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TECHNICAL MEMORANDUM

Date: June 5, 2007

To: Julio Vazquez, USEPA
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Subject: Quarter 2 – Long-Term Monitoring Results for the Ash Landfill at Seneca Army Depot Activity, Romulus, New York

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1. INTRODUCTION

As part of the remedial action at the Ash Landfill Operable Unit (OU) at the Seneca Army Depot Activity (SEDA or the Depot), Romulus, New York, groundwater monitoring is being performed as a requirement of post-closure operations for the Ash Landfill. Three sets of dual biowalls were installed in September and October 2006 to treat the chlorinated ethenes plume. In accordance with the Post-Closure Monitoring and Maintenance Plan (PCMMP) presented in the "Remedial Design Report for the Ash Landfill Operable Unit, Revised Final" (RDR) (Parsons, 2006), quarterly groundwater monitoring is required during the first year of biowall operation to monitor the plume and the biowall treatment process. The first round of quarterly groundwater monitoring was completed between January 2, 2007 and January 4, 2007 and the results were presented in a letter report issued on April 23, 2007. The second round of quarterly groundwater monitoring was completed between March 15, 2007 and March 17, 2007. The results of this second sampling event are presented below.

1.1 Objective

Groundwater monitoring is required since contaminant concentrations in the groundwater at the site currently exceed the NYSDEC Ambient Water Quality Criteria (AWQS) Class GA Standards for groundwater. For this reason, two types of long-term groundwater monitoring (LTM) are being performed: (i) plume performance monitoring and (ii) biowall process monitoring.

Performance monitoring is conducted to measure groundwater contaminant concentrations and the effectiveness of the biowalls as a remedy for the Ash Landfill OU. The LTM results from performance monitoring will be used to demonstrate that contaminants of concern (COCs) are not detected off-site at

MW-56 above groundwater standards and that COCs meet the GA groundwater standards on-site before LTM is discontinued.

The second type of monitoring, biowall process monitoring, are wells located either within or immediately downgradient of the biowalls and will be used to assess when and if the biowalls may require additional substrate.

1.2 Site Description

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. SEDA is located between Seneca Lake and Cayuga Lake in Seneca County and 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 Ash Landfill site (shown in **Figure 1**) 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) contains a groundwater plume that emanates from the 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, primarily trichloroethene (TCE) and cis-1,2-dichloroethene (DCE).

1.3 Background

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.

Three dual biowall systems (A1/A2, B1/B2, C1/C2) were constructed to address chlorinated solvent contamination in groundwater installed in September 2006. Biowalls A1/A2, B1/B2, and C1/C2 were constructed perpendicular to the chlorinated solvent plume in the locations prescribed in the RDR. The entire length of Biowalls A1/A2 and the northern portion of B1/B2 were combined into a single double-width trench (minimum of 6 feet in width) due to unstable soil conditions encountered, which caused trench widening. These systems involved the excavation of three pairs of trenches down to bedrock. Approximately 2,705 linear feet (lf) 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. Each trench was filled with an organic substrate (mulch/sand mixture coated with soybean oil) that enhances biodegradation of chlorinated solvents. Details of the final biowall system can be found in the "Draft Construction Completion Report for the Ash Landfill OU" (Parsons 2007).

TCE and the dichloroethene isomer cDCE are the most prevalent chlorinated ethenes in both extent and concentration in groundwater at the Ash Landfill. The areal extent of TCE based on groundwater samples collected in January 2000 is illustrated in **Figure 4**. 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. Historic sampling indicates that the plume does not extend to the west beyond monitoring well (MW-56) located on the adjacent property.

1.4 Technology Description

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.

Reductive dechlorination is the most important process for natural biodegradation of the more highly chlorinated solvents (EPA, 1998) and is shown in **Figure 2**. Complete dechlorination of TCE and the other chlorinated solvents present in the groundwater is the goal of anaerobic biodegradation using the mulch biowall technology.

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).

2. GROUNDWATER MONITORING ACTIVITES

All groundwater samples were collected using low flow sampling techniques at the Ash Landfill. Sampling procedures, sample handling and custody, holding times, and collection of field parameters were conducted in accordance with the "Final Sampling and Analysis Plan for Seneca Army Depot Activity (SAP)" (Parsons, 2005).

Thirteen monitoring wells were sampled between March 15 and 17, 2007. The wells were classified into two groups: on-site plume performance monitoring and biowall process monitoring. The off-site performance monitoring well, MW-56, is monitored on a semi-annual basis, in accordance with the RDR, and was not included in this sampling round. The wells in each group are listed in **Table 1**.

The biowall process monitoring wells includes three wells from the plume performance group (MWT-23, MWT-28, and MWT-29). These wells are either within or immediately downgradient of the biowalls and will be used to assess when and if the biowalls may require additional substrate.

At each well, groundwater samples were collected and submitted to Severn Trent Laboratory (STL) in Buffalo, New York. The wells that were in the plume performance group only were analyzed for VOCs by USEPA SW846 Method 8260B. The samples from the five wells in the process monitoring group were submitted to STL for the following analyses:

- VOCs by USEPA SW846 Method 8260B
- Sulfate by USEPA Method 300.1
- Total organic carbon (TOC) by USEPA SW846 Method 9060A

The samples from the five wells in the process monitoring group were also submitted to Microseeps, Inc. located in Pittsburgh, Pennsylvania for analysis for methane, ethane, and ethene by AM20GAX, Microseeps version of Method RSK 175. In the field, the following geochemical parameters were measured and recorded for each groundwater sample: pH, oxidation-reduction potential (ORP), conductivity, and temperature were measured using the Horiba U-22; dissolved oxygen was measured with a YSI 55; and turbidity was measured with a Lamotte 2020 turbidity meter. In addition, a HACH® DR/850 Colorimeter was used in the field to measure manganese and ferrous iron by USEPA Method 8034 and USEPA Method 8146, respectively. A summary of the samples collected in presented is **Table 1.**

3. GROUNDWATER MONITORING RESULTS

Groundwater Elevations

Historic groundwater elevations are presented in **Table 2**. Groundwater contour lines based on the groundwater elevations measured in December 2006 are shown in **Figure 3**. The figure shows that groundwater is generally flowing west across the Ash Landfill OU, perpendicular to the orientation of the biowalls. The groundwater contour map is similar to previous maps developed from historic water levels. Groundwater levels were not recorded at the time of the March 2007 sampling due to unseasonably cold weather, which resulted in the presence of chunks of ice inside the wells; therefore, accurate measurement of the saturated thickness in each well was not possible.

Geochemical Results

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 effective process, the groundwater typically must be sulfate-reducing or methanogenic. Geochemical parameters collected in the field that also serve as water quality indicators, such as ORP, DO, and conductivity, were recorded for all the wells in the LTM program. Analysis for geochemical parameters (TOC, sulfate, and methane/ethene/ethane) was completed for the five wells in the biowall process monitoring group, as indicated in **Section 2** above. Anaerobic reductive dechlorination is occurring if the following geochemical signatures are identified:

- Depleted concentrations of dissolved oxygen (DO) and sulfate;
- Elevated concentrations of methane;
- Reduced oxidation reduction potential (ORP); and
- Distribution of soluble organic substrate in groundwater (TOC).

Geochemical parameter results are shown on **Table 3**. Comparison of geochemical parameters for biowall locations MWT-26 (upgradient of Biowall B1) to MWT-28 (in Biowall B2) are summarized below to evaluate the biowall process performance, demonstrating the change in geochemistry across the B1/B2 Biowall pair.

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. DO levels are depleted (less than 2 milligrams per liter [mg/L]) in the wells downgradient from Biowall A1/A2 until the well near the site boundary, PT-24. DO levels in the wells close to the biowalls (MWT-26, MWT-27, MWT-28, MWT-29, and MWT-22 near Biowalls B1/B2; and MWT-23 and MWT-24 downgradient of Biowall C2) were less than 0.5 mg/L. This indicates that DO is depleted due to the presence of the biowall substrate. The unavailability of DO enhances the degradation of chlorinated ethenes in the aquifer.

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 (USEPA, 1998). The sulfate level upgradient of Biowall B1/B2 at MWT-26 has been reduced from 958 mg/L in the first round (January 2007) to 738 mg/L. Sulfate concentrations within the Biowalls B1, B2, and C2 (at MWT-27, MWT-28, and MWT-23) were reduced to less that 2.0 mg/L, indicating that the availability of this electron acceptor is diminished and conditions for anaerobic dechlorination are enhanced.

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 was detected in the well upgradient of Biowall B1/B2 (MWT-26) at a concentration of 210 µg/L, indicating that Biowall A1/A2 is beginning to impact that area. The methane concentration increased at the wells in the biowalls and immediately downgradient of the biowalls. Methane was detected in Biowalls B1, B2, and C2 at 15,000 µg/L, 19,000 µg/L, and 23,000 µg/L at MWT-27, MWT-28 and MWT-23, respectively. Methane was detected at 8,100 µg/L at MWT-29, located approximately 40 feet downgradient of Biowall B2. This data demonstrates that there is an increase in the level of methanogenic activity within the biowalls and in downgradient areas.

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 (USEPA, 1998). During the Quarter 2 March 2007 monitoring event, ORP upgradient of Biowall A1/A2 was 52 mV at MWT-25. Within Biowalls B1/B2, ORP has been lowered to a range of -145 mV to -113 mV at MWT-27 and MWT-28, respectively. These levels of ORP indicate conditions are sufficiently reducing within the biowalls to support sulfate reduction, methanogenesis, and anaerobic reductive dechlorination. Low ORP values were also observed in Biowall C2 (MWT-23: -109 mV), in the Ash Landfill upgradient of the biowall systems (PT-18A: -135 mV) and at two wells located approximately 150 feet downgradient of Biowalls C1/C2 (MWT-24: -146 mV and PT-17: -151 mV).

Total Organic Carbon. The presence of organic substrate is necessary to fuel anaerobic degradation processes, including reductive dechlorination. Carbon is an energy source for anaerobic bacteria and drives reductive dechlorination. Levels of TOC greater than 20 mg/L are sufficient to maintain sulfate reducing and methanogenic conditions (USEPA, 1998). TOC levels increased greatly in the biowalls compared to the upgradient concentrations. The TOC level at the well upgradient of Biowall B1 (MWT-26) was 15.2 mg/L. The TOC values in Biowalls B1 and B2 were 1,350 mg/L and 171 mg/L, respectively. The concentration of TOC decreased to 36.7 mg/L at MWT-29 (downgradient of the B1/B2 Biowalls), remaining above the threshold value of 20 mg/L. The TOC level in the C1 Biowall at MWT-23 was 210 mg/L.

Chemical Results

Table 4 summarizes chlorinated ethenes detected in groundwater during the first two quarterly sampling rounds. The second round of groundwater sampling was performed approximately 24 weeks after installation of the biowall. The primary contaminants detected at the site include TCE, cDCE, and vinyl chloride (VC). A summary of the data detected is presented in **Table 5**, and the detections of the TCE, cDCE, and VC are presented in **Figure 4**. TCE was detected in 10 of the 13 wells; TCE was non-detect at the wells within the biowalls (MWT-27, MWT-28, and MWT-23). Upgradient of the biowall systems, TCE was detected well above the groundwater standard at concentrations of 1,000 μg/L at PT-18A and 55 μg/L at MWT-25. The change in groundwater concentrations of TCE, DCE, and VC as the groundwater passes through the biowalls is shown in **Figure 5**. The figure shows that the concentration of TCE is reduced to concentrations below the detection limit as it flows through the walls. The concentration of TCE does rebound as the distance away from biowalls B1/B2 increases, which is likely outside the treatment zone. Geochemical parameters such as ORP, sulfate, and TOC at MWT-29 indicate that conditions at this point in the plume are not as supportive of anaerobic degradation as further upgradient. Downgradient of the C1/C2 Biowalls, the concentrations of TCE were detected at 11 μg/L at PT-17 and was not detected at MWT-24, both within 150 feet of C1/C2. These two wells both exhibited ORP values favorable to anaerobic degradation (-151 mV and -146 mV, respectively). Further downgradient, TCE was detected at 440 μg/L at MWT-7 (310 feet from C1/C2) and at 2.8 μg/L (below the Class GA groundwater standard) at PT-24 downgradient of the ZVI wall.

The concentration of cDCE is similarly reduced as it enters the biowalls, and subsequently rebounds. The cDCE concentration increase observed immediately after the biowalls is an indication that TCE is being converted to cDCE, the next sequential step in the dechlorination process. This suggests that a treatment zone is beginning to be established in the biowalls.

Upgradient of the biowalls at PT-18A, VC was detected at a concentration of 2.9 μg/L. VC was detected at locations downgradient of each biowall pair, with a maximum detection of 165 μg/L (average of the sample and duplicate pair) at MWT-29, located 42 feet downgradient of Biowall B2. A product of reductive dechlorination is the temporary production of VC. Thus the presence of elevated concentrations of VC at MWT-29 indicates that reductive dechlorination is occurring. VC was not detected in the well located near the site boundary, PT-24. Low concentrations (less than 4 μg/L) of 1,1,1-trichloroethane (TCA), 1,1-dichloroethane, 1,1-dichloroethene, and 1,2-dichloroethane were detected once. TCA and 1,1-dichloroethane were each detected at MWT-24 at estimated concentrations of 0.58 J μg/L and 0.83 J μg/L, respectively. 1,1-dichloroethene was detected at the upgradient well PT-18A at an estimated value of 0.73 J μg/L, and 1,2-dichloroethane was detected once at PT-22 at 2.4 μg/L.

<u>Other Compounds</u>

Other non-chlorinated ethenes were detected in the groundwater. Toluene was detected in three wells, and exceeded the NYSDEC Class GA groundwater standard at two of the wells located within biowalls at MWT-28 (160 μg/L) and MWT-23 (7.4 μg/L). Toluene was detected below its Class GA groundwater standard, 5 μg/L, at MWT-29 (2.2 J μg/L). Toluene is not a historic contaminant of concern, and the detection of toluene is not believed to be associated with historic site operations. Ketones were detected in the monitoring wells located within the biowalls. The maximum detections of acetone and methyl ethyl ketone were observed at the well in Biowall B1, MTW-27, at concentrations of 1,300 μg/L and 2,200 μg/L, respectively. These compounds, produced by fermentation reactions in the biowalls, readily degrade in aerobic conditions and were not detected within 100 feet of the site boundary.

4. CONCLUSIONS

Based on the second round of long-term monitoring at the Ash Landfill since the installation of the full-scale biowalls, the Army has made the following conclusions:

- TCE and cDCE are present in the groundwater at concentrations above the GA groundwater standard;
- Chemical results indicate that the chlorinated ethenes are decreasing as they pass through the biowall systems; and
- Geochemical parameters indicate that reductive dechlorination is occurring and that anaerobic treatment zones are established within the biowalls.

In accordance with the PCMMP in the RDR, quarterly monitoring will continue for the first year, and annually or semi-annually thereafter based on the decision flow diagram in the RDR. The third quarterly sampling event is scheduled for the week of June 4, 2007, and results will be reported in a subsequent interim letter report. An annual LTM report will be submitted at the completion of the first year of monitoring.

5. REFERENCES

Parsons, 2005. Sampling and Analysis Plan for the Seneca Army Depot Activity. Final. December 2005.

Parsons, 2006. Remedial Design Report for the Ash Landfill Operable Unit. Revised Final. September, 2006.

Parsons, 2007. Construction Completion Report for the Ash Landfill Operable Unit. Final. January, 2007.

USEPA, 1998. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*. EPA/600/R-98/128, September 1998. http://www.epa.gov/ada/reports.html

Table 1
Sample Collection Summary
Quarter 2 - March 2007
Ash Landfill Long-Term Monitoring
Seneca Army Depot Activity

Monitoring Wells	Monitoring Well Group			Laboratory Analysis			
	On-Site Plume Performance Monitoring	Biowall Process Monitoring	Off-Site Performance Monitoring	VOC 8260B	TOC 9060A	MEE RSK-175	Sulfate EPA 300.1
PT-18A	X			X			
MWT-25	X			X			
MWT-26		X		X	X	X	X
MWT-27		X		X	X	X	X
MWT-28	X	X		X	X	X	X
MWT-29	X	X		X	X	X	X
MWT-22	X			X			
PT-22	X			X			
MWT-23	X	X		X	X	X	X
MWT-24	X			X			
PT-17	X			X			
MWT-7	X			X			
PT-24	X			X			
MW-56							

Notes: All samples were analyzed for field parameters including pH, ORP, dissolved oxygen, conductivity, temperature, and turbidity.

Table 2
Groundwater Elevations
Quarter 1 - December 2006
Ash Landfill Long-Term Monitoring
Seneca Army Depot Activity

Monitoring Well	Top of Riser Elevation (ft)	Well Depth (rel. TOC) (ft)	Dec-06			
			Date Measured [1]	Saturated Thickness (ft)	Depth to Groundwater (ft)	Water Level Elevation (ft)
PT-11	658.22	19.55	12/12/2006	14.78	4.77	653.45
PT-12A	652.15	13.38	12/13/2006	8.04	5.34	646.81
PT-17 [2]	640.14	11.65				
PT-18A	659.05	12.85	12/12/2006	5.19	7.66	651.39
PT-19	645.26	11.70	12/12/2006	7.83	3.87	641.39
PT-20	647.28	11.80	12/13/2006	5.65	6.15	641.13
PT-21A	647.73	19.46	12/13/2006	13.02	6.44	641.29
PT-22	648.61	11.81	12/13/2006	4.94	6.87	641.74
PT-23	641.58	12.80	12/12/2006	7.98	4.82	636.76
PT-24	636.40	11.88	12/12/2006	7.05	4.83	631.57
MW-27	639.32	10.54	12/12/2006	4.99	5.55	633.77
MW-28	637.21	10.39	12/12/2006	6.08	4.31	632.90
MW-29	637.31	10.54	12/12/2006	5.44	5.10	632.21
MW-30	640.32	10.52	12/12/2006	3.28	7.24	633.08
MW-31	636.70	10.34	12/12/2006	6.03	4.31	632.39
MW-32	641.68	10.37	12/12/2006	3.76	6.61	635.07
MW-33	639.56	10.36	12/12/2006	4.08	6.28	633.28
MW-36	631.79	16.58	12/12/2006	13.81	2.77	629.02
MW-40	659.30	14.71	12/12/2006	10.44	4.27	655.03
MW-43	657.73	7.47	12/12/2006	4.70	2.77	654.96
MW-44A	653.85	12.48	12/12/2006	7.88	4.60	649.25
MW-45	650.90	8.34	12/13/2006	5.16	3.18	647.72
MW-46	650.41	11.45	12/12/2006	5.38	6.07	644.34
MW-48	648.32	11.50	12/13/2006	7.93	3.57	644.75
MW-53	639.41	10.35	12/12/2006	4.26	6.09	633.32
MW-56	630.51	6.88	12/12/2006	3.64	3.24	627.27
MWT-1	637.24	10.13	12/12/2006	6.33	3.80	633.44
MWT-3	637.31	10.13	12/12/2006	4.92	5.21	632.10
MWT-4	637.68	12.43	12/12/2006	7.72	4.71	632.97
MWT-6	637.59	12.65	12/12/2006	6.94	5.71	631.88
MWT-7	638.34	13.64	12/12/2006	8.47	5.17	633.17
MWT-9	638.08	14.14	12/12/2006	7.86	6.28	631.80
MWT-10	636.07	9.00	12/12/2006	5.23	3.77	632.30
MWT-17R	650.282	11.4	12/13/2006	5.11	6.29	643.99
MWT-22	650.663	14.9	12/13/2006	8.47	6.43	644.23
MWT-23	646.772	13.7	12/12/2006	7.38	6.32	640.45
MWT-24	641.564	13	12/12/2006	6.26	6.74	634.82
MWT-25	654.507	13.25	12/13/2006	7.61	5.64	648.87
MWT-26	652.191	13.22	12/15/2006	8.51	4.71	647.48
MWT-27	652.993	12.9	12/13/2006	7.49	5.41	647.58
MWT-28	652.685	12.85	12/13/2006	6.79	6.06	646.63
MWT-29	651.816	13.1	12/13/2006	6.71	6.39	645.43

Notes:

1. Groundwater levels were recorded in December 2006 in preparation for the Quarter 1 sampling event which commenced on January 2, 2007.
2. Groundwater elevation data is not available.

Table 3
Groundwater Geochemical Data
Ash Landfill Long-Term Monitoring - Quarter 2, 2007
Seneca Army Depot Activity

Well ID	location description	Sample ID	Sample Round	pH	turbidity (NTU)	Specific Conductance (mS/cm)	DO (mg/L)	ORP (mV)	TOC (mg/L)	Sulfate (mg/L)	Ethane (ug/L)	Ethene (ug/L)	Methane (ug/L)
PT-18A	upgradient of walls	ALBW20059	1Q2007	6.63	141	1.69	1.33	93					
		ALBW20074	2Q2007	6.44	110	2.87	0.76	-177					
MWT-25	upgradient of Biowall A	ALBW20064	1Q2007	8	9.6	0.29	2.83	63					
		ALBW20079	2Q2007	7.27	14	2.2	2.8	52					
MWT-26	**upgradient of Biowalls B1/B2**	ALBW20066	1Q2007	6.89	10	2.01	1.84	-3	3.9 J	958	ND	ND	ND
		ALBW20081	2Q2007	7.26	9	1.9	0.48	-135	15.2	738	0.4	7.8	210
MWT-27	**in Biowall B1**	ALBW20067	1Q2007	6.34	120	5.31	0.25	-158	2050 J	ND	ND	ND	ND
		ALBW20082	2Q2007	6.65	87	4.37	0.08	-145	1350	ND	0.15	2.7	15,000
MWT-28	**in Biowall B2**	ALBW20068	1Q2007	7.5	163	0.61	0.16	-150	1775 J	1.7	ND	ND	12,500 J
		ALBW20083	2Q2007	6.6	21	2.3	0.09	-113	171	ND	0.67	0.48	19,000
MWT-29	**downgradient of Biowall B2**	ALBW20070	1Q2007	6.49	7.2	2.1	0.33	-76	25.1 J	113	ND	ND	ND
		ALBW20084/5	2Q2007	6.8	1.7	2.21	0.39	-53	36.7	173	25	150	8,100
MWT-22	downgradient of Biowall B2	ALBW20071	1Q2007	7.7	4.5	0.13	0.09	-80					
		ALBW20075	2Q2007	6.72	41	2.16	0.3	-65					
PT-22	between Biowalls B and C	ALBW20060	1Q2007	7.70	4.5	0.13	0.09	-80					
		ALBW20086	2Q2007	6.78	7	1.18	0.78	-54					
MWT-23	**in Biowall C2**	ALBW20065	1Q2007	7.2	5	0.2	0.26	-122	260 J	ND	ND	ND	12,000
		ALBW20080	2Q2007	6.51	30	1.8	0.35	-109	210	ND	45	5.9	23,000
MWT-24	downgradient of Biowalls C1/C2	ALBW20063	1Q2007	7.02	10	0.762	0.27	-160					
		ALBW20078	2Q2007	6.91	59	1.08	0.32	-146					
PT-17	downgradient of biowalls	ALBW20058	1Q2007	8	3.8	92	0.23	-111					
		ALBW20073	2Q2007	7.1	14	0.729	0.76	-151					
MWT-7	immed. Upgradient of ZVI wall	ALBW20062	1Q2007	6.8	19.6	0.581	0.01	62					
		ALBW20077	2Q2007	6.95	8	0.763	0.76	52					
PT-24	downgradient of ZVI wall	ALBW20061	1Q2007	8.1	10	70	0.37	-59					
		ALBW20076	2Q2007	7.58	0	0.464	2.2	-59					
MW-56	off-site well	ALBW20072	1Q2007	6.85	3.3	0.462	0.37	-102					

Notes:
ND = Non-detect
1Q2007 - First round of LTM (January 2007)
2Q2007 - Second round of LTM (March 2007)
Empty cells indicate that the specified analysis was not completed for that well. The bolded wells are the five wells included in the biowall process monitoring group.
Analysis of TOC, sulfate, methane, ethane, and ethene were completed for the biowall process wells only.

TABLE 4
VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER
Ash Landfill Long-Term Monitoring
Seneca Army Depot Activity

Sample Identification		Sample Date	PCE ug/L	TCE ug/L	1,1-DCE ug/L	cis-DCE ug/L	trans-DCE ug/L	VC ug/L	1,1-DCA ug/L
PT-18A	upgradient of walls	3-Jan-07	1 U	2000	0.64 J	220	1.6	2.4	1 U
		17-Mar-07	1 U	1000	0.73 J	170	1.4	2.9	1 U
MWT-25	upgradient of Biowall A	3-Jan-07	1 U	50	1 U	41	0.56 J	1.6	1 U
		17-Mar-07	1 U	55	1 U	84	1.2	9.6	1 U
MWT-26	upgradient of Biowalls B1/B2	3-Jan-07	1 U	10	1 U	19	0.6 J	2	1 U
		17-Mar-07	1 U	11	1 U	17	1	6.1	1 U
MWT-27	in Biowall B1	3-Jan-07	20 U	20 UJ	20 UJ	49 J	20 UJ	20 UJ	20 UJ
		16-Mar-07	20 U	20 U	20 U	20 U	20 U	20 U	20 U
MWT-28	in Biowall B2	3-Jan-07	20 U	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ	20 UJ
		16-Mar-07	20 U	20 U	20 U	20 U	20 U	20 U	20 U
MWT-29	downgradient of Biowall B2	3-Jan-07	2 U	22	2 U	280	6.5	140	2 U
		16-Mar-07	4 U	19	4.5 U	220	7.8	165	4.5 U
MWT-22	downgradient of Biowall B2	3-Jan-07	2 U	5.2	2 U	130	2.7	98	2 U
		17-Mar-07	4 U	3.8 J	4 U	90	4 U	64	4 U
PT-22	between Biowalls B and C	3-Jan-07	1 U	11	1 U	57	0.86 J	22	1 U
		15-Mar-07	1 U	16	1 U	41	0.51 J	13	1 U
MWT-23	in Biowall C2	3-Jan-07	4 U	4 U	4 U	60	4 U	23	4 U
		16-Mar-07	4 U	4 U	4 U	11	4 U	4.8	4 U
MWT-24	downgradient of Biowalls C1/C2	3-Jan-07	1 U	0.94 J	1 U	210	2.1	19	0.81 J
		15-Mar-07	1 U	1 U	1 U	68	0.88 J	45	0.83 J
PT-17	downgradient of biowalls	2-Jan-07	1 U	6	1 U	62	1 U	21	1 U
		15-Mar-07	2 U	11	2 U	26	2 U	21	2 U
MWT-7	immed. Upgradient of ZVI wall	4-Jan-07	1 U	490	1 U	35	1 U	0.51 J	1 U
		15-Mar-07	1 U	440	1 U	42	1 U	9.7	1 U
PT-24	downgradient of ZVI wall	2-Jan-07	1 U	4	1 U	54	0.86 J	0.6 J	0.68 J
		15-Mar-07	1 U	2.8	1 U	38	0.81 J	1 U	1 U
MW-56	off-site well	4-Jan-07	1 U	1 U	1 U	1.2	1 U	1 U	1 U

Note:
1) Sample duplicate pairs were collected at MWT-28 in Jan-07 and at MWT-29 in Mar-07. 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.
U = compound was not detected
J = the reported value is an estimated concentration

Table 5
Summary of VOCs in Groundwater - Quarter 2, 2007
Ash Landfill Long-Term Monitoring
Seneca Army Depot Activity

Facility								ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID								PT-18A	MWT-25	MWT-26	MWT-27	MWT-28
Matrix								GW	GW	GW	GW	GW
Sample ID								ALBW20074	ALBW20079	ALBW20081	ALBW20082	ALBW20083
Sample Date								3/17/2007	3/17/2007	3/17/2007	3/16/2007	3/16/2007
QC Code								SA	SA	SA	SA	SA
Study ID								LTM	LTM	LTM	LTM	LTM
Sampling Round								2	2	2	2	2
Parameter[1]	Units	Maximum Value	Frequency of Detection	Cleanup Goal[2]	Number of Exceedances	Number of Times Detected	Number of Samples Collected	Value (Q)	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1,1-Trichloroethane	UG/L	0.58	7%	5	0	1	14	1 U	1 U	1 U	20 U	20 U
1,1-Dichloroethane	UG/L	0.83	7%	5	0	1	14	1 U	1 U	1 U	20 U	20 U
1,1-Dichloroethene	UG/L	0.73	7%	5	0	1	14	0.73 J	1 U	1 U	20 U	20 U
1,2-Dichloroethane	UG/L	2.4	7%	0.6	1	1	14	1 U	1 U	1 U	20 U	20 U
Acetone	UG/L	1300	71%		0	10	14	2 J	5 U	17	1300	170
Cis-1,2-Dichloroethene	UG/L	220	86%	5	12	12	14	170	84	17	20 U	20 U
Methyl ethyl ketone	UG/L	2200	43%		0	6	14	5 U	5 U	15	2200	180
Methylene chloride	UG/L	2.5	14%	5	0	2	14	1 U	1 U	1 U	20 U	20 U
Toluene	UG/L	160	21%	5	2	3	14	1 U	1 U	1 U	20 U	160
Trans-1,2-Dichloroethene	UG/L	8	57%	5	2	8	14	1.4	1.2	1	20 U	20 U
Trichloroethene	UG/L	1000	71%	5	8	10	14	1000	55	11	20 U	20 U
Vinyl chloride	UG/L	170	79%	2	11	11	14	2.9	9.6	6.1	20 U	20 U

Notes:
1. Only detected VOCs are included in this summary table.
2. The cleanup goal values are NYSDEC Class GA Groundwater Standards (TOGS 1.1.1, June 1998).
3. Shading indicates a concentration above the GA groundwater standard.

U = compound was not detected
J = the reported value is an estimated concentration

Table 5
Summary of VOCs in Groundwater - Quarter 2, 2007
Ash Landfill Long-Term Monitoring
Seneca Army Depot Activity

Facility								ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID								MWT-29	MWT-29	MWT-22	PT-22	MWT-23
Matrix								GW	GW	GW	GW	GW
Sample ID								ALBW20085	ALBW20084	ALBW20075	ALBW20086	ALBW20080
Sample Date								3/16/2007	3/16/2007	3/17/2007	3/15/2007	3/16/2007
QC Code								DU	SA	SA	SA	SA
Study ID								LTM	LTM	LTM	LTM	LTM
Sampling Round								2	2	2	2	2
Parameter[1]	Units	Maximum Value	Frequency of Detection	Cleanup Goal[2]	Number of Exceedances	Number of Times Detected	Number of Samples Collected	Value (Q)	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1,1-Trichloroethane	UG/L	0.58	7%	5	0	1	14	4 U	5 U	4 U	1 U	4 U
1,1-Dichloroethane	UG/L	0.83	7%	5	0	1	14	4 U	5 U	4 U	1 U	4 U
1,1-Dichloroethene	UG/L	0.73	7%	5	0	1	14	4 U	5 U	4 U	1 U	4 U
1,2-Dichloroethane	UG/L	2.4	7%	0.6	1	1	14	4 U	5 U	4 U	2.4	4 U
Acetone	UG/L	1300	71%		0	10	14	14 J	15 J	18 J	5 U	190
Cis-1,2-Dichloroethene	UG/L	220	86%	5	12	12	14	220	220	90	41	11
Methyl ethyl ketone	UG/L	2200	43%		0	6	14	20 U	25 U	20 U	5 U	130
Methylene chloride	UG/L	2.5	14%	5	0	2	14	4 U	2.5 J	4 U	1 U	4 U
Toluene	UG/L	160	21%	5	2	3	14	2.2 J	5 U	4 U	1 U	7.4
Trans-1,2-Dichloroethene	UG/L	8	57%	5	2	8	14	8	7.5	4 U	0.51 J	4 U
Trichloroethene	UG/L	1000	71%	5	8	10	14	19	19	3.8 J	16	4 U
Vinyl chloride	UG/L	170	79%	2	11	11	14	170	160	64	13	4.8

Notes:
1. Only detected VOCs are included in this summary table.
2. The cleanup goal values are NYSDEC Class GA Groundwater Standards (TOGS 1.1.1, June 1998).
3. Shading indicates a concentration above the GA groundwater standard.

U = compound was not detected
J = the reported value is an estimated concentration

Table 5
Summary of VOCs in Groundwater - Quarter 2, 2007
Ash Landfill Long-Term Monitoring
Seneca Army Depot Activity

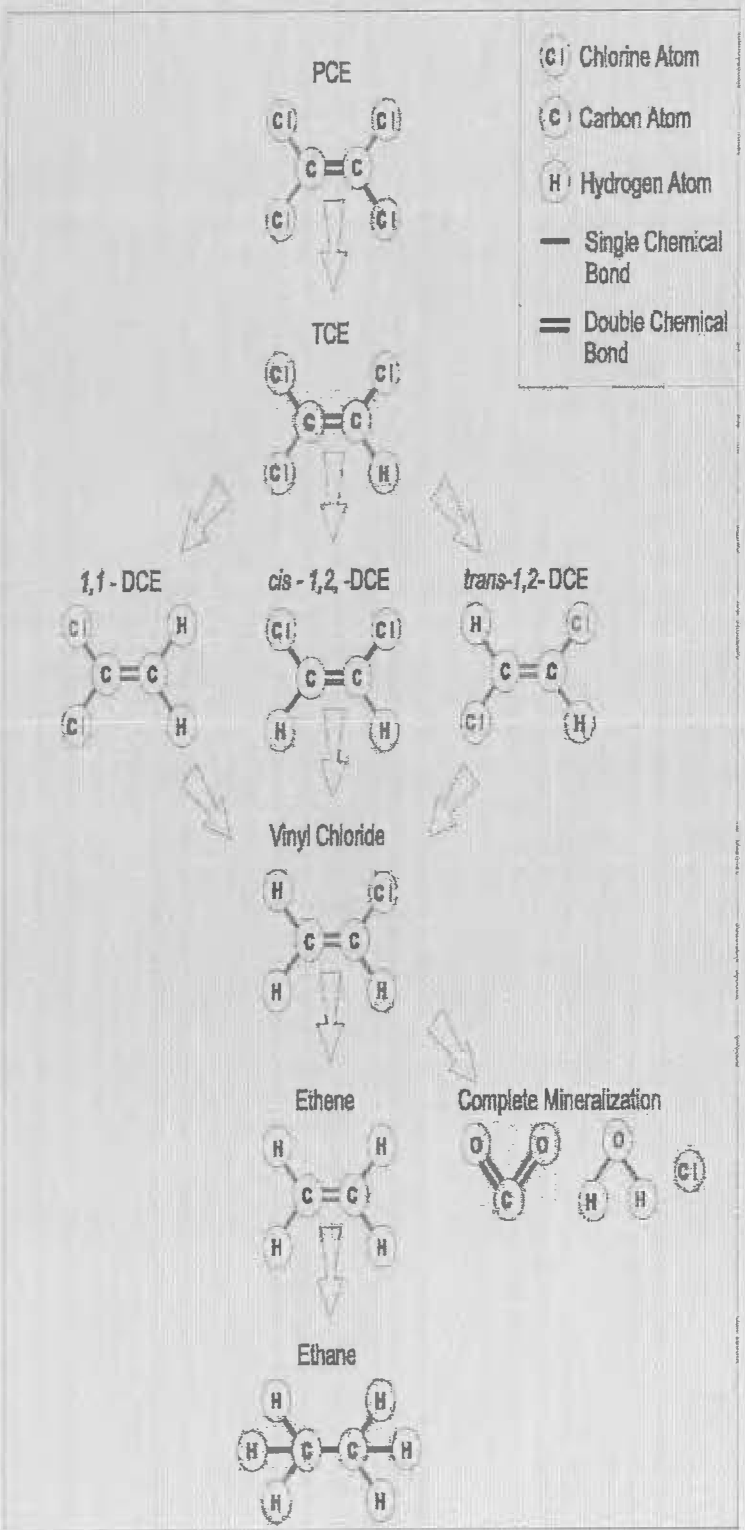
Facility								ASH LANDFILL	ASH LANDFILL	ASH LANDFILL	ASH LANDFILL
Location ID								MWT-24	PT-17	MWT-7	PT-24
Matrix								GW	GW	GW	GW
Sample ID								ALBW20078	ALBW20073	ALBW20077	ALBW20076
Sample Date								3/15/2007	3/15/2007	3/15/2007	3/15/2007
QC Code								SA	SA	SA	SA
Study ID								LTM	LTM	LTM	LTM
Sampling Round								2	2	2	2
Parameter[1]	Units	Maximum Value	Frequency of Detection	Cleanup Goal[2]	Number of Exceedances	Number of Times Detected	Number of Samples Collected	Value (Q)	Value (Q)	Value (Q)	Value (Q)
1,1,1-Trichloroethane	UG/L	0.58	7%	5	0	1	14	0.58 J	2 U	1 U	1 U
1,1-Dichloroethane	UG/L	0.83	7%	5	0	1	14	0.83 J	2 U	1 U	1 U
1,1-Dichloroethene	UG/L	0.73	7%	5	0	1	14	1 U	2 U	1 U	1 U
1,2-Dichloroethane	UG/L	2.4	7%	0.6	1	1	14	1 U	2 U	1 U	1 U
Acetone	UG/L	1300	71%		0	10	14	54	22	5 U	5 U
Cis-1,2-Dichloroethene	UG/L	220	86%	5	12	12	14	68	26	42	38
Methyl ethyl ketone	UG/L	2200	43%		0	6	14	36	11	5 U	5 U
Methylene chloride	UG/L	2.5	14%	5	0	2	14	1 U	1.2 J	1 U	1 U
Toluene	UG/L	160	21%	5	2	3	14	1 U	2 U	1 U	1 U
Trans-1,2-Dichloroethene	UG/L	8	57%	5	2	8	14	0.88 J	2 U	1 U	0.81 J
Trichloroethene	UG/L	1000	71%	5	8	10	14	1 U	11	440	2.8
Vinyl chloride	UG/L	170	79%	2	11	11	14	45	21	9.7	1 U

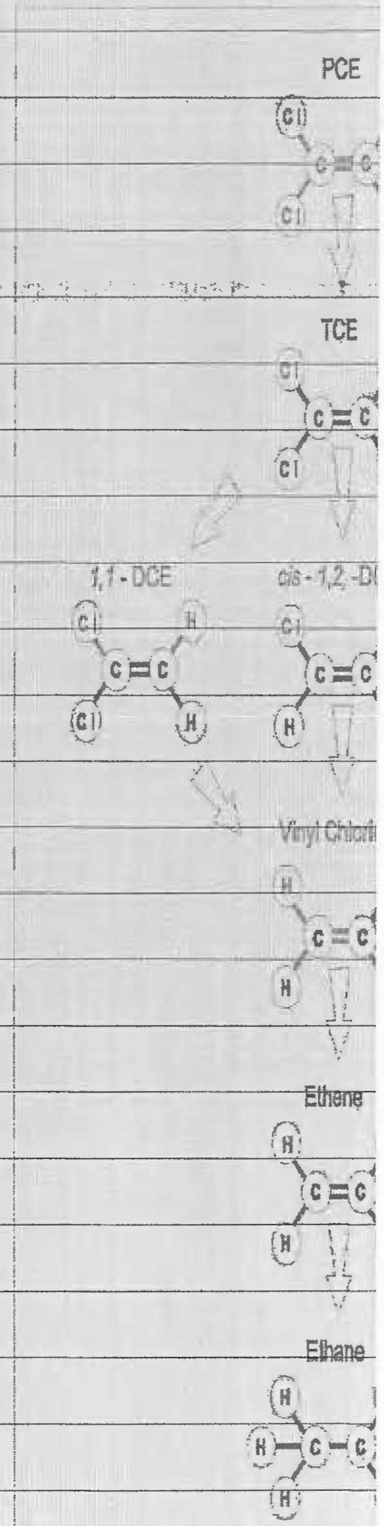
Notes:
1. Only detected VOCs are included in this summary table.
2. The cleanup goal values are NYSDEC Class GA Groundwater Standards (TQGS 1.1.1, June 1998).
3. Shading indicates a concentration above the GA groundwater standard.

U = compound was not detected
J = the reported value is an estimated concentration

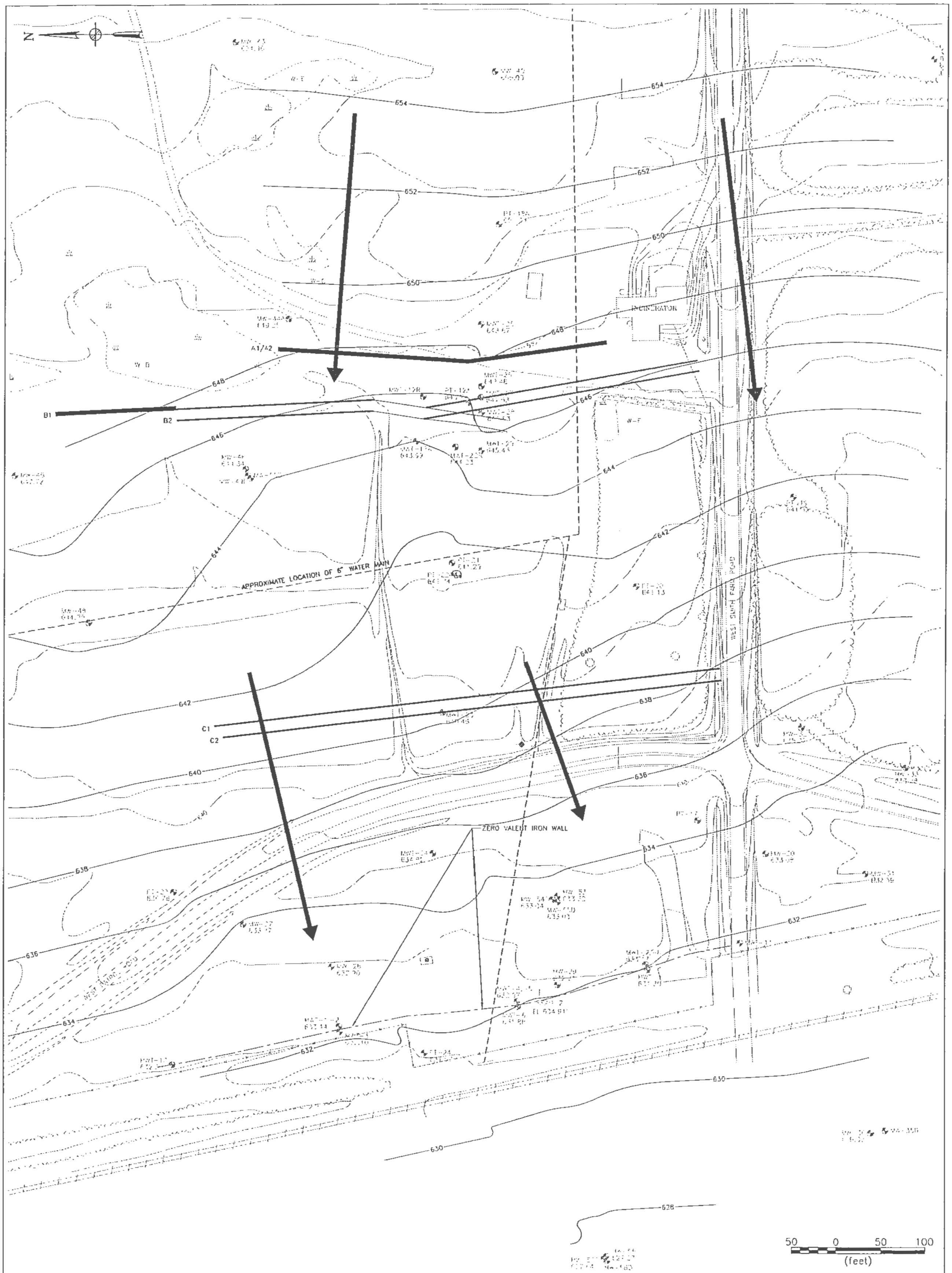

N
NON-COMBUSTIBLE FILL LANDFILL (NCFL) (SEAD-8) 3.4 ACRES
ASH LANDFILL (SEAD-6) 2.2 ACRES
ZERO VALENT IRON WALL
LEGEND:
PAVED ROAD
DIRT ROAD
GROUND CONTOUR AND ELEVATION
TREE
WETLAND & DESIGNATION
BRUSH
CHAIN LINK FENCE
UTILITY POLE
APPROXIMATE LOCATION OF FIRE HYDRANT
FUEL OR UNDERGROUND STORAGE TANK
SURVEY MONUMENT
MONITORING WELL AND DESIGNATION
RAILROAD TRACKS
WATER MAIN
POST CONSTRUCTION AS BUILT GROUND ELEVATION CONTOUR
PILOT STUDY BIOWALL (2005)
SINGLE BIOWALL (2006)
DOUBLE-WIDE BIOWALL (2006)
ZERO VALENT IRON WALL (1998)
100 0 100 200
(feet)
PARSONS
CLIENT/PROJECT TITLE
SENECA ARMY DEPOT
ASH LANDFILL
LONG-TERM MONITORING REPORT
DEPT. ENVIRONMENTAL ENGINEERING
Dwg No. 744538-01400
FIGURE 1
ASH LANDFILL
SITE PLAN
SCALE 1" = 200'
DATE MAY 2007
REV -

Figure 2
Reductive Dechlorination of Chlorinated Ethenes
Ash Landfill Long-Term Monitoring
Seneca Army Depot Activity





(USEPA, 1998)



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
- ABANDONED MONITORING WELL
- APPROXIMATE LOCATION OF WATER MAIN
- PILOT STUDY BIOWALL (2005)
- SINGLE BIOWALL (2006)
- DOUBLE-WIDE BIOWALL (2006)
- ZERO VALENT IRON WALL (1998)
- 640 GROUNDWATER CONTOUR
- GROUNDWATER FLOW DIRECTION

PARSONS

CLIENT/PROJECT TITLE

SENECA ARMY DEPOT
ASH LANDFILL
LONG-TERM MONITORING REPORT

DEPT.	Dwg No.
ENVIRONMENTAL ENGINEERING	744536-01400

FIGURE 3

GROUNDWATER CONTOURS & GROUNDWATER FLOW DIRECTION DECEMBER 2006

SCALE	DATE	REV
1" = 100'	MAY 2007	-

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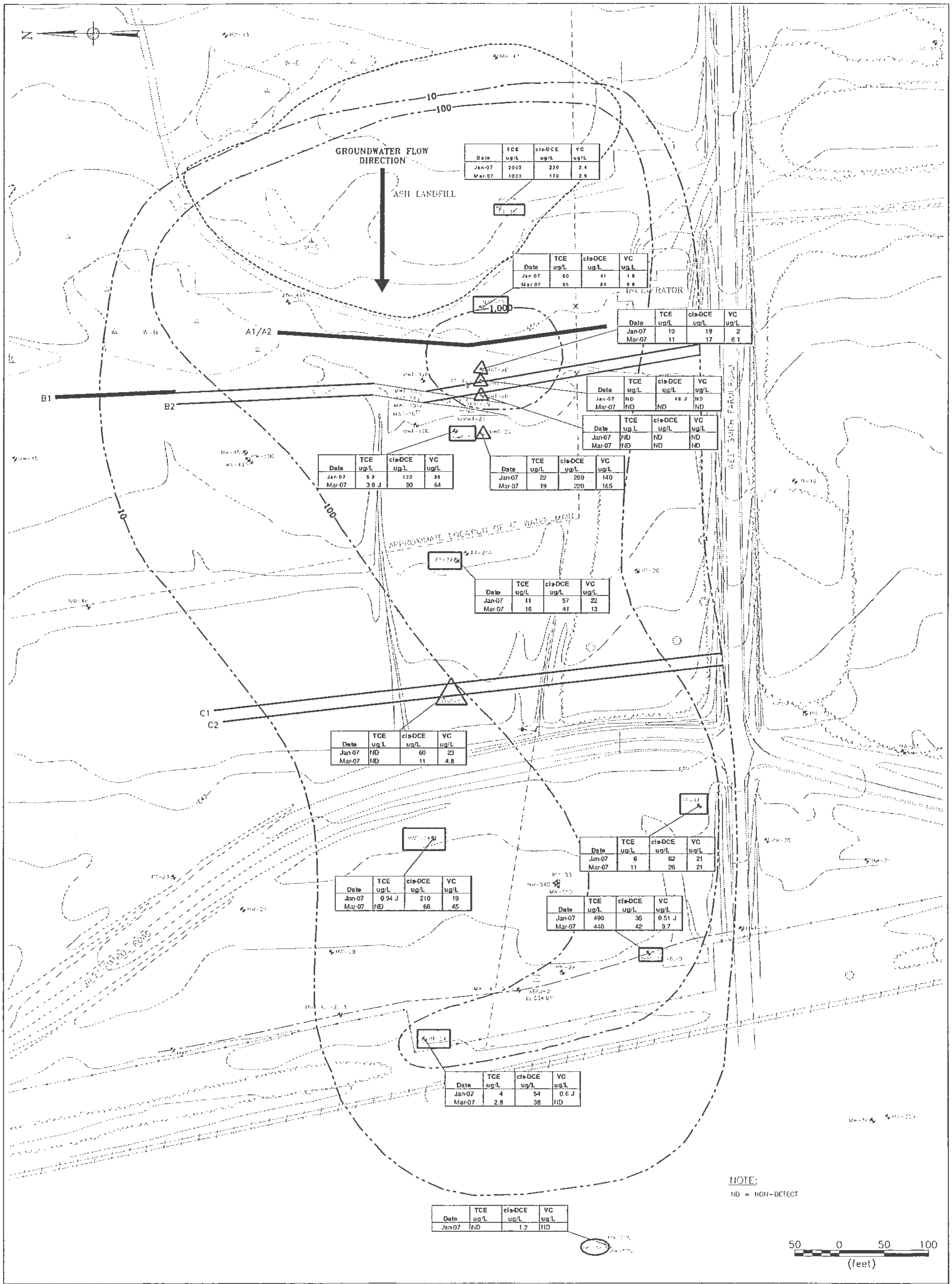

LEGEND:

- 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
- ABANDONED MONITORING WELL
- APPROXIMATE LOCATION OF WATER MAIN
- PILOT STUDY BIOWALL (2005)
- SINGLE BIOWALL (2006)
- DOUBLE-WIDE BIOWALL (2006)
- ZERO VALENT IRON WALL (1998)
- GROUNDWATER 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

LONG-TERM MONITORING REPORT

DEPT. ENVIRONMENTAL ENGINEERING | DWG No. 744538-01400

FIGURE 4

CHLORINATED ETHENES CONCENTRATIONS IN GROUNDWATER QTR 2 – MARCH 2007

SCALE 1" = 100' | DATE MAY 2007 | REV -

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Figure 5
Concentrations of VOCs Along the Biowalls - Quarter 2, 2007
Ash Landfill Long-Term Monitoring
Seneca Army Depot Activity