US Army, Engineering & Support Center
Huntsville, AL

Seneca Army Depot Activity
Romulus, New York

Final Work Plan

Ash Landfill Biowall Recharge
Seneca Army Depot Activity

Contract No. W912DY-09-D-0062-0023
Task Order No. 23
EPA SITE ID# NY0213820830
NY Site ID# 8-50-006

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June 29, 2017

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SUBJECT: **Final Work Plan Ash Landfill Biowall Recharge at Seneca Army Depot Activity in Romulus, NY; Contract W912DY-09-D-0062, Task Order 0023**

Dear Mr. Pommerenck:

Parsons Federal (Parsons) is pleased to submit the Final Work Plan for the Ash Landfill Biowall Recharge at the Seneca Army Depot Activity (SEDA) in Romulus, New York. The fieldwork for the Biowall Recharge is expected to take place beginning in approximately mid-July 2017.

The Work Plan was prepared in accordance with the Scope of Work (SOW) for Contract No. W912DY-09-D-0062, Task Order 0023.

Parsons appreciates the opportunity to provide you with this Work Plan. Should you have any questions, please do not hesitate to call me at (617) 449-1565 to discuss them.

Sincerely,

Beth Badik
Project Manager

Enclosures

cc: R. Battaglia, USACE, NY District
B. Frazier, USACE, Huntsville
K. Hoddinott, USACHPPM

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June 29, 2017

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SUBJECT: Final Work Plan Ash Landfill Biowall Recharge at Seneca Army Depot Activity in Romulus, NY; EPA Site ID# NY0213820830 and NY Site ID# 8-50-006

Dear Mr. Vazquez/Ms. Sweet/Mr. Sergott:

Parsons Federal (Parsons) is pleased to submit the Final Work Plan for the Ash Landfill Biowall Recharge at the Seneca Army Depot Activity (SEDA) in Romulus, New York. (USEPA Site ID# NY0213820830 and NY Site ID# 8-50-006). The fieldwork for the Biowall Recharge is expected to take place beginning in approximately mid-July 2017.

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

Sincerely,

Beth Badik
Project Manager

Enclosures

cc: R. Battaglia, USACE-NY
K. Pommerenck, USACESCH
B. Frazier, USACESCH
K. Hoddinott, USACHPPM

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Appendix A – Response to Comments

ACRONYMS AND ABBREVIATIONS

3D	3-dimensional
Ash Landfill OU	Ash Landfill Operable Unit
bgs	below ground surface
BMP	Best Management Practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
cm	centimeter(s)
CoC	chain-of-custody
COC	contaminants of concern
COR	Contracting Officer's Representative
DCE	dichloroethene
DL	detection limit
DO	Dissolved Oxygen
EVO	emulsified vegetable oil
FFA	Federal Facility Agreement
FS	Feasibility Study
g	gram(s)
gpm	Gallons per minute
GIS	geographic information system
HRO™	Newman Zone HRO™
ID	identification
IDW	Investigation derived waste
IRM	Interim Removal Action
LTM	long-term monitoring
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
mm	millimeter(s)
NCFL	Non-Combustible Fill Landfill
NTCRA	Non-Time Critical Removal Action
NYSDEC	New York State Department of Environmental Conservation
O&M	operations and maintenance
ORP	oxidation-reduction potential
PAH	Polynuclear Aromatic Hydrocarbon
PAL	project action limit
Parsons	Parsons Federal
PM	Project Manager

POC	point of contact
PPE	personal protective equipment
PRB	permeable reactive barrier
psi	pounds per square inch
PVC	polyvinyl chloride
RA	Remedial Action
RDR	Remedial Design Report
RI	Remedial Investigation
ROD	Record of Decision
SEDA	Seneca Army Depot Activity
SHEP	Safety, Health and Environment Plan
SHSO	Site Health and Safety Officer
SI	Site Inspection
SOP	standard operating procedure
SVOC	semi-volatile organic compound
SWMU	solid waste management unit
TBD	to be determined
TCE	trichloroethene
TO	task order
U.S.	United States
USAEC	United States Army Environmental Command
USAEHA	U.S. Army Environmental Hygiene Agency
USAESCH	United States Army, Engineering & Support Center, Huntsville
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound
ZVI	zero valance iron

Chapter 1 Introduction

1.1 PROJECT BACKGROUND

This Work Plan was prepared by Parsons Federal (Parsons) for the Seneca Army Depot Activity (SEDA or the Depot) and the United States Army, Engineering & Support Center, Huntsville (USAESCH) under Contract No. W912DY-09-D-0062-0023, Task Order 0023 (TO 0023). Under this TO, Parsons is assigned the task of refreshing the organic carbon content in the permeable mulch biowalls installed by Parsons in 2006 at the Ash Landfill Operable Unit (Ash Landfill OU) (**Figure 1.1**). This refresh will extend the effective lifespan of the remedial action (RA) completed in October and November 2006 in accordance with the *Final Record of Decision* (ROD) *for the Ash Landfill* (Parsons, 2004), the *Remedial Design Work Plan* (Parsons, 2006a), and the *Remedial Design Report* (RDR) (Parsons, 2006b).

This work plan describes the technical approach that will be implemented at the Ash Landfill to achieve the project objective of refreshing the organic carbon loading within the biowalls to extend the effective lifespan of the remedy. This work plan was developed in accordance with the requirements of the Federal Facility Agreement (FFA) between the United States Environmental Protection Agency (USEPA), New York State Department of Environmental Conservation (NYSDEC), and the United States Army (the Army).

1.2 WORK PLAN ORGANIZATION

Chapter 1 serves as an introduction to the work plan, provides background for the project, and states the project objectives.

Chapter 2 provides historic site information including previous remedial studies, investigations, and activities as well as describing the nature and extent of the groundwater contamination on-site.

Chapter 3 outlines the project management organization to be implemented throughout the course of the project.

Chapter 4 summarizes the basis for the groundwater remediation design to refresh the biowalls at the Ash Landfill to address the volatile organic compound (VOC) groundwater contamination on-site.

Chapter 5 describes the activities to be completed in order to effectively recharge the biowalls on site, including the installation of recirculation wells and injection of organic substrate.

Chapter 6 discusses the long-term monitoring (LTM) to be conducted at the Ash Landfill, the conditions that would indicate another recharge is required, operations and maintenance (O&M) on site, and the reporting.

Chapter 7 presents the anticipated schedule for the remedial design.

Chapter 8 provides a list of references used in preparing this Work Plan.

Appendix A is the site-specific safety, health, and environment plan (presented under separate cover).

Chapter 2 Site Background Information

2.1 SITE DESCRIPTION

SEDA is a 10,587-acre former military facility located in Seneca County near Romulus, New York, that was owned by the United States Government and operated by the Department of the Army from 1941 until 2000. In 2000, the Army assumed a caretaker role at the SEDA, and since this time more than 8,500 acres of the property were transferred to other parties. SEDA is located between Seneca Lake and Cayuga Lake and is bordered by New York State Highway 96 to the east, New York State Highway 96A to the west, and sparsely populated farmland to the north and south.

The location of the Ash Landfill OU, also referred to as the Ash Landfill, is composed of five historic solid waste management units (SWMUs). 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 former Debris Piles (SEAD-14), and the former Abandoned Solid Waste Incinerator Building (SEAD-15).

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

The incinerator was built in 1974. Between 1974 and 1979, materials intended for disposal were transported to the incinerator. Each week the Depot generated approximately 18 tons of refuse, the majority of which was incinerated. The source for the refuse was domestic waste from Depot activities and family housing. Large items that could not be burned were disposed at the NCFL (SEAD-8). The NCFL encompasses approximately three acres located southeast of the former incinerator building, immediately south of a 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 former incinerator were temporarily disposed of 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. An undated aerial photograph depicting the incinerator during operation illustrates that the active area of the Ash Landfill extended at least 500 feet north of the incinerator building, near a bend in a dirt road. A fire destroyed the incinerator on May 8, 1979, and the landfill was subsequently closed. Post-closure, the landfill was apparently covered with native soil of various thicknesses, but was not closed with an engineered cover or cap. Other areas at the site were used as a grease pit and for burning debris.

Remediation activities that have impacted the current site conditions are described below in **Section 2.2**.

2.1.1 SITE GEOLOGY/HYDROGEOLOGY

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 shale, sandstone, conglomerate, limestone and dolostone. At the Ash Landfill site, these rocks (the Ludlowville Formation) are characterized by gray, calcareous shale and mudstone and thin limestone with numerous zones of abundant invertebrate fossils. Locally, the shale is soft, gray, and fissile. The shale, which has a thin weathered zone at the top, is overlain by 2 to 3 feet of Pleistocene-age till deposits. The till matrix varies locally, but generally consists of unsorted silt, clay, sand, and gravel (Brett et al., 1995).

The thickness of the till at the Ash Landfill OU 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 layer and in the deeper competent shale layer. 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 and seasonal fluctuations in the water table and the saturated thickness. Historic data at the Ash Landfill OU indicate that the saturated interval is thin (generally between 1 and 3 feet thick) in the month of September and is thickest (generally between 6 and 8.5 feet thick) between December and March (Parsons Engineering Science Inc., 1994).

The average linear velocity of the groundwater in the till/weathered shale layer was calculated during the Remedial Investigation (RI) in 1994 using the following parameters: 1) average hydraulic conductivity of 4.5×10^{-4} centimeters per second (cm/sec) (1.28 feet per day [ft/day]), 2) estimated effective porosity of 15% to 20%, and 3) groundwater gradient of 1.95×10^{-2} feet per foot (ft/ft) (Parsons Engineering Science, Inc., 1994). The average linear velocity was calculated as 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 of on-site groundwater may be locally influenced by zones of higher-than-average permeability; these zones are possibly associated with variations in the porosity of the till/weathered shale.

2.2 SUMMARY OF PREVIOUS REMEDIAL STUDIES, INVESTIGATIONS, AND ACTIVITIES

An RI/FS investigation was completed in 1996 at the Ash Landfill OU (Parsons Engineering Science Inc., 1994). The RI refocused the site from approximately 130 acres down to 23 acres and identified a groundwater plume emanating from the northern western side of the landfill area. The groundwater plume consisted of chlorinated ethenes (e.g., trichloroethene (TCE), dichloroethene (DCE), vinyl chloride (VC), etc.) and extended 1,100 feet from the original source area towards the western Depot property line. A Non-Time Critical Removal Action (NTCRA), also known as an Interim Removal Action (IRM), was conducted by the Army between August 1994 and June 1995, under CERCLA to remove the contaminant source area. This source removal action involved the excavation of 63,000 cubic yards of soil and treatment using low temperature thermal desorption across 1.5 acres. The IRM thermal treatment project provided a positive benefit for the long-term remedial action by eliminating the continued leaching of VOCs into groundwater and preventing further exposure to humans and the environment.

To address concerns of groundwater contamination migrating off-site, a zero valence iron (ZVI) treatability study was performed between 1998 and 2001 and showed that the permeable wall would effectively degrade chlorinated ethenes (Parsons, 2004a). Based on strong 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 ZVI and sand. A performance monitoring well network was sampled and analyzed from 1999 to 2004 to assess the performance of the wall. A ROD (Parsons, 2004b) for this site was subsequently issued in July 2004 and included the use of permeable reactive barriers (PRBs) as migration control for the groundwater contamination on site.

However, the cost of iron had tripled so the use of reactive iron was no longer considered a cost-effective PRB media. Therefore, the use of mulch in reactive biowalls was evaluated for the full-scale implementation to provide contamination migration control. 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 would effectively control migration of groundwater contaminants from the site (Parsons, 2006a). Based on the successes of the pilot study, three biowall pairs were installed in 2006 (Parsons, 2007). The biowalls were installed by excavating a linear trench perpendicular to the chlorinated solvent plume down to competent bedrock and then backfilling with a mixture of mulch and sand. In total, approximately 2,840 linear feet of biowalls were constructed in the areas downgradient of the Ash Landfill at depths ranging from 7 feet below ground surface (bgs) to 18.5 feet bgs. A 12-inch soil cover was placed over the entire length of the biowalls to impede surface water from preferentially flowing into the biowall trenches.

As part of the RA at the Ash Landfill OU, post-closure operations include LTM. Beginning in January 2007, groundwater samples were collected throughout the Ash Landfill OU to conduct: 1) plume performance monitoring, 2) biowall process monitoring, and 3) off-site compliance monitoring. The first year of sampling was conducted on a quarterly basis, but was completed on a semi-annual basis from Round 5 (June 2008) through the most recent sampling event for Round 21 (June 2016). The results and findings of the each round of groundwater sampling is documented in LTM annual reports. The LTM annual reports also include an evaluation of the need to recharge the biowalls as an operations and maintenance measure to increase the lifespan of the systems.

A summary of the previous remedial studies, investigations, and activities is provided in **Table 2.1** below.

Table 2.1
Summary of Previous Remedial Studies, Investigations, and Activities

Previous Study, Investigation, Or Activity Name	Date	Outcome
Remedial Investigation/ Feasibility Study	1994	A groundwater plume, emanating from the northern corner of the Ash Landfill was delineated. The primary constituents of concern at the Ash Landfill were considered to be VOCs, primarily chlorinated and aromatic hydrocarbons, semi-volatile organic compounds (SVOCs), Polynuclear Aromatic Hydrocarbon (PAH)s, and, to a lesser degree, metals.
Interim Removal Action	1994 –1995	Two source areas (63,000 cubic yards spanning 1.5 acres) were thermally treated to reduce concentrations of VOCs and PAHs and to eliminate continued leaching of contaminants from the soil into the groundwater.
ZVI Treatability Study, Installation, and Monitoring	1998-2004	Based on the results of the treatability study, a ZVI wall was installed near the Depot property line. A performance monitoring well network was sampled and analyzed from 1999-2004 to assess the performance of the wall.
Biowall Pilot Study	2005-2006	Pilot study showed that a mulch biowall system is able to successfully reduce chlorinated ethenes and create a reductive treatment zone based on geochemical parameters.
Remedial Action	2006	Three biowall pairs were installed perpendicular to the groundwater flow, a 12-inch vegetative cover was installed over the Ash Landfill and NCFL, three debris piles were excavated and disposed of, and the Incinerator Cooling Water Pond was re-graded.
Long-Term Groundwater Monitoring	2007 – Present	The network of wells at the Ash Landfill OU were sampled to observe and document that the biowalls are operating properly and successfully and to ensure the plume is not migrating off-site.

2.3 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

The primary potential impact to human health and the environment at the Ash Landfill OU is a groundwater contaminant plume containing dissolved chlorinated solvents, primarily TCE, isomers of DCE, and VC. The plume originates in the “Bend in the Road” area near the northwestern edge of the Ash Landfill OU (**Figure 2-1**). As detailed in the *Final Remedial Design Work Plan for the Ash Landfill OU* (Parsons, 2006a), the chlorinated ethenes are transformed via reductive dechlorination to less harmful forms, as the groundwater flows through the anaerobic treatment zone established within the biowalls. Concentrations of TCE, *cis*-1,2-dichloroethene (*cis*-1,2-DCE), and VC have decreased over the twenty-two sampling events to date at the wells within and downgradient of the biowalls. The analytical data from each round of LTM and trends in site geochemical parameters continue to demonstrate the ability of the environment within the biowalls to promote reductive dechlorination can be seen in the most recent LTM Annual Report (Parsons, 2016).

Current geochemical conditions within the biowalls remain consistently and moderately-to-strongly anaerobic with dissolved oxygen (DO) concentrations below 1 milligrams per liter (mg/L) and oxidation-reduction potential (ORP) values of generally less than -100 millivolts (mV) based on Parsons’ 2015 data (Parsons, 2016). The presence of high concentrations of methane within the biowalls (greater than 10 mg/L) and reduced concentrations of sulfate within the walls with respect to upgradient concentrations support the conclusion that geochemical conditions within the biowalls continue to be sufficiently anaerobic (i.e., sulfate reducing to methanogenic conditions) to support rapid and complete reductive dechlorination of incoming TCE/dichloroethene (DCE) mass. The comparison of chlorinated solvent concentrations upgradient from the biowalls (PT-18A) to concentrations within the walls (MWT-27 and MWT-28) and downgradient from the walls (MWT-29) indicate that chlorinated solvent concentrations continue to be strongly reduced by the biowalls.

While current geochemical conditions within the biowalls remain optimal for complete reductive dechlorination, there are some indications that the biowalls will require refresh. Oxidation-reduction potential (ORP) values have historically been indicative of sulfate reducing and methanogenic conditions in all the biowalls; however, during more recent sampling events, ORP appears to be increasing very slowly to less reducing conditions, particularly in Biowall C2. Dissolved organic carbon concentrations are also in slow decline, approaching 20 mg/L or less in some cases (Parsons, 2015). In addition, during the June 2015 sampling round, sulfate concentrations increased slightly in all the biowalls indicating that sulfate reduction may be slowing down within the biowalls. Sulfate concentrations within the biowalls remain very low in comparison to upgradient concentrations indicating that sulfate reduction continues to occur. However, the consistent increases in sulfate concentrations, coupled with the other lines of evidence discussed above, indicate that bioavailable organic carbon concentrations within the biowalls are declining. These lines of evidence indicate that the biowalls will require refresh to maintain system performance. Analysis of the rate of decline in dissolved organic carbon concentrations and the rate of increase in ORP values and sulfate concentrations indicates that refresh will be required in the next 12-24 months. Parsons proposes to refresh the organic carbon content within the Ash Landfill biowalls during the summer of 2017, as presented on the project schedule in Chapter 7.

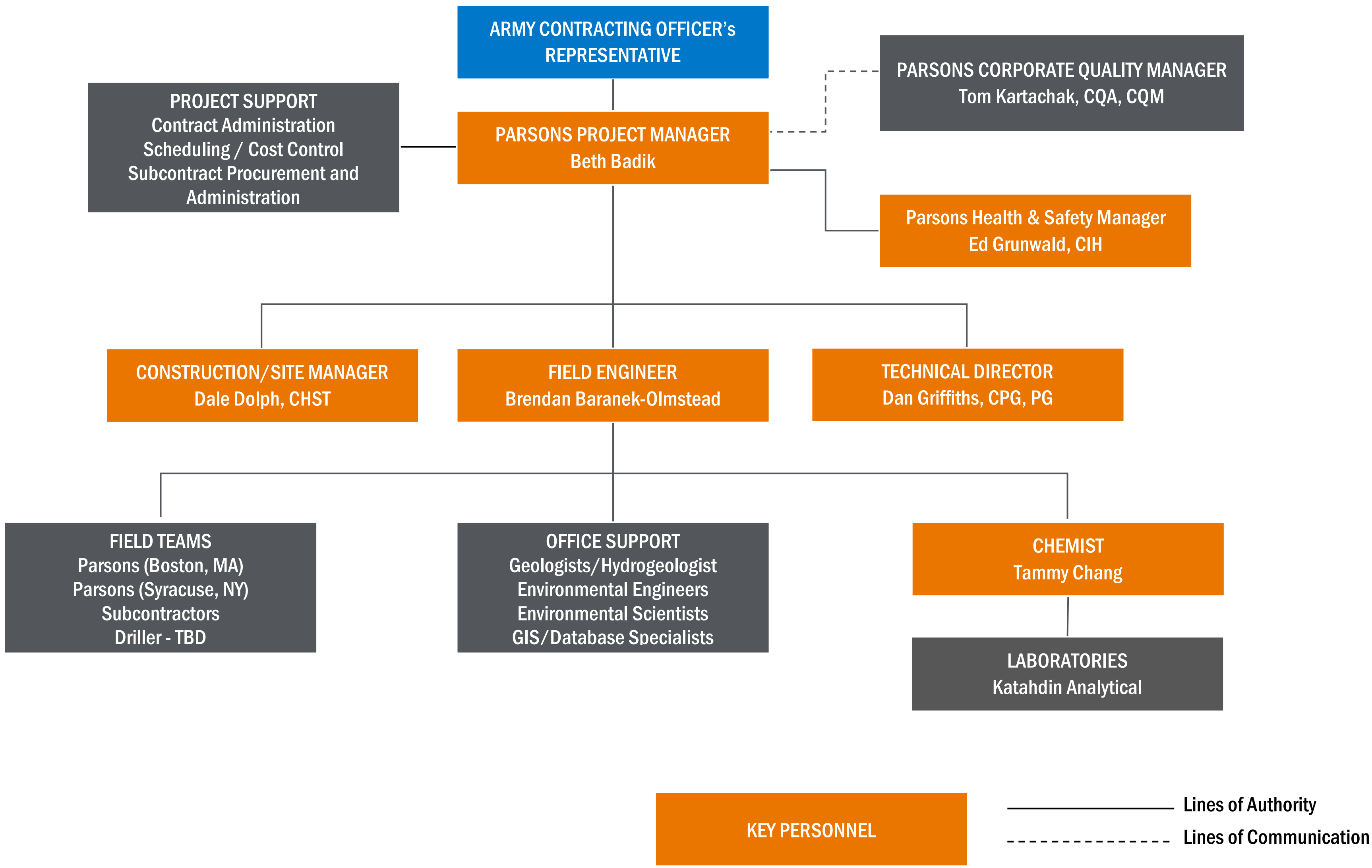
Chapter 3 Project Management Organization

The contact information for key project management personnel is presented in **Table 3.1** below. All on-site work at the Ash Landfill OU will be completed by Parsons personnel, with the exception of a subcontracted driller. The lines of authority and communication among project personnel is presented in **Exhibit 3.1**.

Table 3.1
Project Management Contact Information

Project Title/Role	Name	Organization	Phone Number/Email
USACE Contracting Officer Representative (COR)	George Brown	USAESCH	256-895-1577 George.L.Brown2@usace.army.mil
USACE Project Manager (PM)	Randy Battaglia	CENAN	607-869-1523 Randy.W.Battaglia@usace.army.mil
Project Manager	Beth Badik	Parsons	617-449-1565 beth.badik@parsons.com
Health & Safety Manager	Ed Grunwald	Parsons	678-969-2394 ed.grunwald@parsons.com
Technical Director	Daniel R. Griffiths	Parsons	303-764-1940 Daniel.R.Griffiths@parsons.com
Construction Manager	Dale Dolph	Parsons	315-506-3939 dale.dolph@parsons.com
Field Engineer	Brendan Baranek-Olmstead	Parsons	617-449-1404 brendan.baranek-olmstead@parsons.com

Exhibit 3.1
Project Organizational Chart



Chapter 4 Remedy Maintenance and Refresh Design

4.1 REMEDY REFRESH DESIGN BASIS

4.1.1 OPTIONS FOR BIOWALL REFRESH

Three methods of refreshing the Ash Landfill biowalls were considered based on the characteristics of their short-term constructability, long-term effectiveness, and cost. The refresh methods considered included:

- Excavation of the old biowall materials and replacement with new tree mulch and sand,
- Injection of liquid substrates using direct push techniques,
- Injection of liquid substrates using injection wells and in-wall recirculation.

Direct replacement of the mulch materials in the Ash Landfill biowalls was initially considered as an option to rejuvenate biowall effectiveness and longevity. Direct replacement through excavation would add a large mass of slowly soluble organic material in the form of new tree mulch much like the original biowall installation. The longevity of the refresh would be expected to be approximately equal to the lifespan of the original installation (10-12 years). However, the removal of the old biowalls would necessitate the disposal of these materials as impacted waste (approximately 6,500 cubic yards) at significant cost. In addition, the replacement of the biowalls with new tree mulch would cause a rebound in ORP conditions within the walls which would remove or destroy the dechlorinating microbial population that has been built up over time. This shift in geochemical conditions and resultant shift in microbial population would cause a significant delay in the restart of complete contaminant destruction in the biowalls. Finally, the construction cost to replace the biowalls and the performance monitoring wells in the biowalls was deemed to be prohibitive.

An alternative to the direct replacement of the biowall materials is a refresh accomplished through the injection of additional organic substrate. The injection of liquid organic substrates (e.g., soybean oil or emulsified vegetable oil) using direct push injection techniques was assessed for suitability and cost. The use of this technique would require the installation of direct push points along each biowall transect using a relatively close spacing (approximately 10-15 feet) in order to distribute substrate evenly and to ensure that gaps in distribution are not formed. The use of direct push drilling would 1) reduce biowall refresh costs significantly; 2) effectively deliver liquid substrates to the biowalls to extend the lifespan of the remedy by approximately 5-7 years; and, 3) offer the lowest possible cost to achieve project objectives. However, substrate injection using direct push would require the use of potable or non-potable surface water as a carrier for the organic substrates, resulting in a significant short term shift in geochemical and microbiological conditions within the biowalls. In addition, the use of direct push injection on a close point spacing results in significant risk of daylighting substrate and contaminated groundwater onto the ground surface. For these reasons, direct push injection was not considered an optimal means to refresh the biowalls.

The injection of organic substrates to refresh the biowalls is a viable method to extend the lifespan of the remedy. Thus, alternate means to inject liquid substrates were considered. Substrate injection through in-wall recirculation was considered and ultimately selected as the optimal mix of effectiveness verses cost and risk. In-wall recirculation involves the installation of recirculation wells within each biowall segment. Groundwater is extracted, amended with organic substrates, and reinjected back into the biowall. This simultaneous extraction and reinjection drives recirculation within the biowall. This recirculation flow pattern very effectively distributes organic substrate within the biowall. Recirculation, though more expensive than direct push, allows for biowall refresh without risking significant geochemical and microbial shifts because the water being used to distribute the substrates is extracted directly from the biowall. In addition, since extraction and injection flow rates can be balanced, the potential for daylighting organic substrate and impacted groundwater on the ground surface during recirculation is much lower than direct push injection. For these reasons recirculation was selected as the optimal method to refresh the Ash Landfill biowalls.

4.1.2 PROPOSED BIOWALL REFRESH DESIGN APPROACH

The Seneca Ash Landfill Biowall refresh design was developed through a series of volumetric calculations established to replace one entire pore volume of fluid in each of the biowall segments with a mixture of water and organic substrate, in order to achieve the primary project objective of refreshing organic carbon content in the biowalls and extending the operational lifespan of the remedy. This volumetric calculation served as the design basis for this project, in terms of establishing minimum fluid volumes and substrate loading for each biowall transect (**Table 4.1**).

After the volumetric calculations were complete, several substrate emplacement methods were evaluated ranging from direct injection of small volumes of pure substrate (i.e., pure soybean oil with no water phase) via direct push temporary injection points to the emplacement of a dilute soybean oil in water mixture through recirculation wells. Recirculation of groundwater and water mixed with dilute emulsified vegetable oil (EVO) was selected as the optimal means to emplace additional organic substrate into the biowalls while minimizing potential problems, including poor in-biowall substrate distribution, daylighting of impacted groundwater on the ground surface, and biowall plugging resulting in impacted groundwater migrating around the ends of the walls. Recirculation of dilute EVO in water through recirculation was ultimately selected as the preferred methodology for emplacement and biowall refresh.

Modeling

A custom 3-dimensional (3D) numerical finite difference model was prepared to support the design of recirculation well injection systems for the biowall refresh project. The purpose of the model was to evaluate the injection and extraction rates in each biowall to quantitatively analyze substrate breakthrough from the injection points to the extraction points. The results of multiple scenarios with varied flow rate and well spacing were integrated into a cost benefit analysis to determine the optimal well spacing (balancing the cost of well installation versus substrate injection time). Given a shallow depth to water (~5 ft) and shallow biowall (10-20 ft) the design needed to balance flow rate versus change in head. If design flow rates exceed barrier wall capacity, then undesirable outcomes might occur at the injection point or the extraction point (daylighting or extraction well evacuation).

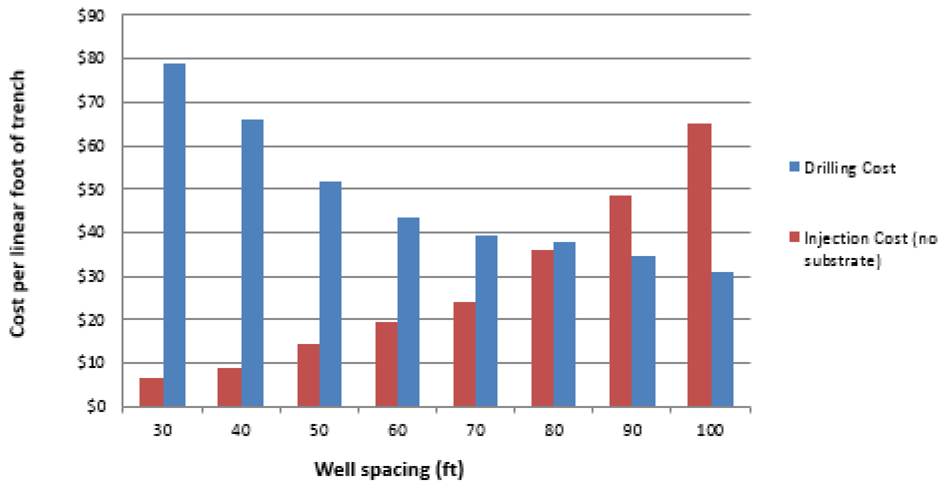
The model consisted of a MODFLOW 2000 with pre-conjugate gradient solver (PCG2) and Groundwater Vistas for graphical user interface, upfront data assemblage, and post processing. MODPATH 5 was used for groundwater particle tracking. Heads were compared with groundwater surface elevation and total depth of the barrier wall to provide a reasonable buffer distance which would avoid daylighting or well drying. Time of breakthrough was graphically depicted from MODPATH output. The model was steady-state; however, initial testing was completed in the transient mobile state in order to identify model performance and reliability of steady-state conditions. Each biowall segment was a 3D component of the model simulated as a zone of higher hydraulic conductivity and assigned site-specific parameters. One wall was established in the model for the testing which is scalable for all walls at the site, given the similarities and general insensitivity of the analysis to wall thickness or depth.

To achieve complete substrate distribution between recirculation wells while minimizing the potential for daylighting of impacted groundwater and/or groundwater substrate mixture on the ground surface, a balance must be achieved between installing numerous, closely-spaced recirculation wells versus fewer, widely-spaced recirculation wells. To ensure that optimal substrate distribution is achieved, the 3D modeling process compared well spacing distances and their effect on substrate distribution, drilling costs, and injection costs. Modeling results indicate an optimal recirculation well spacing of approximately 80 to 90 feet (**Exhibit 4.1**).

Table 4.1
Proposed Biowall Recirculation Injection Volumes

Section	Length	Average Width	Number Wells	Range Saturated Thickness	Assumed Saturated Thickness	Total Volume	Pore Volume at 18%	Injection Volume (one pore volume)	Percent Oil Saturation	Neat Oil Volume	Neat Oil Volume	Neat Oil Weight	Percent pH Buffer Saturation	pH Buffer Volume	pH Buffer Weight
Units	feet	feet	each	feet	feet	cubic ft	cubic ft	gallons	percent	cubic ft	gallons	lbs	percent	gallons	lbs
A1/A2	375	12	5	5 - 9	8	36,000	6,480	48,470	5.5%	356	2,666	20,794	1.5%	727	8,725
B1/B2	140	15	2	2 - 5	4.5	9,450	1,701	12,723	5.5%	94	700	5,458	1.5%	191	2,290
B1(1)	535	10	8	2 - 5	4.5	24,075	4,334	32,415	5.5%	238	1,783	13,906	1.5%	486	5,835
B2(2)	540	10	8	2 - 5	4.5	24,300	4,374	32,718	5.5%	241	1,799	14,036	1.5%	491	5,889
C1	560	6	7	4 - 7	6.5	21,840	3,931	29,405	5.5%	216	1,617	12,615	1.5%	441	5,293
C2	560	6	7	4 - 7	6.5	21,840	3,931	29,405	5.5%	216	1,617	12,615	1.5%	441	5,293
								185,137				79,424			33,325
							Injection Rate (gpm)	10							
							Injection Time (hours)	309							
							Injection Days (8.5 hour/day)	36							

Exhibit 4.1
Drilling and Injection Costs (not including injection materials)
Versus Well Spacing



4.2 ASH LANDFILL BIOWALL REFRESH APPROACH

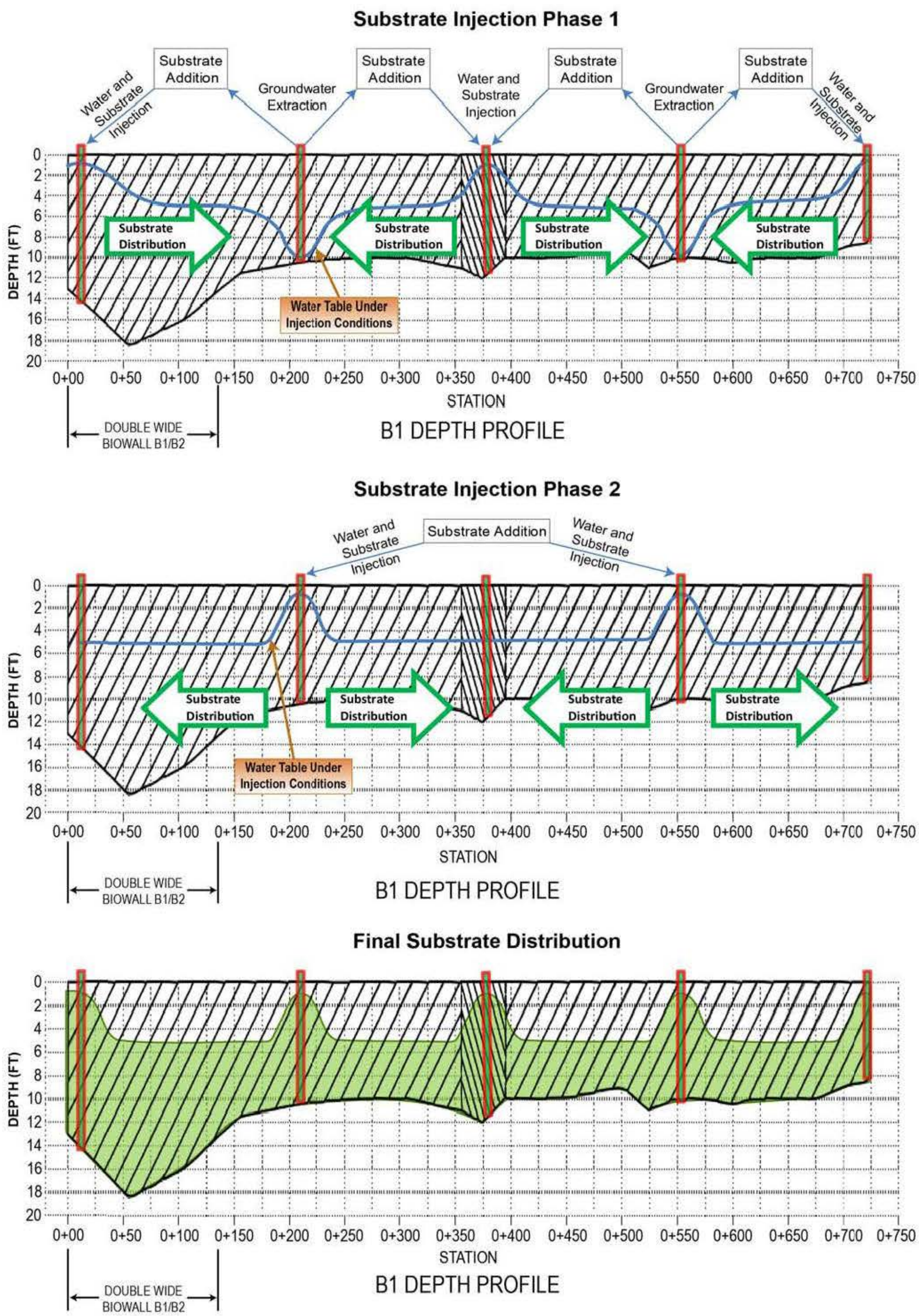
The Ash Landfill biowalls will be refreshed and returned to full operating condition by installing a series of recirculation wells in the biowalls and injecting organic substrate into the biowalls. The location of the proposed recirculation wells are shown on **Figure 4.1**. Organic carbon content in the biowalls will be refreshed most efficiently and effectively through the recirculation of a mixture of water, EVO, and pH buffer along each section of biowall. The recirculation process will consist of extracting groundwater from one extraction well, amending the water in-line with EVO and pH buffer, and re-injecting the resultant mixture into the neighboring recirculation well (**Exhibit 4.2**). Since the permeability of the biowall is several orders of magnitude higher than the surrounding native soil, flow will primarily be along the length of the biowall and organic carbon, in the form of EVO, will be distributed evenly between the two recirculation wells that are in use.

The Ash Landfill biowall refresh process will start with the installation of recirculation wells in the biowalls. A total of 37 recirculation wells will be installed in the Ash Landfill biowalls in order to efficiently emplace additional organic carbon and achieve the 80 to 100 foot recirculation well spacing (**Figure 4.1**). Each well will consist of 4-inch inside diameter schedule 40 polyvinyl chloride (PVC) well casing and screen. The recirculation well screens will be installed such that the bottom of the screen is coincident with the bottom of the biowalls at an average depth of approximately 12 feet below ground surface. All 37 recirculation wells will be installed in a single well installation event using hollow stem auger drilling equipment and techniques. After the recirculation wells are installed they will be completed as permanent wells with stick-up type completions.

After the recirculation wells are installed, Parsons will mobilize a substrate injection system consisting of air operated diaphragm pumps, mixing tanks, hoses, and various other equipment, in addition to rented compressors and groundwater extraction pumps. The injection system will be set up to extract groundwater from multiple recirculation wells while simultaneously mixing in the substrates and injecting the resultant mixture at multiple locations. Extracting groundwater and injecting water plus substrate at multiple points at the same time will allow us to complete the substrate refresh event more efficiently and will result in more effective substrate distribution within the walls.

Substrate will be injected into each biowall in a phased approach. The first phase will consist of recirculating groundwater mixed with substrate as shown in **Exhibit 4.2.** Substrate and water will be injected into every other recirculation well along a biowall transect and groundwater will be extracted from adjacent recirculation wells. After the first phase is complete at each biowall segment additional substrate and water will be injected into the

Exhibit 4.2
Cross-Section of the Recirculation Process



recirculation wells that were used for groundwater extraction in phase 1. This two-step process will result in complete substrate distribution with a high degree of confidence.

A total of approximately 185,000 gallons of water will be injected with the addition of approximately 80,000 pounds of soybean oil in the form of EVO. Approximately 33,000 pounds of pH buffer will also be added during injection to ensure that pH conditions remain in the neutral range and conducive to biological degradation of chlorinated solvents immediately after injection. This equates to a total fluid volume of 235,000 gallons which is approximately 1.1 complete pore volumes of all of the Ash Landfill biowalls (**Table 4.1**). Recirculating this volume of fluid will ensure that substrate is distributed completely throughout all the biowalls such that system performance is consistent and no gaps in wall performance develop.

After substrate injection is complete, the recirculation wells will remain in place for use in future substrate recharge events.

4.2.1 INJECTION SUBSTRATES

During the preparation process of this Work Plan a range of organic substrates were considered for application at the Ash Landfill site. EVO was selected as the preferred organic substrate for this application, because vegetable oil provides a long term stable source of organic carbon to the enhanced bioremediation system. The addition of the proposed mass of vegetable oil will maintain strongly anaerobic conditions and complete dechlorination within the biowall systems for at least 6 to 8 years following refresh. A pH buffer product will also be added to protect the currently neutral pH conditions within the biowalls and to prevent low pH shock. pH shock is a common phenomenon that occurs immediately after organic carbon is added to a system that is already anaerobic (much like the Ash Landfill biowalls) and is caused by a large increase in biological metabolic acid production that is driven by the addition of the new organic carbon source. This effect commonly causes short term declines in pH that, if left uncontrolled, can damage dechlorinating microorganisms (like Dehalococcoides Ethenogenes) resulting in the halt of complete dechlorination and the accumulation of cis-1,2-DCE and VC.

The specific substrate products to be applied at the Ash Landfill site include:

- Soybean Oil

  A food-grade soybean oil emulsion product called Newman Zone HRO™ (hereinafter referred to as HRO™) will be obtained from a commercial supplier such as Remediation and Natural Attenuation Services, Inc. of Minneapolis, Minnesota. Soybean oil is a food-grade material that is extracted from soybeans and is widely used in the food industry for a variety of applications.

  Because soybean oil is relatively insoluble in water, the oil must be emulsified with water and stabilized using food grade stabilizers so that it can be easily mixed with water prior to injection. The emulsification and stabilization steps are completed in a food processing plant and the resultant soybean oil-in-water emulsion is shipped to the site in refrigerated trucks. After the emulsion arrives on site, it is diluted with site water to the desired concentration and injected. This dilution step is taken to increase the injection volume without increasing the soybean oil volume. The result is that a relatively small volume of soybean oil can be distributed into a relatively large volume of biowall matrix such that the soybean oil occupies only a small portion of the interstitial void spaces of the aquifer matrix. In this way, a flow-through treatment cell is formed and adequate organic carbon is emplaced without causing unacceptable reductions in soil permeability. This allows groundwater to continue to flow through the biowalls, bringing dissolved contaminant mass with it for treatment within the treatment zones.

  After injection, the soybean oil-in-water emulsion will ultimately break down and be distributed as small droplets of oil trapped within the aquifer matrix. This entrapped oil does not migrate with advective groundwater flow; rather, it remains in place as a relatively immobile, slowly soluble, long-term source of carbon.

- pH Buffer

  A long-lasting pH buffer product will be injected with the organic substrates to maintain groundwater pH in the near neutral range (approximately pH 5 to pH 9). The proposed pH product is Neutral Zone, produced by Remediation and Natural Attenuation Services, Inc. of Minneapolis, Minnesota. Neutral Zone is a proprietary mixture of naturally-occurring pH buffer materials and food grade surfactants to keep the buffer in suspension so that it can be injected. The Neutral Zone product also contains an alcohol preservative to control microbial growth during shipping and storage. Neutral Zone will be delivered to the site in 55-gallon plastic drums or 255-gallon palletized shipping totes for temporary storage prior to dilution, mixing, and injection.

Chapter 5 Biowall Recharge Activities

5.1 SITE ACTIVITIES OVERVIEW

Based on the results of performance monitoring between 2007 and 2017, degradation of the organic substrate within the Ash Landfill biowalls was documented as geochemical values trended outside the parameters of published benchmark values. Recharge of the organic substrate was selected to enhance the ongoing remedy. The site activities will include the drilling of a series of four-inch recirculation wells and the addition of an organic substrate through a recirculation process. Ash Landfill biowall refresh activities are presented in the following subsections.

5.2 SITE MOBILIZATION

Project mobilization will consist of two primary mobilization stages for the implementation phase of the Ash Landfill Biowall refresh project. A hollow stem auger (HSA) drill rig and associated drilling equipment will be mobilized to the site during the first phase to conduct the drilling and recirculation well installation activities. During this mobilization step, temporary materials storage and equipment decontamination facilities will be established, including temporary erosion control and surface water runoff control structures.

After the recirculation wells are installed, the drilling equipment and materials will be demobilized and the substrate injection equipment and materials will be mobilized to the site. It is expected that the temporary storage area used during drilling will be reused during substrate injection. The temporary drilling decontamination pad will not be needed during the substrate injection step and will thus be demobilized with the drilling equipment. Upon completion of the substrate injection activities, all injection equipment and materials will be removed from the site. At this point all temporary erosion and surface water runoff control measures will also be removed and any areas where the ground surface may have been rutted or disturbed will be repaired and reseeded.

5.2.1 ESTABLISH WORK ZONES

Site access will be coordinated with the Seneca Army Depot facility coordinator and local property owners to obtain access and approval. Once onsite, the site will be staged with delivery of organic substrates and injection equipment. Exclusion zones, contamination reduction, and clean work zones will be established with visible barriers to maintain site safety requirements and prevent waste migration. Barriers will be orange construction style fencing staked into the ground or similar. The work zones shall be relocated, as needed, based on existing site conditions and upon agreement of the Site Manager.

5.2.2 STAGING AREAS

Temporarily storage of totes of substrate and equipment related to the injection system will be located adjacent to the east-west road south of the Ash Landfill or within the Parsons field office/parking area. An area with firm ground support will be selected. Equipment will be staged off the road such that vehicles may safely pass.

5.2.3 STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

Site activities are not expected to disturb more than an acre of soil as a result of the vegetable oil injections. Excavation dewatering or discharge to the sewer are not expected therefore a NYSDEC state pollutant discharge elimination system general permit and/or Seneca County Sewer District No. 2 discharge permit are not necessary. Best Management Procedures (BMP) will be used to control erosion and sediment runoff.

5.2.4 PROTECTION OF WETLANDS

Based on the New York regulated wetland maps (Geneva South, Romulus, Ovid, and Dresden quads), there are six regulated wetlands within 2-miles of the 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 the "Bend in the Road". Measures will be taken, such as installing silt fencing, as necessary, to protect the emergent wetland areas.

5.2.5 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 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.

5.2.6 SITE HEALTH AND SAFETY

All field activities during the remedial design will be performed in accordance with the site-specific safety, health, and environment plan (SSHEP) (**Appendix A**). The SHEP portion of this document will protect site workers through the identification, evaluation, and control of health and safety hazards.

5.2.7 SITE ACTIVITIES STAFFING

The injection field work will be staffed with two full-time Parsons personnel. The Site Manager will be on site during injection activities to lead the biowall refresh effort and to ensure that injection field activities are conducted as expeditiously as possible. The Site Manager will also assist, as needed, to conduct project health and safety audits during the course of the injection work. Primary field staff and associated responsibilities will be:

Site Manager: The Site Manager will be responsible for ensuring that the injection process is conducted in accordance with the work plan, any applicable permits, and the health and safety plan. The Site Manager will be stationed at the injection system during operation and will be the primary authority over injection operations. Duties will include managing the injection system; monitoring and recording injection flow rates, pressures, and volumes; determining when injection is complete at each injection well (as defined by achieving the proposed volumes, observing substrate breakthrough at the extraction well, or observing unacceptable daylighting of substrate onto the ground surface); and orchestrating the movement of the injection system. In addition to these primary responsibilities, duties will include interactions with either the property owner or the Army representative, as well as oversite of the field activities to ensure that activities are being conducted as expeditiously as possible while minimizing impacts to the site property. The Site Manager will be responsible for conducting the field inspections at the end of each day, as well as the final site inspection with the property owner and/or Army representative at the end of the injection phase.

Project Technical Director: The Technical Director will be responsible for injection system field program start-up and field crew training and ensuring that the injection phase is completed properly and in adherence to the project Work Plan and any applicable permits. The Technical Director will be available by phone/email or could visit the site on an as-needed basis.

Site Health and Safety Officer: The SHSO will be responsible for providing site specific training to the field staff at the start of the project and day to day health and safety in the field during project execution. The SHSO will lead the morning health and safety meetings, conduct daily inspections of the field activities, and assist in periodic project health and safety audits. The SHSO will also be responsible for maintaining health and safety logs, forms, and copies of certifications as well as ensuring that the field staff are current with required certifications and training. Finally, the SHSO will assist with any near miss or incident investigations that may occur in the field during the course of the injection activities.

Project Field Staff: Project field staff will be responsible for day-to-day field support including running hoses, performing leak detection inspections, decontamination activities, etc. Field staff and the SHSO will be interchangeable such that one will be on-site at all times.

Subcontractor Staff: Approximately two subcontractor staff members will be required to operate the provided forklift, flatbed truck, and groundwater extraction pumps. Subcontractor field staff requirements are discussed in more detail below.

5.3 WELL INSTALLATION

Installation of groundwater recirculation wells will be accomplished using HSA drilling techniques. The recirculation wells will be used for both the injection of substrate and extraction of formation groundwater. Boreholes will be advanced to the bottom of the biowalls at an average depth of approximately 12 feet bgs. A Parsons field scientist will monitor the drill cuttings and coordinate with the driller to confirm the bottom of the biowall (e.g., change in cuttings from mulch to till, monitoring drilling pressure). Generated soil cutting will be handled in accordance with investigation derived waste (IDW) procedures discussed in **Section 5.6.** Water to be used during well installation and equipment decontamination will be obtained from an onsite water supply (if identified) or from an off-site source.

All completion materials will be inspected by the field scientist and determined to be clean and acceptable prior to use. If not obtained in factory-sealed packages, riser, screen, end caps, and surface plugs will be cleaned prior to use with a high-pressure, steam/hot-water cleaner using approved water. Materials that cannot be cleaned to the satisfaction of the field scientist will not be used.

Recirculation wells will be constructed of 4-inch inside diameter, PVC screen and riser. The screens will be factory slotted with 0.020-inch (20-slot) openings and set such that the bottom of the screen is coincident with the bottom (or just below) of the biowall and the top of the screen is just below the water table. The casing string will be fitted with a PVC bottom cap and a locking well plug/end cap.

Sandpack is not necessary, but will be installed at the request of NYSDEC. A sanitary seal will start approximately two feet above the mean high water table to land surface. The seal will be hydrated with potable water to ensure complete hydration of the seal. Surface completions will consist of a "stickup" well head protector set in bentonite and covered with a crushed rock and/or gravel collar. Concrete grout will not be used during installation of monitoring wells installed in the biowalls to allow for any additional settlement of the biowall backfill material.

The field scientist will verify and record the total depth of each well, the length of all casing sections, and the depth to the top of all completion materials. All lengths and depths will be measured to the nearest 0.1 foot.

5.4 SUBSTRATE INJECTION LOGISTICAL REQUIREMENTS

Logistical requirements associated with the second phase of the Ash Landfill Biowall refresh involve the acquisition of additional equipment (e.g., hoses) and supplies, as well as storage for these items, over the course of field operations. These requirements are briefly discussed within the following sections.

5.4.1 SUBSTRATE INJECTION MATERIALS

Organic substrate and pH buffer will be required to complete the proposed biowall refresh field effort. Based on **Table 4-1**, the following volumes of substrate will be required:

- Newman Zone HRO™ Soybean Oil Emulsion Product: 79,424 pounds;
- Neutral Zone pH Buffer: 33,325 pounds;

The products will be shipped to the site in weatherproof packaging to reduce potential for damage during shipping and so that the products can be stored outside in the storage area. The products and packaging will be inspected for damage upon arrival at the site. Damaged goods will not be accepted at the site. The product totes, drums, and bags will be covered with additional tarps as an added protection measure from weather and other elements.

5.4.2 STORAGE AREA REQUIREMENTS

A storage area located in close proximity to or on the Ash Landfill Site will be identified and used for the staging and storage of equipment and supplies used for the duration of injection operations. The selected area will be relatively flat, clear of obstructions, and easily accessible from the paved road such that totes of substrate and pallets of equipment can be unloaded from trucks and temporarily stored. Any sections of the storage area perimeter that may abut sensitive areas (drainage swales, wetlands, etc.) will be lined with erosion control measures such as silt fencing and haybales, as appropriate.

5.4.3 VEHICLE AND TRANSPORT REQUIREMENTS

Several vehicles and trailers will be utilized to support the biowall refresh operations at the Ash Landfill Site. The following pieces of equipment will be used in the course of this planned field program:

- A flatbed truck (or truck and trailer), 12,000 lbs minimal capacity
  - Used for transport of materials from storage area to field location
- 4,000-lb (or equivalent) rough terrain forklift (subcontractor rental) with separate drum handler
  - Used to load totes of substrate and equipment for transport to the site and unload empty totes at the storage area
- Crew cab pickup truck (Parsons rental)

5.4.4 DAILY START-UP ACTIVITIES AND EQUIPMENT PLACEMENT

Each work day field personnel will arrive at the Parsons field office to complete the daily health and safety meeting and prepare the injection system and other equipment for use. Daily start-up will include the following tasks:

- Fueling the compressors;
- Establishment of traffic control plan requirements;
- Inspecting all equipment; and
- General housekeeping.

Following start-up activities each day, the flatbed truck carrying the totes of substrate and injection equipment will be driven to the Ash Landfill site and placed in the injection area. Once placed, equipment will be offloaded and the system will be set up for injection. This will include unloading the compressors, installation of the extraction pumps, and the placement and alignment of substrate delivery hoses. Each day, plastic sheeting will be placed underneath the truck so as to limit the potential of leakage of and substrate sills from the truck onto the underlying ground surface. Plastic trays may be utilized as necessary to collect injection substrate at hose connections.

The injection manifold legs will be labeled as the injection hoses are run and connected with the recirculation well identification (ID) that each leg is connected to, so that injected volumes and pressures associated with each recirculation well can be quickly and accurately recorded.

5.4.5 SUBSTRATE PREPARATION AND STAGING

The daily load-out of substrate injection materials is expected to consist of the following materials and quantities:

- 2-255 gallon totes of HRO™ soybean oil emulsion product (2,100 pounds);

- 2-255 gallon totes of buffer (2,500 pounds).

The flatbed truck and the injection system will be staged in close proximity to each other such that both can be monitored easily. Substrate product feed lines will be run from the substrate totes to the injection system and situated in such a way to minimize the potential for trip hazards.

The buffer product and the emulsion product will be pumped into the 500-gallon injection system tanks directly, using an air operated diaphragm pump, while the tanks are being filled with groundwater as these products are completely miscible with water. Each 500-gallon tank will receive approximately 7 gallons of buffer product, 26 gallons of emulsion (measured with a flow meter), and 475 gallons of water (filling the remainder of the tank).

Following the addition of buffer and emulsion materials to the tanks, the groundwater extraction pumps will continue to operate and one of the 500-gallon drop tanks will be filled. As the groundwater extraction pumps are started up, the extraction lines between each of the extraction wells and the injection system will be checked for leaks. After the first tank is filled with extracted groundwater, the injection diaphragm pump will be used to circulate the tank to make sure that the emulsion and buffer are thoroughly mixed. After the tank is mixed, substrate injection will commence at the selected recirculation wells.

5.4.6 SUBSTRATE INJECTION

Prior to substrate injection at any given location, field members will be positioned at the first recirculation well and a second team member at the injection system. The injection system will be started up using the following steps:

- Both team members will ensure that the system valves are closed prior to starting the injection pump.
- The team member at the injection well will open the air relief valve at the top of the first injection well as well as the substrate cutoff valve at the end of the injection hose, position a bucket under the air relief valve, and signal the team member at the injection system that the two valves are open. The field team member at the injection well will stay in place to monitor this end of the injection system for leaks or other problems.
- The team member on the injection trailer will then slowly add air pressure to the diaphragm pump until the pump starts to cycle. At this point the system valves can be opened slowly starting at the valve on the 500-gallon tank and ending with the master injection valve located immediately downstream from the master flow meter. The field personnel will have the appropriate sight, hearing and hand PPE as outlined in the SHEP.
- Once the system valves are open, the injection valve on the appropriate manifold leg will be slowly opened, allowing injection fluid to move down the injection line toward the injection well. The valve will only be opened approximately 20-30 degrees to limit the flow rate to approximately 10 gallons per minute (gpm).
- The team member at the injection well will hear air escaping through the air vent valve as the system fills with fluid. Once the system is full and all of the air has been driven out of the lines, substrate will start coming out of the air vent and the team member will close the vent valve. This recirculation well is now ready for injection and the process of pushing the air out of the injection lines will be repeated with the other injection wells currently plumbed to the system.

After the system is primed, all of the air has been pushed out, and the system has been inspected for leaks, the air pressure on the injection pump will be increased and injection will commence. The injection pressure will not exceed approximately 20-25 per square inch (psi) during injection. This pressure is lower than the water pressure in a garden hose. Low system pressures will be maintained to reduce potential for system leaks, health and safety risks, and the potential to induce soil fractures. The injection pressure and flow rate will be recorded periodically at the main manifold by the system operator. The other field team members will serve as roving patrols along the extraction and injection lines to look for leaks or other problems. Parsons staff will monitor the extraction pumps and lines to ensure that problems are caught and remedied immediately.

As injection proceeds, the 500-gallon tank will be drawn down while the second tank fills with extracted groundwater. In this way groundwater is being extracted and discharged to the empty tank, while second full tank is injected and recirculation between the injection and extraction wells is achieved. When the first tank is nearly empty the valve at the bottom of the tank will be closed and the valve on the second tank will be opened. When the injection system switches to injecting the second tank, the extraction pump hoses will be moved to the first tank such that the recently emptied tank can be refilled. Additional buffer (seven gallons) and emulsion (26 gallons) will be added to the second tank.

As substrate injection activities are completed at each recirculation well, the injection hose and well head fitting will be moved to the next well and the process will be repeated.

5.4.7 DAILY DEMOBILIZATION ACTIVITIES

At the completion of field activities each day, the injection system components will be drained and capped. The system must be relatively empty of water/injectant to reduce the weight of the hoses, tanks, etc. and to reduce potential of accidental spillage. Once emptied, the injection lines will be capped with camlock caps and plugs to reduce the potential for leakage from these hoses during breakdown and system stowage.

After the extraction pumps have been pulled and the extraction and injection lines have been drained and disconnected, the equipment and materials will be removed from the site and moved to the storage area for overnight storage.

The Parsons Site Manager will complete a field inspection of the injection area at the end of each day to ensure that site housekeeping activities have been competed (i.e., no equipment has been left behind and any small leaks have been cleaned-up). Each day, inspections will be documented in the Site Manager's log book and will be supported with digital photos as necessary.

After equipment is offsite, the flatbed truck will be restocked with substrates for the next day while the injection system is serviced. Specific end-of-day activities will include the following:

- Restocking of substrate consumables used during the day;
- Consolidation and transfer of project trash to on-site trash dumpster; and
- Any needed injection system maintenance or repairs.

5.4.8 MATERIALS DISPOSAL

As injection activities progress, substrate packaging material, waste plastic, and other trash will be generated. Totes containing the soybean oil emulsion product are constructed of an inner plastic liner and outer cardboard or wire mesh sidewalls. The liner will be removed and disposed of as trash while the sidewalls and top will be recycled.

5.4.9 PHASE 2 INJECTION COMPLETION AND CLOSEOUT

After the biowall refresh activities are complete, the injection equipment will be flushed out with potable water, drained, and subsequently dried for storage. Completion of refresh activities will be based on achieving planned injection volumes, observation of substrate material reaching recirculation wells used for extracting groundwater needed for substrate mixing, and/or unacceptable daylighting occurring within the vicinity of injection activities. The final task will consist of a site walk by the Site Manager to ensure that the materials have been removed from the injection sites and to ensure that the sites are being left in an acceptable condition. A final site survey will be conducted to provide the northing and easting coordinates and elevations to the nearest 0.01 feet for each new injection well and will be supported by field photographs as necessary.

Ruts, areas surrounding surface completions, and other surface damage caused during drilling or injection activities will be repaired and reseeded/grass pads (as necessary) during the close out phase. After site restoration activities are complete a final site survey will be conducted by the Site Manager to document the final site conditions. The final site assessment survey will be documented in the Site Manager's field log book and will be supported by photo documentation as necessary.

5.5 IDW MANAGEMENT

IDW will include cuttings generated during recirculation well installation and water generated during drilling and decontamination. The cuttings of biowall substrate are not expected to be impacted with chlorinated VOCs based on 22 rounds of groundwater results; therefore, the cuttings may be graded and left on top of the biowall. Water generated during drilling, decontamination, or injection activities will be collected in a bulk storage tank or 55-gallon drums. This water will be sampled and disposed of according to sample results. Expendable equipment and materials that may be generated during field activities (e.g., PPE) will be bagged and disposed of in an on-base trash.

5.6 SITE RESTORATION AND DEMOBILIZATION

The Site Manager will coordinate the removal of all temporary facilities (e.g., portable toilets, erosion control measures, decon pads, etc.), disposal of any trash, and removal of injection equipment. Injection equipment will be decontaminated and loaded onto vehicles for return to the vendor. The installed recirculation wells will remain in place and will be secured with locking caps.

Chapter 6 Performance Monitoring Plan

6.1 LONG-TERM GROUNDWATER MONITORING

6.1.1 MONITORING STRATEGY AND OBJECTIVES

LTM will continue semi-annually as was previously conducted. The scope of the current LTM program will sufficiently monitor the performance of the biowalls following the refresh. Three types of long-term groundwater monitoring are being performed: 1) plume performance monitoring, 2) biowall process monitoring, and 3) off-site compliance monitoring. On-site performance monitoring is being conducted to measure groundwater contaminant concentrations and to evaluate the effectiveness of the biowall remedy for the Ash Landfill OU. The objectives of performance and compliance monitoring are as follows:

- Confirm that there are no exceedances of groundwater standards for contaminants of concern (COCs) at the off-site compliance 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 NYSDEC Class GA groundwater standards.

Biowall process monitoring is being conducted at two locations to determine if, and when, any biowall maintenance activities should be performed. The first location is within Biowalls B1/B2 (MWT-27 and MWT-28) in the segment that runs along the pilot-scale biowalls that were installed in July 2005. The second location is within Biowall C2 (MWT-23), the furthest downgradient biowall. The objectives of biowall process monitoring for O&M activities are as follows:

- Monitor the long-term performance and sustainability of the biowalls;
- Monitor substrate depletion 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).

6.1.2 MONITORING WELL LOCATIONS

No new monitoring wells will be added to the current monitoring well network as the current network is sufficient.

6.1.3 GROUNDWATER SAMPLING AND FREQUENCY

The groundwater long-term monitoring program will remain the same with the following objectives:

- Confirm that there are no exceedances of groundwater standards for contaminants of concern (COCs) at the off-site compliance 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 NYSDEC Class GA groundwater standards.

Groundwater sampling events are semi-annual (December and June) and all wells are analyzed for VOCs and geochemical parameters (e.g., DO, ORP, pH, temperature, and turbidity). Monitoring wells used for plume (PT-18A, -17, -22 and -24 and MWT-7, -22, -23, -24, -25, -28, and -29) and biowall (MWT-23, -26, -27, -28, and -29) performance will also be analyzed for sulfate, total organic carbon, ferrous iron, manganese, methane, ethane, and ethene.

6.2 RECHARGE EVALUATION

LTM will continue as described above until the remediation goals have been reached. Using a lines-of-evidence approach, a recharge evaluation is conducted at the end of each year of monitoring. This approach includes the following strategy:

- A review of chemical concentrations and geochemical parameters to determine the need to recharge. No single criteria will be used alone to determine the efficacy of the biowall system, but rather the collected parameters will be compared to published benchmarks for anaerobic biodegradation systems (EPA, 1998) and contaminant and geochemical trends will be evaluated as a whole. The trends of these parameters, taken as a whole, will be used to assess system efficacy, determine if the biowalls are approaching depletion, and determine if the system requires refresh to maintain remedial performance.
- Using a synoptic analysis of performance sampling data, the following parameters will be evaluated annually to determine if recharge of the biowalls is necessary:
    - Geochemical parameters, specifically ORP, TOC, and DO, in the biowalls (e.g., at MWT-27, MWT-28, and MWT-23). Benchmark values will be used initially to evaluate anaerobic conditions in the groundwater and the capacity of the biowalls to maintain anaerobic conditions. The benchmarks are:
        - ORP < 50 millivolts (mV), optimally < -100 mV
        - TOC > 20 mg/L
        - DO < 1.0 mg/L, optimally < 0.5 mg/L
    - Geochemical parameters upgradient of the biowalls versus within the biowalls.
        - Sulfate elevated upgradient of biowalls; optimally < 20 mg/L within biowalls
        - Methane elevated within biowalls; optimally > 0.5 mg/L
        - Elevated manganese within biowalls
        - Elevated ferrous iron (Fe^{2+}) within biowalls
- COC concentrations (TCE, DCE, VC) in the biowalls (e.g., MWT-27, MWT-28, and MWT-23), particularly parent compounds (TCE) that have increased significantly and are above Class GA standards in consecutive rounds indicate that recharge may need to be considered. Significant contaminant concentration increases within the biowalls in conjunction with in-wall geochemical shifts toward aerobic geochemical conditions may indicate that organic loading in the biowalls may be reaching depletion. 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.

Parameters described in the bullets above are guidelines and will be considered in evaluating if, and when, a depletion of bioavailable organic substrate results in a rebound in geochemical redox conditions under which effective anaerobic degradation of chlorinated ethenes does not occur.

6.3 REPORTING

6.3.1 FIELD LOGBOOKS

All field activities will be carefully documented in field logbooks. Entries will be of sufficient detail that a complete daily record of significant events, observations, and measurements is obtained. The field books will provide a legal record of the activities conducted at the site. Accordingly:

- Field logbooks will be bound with consecutively numbered pages.
- Field logbooks will be controlled by the Site Manager while fieldwork is in progress.
- Entries will be written with waterproof ink.
- Entries will be signed and dated at the conclusion of each day of fieldwork.
- Erroneous entries made while fieldwork is in progress will be corrected by the person who made the entries. Corrections will be made by drawing a line through the error, entering the correct information, and initialing the correction.
- Corrections made after departing the field will be made by the person who made the original entries. The correction will be made by drawing a line through the error, entering the correct information, and initialing and dating the time of the correction.
- The PM will control field logbooks when fieldwork is not in progress.

At a minimum, daily field logbook entries will include:

- Date and page number on each page or set of pages.
- Location of field activity.
- Date and time of entry.
- Names and titles of field team members.
- Names and titles of any site visitors and site contacts.
- Weather information: temperature, cloud coverage, precipitation, wind speed and direction.
- Purpose of field activity.
- A detailed description of the fieldwork conducted, observations and any measurements or readings. Where appropriate, a hand-drawn sketch map will also be included that identifies significant landmarks, features, sample locations, and utilities.

6.3.2 COMPLETION REPORT

Following the completion of the field work for the biowall recharge, a Completion Report will be prepared. The Completion Report will include drawings and exact dimensions of the well installations, the amounts of substrate and water injected into the system, and the duration of the operations. All field details will be documented in the Completion Report.

Chapter 7 Schedule

A schedule for the biowall recharge task is presented as Figure 7.1. The schedule allows for 30 days for the Army, NYSDEC, and USEPA to review and provide comments on the work plan documents. It also allows two weeks for Parsons to incorporate comments into the work plan documents. The schedule will be updated on a continuing basis.

Chapter 8 References

Parsons Engineering Science Inc., 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, 2004a. Action Memorandum: Ash Landfill Removal Action. 1994.

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

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

Parsons, 2006b. Remedial Design Report for the Ash Landfill Operable Unit. August, 2006.

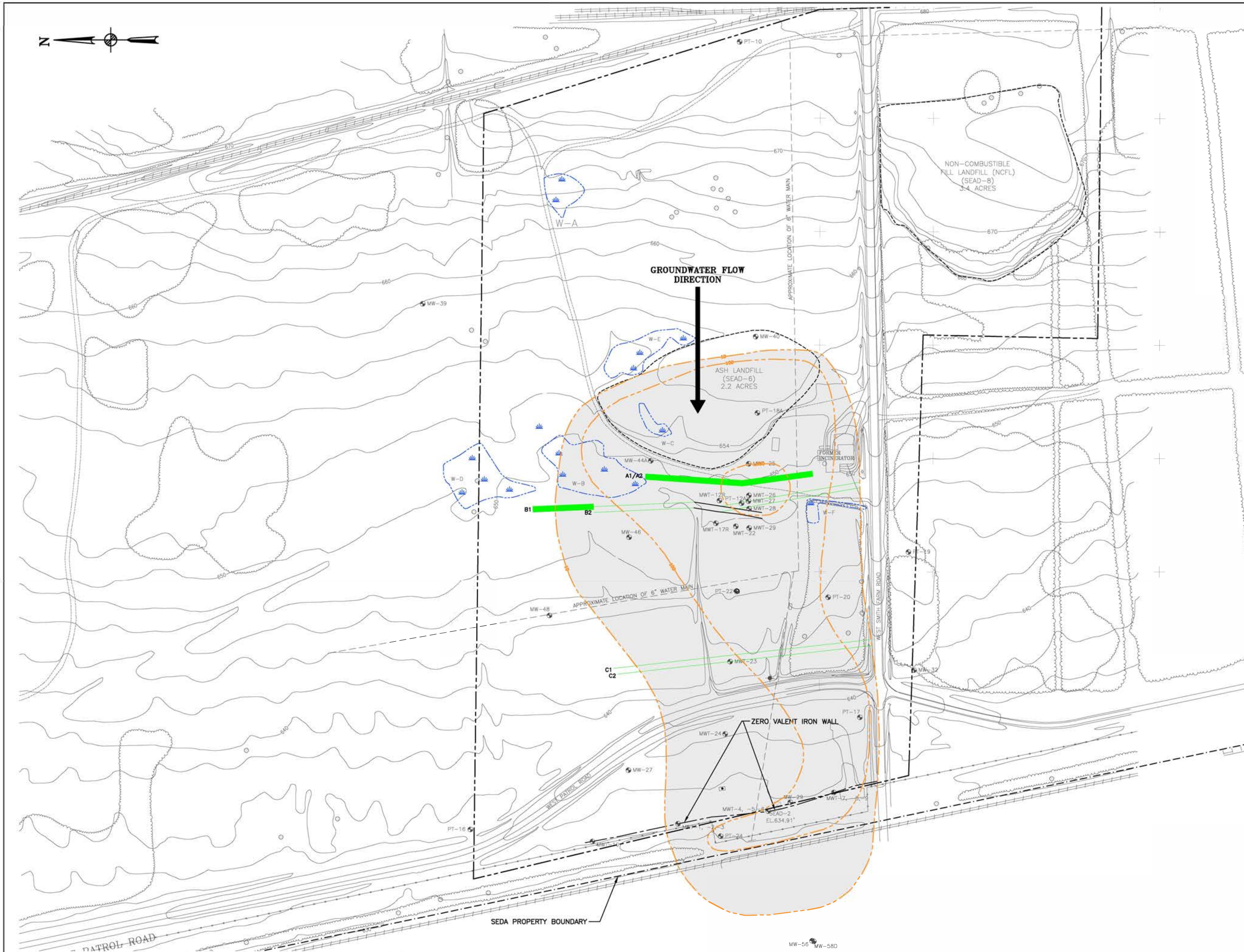
Parsons, 2007. Draft Final Construction Completion Report for the Ash Landfill Operable Unit, Seneca Army Depot Activity. April 2007

Parsons, 2016. Draft Annual Report and Year 9 Review, Ash Landfill Operable Unit, Seneca Army Depot Activity. August 2016.

United States Environmental Protection Agency (EPA), 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater. EPA/600/R-98/128. September 1998.

Figures

Figure 1.1 Ash Landfill Biowall Locations and Groundwater Plume Footprint
Figure 2.1 Groundwater Potentiometric Surface & TCE Isoconcentration Map
Figure 4.1 Biowall Recirculation Proposed Well Locations
Figure 7.1 Schedule



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
- POST CONSTRUCTION AS BUILT GROUND ELEVATION CONTOUR (670)
- PILOT STUDY BIOWALL (2005)
- SINGLE BIOWALL (2006)
- DOUBLE-WIDE BIOWALL (2006)
- ZERO VALENT IRON WALL (1998)
- LIMITS OF LANDFILL
- SEDA PROPERTY BOUNDARY
- OU BOUNDARY
- TCE PLUME (2000)

100 0 100 200
(feet)

PARSONS

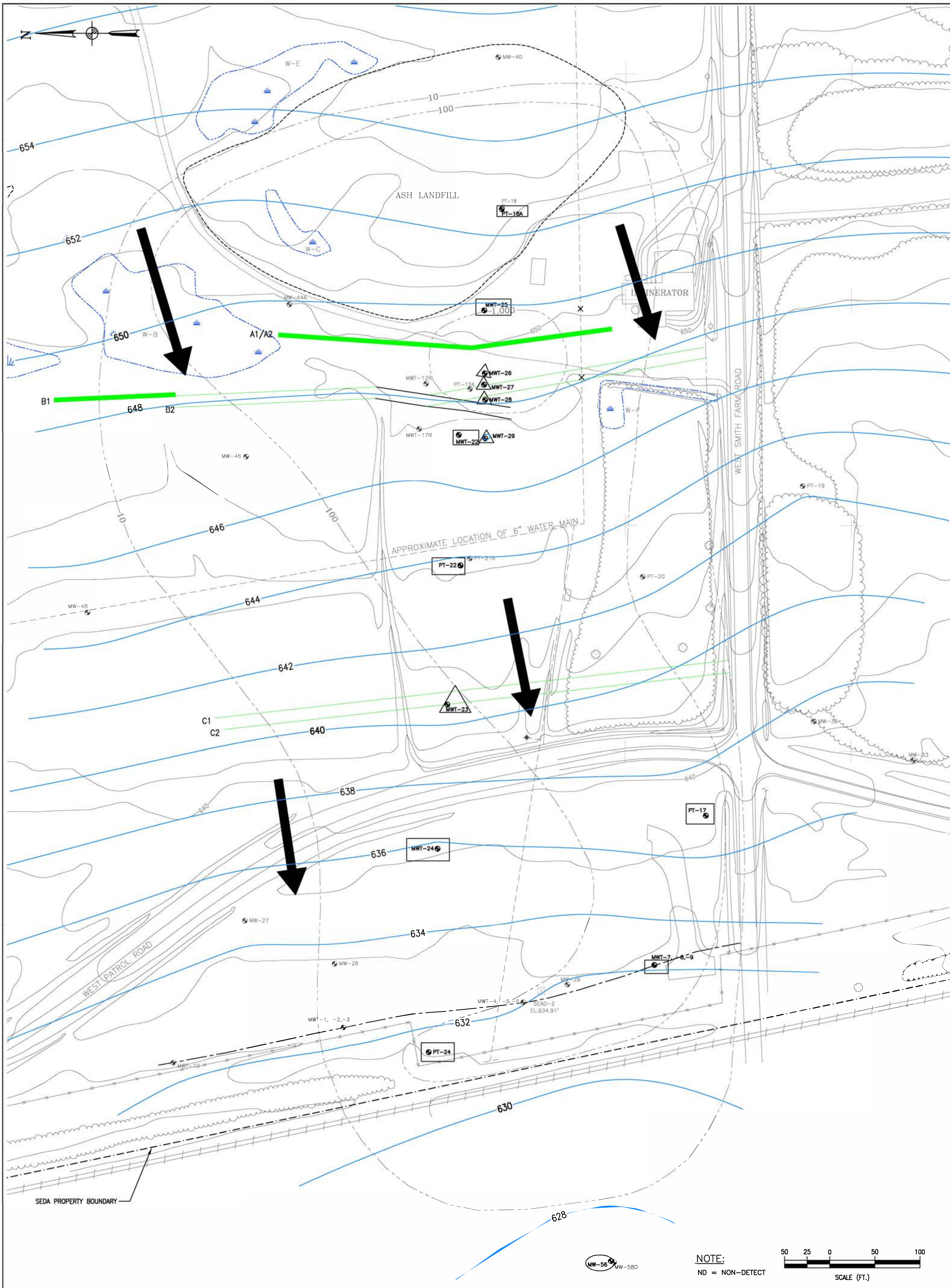
CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
ASH LANDFILL
ASH LANDFILL BIOWALL RECHARGE

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No.

FIGURE 1-1
ASH LANDFILL BIOWALL LOCATIONS AND GROUNDWATER PLUME FOOTPRINT (2000)

SCALE | DATE MARCH 2017 | REV –

FILE: P:\PIT\PROJECTS\HUNTSVILLE WERS\SENECA LTM, TO 23\06 – BIOWALL RECHARGE\DRAFT\FIGURES\FIGURE 2-1.DWG, DATE: 03/27/2017 09:08:29AM, p0018397



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

APPROXIMATE LOCATION OF WATER MAIN

INFERRED PONTENTIOMETRIC SURFACE CONTOUR (DEC. 2016)

PILOT STUDY BIOWALL (2005)

SINGLE BIOWALL (2006)

DOUBLE-WIDE BIOWALL (2006)

ZERO VALENT IRON WALL (1998)

TCE ISOCONTOUR (UG/L) BASED ON JANUARY 2000 DATA

OFF-SITE PERFORMANCE MONITORING WELL IN L.T.M. PROGRAM

ON-SITE PLUME PERFORMANCE MONITORING WELL IN L.T.M. PROGRAM

BIOWALL PROCESS MONITORING WELL IN L.T.M. PROGRAM

PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT

ASH LANDFILL

ASH LANDFILL BIOWALL RECHARGE

DEPT. ENVIRONMENTAL ENGINEERING

Dwg. No.

FIGURE 2-1

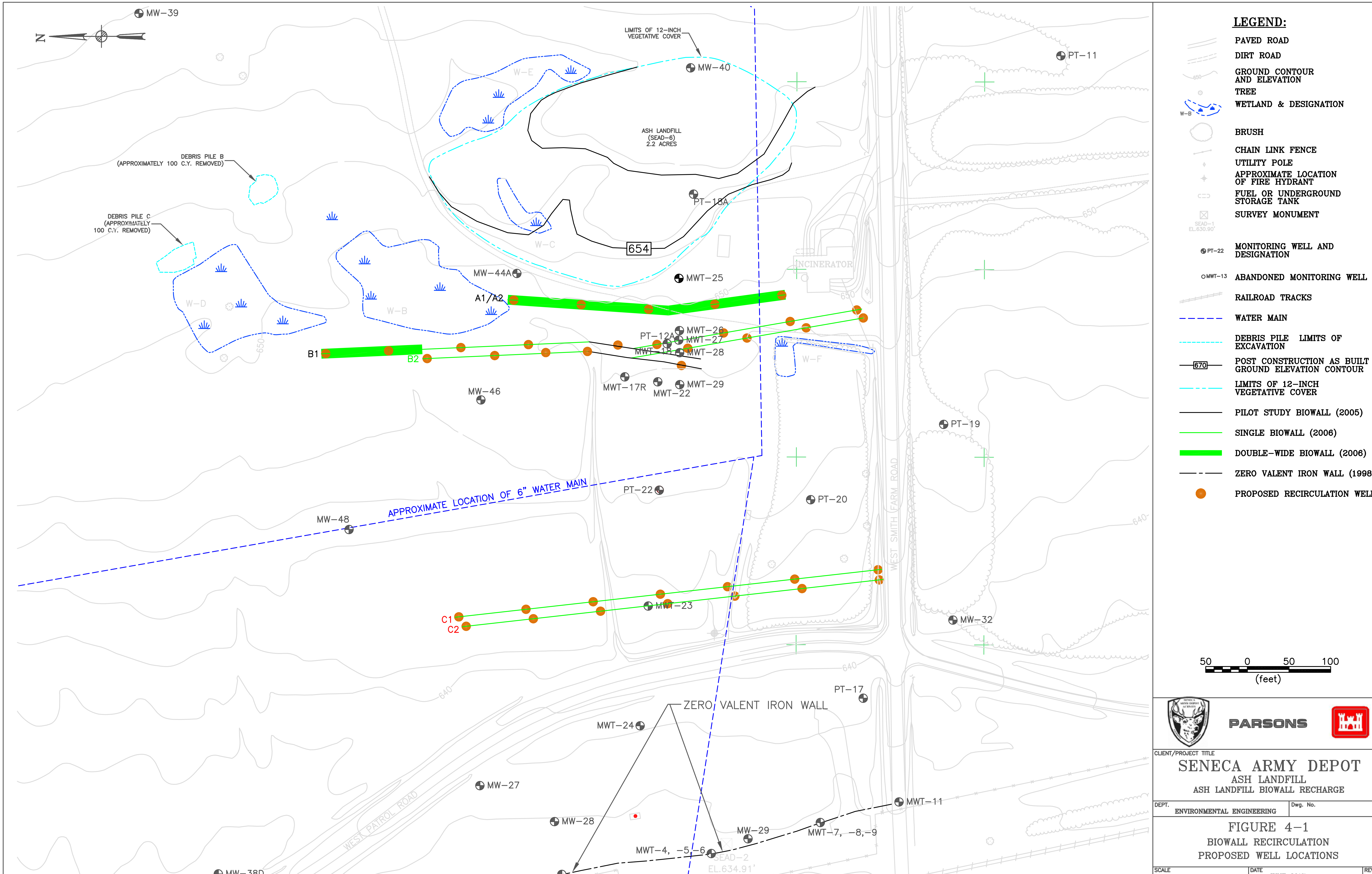
GROUNDWATER POTENTIOMETRIC SURFACE (DEC 2016) & TCE ISOCONCENTRATION MAP

SCALE

DATE MARCH 2017

REV -

FILE: P:\PIT\PROJECTS\HUNTSVILLE WERS\SENECA LTM, TO 23\06 - BIOWALL RECHARGE\DRAFT\FIGURES\FIGURE 2-3.DWG, DATE: 03/27/2017 09:32:28AM, p0018397



PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT
ASH LANDFILL
ASH LANDFILL BIOWALL RECHARGE

DEPT. ENVIRONMENTAL ENGINEERING | Dwg. No.

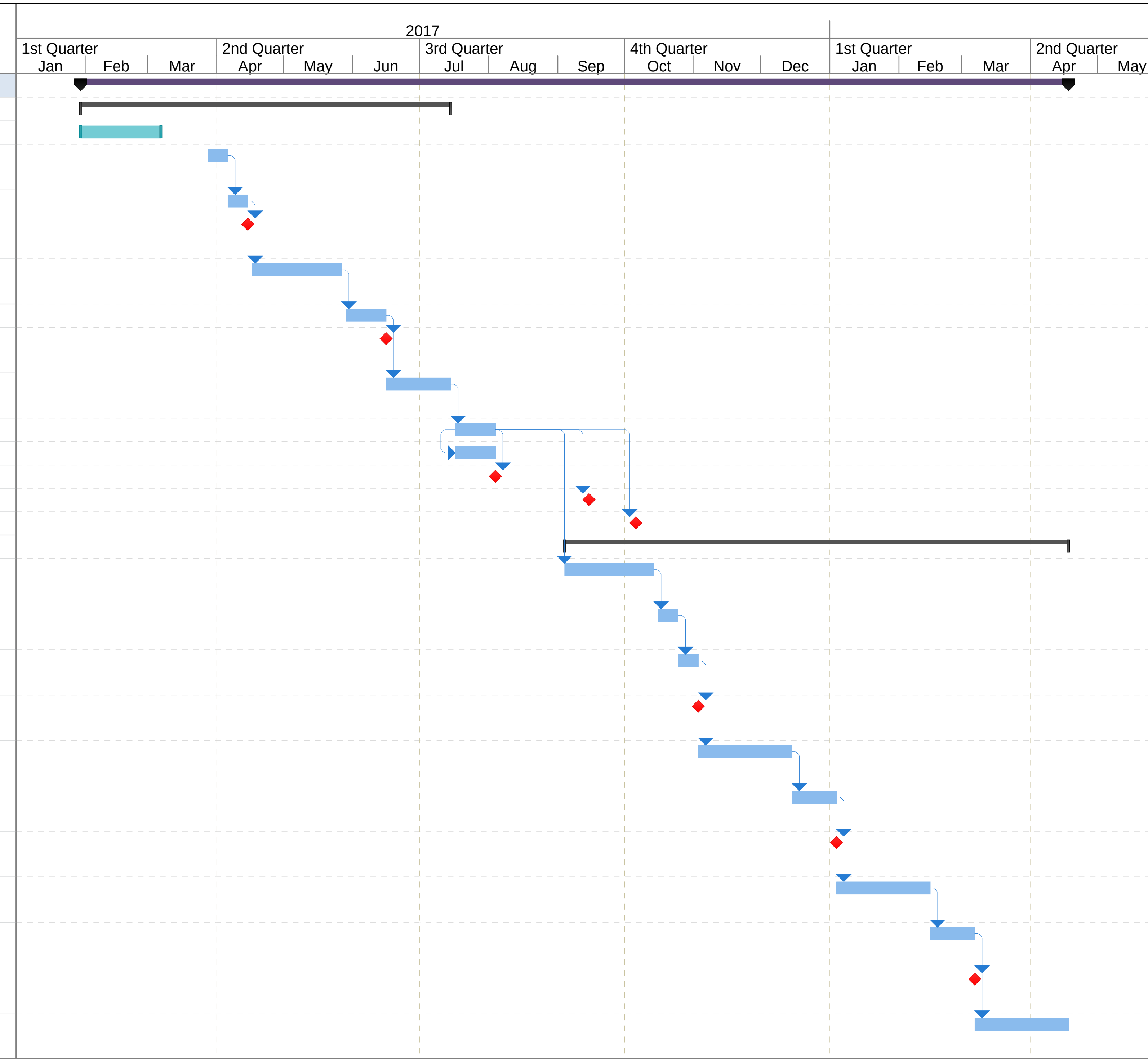
FIGURE 4-1
BIOWALL RECIRCULATION
PROPOSED WELL LOCATIONS

SCALE | DATE JUNE 2017 | REV –

FILE: C:\USERS\P0091241\DOCUMENTS\PROJECTS\SENECA ARMY DEPOT T023\FIGURE 4-2.DWG, DATE: 07/06/2017 08:25:46AM, P0091241

Figure 7.1: Proposed Project Schedule - Biowall Recharge at Seneca Army Depot Activity, Romulus, New York

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Task 6: Ash Landfill Biowall Recharge**	**317 days**	**1/30/17**	**4/17/18**	
2	Ash Landfill Biowall Recharge Work Plan	120 days	1/30/17	7/14/17	
3	Pre-Draft Ash LF Biowall Recharge Work Plan	26 days	1/30/17	3/6/17	
4	Army Review of Pre-Draft Ash LF Biowall Recharge Work Plan	7 days	3/28/17	4/5/17	
5	Draft Ash LF Biowall Recharge Work Plan	7 days	4/6/17	4/14/17	4
6	*Submit Draft Ash LF Biowall Recharge Work Plan*	*0 days*	*4/14/17*	*4/14/17*	*5*
7	Regulatory Review of Draft Ash LF Biowall Recharge Work Plan	30 days	4/17/17	5/26/17	5
8	Final Ash LF Biowall Recharge Work Plan	14 days	5/29/17	6/15/17	7
9	*Submit Final Ash LF Biowall Recharge Work Plan*	*0 days*	*6/15/17*	*6/15/17*	*8*
10	Regulatory Acceptance of Final Ash LF Biowall Recharge Work Plan	21 days	6/16/17	7/14/17	8
11	Ash Landfill Biowall Recharge Field Work	14 days	7/17/17	8/3/17	10
12	Daily QC Report Submittal	14 days	7/17/17	8/3/17	11SS
13	*Final Daily QC Report Submittal*	*0 days*	*8/3/17*	*8/3/17*	*11*
14	*Analytical Data Submittal for QA Evaluation*	*0 days*	*9/14/17*	*9/14/17*	*11FS+30 days*
15	*Electronic Data Submittal for QA Evaluation*	*0 days*	*10/5/17*	*10/5/17*	*11FS+45 days*
16	Ash Landfill Biowall Recharge Completion Report	162 days	9/4/17	4/17/18	
17	Pre-Draft Ash LF Biowall Recharge Completion Report	30 days	9/4/17	10/13/17	11FS+21 days
18	Army Review of Pre-Draft Ash LF Biowall Recharge Completion Report	7 days	10/16/17	10/24/17	17
19	Draft Ash LF Biowall Recharge Completion Report	7 days	10/25/17	11/2/17	18
20	*Submit Draft Ash LF Biowall Recharge Completion Report*	*0 days*	*11/2/17*	*11/2/17*	*19*
21	Regulatory Review of Draft Ash LF Biowall Recharge Completion Report	30 days	11/3/17	12/14/17	19
22	Draft Final Ash LF Biowall Recharge Completion Report	14 days	12/15/17	1/3/18	21
23	*Submit Draft Final Ash LF Biowall Recharge Completion Report*	*0 days*	*1/3/18*	*1/3/18*	*22*
24	Regulatory Review of Draft Final Ash LF Biowall Recharge Completion Report	30 days	1/4/18	2/14/18	22
25	Final Ash LF Biowall Recharge Completion Report	14 days	2/15/18	3/6/18	24
26	*Submit Final Ash LF Biowall Recharge Completion Report*	*0 days*	*3/6/18*	*3/6/18*	*25*
27	Regulatory Acceptance of Final Ash LF Biowall Recharge Completion Report	30 days	3/7/18	4/17/18	25



Date: 3/28/17

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Progress | Manual Progress

Appendix A

Response to Comments

Army's Response to Comments from the New York State Department of Environmental Conservation

Subject: Draft Work Plan for the Ash Landfill Biowall Recharge at Seneca Army Depot
Seneca Army Depot Activity
Romulus, New York

Comments Dated: 01 May 2017

Date of Comment Response: 06 June 2017

Army's Response to Comments

GENERAL COMMENTS

Comment 1: Document the regulatory requirements for this project (i.e. UIC permit requirement).

Response 1: Typically, UIC permits are not required on federal facilities. In most cases the federal facilities meet the "substantive requirements of local permits" and permits have not been necessary. In most cases the permit application requirements are satisfied with the workplan. Note that CERCLA exempts permitting requirements, but requires meeting the substantive requirements of all permits.

Comment 2: Section 4.1.2: I question whether the 80 to 90-foot spacing between the recirculation wells may be too much space between the wells to be effective.

Response 2: The principles and practices manual (which was prepared by Parsons) is focused on applying enhanced bioremediation in natural media (injection into saturated soil) where substrate distribution away from an injection well is radial because the subsurface media is generally homogeneous. In a natural media setting, a 90-foot injection well spacing would require huge injection volumes and would not generally achieve the desired results. In the case of the Seneca Ash Landfill, we are refreshing a biowall which is generally a linear structure of very high permeability material installed in soil of comparatively low permeability. Thus, during injection (and extraction) substrate distribution will be forced along the trench radically increasing distribution in the "along trench" direction and in the direction of the extraction well. Reference page 5-11, section 5.4.2, Recirculation of the Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents (2004) where it states "Highly permeable and uniform lithologies are required to use well spacings on the order of 50 to 100 feet."

Comment 3: Table 4.1: The number of wells in B1/B2 is inconsistent between the Figure 4-1 and Table 4.1.

Response 3: The figure was revised so that it is consistent with Table 4.1.

Comment 4: Table 4.1 and Section 5.4.6: The table states there will be an injection rate of 10 gpm, but the text states an injection rate of 2 gpm. Please clarify.

Response 4: The correct injection rate is 10 gpm. The text was corrected.

Comment 5: Section 4.2.1: What is your reasoning for choosing Soybean Oil as the injection substrate?

Response 5: Soybean oil is an affordable easily obtainable oil-based organic substrate. There are many other options (cotton seed oil, rape seed oil, olive oil, corn oil, etc.), but they are far more expensive. In addition, the industry as a whole (including Parsons) has the greatest body of experience with soybean oil.

Comment 6: Section 5.3: Please provide details on the extraction well construction and installation.

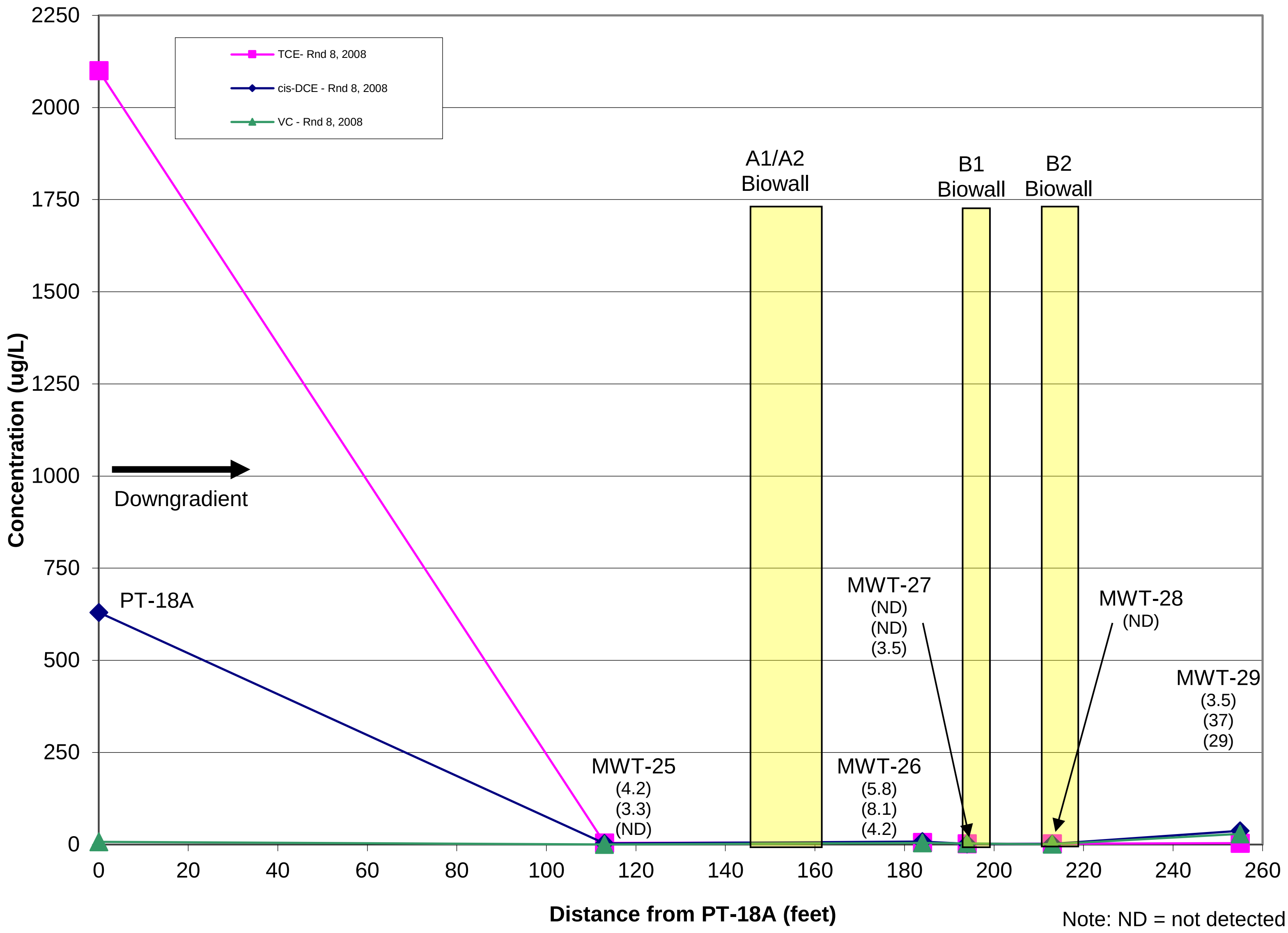
Response 6: The wells installed within the biowall will be used for both extraction and recirculation (i.e., there are no additional extraction wells). Section 5.3 was renamed "Well Installation" and revised to make it clear that extraction wells and recirculation wells have the same construction.

Comment 7: The performance monitoring should include a baseline prior to in the injection event. The parameters that are tested for should include the concentration of the target bacterial population.

Response 7: Sampling of target bacterial populations can be done to confirm the presence of specific bacteria to assesses if the site will support reductive dechlorination. Based on the past ten years of LTM at the Ash Landfill and the lines-of-evidence analyses, we can demonstrate that reductive dechlorination is occurring and that the environment is supportive of these conditions.

Within the Site, parent contaminant concentrations (TCE) are in decline, there is evidence for the production and then destruction of intermediates (cis-DCE, VC) and the production of end products (ethene/ethane). Although the characterization of the microbial population would provide interesting information, these data would provide us with something that is already known.

The graph below illustrates the degradation of TCE with distance from the source and across the various biowalls. These data were collected during the end of the third year of biowall operation. Note the decrease in TCE concentration downgradient of the source and the reduction of TCE within the biowalls. This pattern has continued throughout the ten years of biowall operation. This demonstrates that anaerobic degradation of chlorinated ethenes is occurring in the biowalls.


TCE- Rnd 8, 2008
cis-DCE - Rnd 8, 2008
VC - Rnd 8, 2008
A1/A2 Biowall
B1 Biowall
B2 Biowall
Downgradient
PT-18A
MWT-25 (4.2) (3.3) (ND)
MWT-26 (5.8) (8.1) (4.2)
MWT-27 (ND) (ND) (3.5)
MWT-28 (ND)
MWT-29 (3.5) (37) (29)
Concentration (ug/L)
Distance from PT-18A (feet)
0
250
500
750
1000
1250
1500
1750
2000
2250
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Note: ND = not detected