,740 (3)	1,010 (3)	1.43 (4)	1.42 (7)
Ethane	C_2H_6	30.07 (1)	Gas	19.2 (7)	60.4 (3)	29,300 (3)	1.81 (8)	2.66 (7)

[a/] g/mol = grams per mole.
[b/] g/ml = grams per milliliter; °C = degrees Celsius.
[c/] mg/L = milligrams per liter.
[d/] mm Hg = vapor pressure measured as millimeters of mercury.
[e/] atm-m^3/mol = atmospheres-cubic meter per mole.
[f/] log Kow = log of octanol/water partition coefficient (dissolution coefficient).
[g/] log Koc = log of octanol/carbon coefficient (soil sorption coefficient).

References:

(1) Weast, R.C., M.J. Astle, and W.H. Beyer (eds.). 1989. *CRC Handbook of Chemistry and Physics*. 75th ed. Boca Raton, FL: CRC Press. 75th ed.

(2) Gossett, J.M. 1987. Measurement of Henry's Law Constants for C1 and C2 Chlorinated Hydrocarbons. *Environmental Science & Technology*, Vol. 21(2):202-208.

(3) Verschueren, K. 1983. *Handbook of Environmental Data on Organic Chemicals*. 2nd ed. New York: Van Nostrand Reinhold.

(4) Montgomery, J.H. 1996. *Groundwater Chemicals Desk Reference*. 2nd ed. Chelsea, MI: Lewis.

(5) Montgomery, J.H., and L.M. Welkom. 1990. *Groundwater Chemicals Desk Reference*. Chelsea, MI: Lewis.

(6) Howard, P.H., G.W. Sage, W.F. Jarvis, and D.A. Gray. 1990. *Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Vol. II – Solvents*. Chelsea, MI: Lewis.

(7) Estimated using Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. 1990. *Handbook of Chemical Property Estimation Methods*. Washington, DC: American Chemical Society.

(8) Hansch, C, A. Leo, and D. Hoekman. 1995. *Exploring QSAR – Hydrophobic, Electronic, and Steric Constants*. Washington, DC: American Chemical Society.

(9) Grathwohl, P. 1990. Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons. Environmental Science & Technology, Vol. 24:1687-1693.

TABLE 9A

PERCENT REDUCTIONS IN TCE AND TOTAL CHLOROETHENES IN THE ZVI WALL
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Within Walls

Reductions in Concentration of TCE [a/]

Date	North Transect			Middle Transect			South Transect		
	TCE MWT-1 (µg/L)[b/]	TCE MWT-2 (µg/L)	Percent Reduction TCE	TCE MWT-4 (µg/L)	TCE MWT-5 (µg/L)	Percent Reduction TCE	TCE MWT-7 (µg/L)	TCE MWT-8 (µg/L)	Percent Reduction TCE
TS Rounds									
April-99	23	1	**95.7%**	2	<1	**75.0%**	430	<1	**99.9%**
June-99	8	<1	**93.8%**	2	<1	**75.0%**	530	<2	**99.8%**
September-99	<2	<1	**N/A**	<3	<1	**N/A**	480	<1	**99.9%**
January-00	18	<2	**94%**	<3	<1	**N/A**	480	<3	**99.7%**
Latest Rounds									
March-04	17	3.2	**81.4%**	2.6	<0.5	**90.4%**	386	<0.5	**99.9%**
August-04	22	0.8	**96.4%**	3.9	<0.24	**96.9%**	280	1.8	**99.4%**

Reductions in Molar Concentration of Total Chloroethenes

Date	Northern Transect			Middle Transect			Southern Transect		
	Total Molar Chlorethenes MWT-1 (nmol/L)[c/]	Total Molar Chlorethenes MWT-2 (nmol/L)[c/]	Percent Reduction Total Molar Chloroethenes	Total Molar Chloroethenes MWT-4 (nmol/L)	Total Molar Chlorethenes MWT-5 (nmol/L)	Percent Reduction Total Molar Chloroethenes	Total Molar Chloroethenes MWT-7 (nmol/L)	Total Molar Chlorethenes MWT-8 (nmol/L)	Percent Reduction Total Molar Chloroethenes
TS Rounds									
April-99	981	299	**69.5%**	560	24	**95.7%**	3,768	22	**99.4%**
June-99	417	79	**81.1%**	914	231	**74.7%**	4,772	467	**90.2%**
September-99	81	21	**74.1%**	457	66	**85.6%**	4,352	87	**98.0%**
January-00	924	267	**71.1%**	643	87	**86.5%**	4,222	612	**85.5%**
Latest Rounds									
March-04	565	216	**61.8%**	700	134	**80.9%**	3,159	898	**71.6%**
August-04	1,260	178	**85.9%**	676	60	**91.1%**	2,463	1,593	**35.3%**

[a/] TCE = trichloroethene
[b/] µg/L = micrograms per liter.
[c/] nmol/L = nanomoles per liter.

TABLE 9B

PERCENT REDUCTIONS IN TCE AND TOTAL CHLOROETHENES IN ZVI WALL
ASH LANDFILL MULCH BIOWALL
SENECA ARMY DEPOT, ROMULUS, NEW YORK

Downgradient of Wall

Reductions in Molar Concentration of Total Chloroethenes

	Northern Transect			**Middle Transect**			**Southern Transect**		
Date	Total Molar Chlorethenes MWT-1 (nmol/L)[c/]	Total Molar Chlorethenes MWT-3 (nmol/L)[c/]	Percent Reduction Total Molar Chloroethenes	Total Molar Chloroethenes MWT-4 (nmol/L)	Total Molar Chlorethenes MWT-6 (nmol/L)	Percent Reduction Total Molar Chloroethenes	Total Molar Chloroethenes MWT-7 (nmol/L)	Total Molar Chlorethenes MWT-9 (nmol/L)	Percent Reduction Total Molar Chloroethenes
TS Rounds									
April-99	981	312	**68.2%**	560	48	**91.4%**	3,768	684	**81.8%**
June-99	417	122	**70.7%**	914	196	**78.6%**	4,772	2,048	**57.1%**
September-99	81	35	**56.8%**	457	128	**72.0%**	4,352	862	**80.2%**
January-00	924	543	**41.2%**	643	118	**81.6%**	4,222	730	**82.7%**
Latest Rounds									
March-04	565	307	**45.7%**	700	144	**79.4%**	3,159	1,506	**52.3%**
August-04	1,260	410	**67.5%**	676	193	**71.4%**	2,463	2,922	**-18.6%**

[a/] TCE = trichloroethene
[b/] μg/L = micrograms per liter.
[c/] nmol/L = nanomoles per liter.

Table 10
Treatment Zone Indicator Parameters
Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

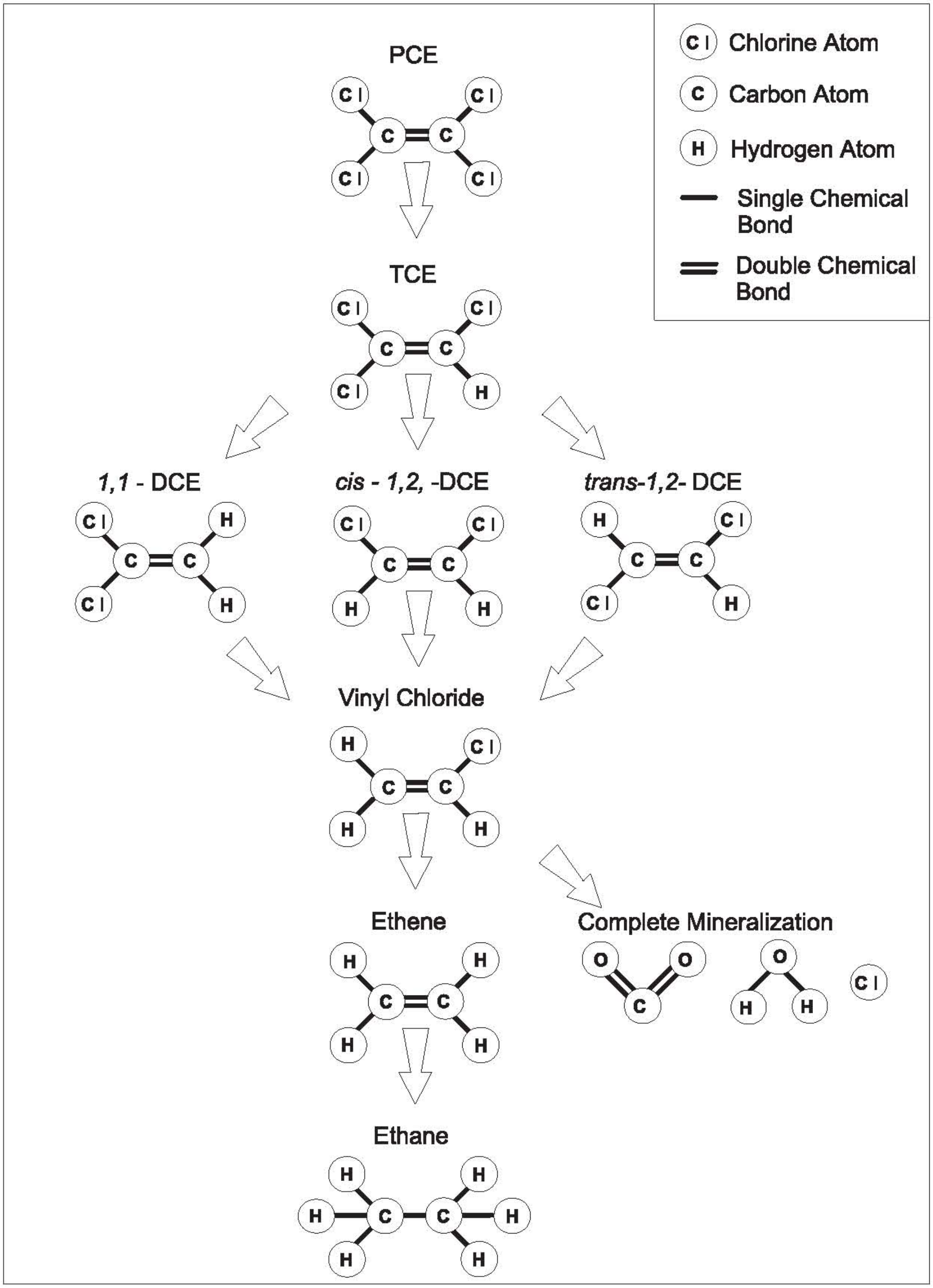
NORTH TRANSECT		MW-39	MWT-12R	MWT-13 & MWT-15	MWT-14 & MWT-16 Treatment Zone Immediately	MWT-17R Further	PT-22 Further
Parameter	Indicator Value [1]	Background	Upgradient	Average In Walls	Downgradient	Downgradient	Downgradient
Dist. from Biowall (ft.)		N/A	-15	0	7.5	22.5	~140
Oxygen	<0.5 mg/L	0.31	0.56	0.14	0.17	0.29	0.1
Iron (ferrous)	>1.0 mg/L	4	0	2.87	2.64	3.3	0.17
Sulfate	<20 mg/L	27.2	741	17.6	39.9	58.5	78.3
CO_2	>2x background	400	656	1,000	983	960	380
ORP	<-100 mV	76	54	-150	-121	-156	-91
Methane	>500 ug/L	0.79	150	21,000	12,500	7,300	970
Volatile Fatty Acids [2]	>0.1 mg/L	ND	0.21	403	199	7.61	0.059
TOC	>20 mg/L	<1.0	3.8	172	130	29.8	6.9
Temperature	>20 degrees C	9.85	7.40	6.95	7.30	6.7	7
Alkalinity	>2x background	212	296	623	904	781	472
Chlorides	>2x background	2.8	169	59.8	50.0	23.7	16.9

SOUTH TRANSECT		MW-39	PT-12A	MWT-18 & MWT-20	MWT-19 & MWT-21 Treatment Zone Immediately	MWT-22 Further	PT-22 Further
Parameter	Indicator Value [1]	Background	Upgradient	Average In Walls	Downgradient	Downgradient	Downgradient
Dist. from Biowall (ft.)			-15	0	7.5	22.5	~140
Oxygen	<0.5 mg/L	0.31	0.39	0.07	0.08	0.15	0.1
Iron (ferrous)	>1.0 mg/L	4	0.16	3.21	2.86	2.3	0.17
Sulfate	<20 mg/L	27.2	585	<4	97.15	370	78
CO_2	>2x background	400	380	993	960	722	380
ORP	<-100 mV	76	93	-161	-265	-104	-91
Methane	>500 ug/L	0.79	26	18,500	7,425	2,300	970
Volatile Fatty Acids [2]	>0.1 mg/L	ND	0.048	675.7	72.2	4.095	0.059
TOC	>20 mg/L	<1.0	4.2	375	63.8	35.5	6.9
Temperature	>20 degrees C	9.85	7.0	7.6	7.45	8.3	7.00
Alkalinity	>2x background	212	320	1,213	1,043	731	472
Chlorides	>2x background	2.8	40.3	68.1	60.6	63.5	16.9

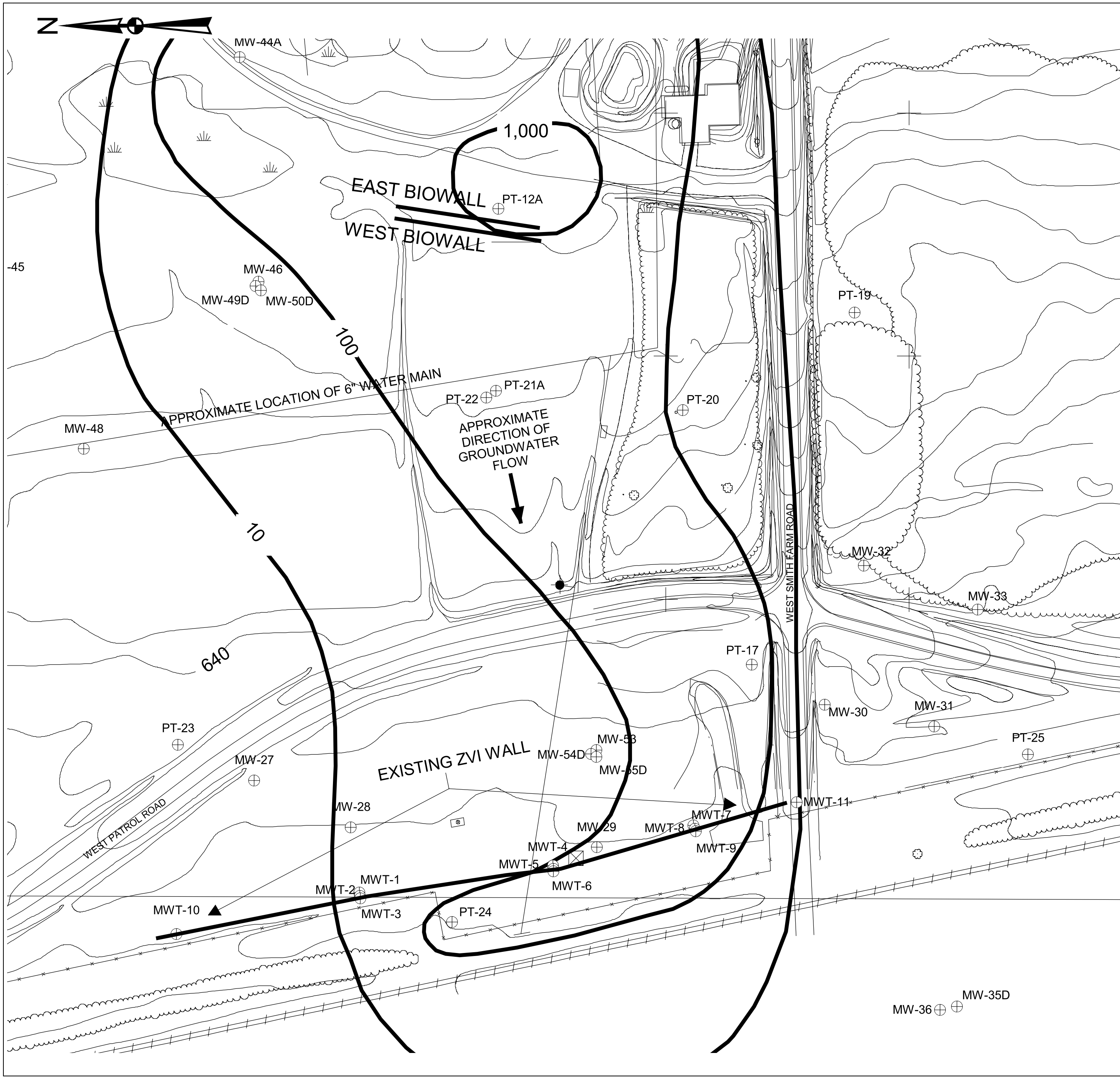
Notes:
Laboratory and field data for the biowall monitoring network were recorded during Round 4 of sampling in January 2006. Data from the background well (MW-39) was sampled once in December 2005 and the far downgradient well (PT-22) were collected on 1/28/06.
(1) Indicator values are listed in "Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater" (USEPA, 1998).
(2) Volatile fatty acid concentrations are the sum of detected concentrations of acetic acid, butyric acid, hexanoic acid, pentatonic acid, propionic acid, and pyruvic acid.

FIGURES

Figure 1
Reductive Dechlorination of Chlorinated Ethenes
Ash Landfill Biowall Pilot Study
Seneca Army Depot Activity



(USEPA, 1998)



PARSONS

SENECA ARMY DEPOT ACTIVITY

ASH LANDFILL BIOWALL PILOT STUDY

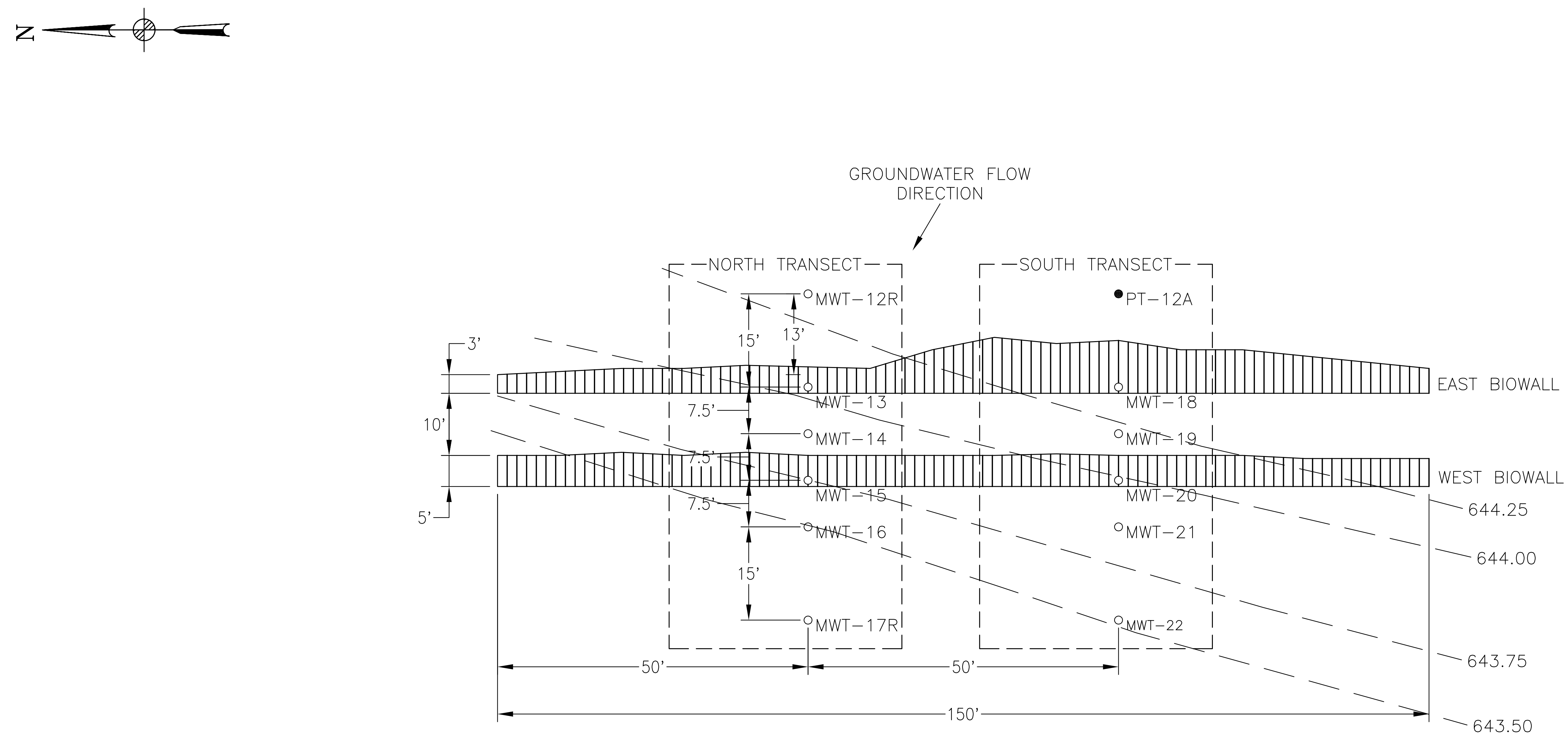
ENVIRONMENTAL ENGINEERING 744538-01000

FIGURE 2 APPROXIMATE LOCATION OF BIOWALLS AND TOTAL CHLORINATED ETHENES IN GROUNDWATER

SCALE: 1" = 150'

MARCH 2006

O:\Seneca\Ash_lf\Ash RD WP\ash_rd_wp.apr\Fig 2-Ash base Plume & Biowall



LEGEND

- ● PT-12A 2" GROUNDWATER MONITORING WELL INSTALLED PRE-BIOWALL INSTALLATION
- ○ MWT-17 2" GROUNDWATER MONITORING WELL INSTALLED POST-BIOWALL INSTALLATION
- BIOWALL

20' 10' 0 20'

SCALE: 1" = 20'

PARSONS

SENECA ARMY DEPOT ACTIVITY
ASH LANDFILL
BIOWALL PILOT STUDY

ENVIRONMENTAL ENGINEERING	744538-01100

FIGURE 3
GROUNDWATER ELEVATIONS IN BIOWALL MONITORING NETWORK
SEPTEMBER 7, 2005

1" = 20'	MARCH 2006

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Figure 4
Fraction of Total Ethenes Along the North Transect - Round 2

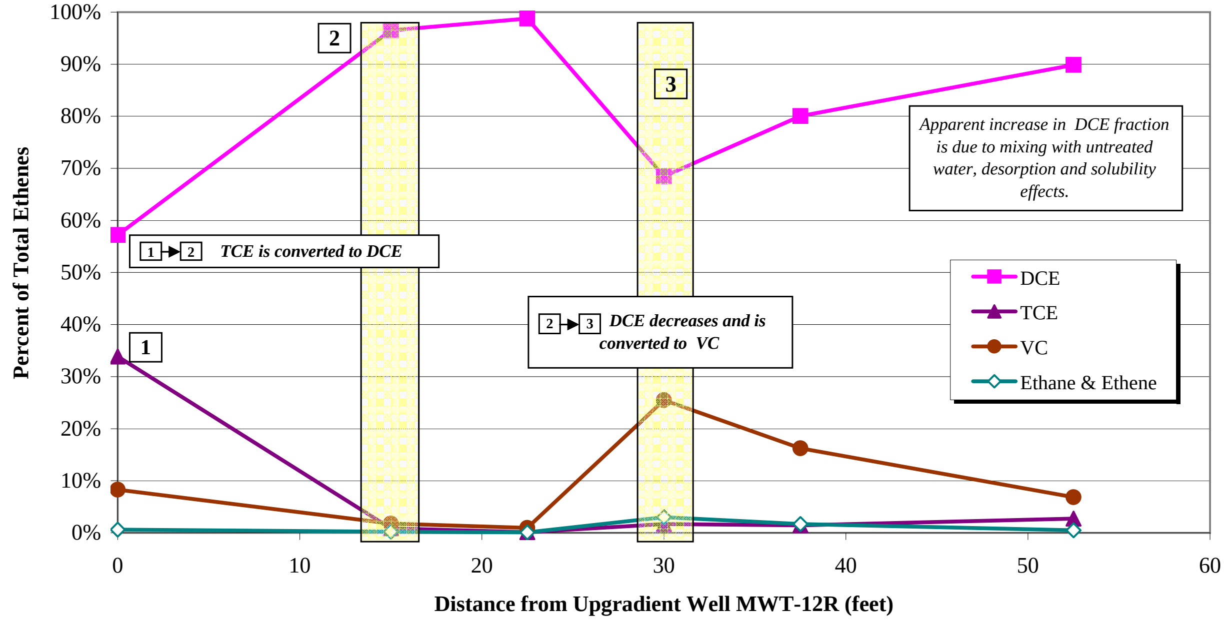
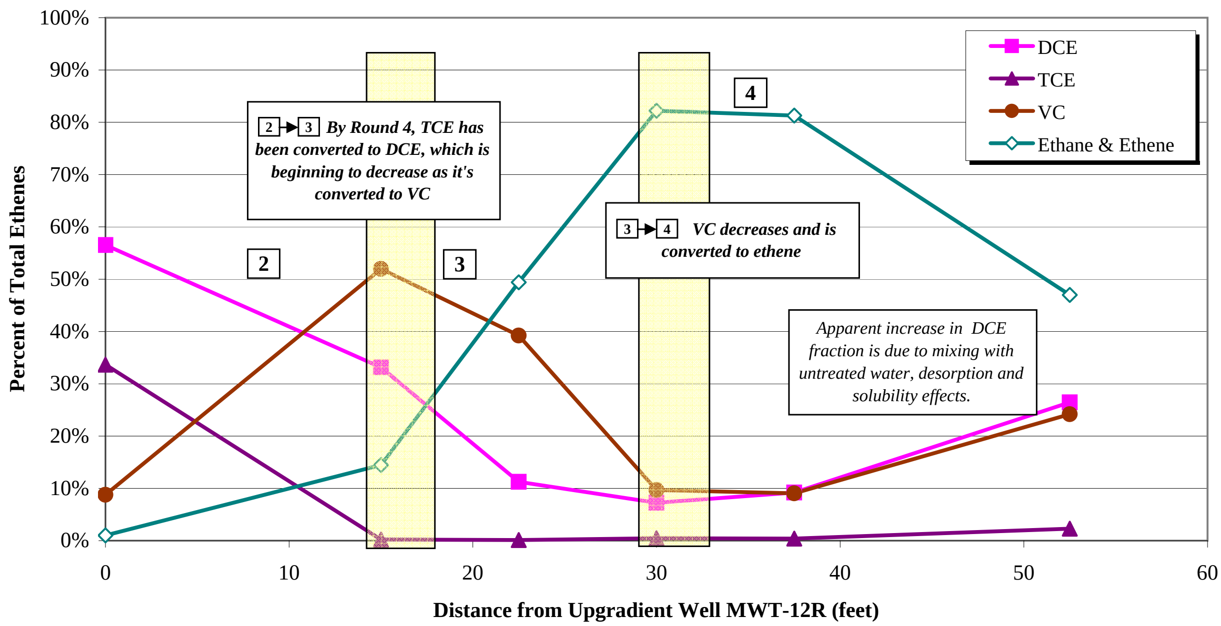
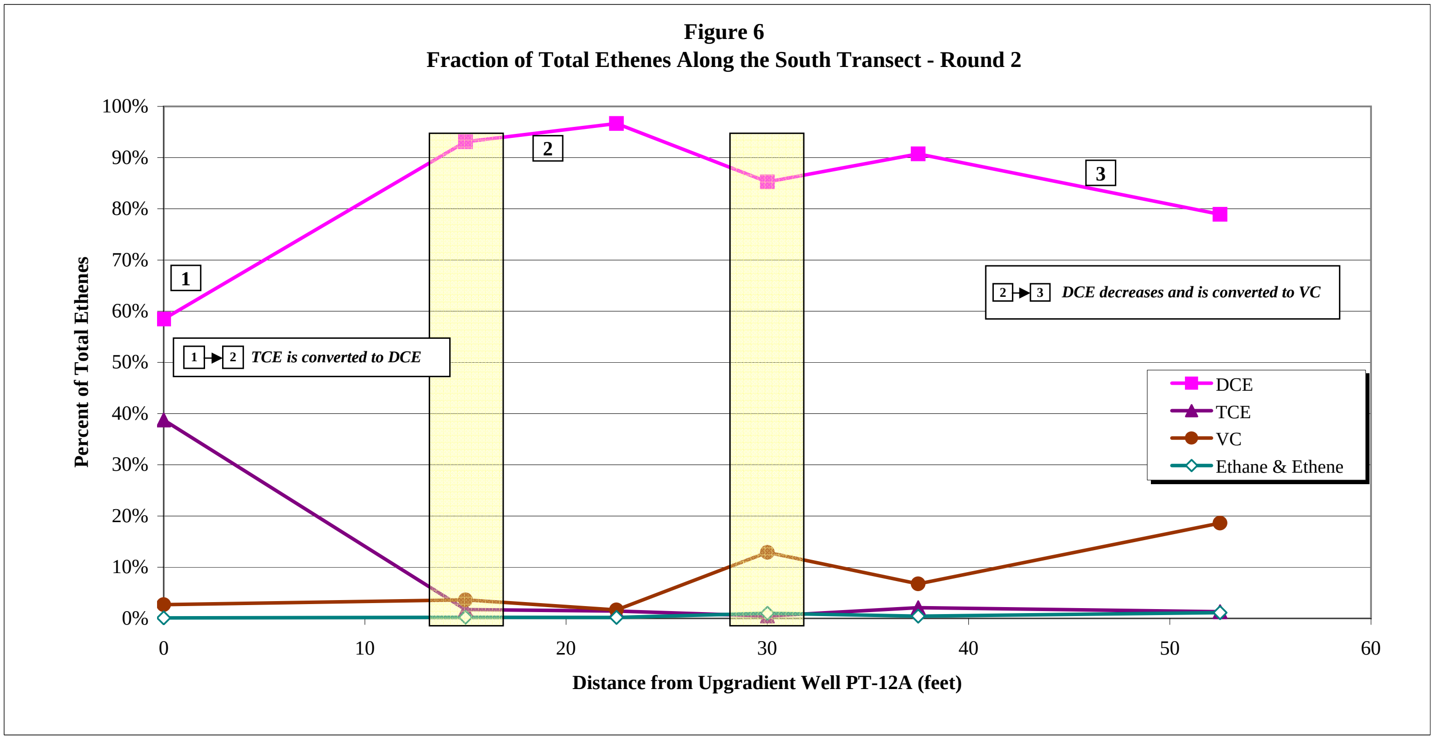


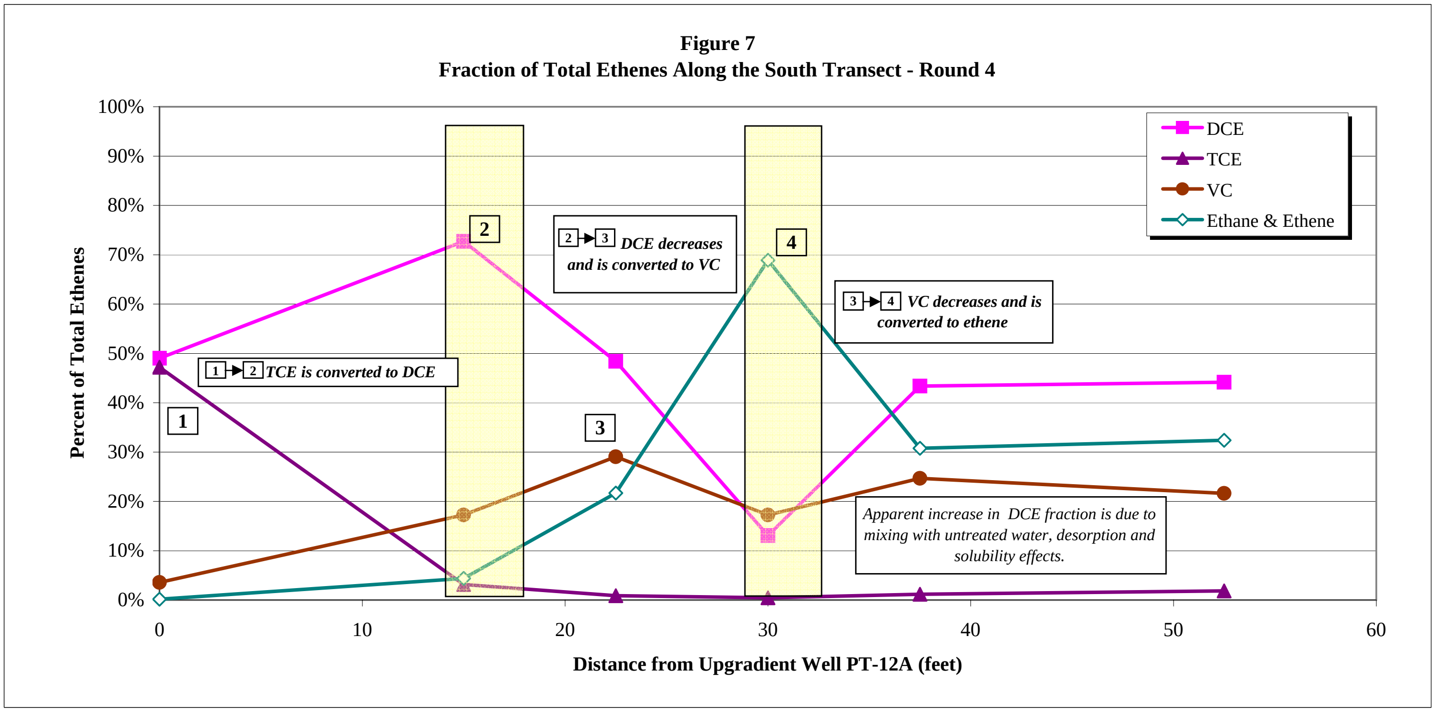
Figure 5
Fraction of Total Ethenes Along the North Transect - Round 4



Note: The bolded numbers (1 through 4) denote the dominant step of the dechlorination process shown in the schematic in Section 4.4.

P:\PIT\Projects\Seneca PBC I\Pilot Study Report\Draft Report\Tables\Total Molar Ethenes.xls\North T Figure 4&5





Note: The bolded numbers (1 through 4) denote the dominant step of the dechlorination process shown in the schematic in Section 4.4.

P:\PIT\Projects\Seneca PBC I\Pilot Study Report\Draft Report\Tables\Total Molar Ethenes.xls\South T Figure 6&7

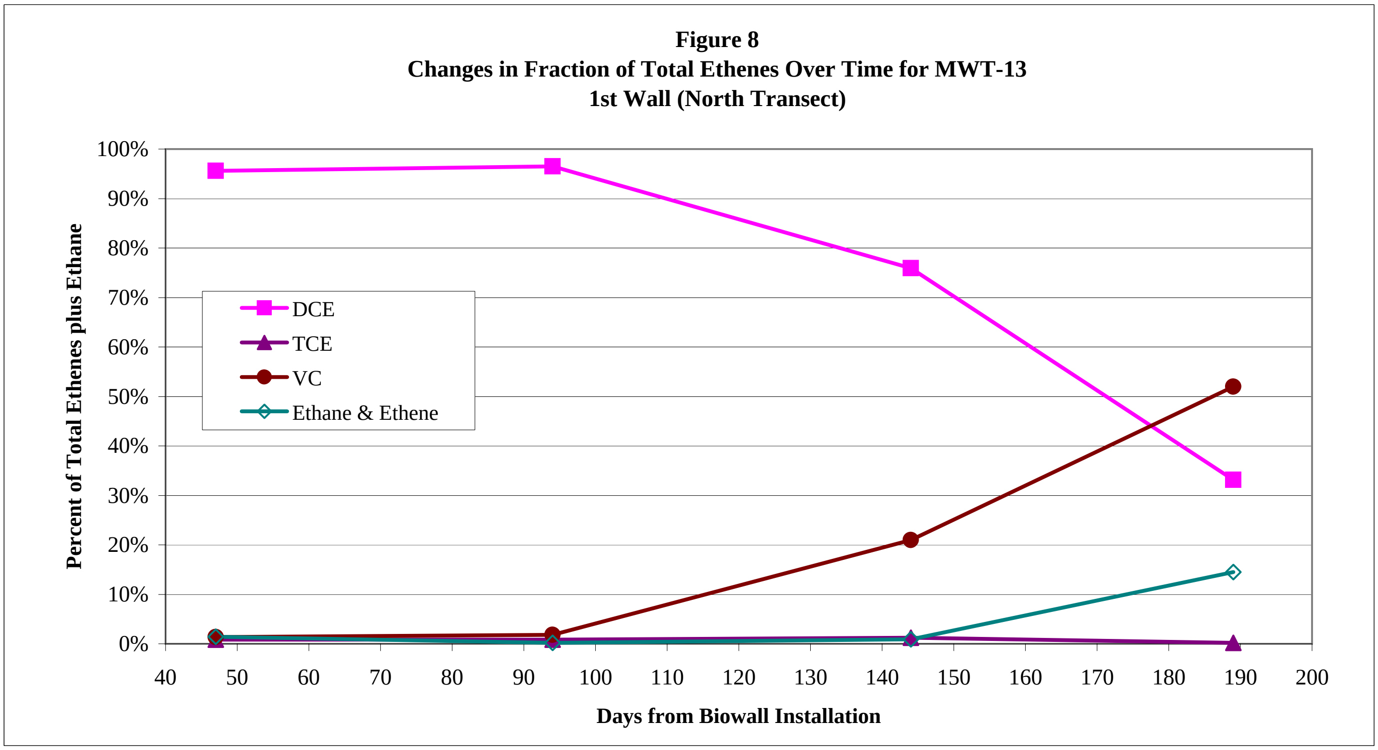


Figure 8
Changes in Fraction of Total Ethenes Over Time for MWT-13
1st Wall (North Transect)
Percent of Total Ethenes plus Ethane
Days from Biowall Installation
DCE
TCE
VC
Ethane & Ethene
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

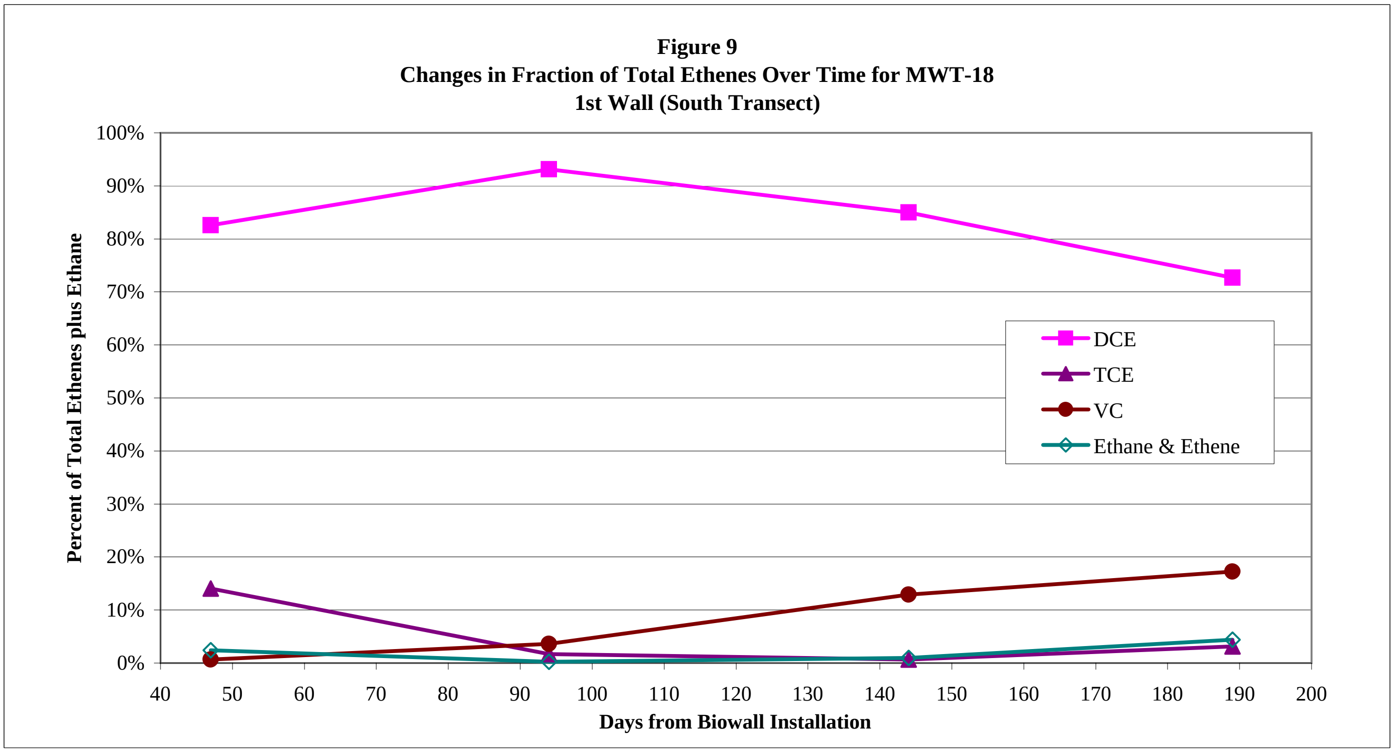


Figure 9
Changes in Fraction of Total Ethenes Over Time for MWT-18
1st Wall (South Transect)
Percent of Total Ethenes plus Ethane
Days from Biowall Installation
DCE
TCE
VC
Ethane & Ethene
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

Figure 10
Changes in Fraction of Total Ethenes Over Time for MWT-16
1st Downgradient Well (North Transect)

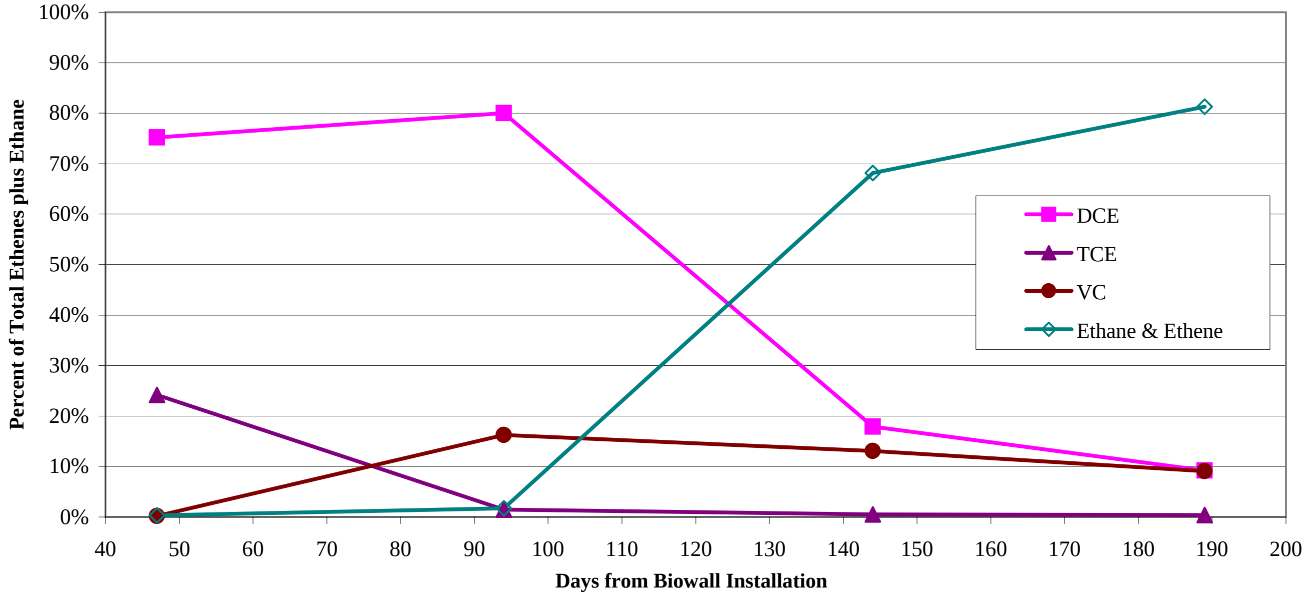


Figure 11
Changes in Fraction of Total Ethenes Over Time for MWT-21
1st Downgradient Well (South Transect)

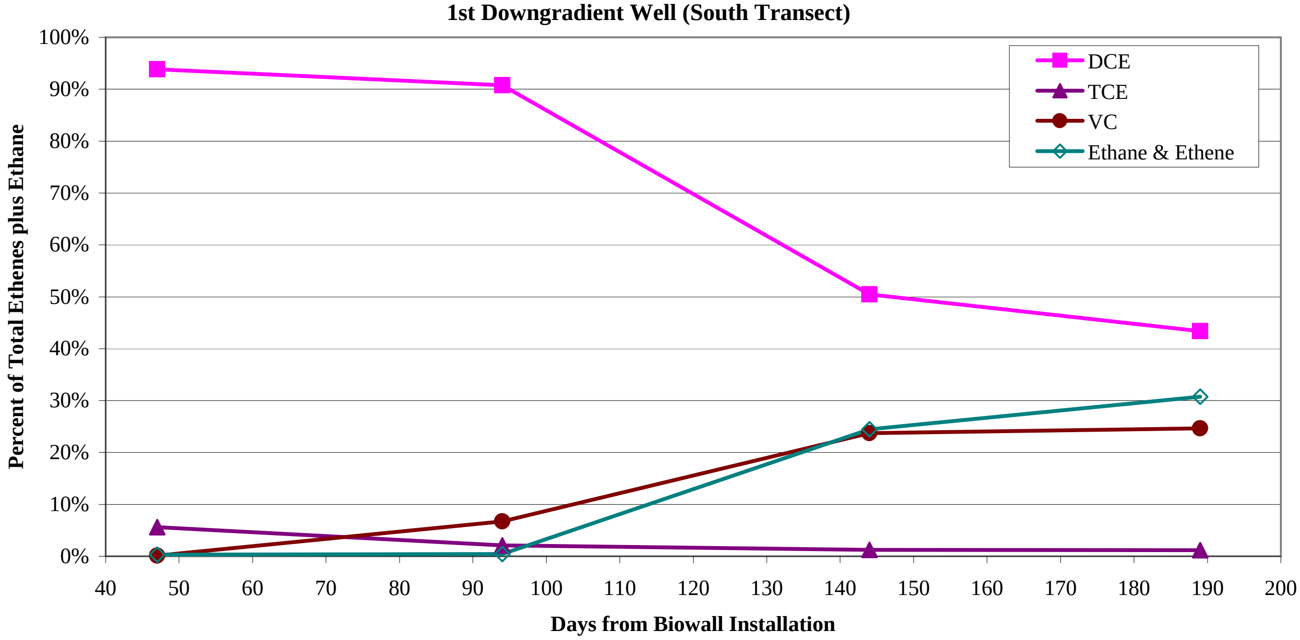


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Figure 12
Ketone Concentrations along the North Transect - Round 2

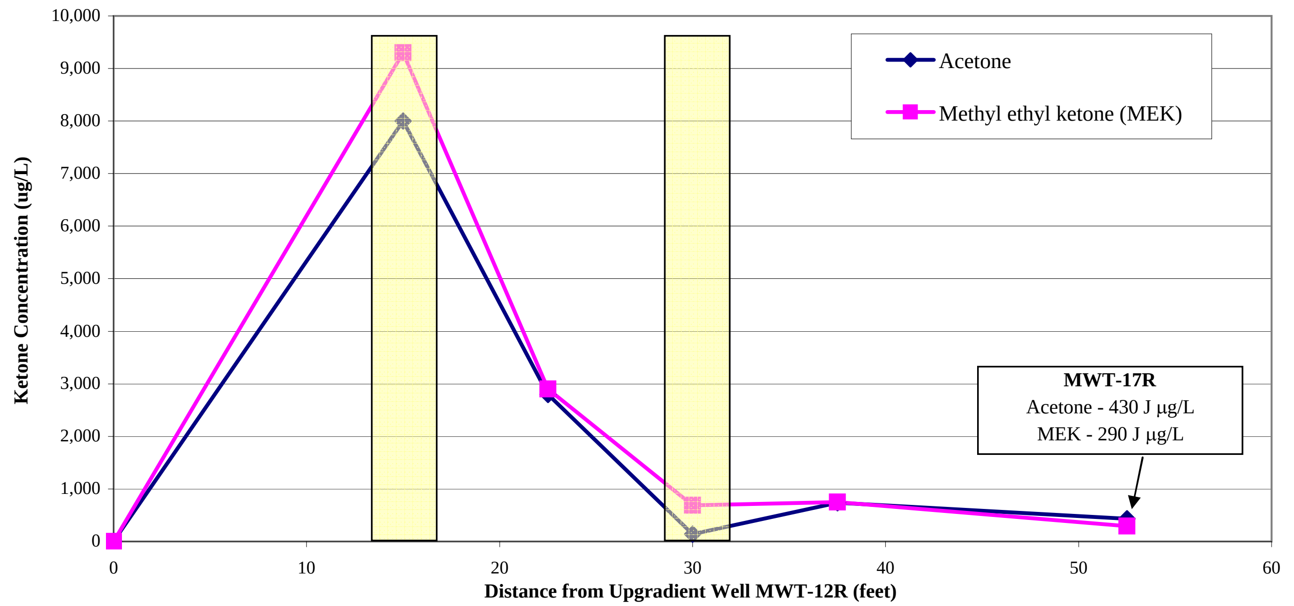


Figure 13
Ketone Concentrations along the North Transect - Round 4

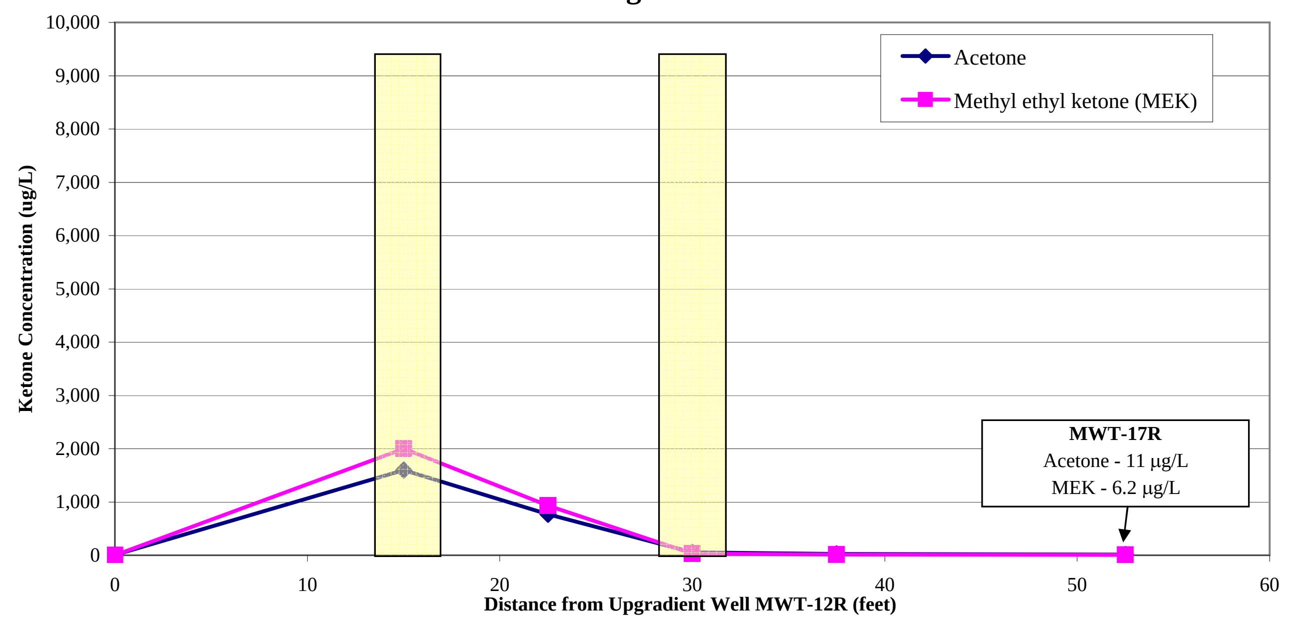


Figure 14
Ketone Concentrations along the South Transect - Round 2

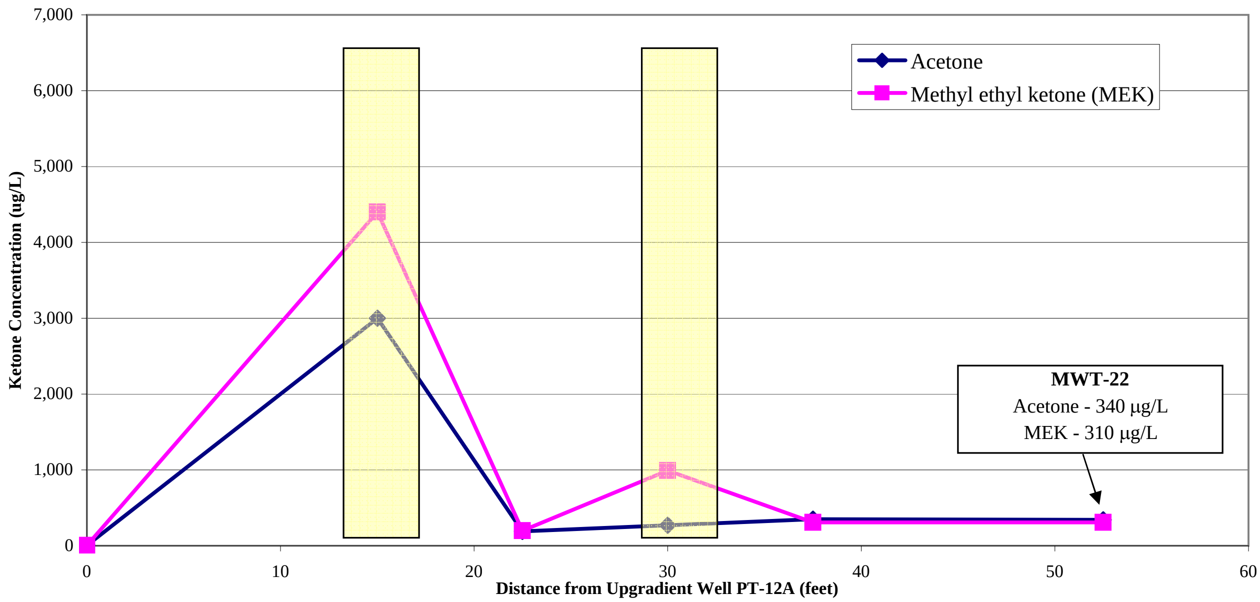
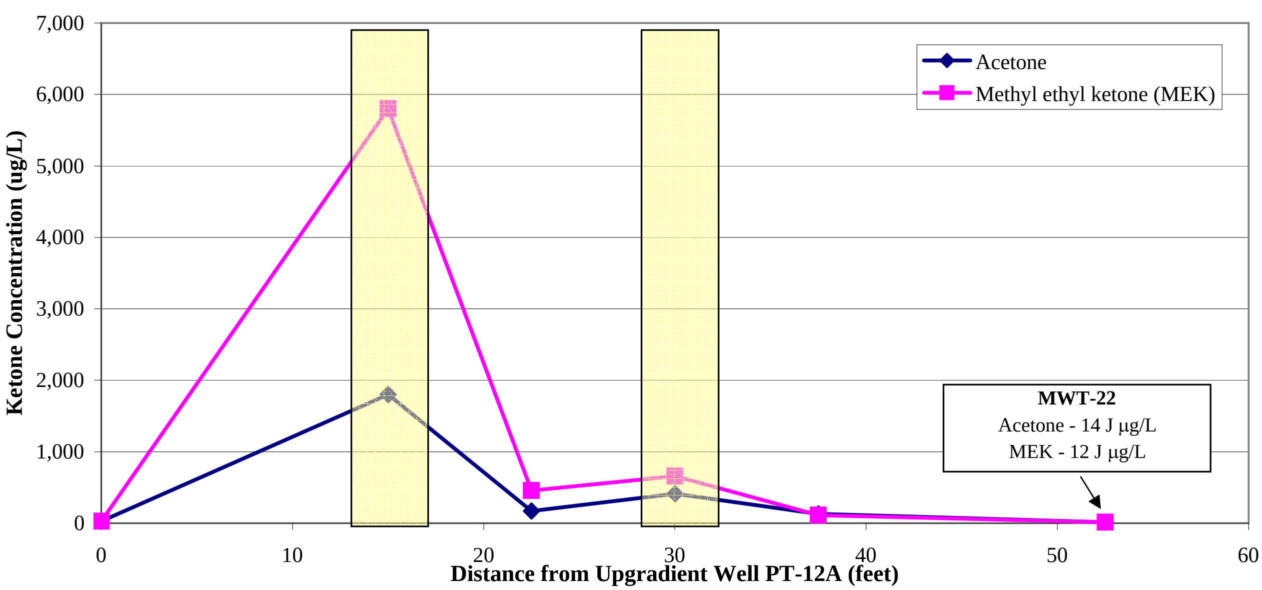


Figure 15
Ketone Concentrations along the South Transect - Round 4



ATTACHMENTS

Attachment A

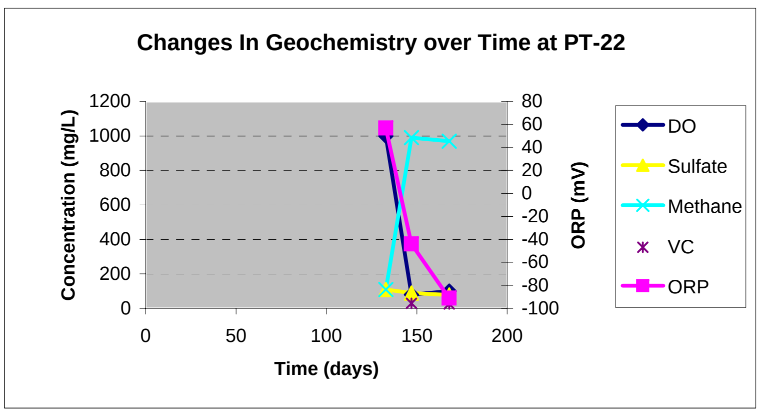
South Transect		Time from Installation (days)	DO	ORP	Sulfate	Iron	Mn	Methane	Ethane	Ethene	VC	TOC
MWT-22	22-Jul-05	0										
(22.5' downgradient)	2-Sep-05	42	0.45	-180	278	**4.73**	**22**	**1300**	1.7	3.4	2.4 U	**361**
	5-Oct-05	75	1.28	-228	296	**2.68**	**6.1**	**1900**	1.2	3.5	170	33.2
	15-Dec-05	146	0.04	-206	282	**2.27**	**0.7**	**1900**	1.2	95	140	34.5
	6-Jan-06	168	0.15	-104	370	**2.3**	**6.1**	**2300**	1.2	93	140 D	35.5

MWT-22 located 22.5 feet from biowall
Detection of anaerobic geochemical indicators occurred by 42 days.
Indicates minimum seepage velocity of approximately 0.54 ft/day, or 196 ft/year.

North Transect		Time from Installation (days)	DO	ORP	Sulfate	Iron	Mn	Methane	Ethane	Ethene	VC	TOC
MWT-17R	22-Jul-05	0										
(22.5' downgradient)	2-Sep-05	42	1.25	60	408	0	0.1	1.1	0.085	0.21	0.24 U	9.3
	5-Oct-05	75	**0**	**-27**	**80.5**	0.2	**5.2**	**1000**	0.049	0.58	**19**	**111**
	15-Dec-05	146	**0**	**-126**	**43.8**	0.8	**3.3**	**4700**	**0.38**	**42**	**42**	63.8
	6-Jan-06	168	**0.29**	**-156**	**58.5**	**3.30***	**15.2**	**7300**	**1.4**	**51**	**60**	29.8

MWT-17R located 22.5 feet from biowall
Detection of anaerobic geochemical indicators occurred by 75 days.
Indicates minimum seepage velocity of approximately 0.3 ft/day, or 110 ft/year.

PT-22		Time from Installation (days)	DO x1000	ORP	Sulfate	Iron	Mn	Methane	Ethane	Ethene	VC	TOC
PT-22	22-Jul-05	0										
(150' Downgradient)	2-Dec-05	133	1000.0	57	110	4	1.4	110	0.017	10		7.8
	16-Dec-05	147	**80**	**-44**	**88.8**	0.1	0.8	**990**	**0.14**	45	**30**	**13.4**
	6-Jan-06	168	**100**	**-91**	**78.3**	0.17	1.5	**970**	**0.3**	30	**26**	6.9



PT-22 located 150 feet from biowall
Detection of anaerobic geochemical indicators by 150 days.
Indicates seepage velocity of approximately 1 ft/day, or 365 ft/year.

Attachment B

Table B.1 Contaminant Distribution and Mass Flux North Transect - January 2006

NOTE: Shaded boxes are user input.

1. Treatment Zone Physical Dimensions

	Values	Range	Units
Length (Perpendicular to predominant groundwater flow direction)	75	1-10,000	feet
Width (Parallel to predominant groundwater flow)	30	1-1,000	feet
Saturated Thickness	6	1-100	feet
Treatment Zone Cross Sectional Area	450	--	ft^2
Treatment Zone Volume	13,500	--	ft^3
Treatment Zone Total Pore Volume (total volume x total porosity)	25,252	--	gallons
Treatment Zone Effective Groundwater Volume (total volume x effective porosity)	303,021	--	gallons
Period of Performance	1	--	per year

2. Treatment Zone Hydrogeologic Properties

Total Porosity	0.25	.05-50	
Effective Porosity	3	.05-50	
Average Aquifer Hydraulic Conductivity	14	.01-1000	ft/day
Average Hydraulic Gradient	0.06	0.1-0.0001	ft/ft
Average Groundwater Seepage Velocity through the Treatment Zone	0.28	--	ft/day
Average Groundwater Seepage Velocity through the Treatment Zone	102.2	--	ft/yr
Average Groundwater Flux through the Treatment Zone	1,032,292	--	**gallons/year**
Soil Bulk Density	1.69	1.4-2.0	gm/cm^3
Soil Fraction Organic Carbon (foc)	0.02	0.0001-0.1	

3. Initial Distribution of Mass in the Treatment Zone (one total pore volume)

Concentrations for Well MWT-12R

A. Dissolved Contaminants

	Concentration (mg/L)	Mass (lb)
Tetrachloroethene (PCE)	0.000	0.000
Trichloroethene (TCE)	0.540	**0.114**
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	0.669	**0.141**
Vinyl Chloride (VC)	0.067	**0.014**
Carbon Tetrachloride (CT)	0.000	0.000
Trichloromethane (or chloroform) (CF)	0.000	0.000
Dichloromethane (or methylene chloride) (MC)	0.000	0.000
Chloromethane	0.000	0.000
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	0.000
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	0.000
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	0.000
Chloroethane	0.000	0.000

0.269 lbs dissoved in gw

B. Sorbed Contaminants

(Soil Concentration = Koc x foc x Cgw)

	Koc (mL/g)	Soil Conc. (mg/kg)	Mass (lb)
Tetrachloroethene (PCE)	263	0.00	0.000
Trichloroethene (TCE)	107	1.16	**1.646**
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	45	0.60	**0.858**
Vinyl Chloride (VC)	3.0	0.00	**0.006**
Carbon Tetrachloride (CT)	224	0.00	0.000
Trichloromethane (or chloroform) (CF)	63	0.00	0.000
Dichloromethane (or methylene chloride) (MC)	28	0.00	0.000
Chloromethane	25	0.00	0.000
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	117	0.00	0.000
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	105	0.00	0.000
Dichloroethane (1,1-DCA and 1,2-DCA)	30	0.00	0.000
Chloroethane	3	0.00	0.000

2.510 lbs sorbed in soil

4. Treatment Cell Dissolved Contaminant Flux (per year)

A. Soluble Contaminant Flux

	Flux In (MWT-12R) Concentration (mg/L)	Flux In (MWT-12R) Mass (lb)	Flux Out (MWT-15) Concentration (mg/L)	Flux Out (MWT-15) Mass (lb)	Percent Reduction in Mass: Percent Reduction
Tetrachloroethene (PCE)	0.000	0.000	0.000	0.000	
Trichloroethene (TCE)	0.540	**4.652**	0.000	**0.000**	**100%**
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	0.669	**5.765**	0.005	0.046	**99.2%**
Vinyl Chloride (VC)	0.067	**0.577**	0.005	0.043	**92.5%**
Carbon Tetrachloride (CT)	0.000	0.000	0.000	0.000	
Trichloromethane (or chloroform) (CF)	0.000	0.000	0.000	0.000	
Dichloromethane (or methylene chloride) (MC)	0.000	0.000	0.000	0.000	
Chloromethane	0.000	0.000	0.000	0.000	
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	0.000	0.000	0.000	
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	0.000	0.000	0.000	
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	0.000	0.000	0.000	
Chloroethane	0.000	0.000	0.000	0.000	
TOTAL MASS		**10.99**		**0.09**	**99.2%**

Attachment B

Table B.2 Contaminant Distribution and Mass Flux South Transect - January 2006

NOTE: Shaded boxes are user input.

1. Treatment Zone Physical Dimensions

	Values	Range	Units
Length (Perpendicular to predominant groundwater flow direction)	75	1-10,000	feet
Width (Parallel to predominant groundwater flow)	30	1-1,000	feet
Saturated Thickness	6	1-100	feet
Treatment Zone Cross Sectional Area	450	--	ft^2
Treatment Zone Volume	13,500	--	ft^3
Treatment Zone Total Pore Volume (total volume x total porosity)	25,252	--	gallons
Treatment Zone Effective Groundwater Volume (total volume x effective porosity)	15,151	--	gallons
Period of Performance	1	--	per year

2. Treatment Zone Hydrogeologic Properties

	Values	Range	Units
Total Porosity	0.25	.05-50	
Effective Porosity	0.15	.05-50	
Average Aquifer Hydraulic Conductivity	4.1	.01-1000	ft/day
Average Hydraulic Gradient	0.02	0.1-0.0001	ft/ft
Average Groundwater Seepage Velocity through the Treatment Zone	0.55	--	ft/day
Average Groundwater Seepage Velocity through the Treatment Zone	199.5	--	ft/yr
Average Groundwater Flux through the Treatment Zone	100,771	--	**gallons/design life**
Soil Bulk Density	1.69	1.4-2.0	gm/cm^3
Soil Fraction Organic Carbon (foc)	0.02	0.0001-0.1	

3. Initial Distribution of Mass in the Treatment Zone (one total pore volume)

Concentrations are for Well PT-12A

A. Dissolved Contaminants

	Concentration (mg/L)	Mass (lb)
Tetrachloroethene (PCE)	0.000	0.000
Trichloroethene (TCE)	0.530	**0.112**
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	0.406	**0.085**
Vinyl Chloride (VC)	0.019	**0.004**
Carbon Tetrachloride (CT)	0.000	0.000
Trichloromethane (or chloroform) (CF)	0.000	0.000
Dichloromethane (or methylene chloride) (MC)	0.000	0.000
Chloromethane	0.000	0.000
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	0.000
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	0.000
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	0.000
Chloroethane	0.000	0.000

0.201 lbs in dissolved phase

B. Sorbed Contaminants

(Soil Concentration = Koc x foc x Cgw)

	Koc (mL/g)	Soil Conc. (mg/kg)	Mass (lb)
Tetrachloroethene (PCE)	263	0.00	0.000
Trichloroethene (TCE)	107	1.13	**1.616**
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	45	0.37	**0.520**
Vinyl Chloride (VC)	3.0	0.00	**0.002**
Carbon Tetrachloride (CT)	224	0.00	0.000
Trichloromethane (or chloroform) (CF)	63	0.00	0.000
Dichloromethane (or methylene chloride) (MC)	28	0.00	0.000
Chloromethane	25	0.00	0.000
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	117	0.00	0.000
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	105	0.00	0.000
Dichloroethane (1,1-DCA and 1,2-DCA)	30	0.00	0.000
Chloroethane	3	0.00	0.000

2.137 lbs sorbed

4. Treatment Cell Dissolved Contaminant Flux (per year)

A. Soluble Contaminant Flux

	Flux In (PT-12A) Concentration (mg/L)	Flux In (PT-12A) Mass (lb)	Flux Out (MWT-20) Concentration (mg/L)	Flux Out (MWT-20) Mass (lb)	Percent Reduction in Mass
Tetrachloroethene (PCE)	0.000	0.000	0.000	0.000	
Trichloroethene (TCE)	0.530	**0.446**	0.000	**0.000**	**100%**
Dichloroethene (cis-DCE, trans-DCE, and 1,1-DCE)	0.406	**0.341**	0.010	**0.009**	**97.5%**
Vinyl Chloride (VC)	0.019	**0.016**	0.009	**0.008**	**52.1%**
Carbon Tetrachloride (CT)	0.000	0.000	0.000	0.000	
Trichloromethane (or chloroform) (CF)	0.000	0.000	0.000	0.000	
Dichloromethane (or methylene chloride) (MC)	0.000	0.000	0.000	0.000	
Chloromethane	0.000	0.000	0.000	0.000	
Tetrachloroethane (1,1,1,2-PCA and 1,1,2,2-PCA)	0.000	0.000	0.000	0.000	
Trichloroethane (1,1,1-TCA and 1,1,2-TCA)	0.000	0.000	0.000	0.000	
Dichloroethane (1,1-DCA and 1,2-DCA)	0.000	0.000	0.000	0.000	
Chloroethane	0.000	0.000	0.000	0.000	
TOTAL MASS		**0.80**		**0.02**	**98.0%**

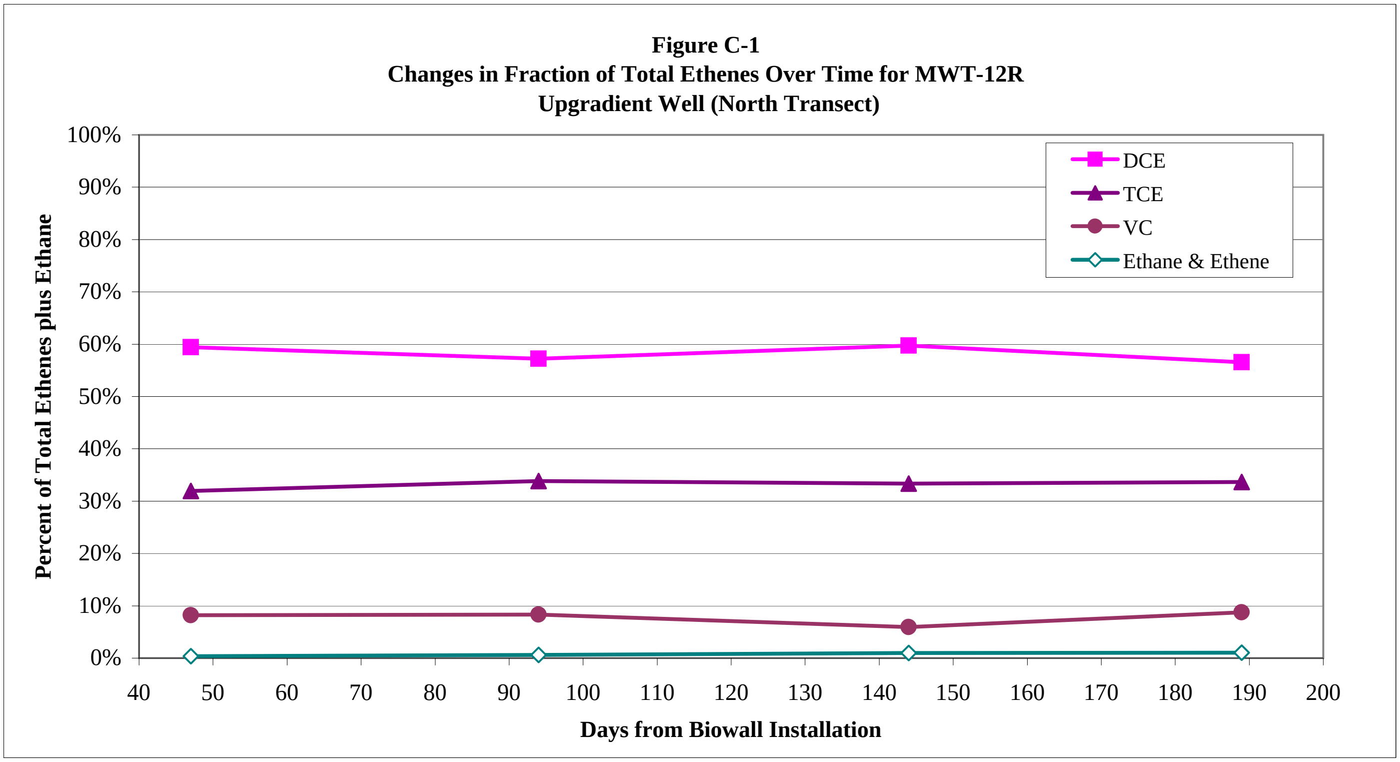


Figure C-1
Changes in Fraction of Total Ethenes Over Time for MWT-12R
Upgradient Well (North Transect)
Percent of Total Ethenes plus Ethane
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Days from Biowall Installation
DCE
TCE
VC
Ethane & Ethene

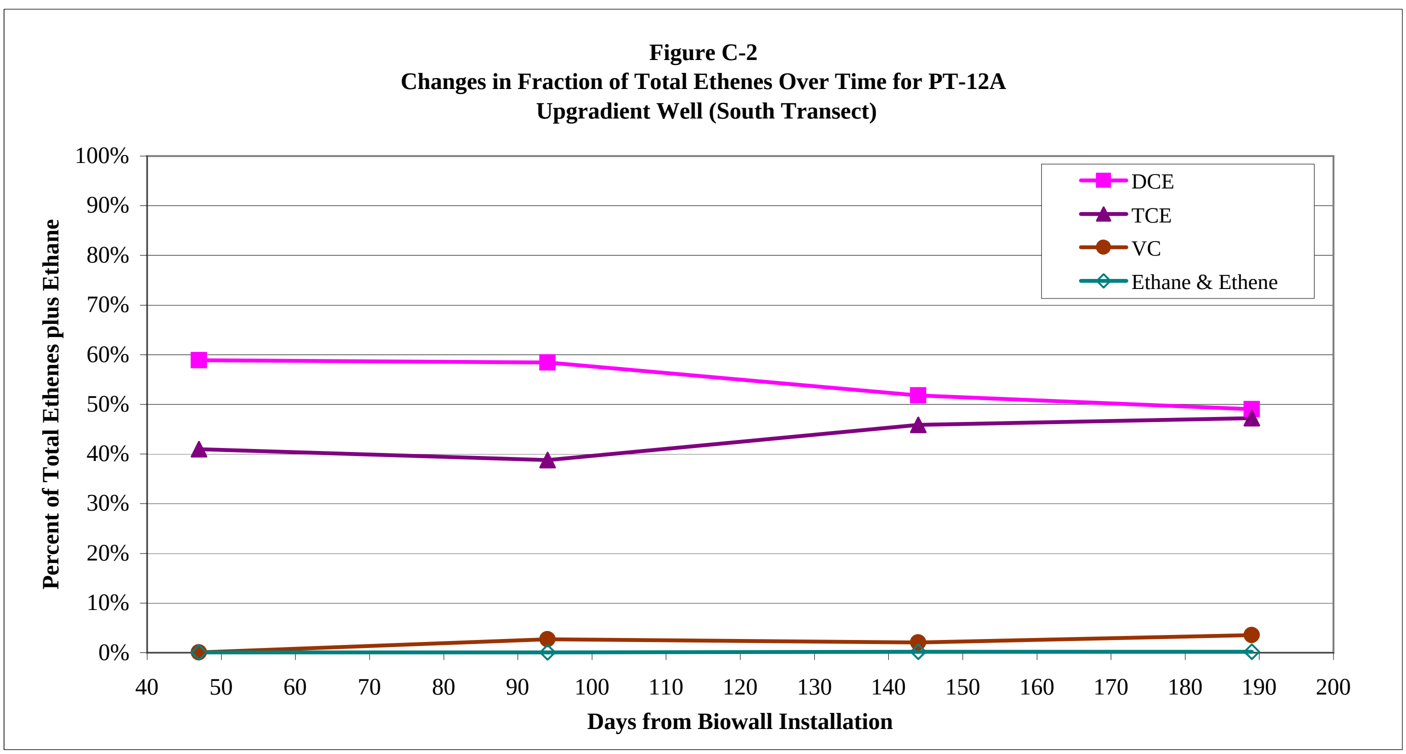


Figure C-2
Changes in Fraction of Total Ethenes Over Time for PT-12A
Upgradient Well (South Transect)
Percent of Total Ethenes plus Ethane
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Days from Biowall Installation
DCE
TCE
VC
Ethane & Ethene

Figure C-3
Changes in Fraction of Total Ethenes Over Time for MWT-13
1st Wall (North Transect)

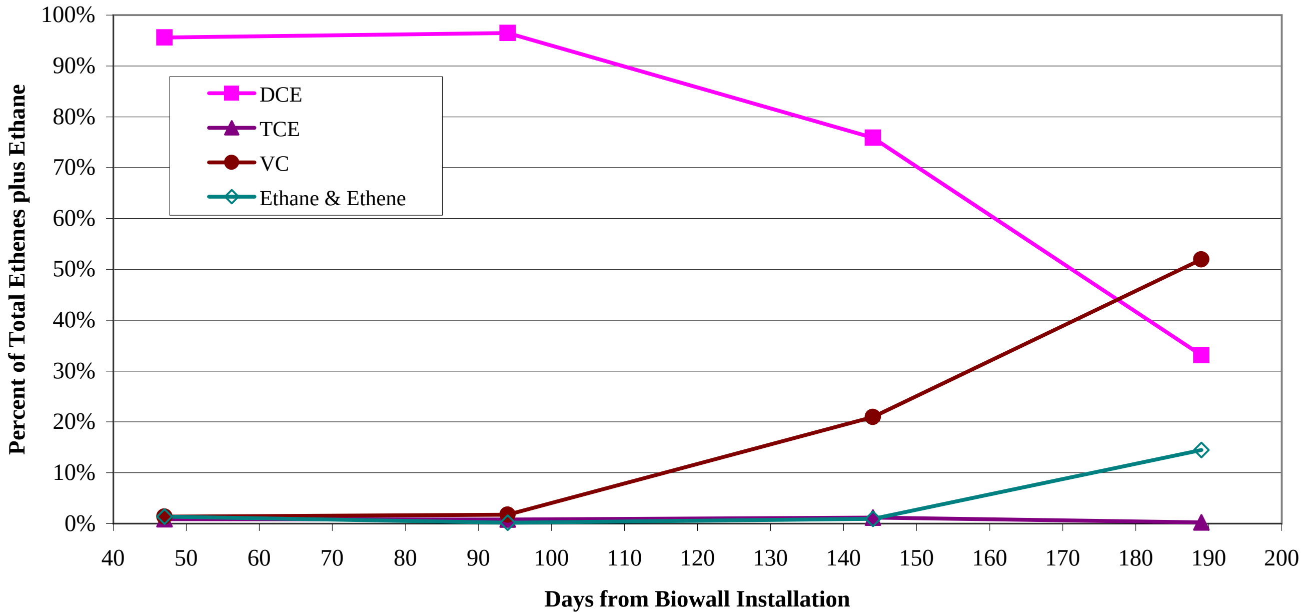
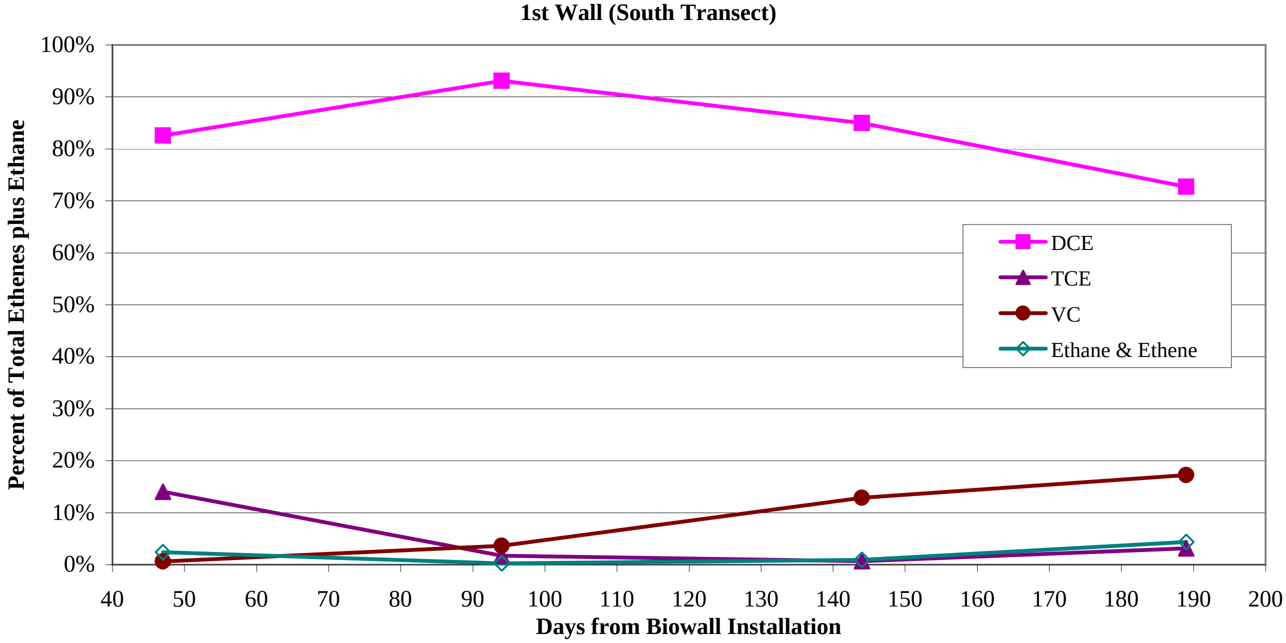


Figure C-4
Changes in Fraction of Total Ethenes Over Time for MWT-18
1st Wall (South Transect)



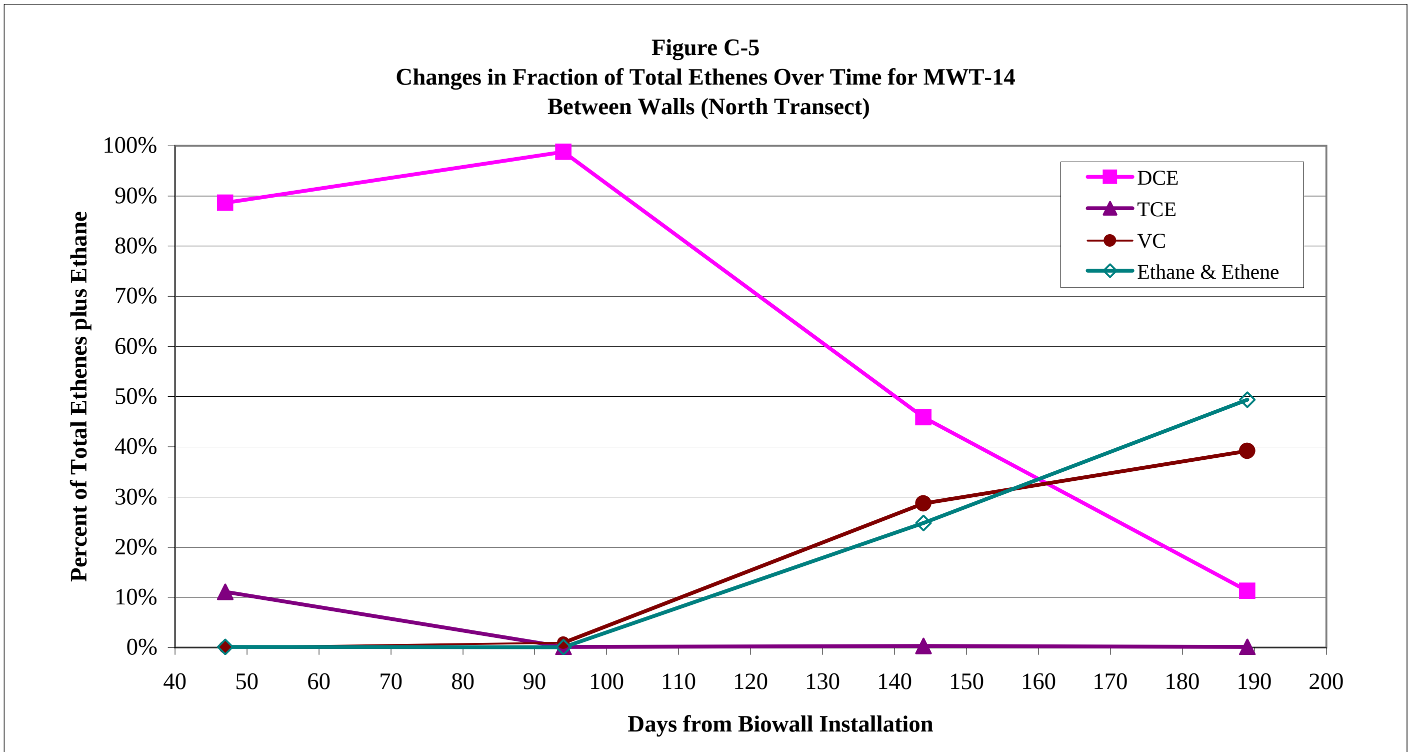


Figure C-5
Changes in Fraction of Total Ethenes Over Time for MWT-14
Between Walls (North Transect)
Percent of Total Ethenes plus Ethane
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Days from Biowall Installation
DCE
TCE
VC
Ethane & Ethene

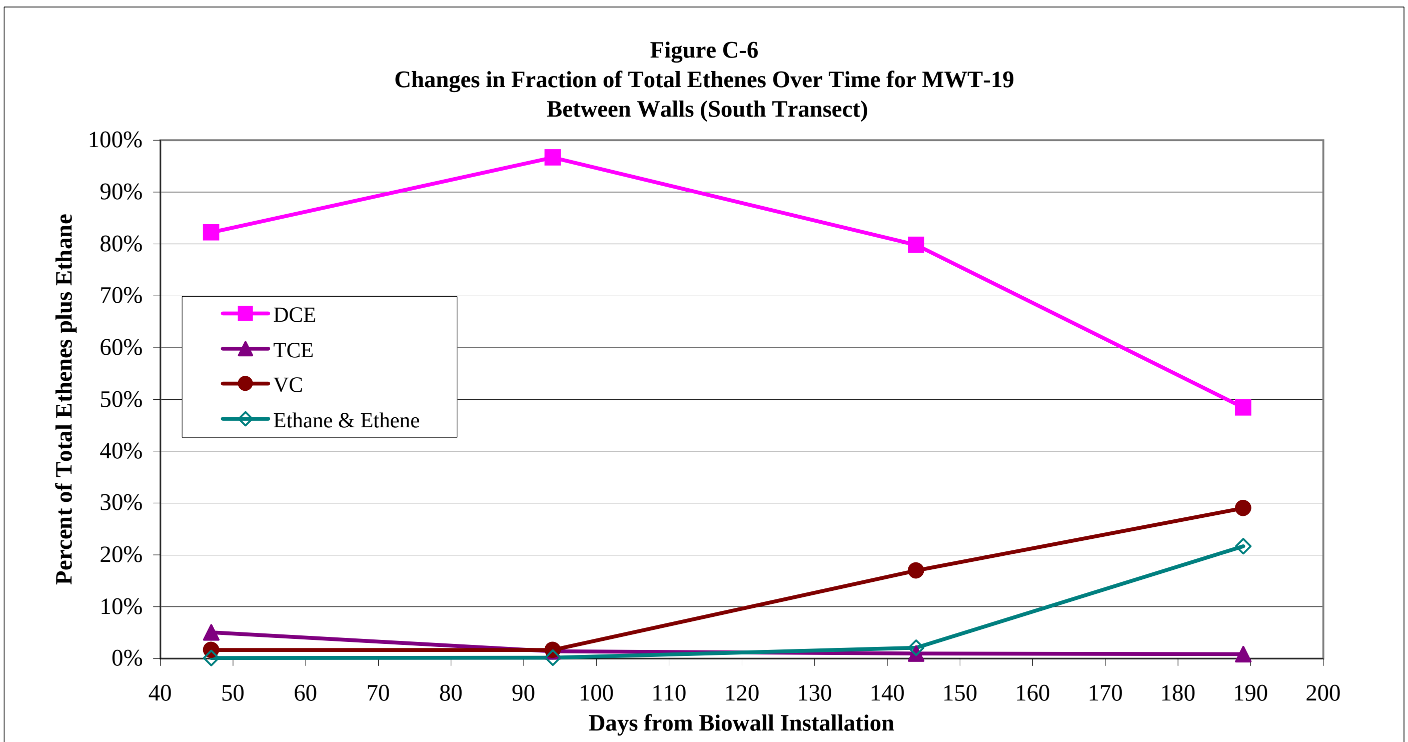


Figure C-6
Changes in Fraction of Total Ethenes Over Time for MWT-19
Between Walls (South Transect)
Percent of Total Ethenes plus Ethane
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Days from Biowall Installation
DCE
TCE
VC
Ethane & Ethene

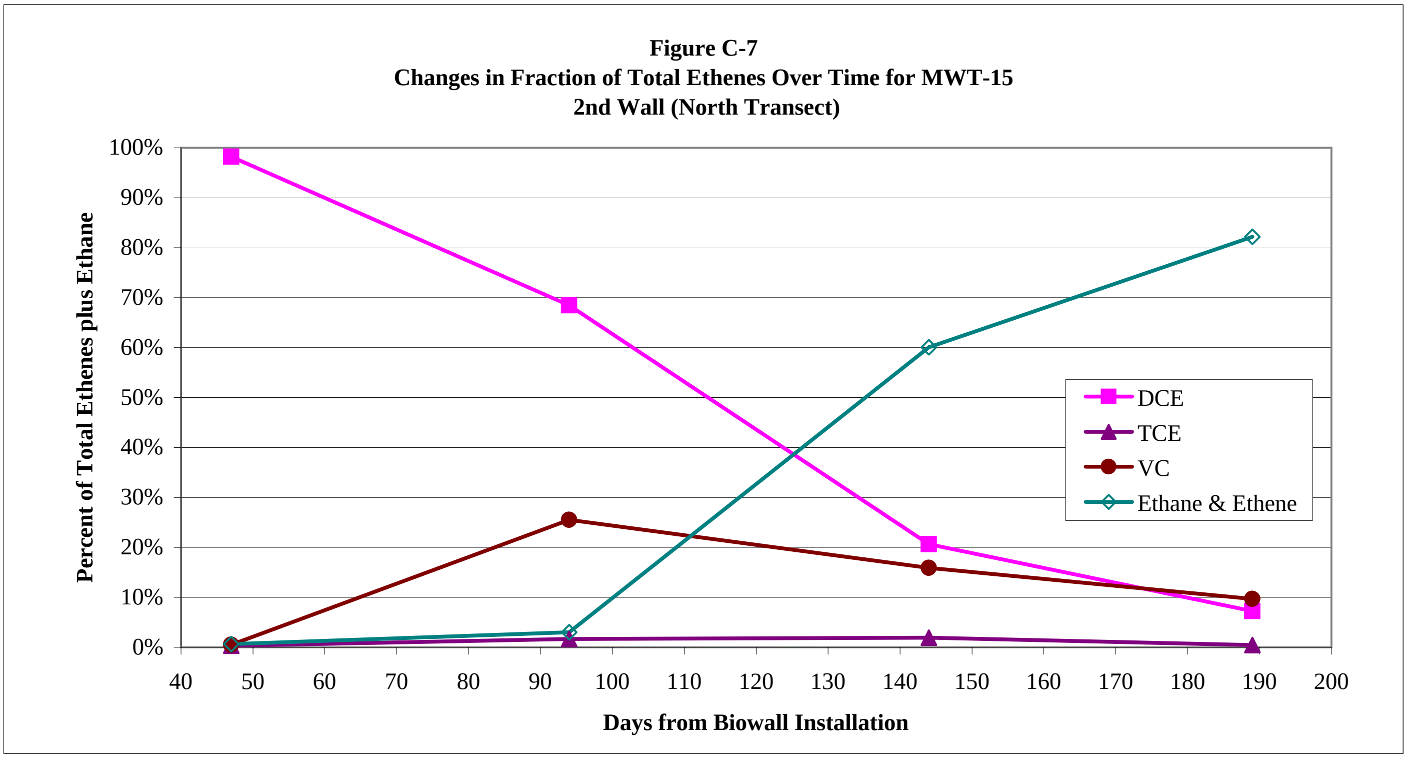


Figure C-7
Changes in Fraction of Total Ethenes Over Time for MWT-15
2nd Wall (North Transect)
Percent of Total Ethenes plus Ethane
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Days from Biowall Installation
DCE
TCE
VC
Ethane & Ethene

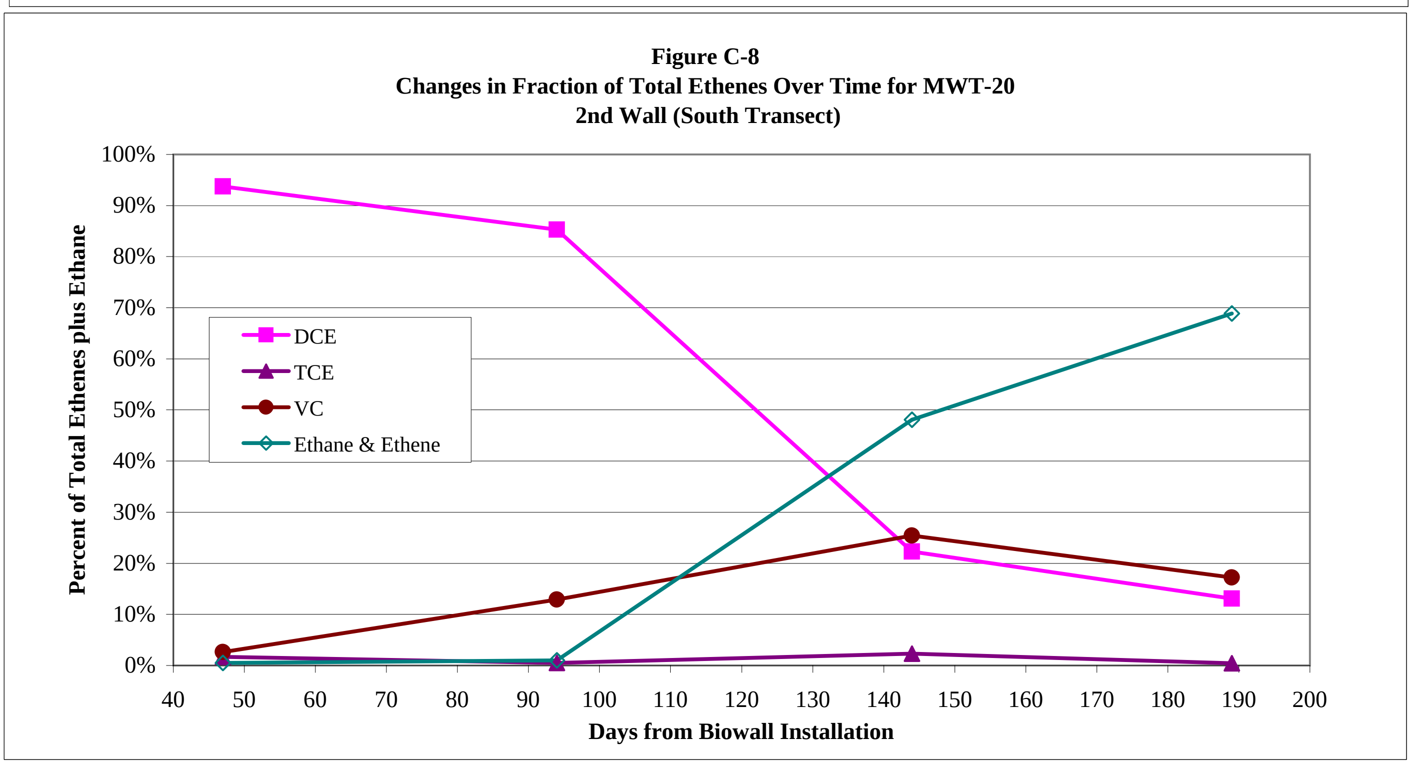


Figure C-8
Changes in Fraction of Total Ethenes Over Time for MWT-20
2nd Wall (South Transect)
Percent of Total Ethenes plus Ethane
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Days from Biowall Installation
DCE
TCE
VC
Ethane & Ethene

Figure C-9
Changes in Fraction of Total Ethenes Over Time for MWT-16
1st Downgradient Well (North Transect)

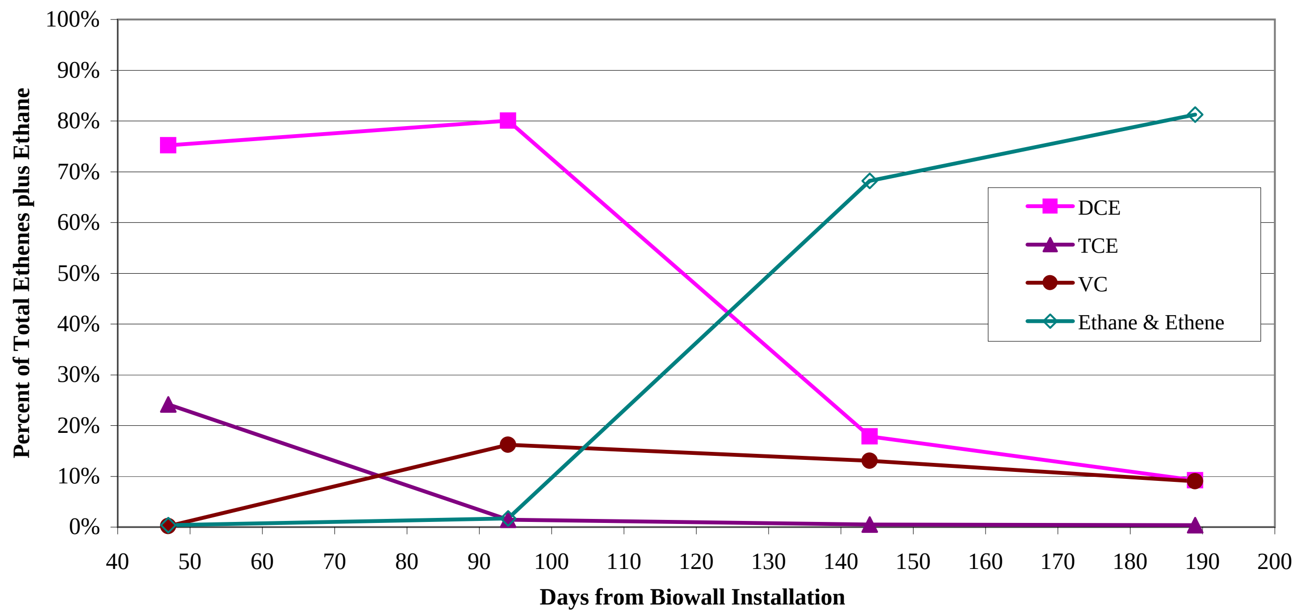


Figure C-10
Changes in Fraction of Total Ethenes Over Time for MWT-21
1st Downgradient Well (South Transect)

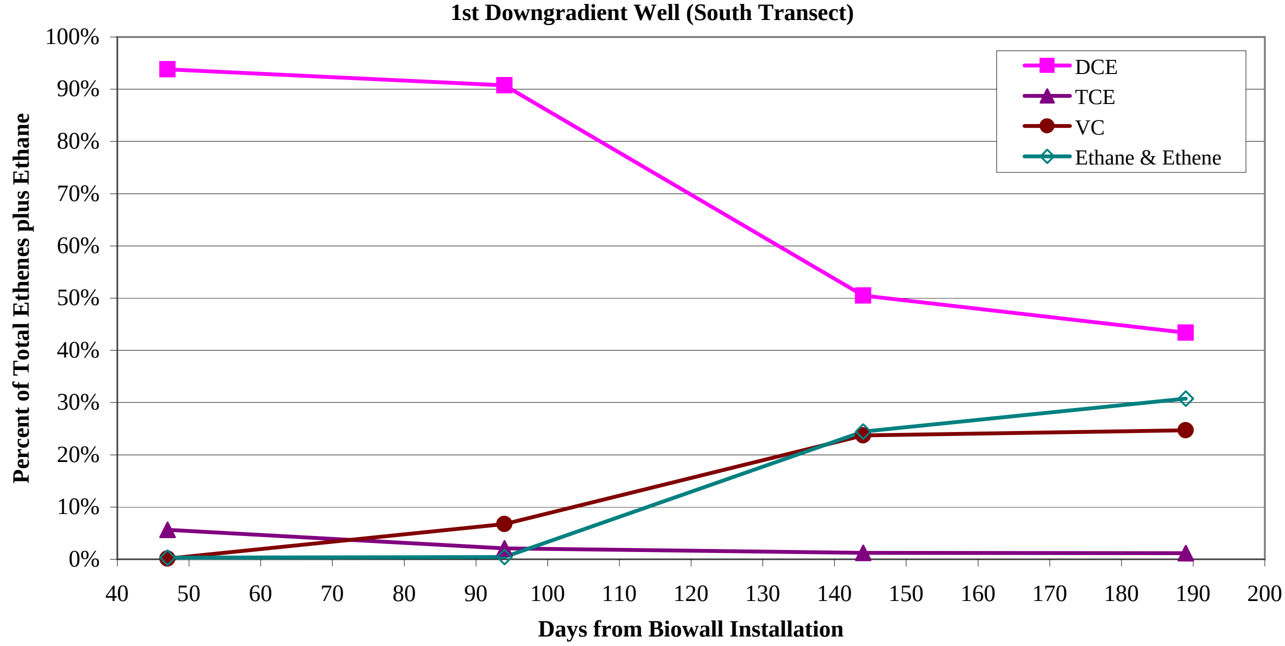


Figure C-11
Changes in Fraction of Total Ethenes Over Time for MWT-17R
2nd Downgradient Well (North Transect)

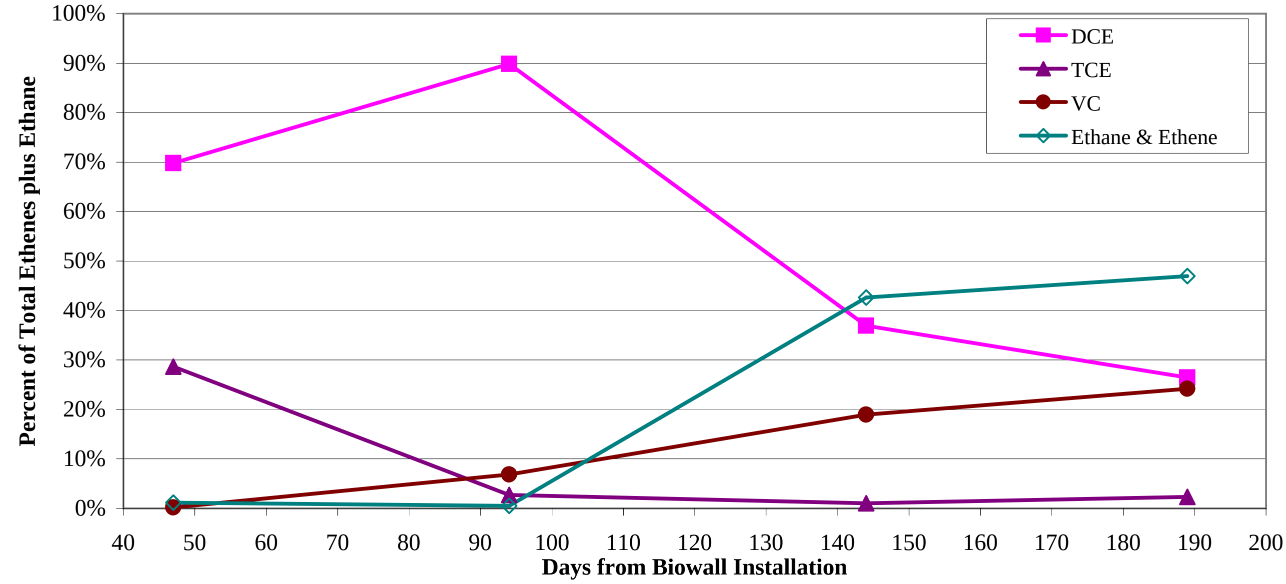
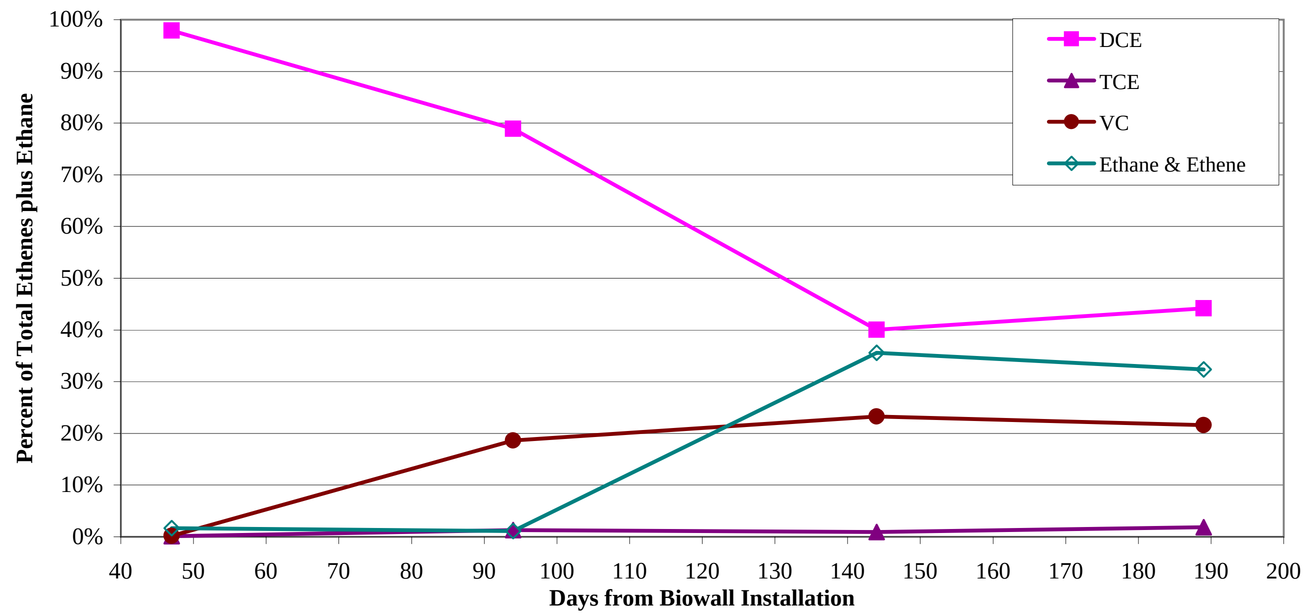


Figure C-12
Changes in Fraction of Total Ethenes Over Time from MWT-22
2nd Downgradient Well (South Transect)



ATTACHMENT D-1
Detected VOCs - Round 1 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									MWT-12R	MWT-12R	MWT-13	MWT-14	MWT-15
Matrix									GW	GW	GW	GW	GW
Sample ID									ALBW20013	ALBW20012	ALBW20011	ALBW20010	ALBW20009
Sample Depth to Top of Sample									0	0	0	0	0
Sample Depth to Bottom of Sample									0	0	0	0	0
Sample Date									9/12/2005	9/12/2005	9/12/2005	9/9/2005	9/9/2005
QC Code									DU	SA	SA	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									1	1	1	1	1
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2	8%	5	GA	0	1	13	80 U	80 U	250 U	50 U	50 U
1,2-Dichloroethane	UG/L	22	15%	0.6	GA	2	2	13	80 U	80 U	250 U	50 U	50 U
Acetone	UG/L	3400	69%			0	9	13	80 U	80 U	1600	660	3400
Cis-1,2-Dichloroethene	UG/L	1300	100%	5	GA	13	13	13	960	970	320	1000	170
Methyl butyl ketone	UG/L	27	15%			0	2	13	80 U	80 U	250 U	50 U	50 U
Methyl ethyl ketone	UG/L	2700	69%			0	9	13	80 UJ	80 U	2700	910	820
Trans-1,2-Dichloroethene	UG/L	13	8%	5	GA	1	1	13	80 U	80 U	250 U	50 U	50 U
Trichloroethene	UG/L	860	69%	5	GA	9	9	13	730	680	250 U	170	50 U
Vinyl chloride	UG/L	95	23%	2	GA	3	3	13	95	77 J	250 U	50 U	50 U

ATTACHMENT D-1
Detected VOCs - Round 1 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									MWT-16	MWT-17R	MWT-18	MWT-19	MWT-20
Matrix									GW	GW	GW	GW	GW
Sample ID									ALBW20008	ALBW20007	ALBW20005	ALBW20004	ALBW20003
Sample Depth to Top of Sample									0	0	0	0	0
Sample Depth to Bottom of Sample									0	0	0	0	0
Sample Date									9/9/2005	9/9/2005	9/8/2005	9/8/2005	9/7/2005
QC Code									SA	SA	SA	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									1	1	1	1	1
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2	8%	5	GA	0	1	13	20 U	10 U	50 U	2 J	250 U
1,2-Dichloroethane	UG/L	22	15%	0.6	GA	2	2	13	22	22	50 U	10 U	250 U
Acetone	UG/L	3400	69%			0	9	13	270	10 U	1200 J	370	3200
Cis-1,2-Dichloroethene	UG/L	1300	100%	5	GA	13	13	13	160	59	120	1300	160 J
Methyl butyl ketone	UG/L	27	15%			0	2	13	20 U	10 U	27 J	4 J	250 U
Methyl ethyl ketone	UG/L	2700	69%			0	9	13	120	10 U	2500 J	600	1700
Trans-1,2-Dichloroethene	UG/L	13	8%	5	GA	1	1	13	20 U	10 U	50 U	13	250 U
Trichloroethene	UG/L	860	69%	5	GA	9	9	13	70	33	28 J	110	250 U
Vinyl chloride	UG/L	95	23%	2	GA	3	3	13	20 U	10 U	50 U	17	250 U

ATTACHMENT D-1
Detected VOCs - Round 1 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									MWT-21	MWT-22	PT-12A
Matrix									GW	GW	GW
Sample ID									ALBW20002	ALBW20001	ALBW20006
Sample Depth to Top of Sample									0	0	0
Sample Depth to Bottom of Sample									0	0	0
Sample Date									9/7/2005	9/7/2005	9/9/2005
QC Code									SA	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									1	1	1
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2	8%	5	GA	0	1	13	100 U	100 U	50 U
1,2-Dichloroethane	UG/L	22	15%	0.6	GA	2	2	13	100 U	100 U	50 U
Acetone	UG/L	3400	69%			0	9	13	250	440	50 U
Cis-1,2-Dichloroethene	UG/L	1300	100%	5	GA	13	13	13	1200	1000	910
Methyl butyl ketone	UG/L	27	15%			0	2	13	100 U	100 U	50 U
Methyl ethyl ketone	UG/L	2700	69%			0	9	13	270	480	50 U
Trans-1,2-Dichloroethene	UG/L	13	8%	5	GA	1	1	13	100 U	100 U	50 U
Trichloroethene	UG/L	860	69%	5	GA	9	9	13	98 J	100 U	860
Vinyl chloride	UG/L	95	23%	2	GA	3	3	13	100 U	100 U	50 U

ATTACHMENT D-2
Detected VOCs - Round 2 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL			ASH LANDFILL			ASH LANDFILL			ASH LANDFILL			ASH LANDFILL
Location ID									MW-56			MWT-12R			MWT-12R			MWT-13			MWT-14
Matrix									GW			GW			GW			GW			GW
Sample ID									ALBW20026			ALBW20027			ALBW20025			ALBW20024			ALBW20023
Sample Depth to Top of Sample									0			0			0			0			0
Sample Depth to Bottom of Sample									0			0			0			0			0
Sample Date									10/26/2005			10/26/2005			10/26/2005			10/26/2005			10/25/2005
QC Code									SA			DU			SA			SA			SA
Study ID									BIOWALL TS			BIOWALL TS			BIOWALL TS			BIOWALL TS			BIOWALL TS
Round									2			2			2			2			2
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value	(Q)		Value	(Q)	Value	(Q)		Value	(Q)		Value	(Q)
1,1-Dichloroethene	UG/L	2.8	29%	5	GA	0	4	14	1	U		2.6		2.8			20	U		10	U
1,2-Dichloroethane	UG/L	12	36%	0.6	GA	5	5	14	1	U		0.74	J	0.7	J		20	U		10	U
Acetone	UG/L	8000	93%			0	13	14	4.3	J		3	J	4.1	J		8000			2800	
Benzene	UG/L	0.48	14%	1	GA	0	2	14	1	U		0.45	J	0.48	J		20	UJ		10	U
Cis-1,2-Dichloroethene	UG/L	1600	100%	5	GA	13	14	14	1.8			880		910			410			1600	
Methyl butyl ketone	UG/L	34	21%			0	3	14	5	U		5	U	5	U		100	U		50	U
Methyl ethyl ketone	UG/L	9300	71%			0	10	14	5	U		5	U	5	U		9300			2900	
Toluene	UG/L	15	21%	5	GA	1	3	14	1	U		1	U	1	U		20	UJ		10	U
Trans-1,2-Dichloroethene	UG/L	38	64%	5	GA	8	9	14	1	U		22		23			20	U		22	
Trichloroethene	UG/L	740	57%	5	GA	8	8	14	1	U		710		740			20	U		10	U
Vinyl chloride	UG/L	170	79%	2	GA	11	11	14	1	U		82		87			20	U		10	

ATTACHMENT D-2
Detected VOCs - Round 2 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL		ASH LANDFILL		ASH LANDFILL		ASH LANDFILL		ASH LANDFILL	
Location ID									MWT-15		MWT-16		MWT-17R		MWT-18		MWT-19	
Matrix									GW		GW		GW		GW		GW	
Sample ID									ALBW20022		ALBW20021		ALBW20020		ALBW20018		ALBW20017	
Sample Depth to Top of Sample									0		0		0		0		0	
Sample Depth to Bottom of Sample									0		0		0		0		0	
Sample Date									10/25/2005		10/25/2005		10/24/2005		10/25/2005		10/25/2005	
QC Code									SA		SA		SA		SA		SA	
Study ID									BIOWALL TS		BIOWALL TS		BIOWALL TS		BIOWALL TS		BIOWALL TS	
Round									2		2		2		2		2	
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
1,1-Dichloroethene	UG/L	2.8	29%	5	GA	0	4	14	20	U	20	U	1	U	20	U	5	U
1,2-Dichloroethane	UG/L	12	36%	0.6	GA	5	5	14	20	U	12	J	9.9		20	U	5	U
Acetone	UG/L	8000	93%			0	13	14	140		740		430	J	3000		190	
Benzene	UG/L	0.48	14%	1	GA	0	2	14	20	UJ	20	UJ	1	U	20	UJ	5	U
Cis-1,2-Dichloroethene	UG/L	1600	100%	5	GA	13	14	14	140		380		380		190		1600	
Methyl butyl ketone	UG/L	34	21%			0	3	14	100	U	100	U	3.6	J	100	U	25	U
Methyl ethyl ketone	UG/L	9300	71%			0	10	14	690		750		290	J	4400		200	
Toluene	UG/L	15	21%	5	GA	1	3	14	20	UJ	20	UJ	1.1		20	UJ	5	U
Trans-1,2-Dichloroethene	UG/L	38	64%	5	GA	8	9	14	20	U	20	U	5.9		20	U	21	
Trichloroethene	UG/L	740	57%	5	GA	8	8	14	20	U	9.5	J	16		20	U	33	
Vinyl chloride	UG/L	170	79%	2	GA	11	11	14	36		51		19		20	U	18	

ATTACHMENT D-2
Detected VOCs - Round 2 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL		ASH LANDFILL		ASH LANDFILL		ASH LANDFILL	
Location ID									MWT-20		MWT-21		MWT-22		PT-12A	
Matrix									GW		GW		GW		GW	
Sample ID									ALBW20016		ALBW20015		ALBW20014		ALBW20019	
Sample Depth to Top of Sample									0		0		0		0	
Sample Depth to Bottom of Sample									0		0		0		0	
Sample Date									10/24/2005		10/24/2005		10/26/2005		10/25/2005	
QC Code									SA		SA		SA		SA	
Study ID									BIOWALL TS		BIOWALL TS		BIOWALL TS		BIOWALL TS	
Round									2		2		2		2	
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
1,1-Dichloroethene	UG/L	2.8	29%	5	GA	0	4	14	5	U	2.4	J	5	U	1.3	
1,2-Dichloroethane	UG/L	12	36%	0.6	GA	5	5	14	5	U	0.61	J	5	U	1	U
Acetone	UG/L	8000	93%			0	13	14	270	J	350	J	340		5	U
Benzene	UG/L	0.48	14%	1	GA	0	2	14	5	U	1	U	5	U	1	U
Cis-1,2-Dichloroethene	UG/L	1600	100%	5	GA	13	14	14	160		1400		1100		800	
Methyl butyl ketone	UG/L	34	21%			0	3	14	34		6		25	U	5	U
Methyl ethyl ketone	UG/L	9300	71%			0	10	14	990	J	310	J	310		5	U
Toluene	UG/L	15	21%	5	GA	1	3	14	15		4.8		5	U	1	U
Trans-1,2-Dichloroethene	UG/L	38	64%	5	GA	8	9	14	2.9	J	38		17		11	
Trichloroethene	UG/L	740	57%	5	GA	8	8	14	5	U	45		25		730	
Vinyl chloride	UG/L	170	79%	2	GA	11	11	14	16		69		170		24	

ATTACHMENT D-3
Detected VOCs - Round 3 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									MW-39	MWT-12R	MWT-13	MWT-14
Matrix									GW	GW	GW	GW
Sample ID									ALBW20028	ALBW20041	ALBW20040	ALBW20039
Sample Depth to Top of Sample									0	0	0	0
Sample Depth to Bottom of Sample									0	0	0	0
Sample Date									12/1/2005	12/16/2005	12/16/2005	12/15/2005
QC Code									SA	SA	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									3	3	3	3
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2.9	20%	5	GA	0	3	15		2.9	10 U	10 U
1,2,4-Trichlorobenzene	UG/L	3.8	7%	5	GA	0	1	15		1 U	10 U	10 U
1,2-Dichloroethane	UG/L	6.8	27%	0.6	GA	4	4	15		1 U	10 U	10 U
Acetone	UG/L	4900	80%			0	12	15		3.8 J	4900	2300
Benzene	UG/L	2.9	13%	1	GA	1	2	15		0.5 J	10 U	10 U
Cis-1,2-Dichloroethene	UG/L	1000	100%	5	GA	15	15	15		980	220	550
Methyl butyl ketone	UG/L	62	20%			0	3	15		5 U	62	36 J
Methyl ethyl ketone	UG/L	7600	67%			0	10	15		5 U	6000	2800
Toluene	UG/L	26	40%	5	GA	3	6	15		1 U	10 U	10 U
Trans-1,2-Dichloroethene	UG/L	22	87%	5	GA	7	13	15		21	10 U	15
Trichloroethene	UG/L	760	67%	5	GA	8	10	15		760	10 U	10 U
Vinyl chloride	UG/L	230	100%	2	GA	15	15	15		64	41	230

ATTACHMENT D-3
Detected VOCs - Round 3 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									MWT-15	MWT-16	MWT-17R	MWT-18
Matrix									GW	GW	GW	GW
Sample ID									ALBW20038	ALBW20037	ALBW20036	ALBW20034
Sample Depth to Top of Sample									0	0	0	0
Sample Depth to Bottom of Sample									0	0	0	0
Sample Date									12/14/2005	12/13/2005	12/12/2005	12/14/2005
QC Code									SA	SA	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									3	3	3	3
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2.9	20%	5	GA	0	3	15	5 U	5 U	5 U	5 U
1,2,4-Trichlorobenzene	UG/L	3.8	7%	5	GA	0	1	15	5 U	5 U	5 U	3.8 J
1,2-Dichloroethane	UG/L	6.8	27%	0.6	GA	4	4	15	5 U	6.8	6.6	5 U
Acetone	UG/L	4900	80%			0	12	15	130	85	79	4700 J
Benzene	UG/L	2.9	13%	1	GA	1	2	15	5 U	5 U	5 U	2.9 J
Cis-1,2-Dichloroethene	UG/L	1000	100%	5	GA	15	15	15	15	58	120	230
Methyl butyl ketone	UG/L	62	20%			0	3	15	25 U	25 U	25 U	49
Methyl ethyl ketone	UG/L	7600	67%			0	10	15	140	210	180	7600
Toluene	UG/L	26	40%	5	GA	3	6	15	7.6	4.5 J	2.5 J	4.6 J
Trans-1,2-Dichloroethene	UG/L	22	87%	5	GA	7	13	15	2.6 J	5.3	4.4 J	5 U
Trichloroethene	UG/L	760	67%	5	GA	8	10	15	5 U	2.5 J	4.8 J	5 U
Vinyl chloride	UG/L	230	100%	2	GA	15	15	15	10	31	42	23

ATTACHMENT D-3
Detected VOCs - Round 3 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL		ASH LANDFILL		ASH LANDFILL		ASH LANDFILL	
Location ID									MWT-19		MWT-20		MWT-21		MWT-22	
Matrix									GW		GW		GW		GW	
Sample ID									ALBW20033		ALBW20032		ALBW20031		ALBW20030	
Sample Depth to Top of Sample									0		0		0		0	
Sample Depth to Bottom of Sample									0		0		0		0	
Sample Date									12/13/2005		12/13/2005		12/13/2005		12/12/2005	
QC Code									SA		SA		SA		SA	
Study ID									BIOWALL TS		BIOWALL TS		BIOWALL TS		BIOWALL TS	
Round									3		3		3		3	
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
1,1-Dichloroethene	UG/L	2.9	20%	5	GA	0	3	15	2.1	J	5	U	5	U	5	U
1,2,4-Trichlorobenzene	UG/L	3.8	7%	5	GA	0	1	15	5	U	5	U	5	U	5	U
1,2-Dichloroethane	UG/L	6.8	27%	0.6	GA	4	4	15	5	U	5	U	5	U	5	U
Acetone	UG/L	4900	80%			0	12	15	180		200		73		66	
Benzene	UG/L	2.9	13%	1	GA	1	2	15	5	U	5	U	5	U	5	U
Cis-1,2-Dichloroethene	UG/L	1000	100%	5	GA	15	15	15	1000		13		570		360	
Methyl butyl ketone	UG/L	62	20%			0	3	15	25	U	25	U	25	U	25	U
Methyl ethyl ketone	UG/L	7600	67%			0	10	15	330		260		66		89	
Toluene	UG/L	26	40%	5	GA	3	6	15	5	U	26		6.6		5	U
Trans-1,2-Dichloroethene	UG/L	22	87%	5	GA	7	13	15	17		2.2	J	22		11	
Trichloroethene	UG/L	760	67%	5	GA	8	10	15	17		5	U	20		12	
Vinyl chloride	UG/L	230	100%	2	GA	15	15	15	140	J	13	J	180		140	

ATTACHMENT D-3
Detected VOCs - Round 3 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									PT-12A	PT-12A	PT-22	PT-22
Matrix									GW	GW	GW	GW
Sample ID									ALBW20043	ALBW20035	ALBW20029	ALBW20042
Sample Depth to Top of Sample									0	0	0	0
Sample Depth to Bottom of Sample									0	0	0	0
Sample Date									12/14/2005	12/14/2005	12/1/2005	12/16/2005
QC Code									DU	SA	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									3	3	3	3
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2.9	20%	5	GA	0	3	15	1 U	0.61 J	1 U	1 U
1,2,4-Trichlorobenzene	UG/L	3.8	7%	5	GA	0	1	15	1 U	1 U	1 UJ	1 U
1,2-Dichloroethane	UG/L	6.8	27%	0.6	GA	4	4	15	1 U	1 U	4.3	5.5
Acetone	UG/L	4900	80%			0	12	15	5 U	5 U	5 UJ	3.8 J
Benzene	UG/L	2.9	13%	1	GA	1	2	15	1 U	1 U	1 U	1 U
Cis-1,2-Dichloroethene	UG/L	1000	100%	5	GA	15	15	15	320	310	120	160 J
Methyl butyl ketone	UG/L	62	20%			0	3	15	5 U	5 U	5 UJ	5 U
Methyl ethyl ketone	UG/L	7600	67%			0	10	15	5 U	5 U	5 UJ	5 U
Toluene	UG/L	26	40%	5	GA	3	6	15	1 U	1 U	1 U	1 U
Trans-1,2-Dichloroethene	UG/L	22	87%	5	GA	7	13	15	4.6	5.2	2.3	3.8
Trichloroethene	UG/L	760	67%	5	GA	8	10	15	370	400	46	42
Vinyl chloride	UG/L	230	100%	2	GA	15	15	15	7.6	8.8	17	30

ATTACHMENT D-4
Detected VOCs - Round 4 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									MWT-12R	MWT-13	MWT-14	MWT-15	MWT-16
Matrix									GW	GW	GW	GW	GW
Sample ID									ALBW20056	ALBW20055	ALBW20054	ALBW20053	ALBW20052
Sample Depth to Top of Sample									0	0	0	0	0
Sample Depth to Bottom of Sample									0	0	0	0	0
Sample Date									1/28/2006	1/28/2006	1/27/2006	1/27/2006	1/27/2006
QC Code									SA	SA	SA	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									4	4	4	4	4
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2.3	36%	5	GA	0	5	14	2.3	1 U	1 U	1 U	1 U
1,2-Dichloroethane	UG/L	8.7	36%	0.6	GA	4	5	14	0.53 J	1 U	1.9	1 U	8.7
Acetone	UG/L	1800	86%			0	12	14	5.6 J	1600	770	55 J	24 J
Carbon disulfide	UG/L	4.7	21%			0	3	14	1 UJ	1 UJ	1 J	4.7 J	1 UJ
Cis-1,2-Dichloroethene	UG/L	890	100%	5	GA	13	14	14	650	52	140	3.1	43
Methyl butyl ketone	UG/L	38	43%			0	6	14	5 UJ	38 J	17 J	5 UJ	5 UJ
Methyl ethyl ketone	UG/L	5800	79%			0	11	14	5 UJ	2000	930	33 J	15 J
Methyl isobutyl ketone	UG/L	2.6	7%			0	1	14	5 UJ	2.6 J	5 UJ	5 UJ	5 UJ
Methylene chloride	UG/L	12	7%	5	GA	1	1	14	1 U	1 U	1 U	1 U	1 U
Toluene	UG/L	28	71%	5	GA	3	10	14	1 U	2.9	1	9.8	2.8
Trans-1,2-Dichloroethene	UG/L	20	93%	5	GA	8	13	14	17	1.9	11	2.2	5.4
Trichloroethene	UG/L	540	71%	5	GA	8	10	14	540	1 U	2	1 U	2.9
Vinyl chloride	UG/L	350	100%	2	GA	14	14	14	67	55	340	5	31

ATTACHMENT D-4
Detected VOCs - Round 4 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									MWT-17R	MWT-18	MWT-19	MWT-19	MWT-20
Matrix									GW	GW	GW	GW	GW
Sample ID									ALBW20051	ALBW20049	ALBW20048	ALBW20047	ALBW20046
Sample Depth to Top of Sample									0	0	0	0	0
Sample Depth to Bottom of Sample									0	0	0	0	0
Sample Date									1/26/2006	1/27/2006	1/27/2006	1/27/2006	1/27/2006
QC Code									SA	SA	DU	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									4	4	4	4	4
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2.3	36%	5	GA	0	5	14	1 U	20 U	1.4	1.4	1 U
1,2-Dichloroethane	UG/L	8.7	36%	0.6	GA	4	5	14	5.8	20 U	1 U	1 U	1 U
Acetone	UG/L	1800	86%			0	12	14	11	1800	170 J	170 J	410 J
Carbon disulfide	UG/L	4.7	21%			0	3	14	0.75 J	20 U	1 UJ	1 UJ	1 UJ
Cis-1,2-Dichloroethene	UG/L	890	100%	5	GA	13	14	14	97	150	890	850	8.4
Methyl butyl ketone	UG/L	38	43%			0	6	14	5 U	100 U	5.8 J	5.6 J	17 J
Methyl ethyl ketone	UG/L	5800	79%			0	11	14	6.2	5800	460 J	450 J	660
Methyl isobutyl ketone	UG/L	2.6	7%			0	1	14	5 U	100 U	5 UJ	5 UJ	5 UJ
Methylene chloride	UG/L	12	7%	5	GA	1	1	14	1 U	12 J	1 U	1 U	1 U
Toluene	UG/L	28	71%	5	GA	3	10	14	1.7	20 U	0.62 J	0.6 J	28
Trans-1,2-Dichloroethene	UG/L	20	93%	5	GA	8	13	14	4.2	20 U	20	20	1.8
Trichloroethene	UG/L	540	71%	5	GA	8	10	14	12	20 U	22	21	1 U
Vinyl chloride	UG/L	350	100%	2	GA	14	14	14	60	26	350	340	9.1

ATTACHMENT D-4
Detected VOCs - Round 4 of Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility									ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID									MWT-21	MWT-22	PT-12A	PT-22
Matrix									GW	GW	GW	GW
Sample ID									ALBW20045	ALBW20044	ALBW20050	ALBW20057
Sample Depth to Top of Sample									0	0	0	0
Sample Depth to Bottom of Sample									0	0	0	0
Sample Date									1/27/2006	1/26/2006	1/28/2006	1/28/2006
QC Code									SA	SA	SA	SA
Study ID									BIOWALL TS	BIOWALL TS	BIOWALL TS	BIOWALL TS
Round									4	4	4	4
Parameter	**Units**	**Maximum**	**Frequency**	**Criteria**	**Criteria Source**	**No. Exceed**	**No. Detect**	**No. of Analyses**	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1-Dichloroethene	UG/L	2.3	36%	5	GA	0	5	14	0.74 J	0.72 J	1 U	1 U
1,2-Dichloroethane	UG/L	8.7	36%	0.6	GA	4	5	14	1 U	1 U	1 U	3.5
Acetone	UG/L	1800	86%			0	12	14	130 J	14 J	50 U	5 UJ
Carbon disulfide	UG/L	4.7	21%			0	3	14	1 UJ	1 UJ	1 UJ	1 UJ
Cis-1,2-Dichloroethene	UG/L	890	100%	5	GA	13	14	14	470	430	400	110
Methyl butyl ketone	UG/L	38	43%			0	6	14	5 UJ	5 UJ	13 J	5 UJ
Methyl ethyl ketone	UG/L	5800	79%			0	11	14	110 J	12 J	50 U	5 UJ
Methyl isobutyl ketone	UG/L	2.6	7%			0	1	14	5 UJ	5 UJ	5 UJ	5 UJ
Methylene chloride	UG/L	12	7%	5	GA	1	1	14	1 U	1 U	1 U	1 U
Toluene	UG/L	28	71%	5	GA	3	10	14	6.5	1 U	1.2	1 U
Trans-1,2-Dichloroethene	UG/L	20	93%	5	GA	8	13	14	20	13	5.6	2.6
Trichloroethene	UG/L	540	71%	5	GA	8	10	14	18	25	530	37
Vinyl chloride	UG/L	350	100%	2	GA	14	14	14	180	140	19	26

Attachment D-5
Total Organic Carbon in Soil - Biowall Treatability Study

Ash Landfill Mulch Biowall
Seneca Army Depot, Romulus, New York

Facility		ASH LANDFILL		ASH LANDFILL		ASH LANDFILL		ASH LANDFILL	
Location ID		MWT-17R		MWT-17R		MWT-12R		MWT-12R	
Matrix		SOIL		SOIL		SOIL		SOIL	
Sample ID		ALBW10001		ALBW10002		ALBW10003		ALBW10004	
Sample Depth to Top of Sample		7.4		8.2		5		5.5	
Sample Depth to Bottom of Sample		7.4		8.2		5.5		5.7	
Sample Date		8/12/2005		8/12/2005		8/22/2005		8/22/2005	
QC Code		SA		SA		SA		SA	
Study ID		BIOWALL TS		BIOWALL TS		BIOWALL TS		BIOWALL TS	
Round		1		1		1		1	
Parameter	**Units**	Value	(Q)	Value	(Q)	Value	(Q)	Value	(Q)
Total Organic Carbon	MG/KG	27500		15700		25800		5830	

Response to Comments from the New York State Department of Environmental Conservation

Subject: Draft Remedial Design Report for the Ash Landfill Operable Unit
Seneca Army Depot
Romulus, New York

Comments Dated: August 10, 2006

Date of Comment Response: August 18, 2006

Specific Comments:

Figure 7-3, Notes, Item 1- Achieving GA Stds on site:

Comment 1: "……the On-site Plume wells for two successive monitoring events….", please modify this to "……the On-site Plume wells for subsequent successive monitoring events…."

Response 1: The purpose of the long-term monitoring plan and, specifically, of the decision diagram outlined in Figure 7-3, is to establish a defined process for evaluating the groundwater monitoring program and for detailing the frequency and duration of monitoring. It is the Army's desire that the long-term monitoring plan be definitive as to when monitoring requirements would terminate. The ROD states that monitoring will be conducted at the site until NYSDEC GA standards are achieved. The Army's original wording provides a clear blueprint for when the GA standards in the on-site wells have been achieved. Currently, the Army has recommended that after two successive monitoring events, if GA standards are achieved in all on-site plume wells, the remedy would be complete and no further monitoring would be required for the Ash Landfill Operable Unit. Under the Army's proposed plan, since monitoring would cease after two successive rounds of acceptable data as currently defined, there would not be a "subsequent" round. Therefore, the text in the note on Figure 7-3 remains unchanged.

Comment 2: Decreasing Trend – To determine the trend in all future sampling reports, please provide and show the sampling results using graphical and statistical depictions on figures and diagrams.

Response 2: Graphs and statistics will be used, as appropriate, to determine the trend of the analytical data. The text in Figure 7-3 and on Page 7-5 has been modified.

Response to Comments from the United States Environmental Protection Agency

Subject: Draft Remedial Design Report for the Ash Landfill Operable Unit
Seneca Army Depot
Romulus, New York

Comments Dated: August 1 and August 15, 2006

Date of Comment Response: August 18, 2006

General Comments:

Comment 1: No major issues, other than the added extension of the walls as stated before. [Reference comment dated 7/12/06 from Rob Alvey: *The biowall as designed limits it's extent to the 2003 delineated 10 ug/l impacted area. I recommend extending the proposed biowall approximately 50 feet in the northerly direction for both the C and B walls. It will help prevent bypass as the walls may eventually restrict flow and cause mounding or diversion. For stockpiling purposes, the actual locations for the trenches seem OK. I particularly like hitting the 1000 ug/l twice*.] Also, I think it would be appropriate to have some kind of a technical memorandum to document the assumptions (i.e. conductivity, bio-activity, retention times, etc.) for the design of the walls.

Response 1: Biowalls B1, B2, C1 and C2 will be extended 50 feet to the north as suggested. Table 3-1, Figure 7-2, Figure 10-1, Drawing C-4, Specifications 01010, Specification 02221 and text related to wall lengths and excavation volumes has been updated to reflect this. Regarding the technical memorandum documenting the assumptions of the design, such a report was written and included with the Remedial Design Work Plan for this site. This memorandum will be included as Appendix C of the Remedial Design Report and is now referenced in Section 3, Basis of Groundwater Remediation Design.

Comment 2, Page 4-4, Section 4.1.6: If hazardous substances are found, you propose the material to be treated on-site. This possibility was not addressed within our ROD. Please provide additional details as to the treatment planned to be used and related sampling and disposal information.

Response 2: The following text has been added to the end of Section 4.1.6: “Treatment may include stabilization to immobilize contaminants such as heavy metals. Stabilization involves mixing an additive such as cement, quick lime, fly ash, pozzolans, or a proprietary agent with the soil. The stabilization process decreases the toxicity of the metals because the metals are converted to less soluble forms. Once stabilization is complete, samples would be collected and analyzed for the TCLP parameters for which the waste is characteristically hazardous. Results will be used to render the waste non-hazardous and suitable for disposal at the Ontario County Landfill or Seneca Meadows Landfill.”

Comment 3, Page 4-4, Section 4.1.7: The location of berms is left to be determined in the field. It is my opinion that those locations are best to be estimated on paper according to available topographic maps, and location of berms be modified in field as needed.

Response 3: Agreed. However, in the case of this design, the only subgrade excavation where run-on/run-off water will need to be controlled is during installation of the biowall trenches. Trenches will be backfilled in a timely manner and are not expected to collect water. Fill materials for the biowall will be stockpiled upgradient of the transects to be excavated, providing a berm to divert surface water during installation. The majority of the text in Section 4.1.7 has been deleted as it is not applicable and the explanation given in this response has been inserted. No drawings or figures will be modified.

Comment 4, Page 4-9, Second paragraph: After "Drawing C-4", the text indicates the space between walls as 15 ft. However, the drawings show a space of only 12 feet. Please correct.

Response 4: The text in question has been modified to read: "The walls within each pair will be spaced approximately 15 feet apart measured from the centerline of each trench." Since each trench is three feet wide, this would translate into a 12-foot separation between the edges of each trench, as indicated in Drawing C-5.

Comment 5, Page 4-13, 3rd bullet: I would like to be forwarded a copy of the final inspection.

Response 5: A copy of the final inspection will be provided to the agencies.