Seneca Army Depot Activity
Romulus, New York

USACE - New York District
US Army, Engineering & Support Center
Huntsville, AL

Final 1,4-Dioxane Groundwater Investigation Work Plan

Ash Landfill Operable Unit
Seneca Army Depot Activity

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

December 2018

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LIST OF ACRONYMS

ACRONYM	DEFINITION	ACRONYM	DEFINITION
APP	Accident Prevention Plan	NYSDEC	New York State Department of Environmental Conservation
cm/sec	centimeters per second	OU	Operable Unit
DA	Department of the Army	ORP	Oxidation-Reduction Potential
DO	Dissolved Oxygen	Parsons	Parsons Government Services, Inc.
DoD	Department of Defense	QA	Quality Assurance
DQO	Data Quality Objective	QC	Quality Control
ELAP	Environmental Laboratory Accreditation Program	QSM	Quality Systems Manual
EPA	Environmental Protection Agency	RA	Remedial Action
ESI	Expanded Site Inspection	RI	Remedial Investigation
ft	Feet	RSL	Regional Screening Level
ft/day	feet per day	SAP	Sampling and Analysis Plan
ft/ft	feet per foot	SEDA	Seneca Army Depot Activity
ft/yr	feet per year	SOPs	Standard Operating Procedures
LTM	Long term monitoring	SSHP	Site Safety and Health Plan
mg/L	milligram per liter	SWMUs	Solid Waste Management Units
MW	Monitoring Well	UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
MS	Matrix Spike	U.S.	United States
MSD	Matrix Spike Duplicate	USAEHA	United States Army Environmental Hygiene Agency
NCFL	Non-Combustible Fill Landfill	USEPA	United States Environmental Protection Agency
NTU	Nephelometric Turbidity Unit	VOC	Volatile Organic Compound

1,4-Dioxane Groundwater Investigation Work Plan

Section 1: Objectives

This work plan serves as a supplement to the UFP-QAPP and UFP-QAPP Addendum (Parsons 2017a, 2018a) and presents details of the 1,4-dioxane groundwater investigation at the Ash Landfill Operable Unit (OU), also referred to as the Ash Landfill, at Seneca Army Depot Activity (SEDA) (**Figure 1**). The Ash Landfill was the former location of five historic solid waste management units (SWMUs) used for the disposal of domestic waste. Currently, the Ash Landfill is the subject of long term monitoring (LTM) of the groundwater for chlorinated volatile organic compounds (VOCs) (Parsons, 2018b). The site is sampled semi-annually and includes a permeable reactive barrier (mulch biowalls) installed in 2006 as the active remedy and refreshed in 2017 (**Figure 2**). The addition of a round of 1,4-dioxane sampling is included based on a letter from New York State Department of Environmental Conservation (NYSDEC) dated 07 May 2018 requesting sampling for 1,4-dioxane as part of their emerging contaminants program.

Section 2: Site History

Seneca Army Depot Activity, a 10,587-acre former military facility located in Seneca County near Romulus, New York, is located between Seneca Lake and Cayuga Lake in Seneca County, 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 facility was wholly owned by the United States Government and was operated by the Department of the Army (DA) between 1941 and 2000; since 2000, portions of the Depot have been transferred to other parties for reuse. The primary mission of SEDA was the receipt, storage, maintenance, and supply of military items.

2.1: ASH LANDFILL

The Ash Landfill is composed of five historic 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). According to the U.S. Army Environmental Hygiene Agency (USAEHA) Interim Final Report, Groundwater Contamination Survey No. 38-26-0868-88 (July 1987), the ash from the refuse burning pits was buried in the Ash Landfill (SEAD-6) from 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 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. According to an undated aerial photograph of the incinerator during operation, the active area of the Ash Landfill extended at least 500 feet north of the incinerator building, near a bend in a dirt road (Appendix B – Figure B1). 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.

2.2: ASH LANDFILL GEOLOGY AND 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.

2.3: LONG TERM MONITORING AND REMEDY

A remedial action (RA) was completed in October and November 2006 in accordance with the Record of Decision (ROD) for the Ash Landfill OU (Parsons, 2004), the Remedial Design Work Plan (Parsons, 2006a), and the Remedial Design Report (Parsons, 2006b). The remedial action involved the following:

- Installation of three dual biowall systems, A1/A2, B1/B2, and C1/C2, to address VOCs in groundwater that exceed NYSDEC Class GA groundwater standards;
- Construction and establishment of a 12-inch vegetative cover over the Ash Landfill and the NCFL to prevent ecological receptors from coming into direct contact with the underlying soils that are contaminated with metals and polycyclic aromatic hydrocarbons;
- Excavation and disposal of Debris Piles A, B, and C; and
- Re-grading of the Incinerator Cooling Water Pond to promote positive drainage.

As part of the remedial action at the Ash Landfill, post-closure operations include LTM. Groundwater monitoring is required as part of the remedial design, which was formulated to comply with the ROD. The latest LTM sampling at the Ash Landfill occurred in both January and June of 2018.

Section 3: Description of Work

As noted in Section 1 above, this work is driven by work described in a letter from NYSDEC on 7 May 2018:

> "The NYSDEC is undertaking a state-wide evaluation of remediation sites to better understand the risk posed to citizens by PFAS and 1,4-dioxane. You have already begun the process of evaluation for PFAS in the Seneca Army Depot, however, 1,4-dioxane also represents a health concern. Therefore, the DEC is requiring that 1,4-dioxane also be tested on the site. 1,4- dioxane is most closely used in conjunction with TCA and other chlorinated solvents and can be found in groundwater in addition to those contaminants. To accommodate this requirement, a select number of existing monitoring wells, representative of the potential of the site (in this case the Ash Landfill) to be a source of these emerging contaminants, must be sampled."

The key elements of the 1,4-dioxane sampling approach are as follows:

Groundwater Sampling. Sampling will be conducted at eight existing monitoring wells at the Ash Landfill. Wells will be sampled with bladder pumps using low flow sampling methods. Section 3.1 and 3.2.

Analytical. The samples will be analyzed by the United States Environmental Protection Agency (USEPA) Method 8270D-SIM by Katahdin Analytical Services. A full list of laboratory detection limits and standard operating procedures (SOPs) is included in Amendment 1 to the Final Uniform Federal Policy - Quality Assurance Project Plan (UFP-QAPP) (Parsons, 2018a). Section 3.3.

QAPP. Addendum worksheets for the existing Final QAPP were prepared, as necessary, to document the sampling approach and analytical methods for 1,4-Dioxane [see Addendum 1 to the Final UFP-QAPP (Parsons, 2018a)]. The complete Final QAPP with the Addendum will be provided to the field team prior to the commencement of work.

Health and Safety. Complete health and safety requirements for this project can be found in the Parsons (2017b) Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP). This document will be provided to the field team under separate cover prior to mobilization.

SOPs for implementation of the groundwater investigation activities are provided in Appendix A of this document:

Appendix A – Field Standard Operating Procedures (SOPs)

3.1: GROUNDWATER SAMPLING LOCATIONS

The general scope of the activities for groundwater sampling for 1,4-dioxane at Ash Landfill is:

- Conducting one round of groundwater sampling at ten existing monitoring wells, within the upper overburden aquifer; and
- Analyzing groundwater samples for 1,4-dioxane.

Existing wells are located within the Ash Landfill. Ten existing wells (MW-60, MW-43, PT-18A, MW-44A, MWT-25, PT-22, MWT-23, MW-27, MWT-24, and MW-56) were selected for sampling due to their location within the former chlorinated solvent plume (**Figure 1**). One well, MW-56, will be the off-site sentry well. The other eight cover areas upgradient of the source area (MW-43), within and downgradient of the source area (PT-18A, MW44A, and MWT-25), at the midpoint of the plume (PT-22) and at the toe of the chlorinated solvent plume (MW-27 and MWT-24). These eight wells provide coverage across the former width of the chlorinated solvent plume. The upgradient location (MW-43) provides a background value for comparison. Well MW-60 will be sampled to determine if the NCFL is a source of 1,4-dioxane. Sample locations and their associated sample IDs are presented in **Table 1**. Table 1 is an amendment to Table 18.11 from the Draft UFP-QAPP Addendum (Parsons, 2018a) and includes location IDs.

Four of the wells included in the proposed 1,4-dioxane sampling plan (MW-27, MW-43, MW-44A and MW-60) are not sampled as part of the semi-annual LTM program; as such, these four wells will be developed prior to sampling. A submersible pump and surge block will be used to develop the well. Water quality parameters (temperature, pH, conductivity, and turbidity or as specified in the SOPs) will be recorded at the start of the development and after every borehole volume removed from the well. Development will continue until the water is clear (turbidity ≤10 NTUs) or three consecutive turbidity readings are within 10% and the other field parameters (temperature, pH, and conductivity) have stabilized (pH ±0.2 units, temperature ± 1° Centigrade, and conductivity 10%) (**Appendix A**, SOP ENV-4.00 Well Development). Sampling will occur a minimum of 48 hours after development.

Groundwater elevations and groundwater quality parameters listed below will be measured and recorded prior to sample collection and a groundwater sample will be collected once parameters have stabilized:

- Turbidity: 10% for values greater than 5 nephelometric turbidity unit (NTU); if three turbidity values are less than 5 NTU, consider the values as stabilized;
- Dissolved oxygen (DO): 10% for values greater than 0.5 milligrams per liter (mg/L), if three DO values are less than 0.5 mg/L, consider the values as stabilized;
- Specific Conductance: 3%;
- Temperature: 3%;
- pH: +/- 0.1 unit; and,
- Oxidation-reduction potential: +/- 10 millivolts.

Prior to sample collection, field parameters will be measured approximately every five minutes in order to assess when the well is adequately purged, and the groundwater conditions have stabilized with the surrounding formation water. Groundwater sample locations and ID nomenclature are provided in Addendum 1 to the Final UFP-QAPP [Table 18.11] and below in **Table 1**.

Table 1 [18.11 in QAPP addendum] – Groundwater Sampling Locations and Methods for 1,4-Dioxane at Ash Landfill

LOCATION ID(1)	SAMPLE ID	MATRIX	TYPE	ANALYTE / ANALYTICAL GROUP	SAMPLING SOP	COMMENTS
MW-60	ALMI20001	GW	Sample	1,4-Dioxane	ENV-02	
MW-43	ALMI20002	GW	Sample	1,4-Dioxane	ENV-02	
PT-18A	ALMI20003	GW	Sample	1,4-Dioxane	ENV-02	
MW-44A	ALMI20004	GW	Sample	1,4-Dioxane	ENV-02	
MWT-25	ALMI20005	GW	Sample	1,4-Dioxane	ENV-02	
MWT-25	ALMI20005MS	GW	MS/MSD	1,4-Dioxane	ENV-02	
MWT-25	ALMI20005MSD	GW	MS/MSD	1,4-Dioxane	ENV-02	
MWT-25	ALMI20006	DU	Duplicate	1,4-Dioxane	ENV-02	
PT-22	ALMI20007	GW	Sample	1,4-Dioxane	ENV-02	
MWT-23	ALMI20008	GW	Sample	1,4-Dioxane	ENV-02	
MWT-24	ALMI20009	GW	Sample	1,4-Dioxane	ENV-02	
MW-27	ALMI20010	GW	Sample	1,4-Dioxane	ENV-02	
MW-56	ALMI20011	GW	Sample	1,4-Dioxane	ENV-02	
N/A	ALMI00001	Aqueous	Rinse Blank	1,4-Dioxane	ENV-02	

Key: GW = groundwater; DU = duplicate; MS/MSD = matrix spike/matrix spike duplicate
(1) MS/MSD and Field Duplicate locations may be changed in the field, as groundwater conditions allow.

3.2: GROUNDWATER SAMPLING PROCEDURES

Groundwater samples will be collected using bladder pumps and low-flow sampling techniques (**Appendix A**, SOP ENV-02, Section 5.3.2). Sampling procedures, sample handling and custody, holding times, and collection of field parameters are to be conducted in accordance with Amendment 1 of the Final UFP-QAPP (Parsons, 2018a) and SOP ENV-02. The selected laboratory will have the capability to conform to the project QAPP and have a current DoD Environmental Laboratory

Accreditation Program (DoD ELAP) certification in which the laboratory demonstrated its competency and document conformance to the current DoD Quality Systems Manual for Environmental Laboratories (DoD QSM).

Groundwater elevations and groundwater quality parameters listed below will be measured and recorded prior to sample collection and the groundwater sample will be collected once parameters have stabilized:

- Turbidity: 10% for values greater than 5 nephelometric turbidity unit (NTU); if three turbidity values are less than 5 NTU, consider the values as stabilized;
- Dissolved oxygen (DO): 10% for values greater than 0.5 milligrams per liter (mg/L), if three DO values are less than 0.5 mg/L, consider the values as stabilized;
- Specific Conductance: 3%;
- Temperature: 3%;
- pH: +/- 0.1 unit; and,
- Oxidation-reduction potential (ORP): +/- 10 millivolts.

Prior to sample collection, field parameters will be measured approximately every five minutes in order to assess when the well is adequately purged, and the groundwater conditions have stabilized with the surrounding formation water. Decontamination will be conducted using Alconox as detergent rather than Liquinox. This is due to Liquinox having trace levels of 1,4 Dioxane.

3.3: ANALYTICAL REQUIREMENTS

Groundwater samples will be submitted to Katahdin Analytical Services, a Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) and New York State certified laboratory for 1,4-Dioxane analysis using USEPA Method 8270D-SIM to quantitatively assess the presence or absence of 1,4-Dioxane in groundwater obtained from the Ash Landfill.

Quality Assurance/Quality Control (QA/QC) samples will be collected to monitor accuracy, precision, and the presence of field contamination. QA/QC sample will include equipment blanks (when reusable equipment is used), field duplicates, and matrix spike/matrix spike duplicates (MS/MSDs) (quantities as specified in the QAPP) (**Table 1**). Field water quality parameters will include water temperature, pH, dissolved oxygen, salinity, oxidation-reduction potential, turbidity, and conductivity.

3.4: DATA QUALITY OBJECTIVES

The Parsons (2017a) Final UFP-QAPP was updated (Amendment 1) for this groundwater investigation to ensure environmental data collected are scientifically sound, of known and documented quality, and suitable for their intended purposes. Amendment 1 to the UFP-QAPP (Parsons, 2018a) includes monitoring methods, analytical services, data management and validation procedures, and field and laboratory SOPs.

Project-specific data quality objectives (DQOs) were developed based on the Conceptual Site Model and these are described on **Worksheet #11** of the UFP-QAPP. These DQOs include a design for obtaining data to support the design for sampling for 1,4-Dioxane. The design for obtaining data described in the last column of the DQO tables on **Worksheet #11** summarizes the technical approach. The project approach is described in detail on **Worksheet #17**, and specific analysis are noted on **Worksheet #18**. Performance criteria will be EPA RSLs (**Table 2** and QAPP Addendum Worksheet #15) and if 1,4-Dioxane concentrations exceed the performance criteria, further action will be discussed with the project team.

Table 2 [15.1 in QAPP Addendum] - Project Action Limits and Katahdin Reference Limits for SVOCs in Groundwater (Method SW-846 8270D SIM)

ANALYTE	PROJECT ACTION LIMIT (µG/L) (1)	PAL REFERENCE	ACHIEVABLE LABORATORY LIMITS		
			LOQ (3) (µG/L)	LOD (µG/L)	DL (µG/L)
1,4-Dioxane	0.46	RSL	0.25	0.18	0.085
	0.35	EPA HA (2)			

(1) No NYSDEC value is available. PAL was selected from EPA Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=0.1) May 2018. https://semspub.epa.gov/work/HQ/197235.pdf

(2) The EPA Health Advisory level was provided for informational purposes. EPA risk assessments indicate that the drinking water concentration representing a 1 x 10-6 cancer risk level for 1,4-dioxane is 0.35 µg/L (EPA IRIS 2013). Technical Fact Sheet – 1,4-Dioxane, November 2017. https://www.epa.gov/sites/production/files/2014-03/documents/ffrro_factsheet_contaminant_14-dioxane_january2014_final.pdf

Section 4: Reporting

The results of this groundwater investigation will be documented in a Site Investigation Report/Technical Memorandum. The following components will be addressed:

- Summary of completed field activities;
- Summary of data, including presentation on tables and figures;
- Comparison of sample concentrations to action limits provided in UFP-QAPP, Addendum 1, Worksheet #15;
- Evaluation of contamination and recommendations for future actions.
- The analytical data shall be validated in accordance with EPA and DoD guidance.
    - Analytical data will be provided to NYSDEC as an EDD in NYSDEC format.

References

Brett, C., Baird, G., and Fakundiny, R.H. 1995. Draft Bedrock Geologic Map of the South Onondaga 7.5 Minute Quadrangle, Onondaga County, NY; with engineering geology, groundwater characteristics, and economic potential of bedrock units by Robert H. Fickies. NYSGS Open-File No. 1g1104.

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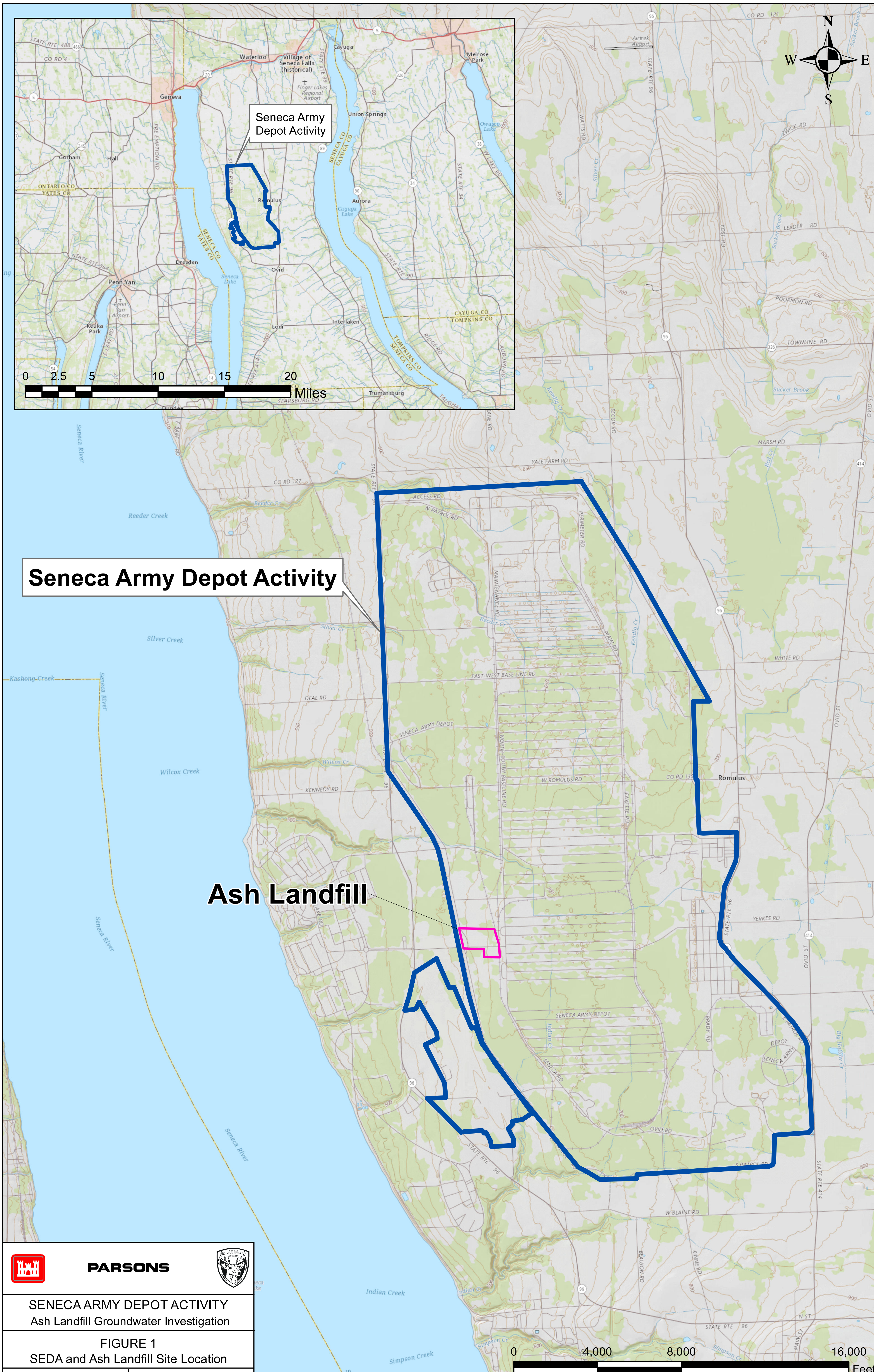
Parsons, 2018a. Draft Addendum 1 to the Final UFP-QAPP. Seneca Army Depot Activity. July 2018.

Parsons, 2018b. Draft Letter Report for the 23rd Round of LTM at the Ash Landfill, Seneca Army Depot Activity. March 2018.

LIST OF FIGURES



SENECA ARMY DEPOT ACTIVITY
Ash Landfill Groundwater Investigation

FIGURE 1
SEDA and Ash Landfill Site Location

1 in = 4,000 ft | August 2018

Path: P:\PIT\Projects\Huntsville WERS\Seneca LTM, TO 23\02 - GIS\AshLandfill\Ash_Site_Location.mxd

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SENECA ARMY DEPOT ACTIVITY

Ash Landfill Groundwater Investigation

FIGURE 3 - Proposed Monitoring Well Network for 1,4-Dioxane Sampling

1 inch = 200 feet	December 2018

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LIST OF APPENDICES

Appendix A – Field Standard Operating Procedures (SOPs)

Procedure # ENV-02	Title: GROUNDWATER SAMPLING	Revision # 01
Effective Date: 11/08/17	**Approved By:** Thomas Mills, PG	**Last Revised:** 11/08/17

1. PURPOSE

The purpose of this SOP is to describe the general methods to be employed when collecting groundwater samples for analysis during munitions response projects. Types of sampling methods include low flow techniques, Hydrasleeve™ sampler, and direct push groundwater sampling (hydropunch). Proper collection procedures are necessary to assure the quality and integrity of the samples.

2. RESPONSIBILITIES

Role	SOP-specific Responsibilities
Project Chemist	Specifies the types and quantities of samples to be collected. Monitors sample collection through communication with project team and field document review to confirm required samples are collected. Coordinates with analytical laboratory during sampling.
Sample Team Leader	Responsible for implementing the sampling activities outlined in the work plan. Ensures required QC and QA samples are collected. Records sample collection on field documentation.
Sample Team Assistant	Assists the Sample Team Leader with sample collection and other sampling activities. The role of Sample Team Assistant may be performed by the accompanying UXO Tech II.
UXO Tech II (or higher)	If explosive hazards are present at the sample location, acts as MEC escort and conducts anomaly avoidance prior to sample collection. May act as Sample Team Assistant.

3. RELEVANT DEFINITIONS

Term	Definition
None	Not applicable.

4. REQUIRED EQUIPMENT

Equipment	Brief Description of Function and Purpose
Sampling tools	_Low flow and direct push groundwater sampling_: Submersible or peristaltic pump, clean tubing, graduated cylinder, purge containers. _Hydrasleeve™ Method_: Hydrasleeve™ sample bags, measured line, and sampler weights.
Sample containers	Bottles as specified in the approved work plan for sample containerization. Coolers for sample shipment.
Logbook	For documentation of the sampling activities.
GPS Unit	To record coordinates of collected sample locations.
Water Level Indicator	To measure depth to static water level and total depth of well.

Procedure # ENV-02	Title: GROUNDWATER SAMPLING	Revision # 01
Effective Date: 11/08/17	**Approved By:** Thomas Mills, PG	**Last Revised:** 11/08/17

Equipment	Brief Description of Function and Purpose
Water Quality Meter	To measure water quality parameters: Temperature, pH, conductivity, turbidity, DO, and ORP or as specified in the approved work plan.
Photo-ionization Detector (PID)	To measure volatile compounds at the wellhead.

5. PROCEDURE

5.1. Health and Safety

All elements of this procedure will be conducted in accordance with the approved site safety and health plan, including but not limited to specified requirements for training, personal protective equipment (PPE), exposure monitoring and air sampling, etc. The UXOSO or designated representative will review the relevant site-specific activity hazard analyses (AHAs) prior to implementing this SOP.

5.2. General Requirements for all Sample Methods

5.2.1. Documentation

The Sample Team Leader or designee shall record the description of sample locations, soil type, and any other relevant or notable details in the Field Sampling Logbook and/or on project-specific sampling forms. The Sample Team Leader or designee shall also record the sample locations using a global positioning system (GPS) unit (e.g., Trimble® GeoXT™ or similar) and document sample coordinates in the Field Sampling Logbook. The Sample Team Leader or designee shall record other information as specified in the approved work plan, including completion of a Daily Quality Control (QC) Report (DQCR) on any day that samples are collected.

5.2.2. Sampling Handling and Shipment

5.2.2.1. The Sample Team Leader is responsible for ensuring samples are packaged and shipped to the analytical laboratories in accordance with the approved work plan. Methods to be used for sample handling and shipment are described in the approved work plan. The Sample Team Leader or designee shall document sample details on the chain-of-custody (CoC) form. The completed CoC form will be included with the shipped sample(s).

5.2.2.2. Sample purge water and equipment decontamination water may be required to be containerized as investigation-derived waste (IDW) and analyzed. The Sample Team Leader will review the requirements in the Waste Management Plan (included as a part of the work plan) for chemical analysis and proper disposal of IDW.

5.2.3. Field Instrument Calibration and Sample Analysis

5.2.3.1. When groundwater samples are being collected, the water quality meter and dissolved oxygen (DO) sensor will be checked at the beginning of each day. The Sample Team Leader or designee shall bump check the water quality meter to ensure the sensors are within 5 percent of the calibration standards (or as specified in the work plan) for: pH 4, pH 7, pH 10, Zobell's ORP Solution (or similar), Turbidity 0 NTUs and Conductivity Standard 1413µS. The Sample Team Leader or designee shall also bump check the DO sensor in a sodium sulfite solution to ensure the sensor is reading less than 0.1 mg/L of oxygen in the zero oxygen solution. If any parameter is outside 5 percent, that parameter will be calibrated and checked again.

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Effective Date: 11/08/17	**Approved By:** Thomas Mills, PG	**Last Revised:** 11/08/17

5.2.3.2. If specified in the work plan, the photo ionization detector (PID) will be used to screen the breathing zone around the open well casing. Air monitoring data shall be recorded on a field form or in the field notebook.

5.2.3.3. Collected groundwater samples shall be analyzed in the field and/or at the analytical laboratory as described in the approved work plan. The Sample Team Leader or designee shall collect the quantities and types of Quality Assurance (QA)/QC samples specified in the approved work plan to ensure proper QC review of each sampling event.

5.2.4. Anomaly Avoidance

If munitions and explosives of concern (MEC) hazards are present at the proposed sample location, a MEC Escort will practice anomaly avoidance in accordance with **SOP MEC-03, MEC Avoidance and Escort** before sample collection from non-existing wells (e.g., groundwater samples collected using Hydropunch). Once the proposed location has been cleared for subsurface anomalies, the sample can be advanced. Down-hole anomaly avoidance shall also be practiced as described in **SOP MEC-03, MEC Avoidance and Escort**. If a subsurface anomaly is detected at the planned sample location, the sample location will be moved to a nearby alternative point and the process will be repeated until a suitable sample location is found. The Sample Team Leader or designee shall record sampling locations that are moved from those proposed in the work plan in the Field Sampling Logbook, along with a brief explanation.

5.3. Sampling Methods for Groundwater

5.3.1. General Preparatory Steps for Groundwater Sampling

The following general steps shall be completed when preparing for collection of groundwater samples:

1. The Sample Team Leader shall review the applicable section(s) of the work plan to confirm the sample location, quantities, required sample containers, and other relevant information.
2. The Sample Team will navigate to the sample location, make initial observations, and complete the required documentation (see Section 5.2.1).
3. The Sample Team shall don clean gloves before each sampling event.
4. The Sample Team shall assemble the necessary sampling equipment and supplies, sample containers, decontamination materials, etc. in the sampling area. If on-site decontamination is required, arrange the necessary supplies in a nearby but separate location, away from the wellhead. All equipment entering the well shall be decontaminated.
5. The Sample Team shall calibrate required equipment and document the calibration on an equipment calibration form.

5.3.2. Low Flow Techniques for Groundwater

5.3.2.1. This sampling method is designed to ensure that a representative groundwater sample is collected while minimizing the volume of purge water generated. This method dictates that pre-sample purging (the removal of standing water from a well and filter pack immediately prior to sample collection) be done at very low flow rates. Low flow purging and sampling involves the use of a submerged or peristaltic pump that can be adjusted to deliver ground water to the surface at rates from less than 100 ml per minute to a maximum of 1 liter per minute. The purpose of this technique is the recovery of representative samples of the water from the soil formation adjacent to the well screen. Stagnant water above the screen and below will not usually be purged or sampled. The technique eliminates the need for collection and costly disposal of several well volumes of groundwater as investigative derived waste (IDW) from wells containing contaminated water.

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5.3.2.2. During low flow purging and sampling the pump intake is placed within the lower depths of the screened interval and the water pumped from the well is monitored for a number of water quality parameters using a flow through cell and field instrumentation. The water level will also be monitored to ensure that draw down is kept to a minimum as specified in the approved work plan. Sampling commences when the measured parameters have stabilized and turbidity is at an acceptable and constant level. Specific procedure for conducting groundwater sampling using low flow techniques are as follows:

5.3.2.3. Preparation: The steps listed in Section 5.3.1 shall be completed prior to sample collection using low flow methods.

5.3.2.4. Groundwater Sampling: Following the preparatory actions described above, the Sample Team shall complete the following steps to collect low flow groundwater samples:

1. Open well and measure depth to static water level and total depth of the well using an electronic water level meter. Record these measurements into the project specific log or electronic form or application.
2. Lower pump slowly into the well to a depth a couple feet above the bottom of the well screen.
3. Allow water column to equilibrate then measure static water level again, use this measurement as the reference point for drawdown.
4. Begin purging the well. Using a graduated cylinder, establish the maximum flow rate that does not cause drawdown of the well (commonly a rate between 100ml and 300ml per minute) or as specified in the approved work plan.
5. Connect tubing through the water quality meter, record initial water quality parameters, then continue recording readings every 3 to 5 minutes, or as specified in the approved work plan. If using an electronic form or groundwater sampling application (e.g. In-Situ low flow test) ensure all required information has been entered prior to starting the flow to the meter.
6. Monitor groundwater parameters as listed below or as specified in approved work plan. The well will be considered properly purged when all measured parameters have stabilized. Stabilization requirements will be specified in the approved work plan or as listed below:

(a)	pH:	± 0.2 pH units
(b)	Conductivity:	± 3% of reading
(c)	Dissolved Oxygen:	± 10% or reading or ± 0.2 mg/l, whichever is greater
(d)	Eh or ORP:	± 20 mV
(e)	Turbidity:	± 10% prior reading or ± 1.0 NTU
(f)	Temperature:	+/- 1ºC

7. Pumping wells dry will be avoided whenever practicable; however, if a well is pumped dry at the lowest consistent flow rate the sampler can establish, then the well is considered properly purged regardless of monitored groundwater parameters. In this case, groundwater samples will be collected when 80% of the initial well water volume is recharged.
8. Arrange the sample containers in the order of use. VOCs first, if required, SVOCs second, if required followed by all other samples.
9. Label each sample container with sample ID, date, time, analysis, and other information required on the sample label. Immediately place the filled containers in the coolers(s) on ice.
10. Record sample types, amounts collected, time, and date of collection in the field logbook and on the monitoring well purge and sample log (**Exhibit 1**).
11. Perform post-sampling activities (Section 5.3.5).

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5.3.3. Hydrasleeve™

5.3.3.1. The HydraSleeve™ groundwater sampling device is designed to collect a representative groundwater sample from a well while eliminating the need to purge the well. The sample is collected from a specific depth within the screened interval of the well without mixing fluid from other depth intervals. Because the HydraSleeve™ sampler does not require purging, field measurements of groundwater parameters (e.g., temperature, pH, conductivity, etc.), normally taken during purge sampling, are not required to evaluate whether the groundwater parameters have stabilized prior to sampling. However, verify in the approved work plan that measuring and recording of water quality parameters are not required when sampling with the HydraSleeve™.

5.3.3.2. The displacement of well water caused by placement of a single HydraSleeve™ sampler is minimal (<100 milliliters). Because the sampler does not disturb the water column significantly, long equilibrations times following insertion of the sampler into the well are generally unnecessary. To obtain a groundwater sample, the HydraSleeve™ is pulled upward on the suspension line through the zone of interest, which causes water to enter the one-way check valve and fill the sampler.

5.3.3.3. Preparation: The steps listed in Section 5.3.1 shall be completed prior to sample collection using low flow methods. The following additional preparatory steps shall be completed:

1. Determine the depth interval at which the HydraSleeve™ sampler will be placed for each sampled well. Review the HydraSleeve™ manufacturer's SOP for helpful information.
2. Verify the HydraSleeve™ sampler selected will be capable of collecting the sufficient volume of groundwater required for the laboratory for analysis at each well.

5.3.3.4. Groundwater Sampling: Following the preparatory actions described above, the Sample Team shall complete the following steps to collect HydraSleeve™ groundwater samples:

1. Open well and measure depth to water level and total depth of the well using an electronic water level meter. Record these measurements into the project specific log or electronic form.
2. Attach the measured line to the top and a weight to the bottom of the empty sampler and slowly lower the assembly into the well. Avoid any rapid upward movements to prevent water accidently filling the sleeve from the incorrect depth interval.
3. The assembly should be designed to stop on the bottom of the well with the top of the HydraSleeve™ just below the zone intended to be sampled (generally the screened portion of the well).
4. Document in detail the specifics of each well assemble so future sampling can replicate the event.
5. After the HydraSleeve™ sampler has been placed in the well, secure the tether at the wellhead ensuring the HydraSleeve™ sampler in the well is not moved or disturbed.
6. Check and record the depth to water in the well. If needed, allow time for the water level in the well to recover to within approximately 10-percent or less of the depth to water as was measured prior to sampler placement.
7. For sample recovery, the HydraSleeve™ sampler will be activated by gripping the tether at the wellhead, keeping the tether taught, and in one smooth motion, pull the sampler upward at a constant rate of 1 to 2 feet of rise per second through the zone of interest (or well screen). This action must be done as one movement, without stopping, over the length of the sample interval desired.
8. If insufficient sample volume is collected when the HydraSleeve™ is retrieved, a new HydraSleeve™ will be deployed and the procedure will be repeated.
9. To transfer a sample from the HydraSleeve™ with the least amount of aeration and agitation, use the short discharge tube included with the sampler.

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(a) First, squeeze the full sampler just below the top to expel water above the flexible reed-valve.
(b) Then push the pointed discharge tube through the outer polyethylene sleeve about 3-4 inches below the white reinforcing strips. Discharge the sample into the sample containers.
(c) Raising and lowering the bottom of the sampler or pinching the sample sleeve just below the discharge tube will control the flow of the sample. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube.

10. Arrange the sample containers in the order of use. VOCs first, if required, SVOCs second, if required, followed by all other samples.
11. Label each sample container with sample ID, date, time, analysis, and other information required on the sample label. Immediately place the filled containers in the coolers(s) on ice.
12. Record sample types, amounts collected, time, and date of collection in the field logbook and on the monitoring well purge and sample log (**Exhibit 1**).
13. Perform post-sampling activities (Section 5.3.5).

5.3.4. Direct Push Groundwater Sampling

5.3.4.1. The direct push groundwater sampling method (also referred to as Hydropunch) is used to acquire groundwater samples from the most permeable zones (sand and gravel layers and lenses) at lower costs than the drilling and installation of groundwater monitoring wells. Chemical analysis of the groundwater samples will provide information about the distribution of contamination and can aid in effectively locating permanent monitoring wells at the site. The techniques are intended to provide the following information:

- Confirmation of potentially contaminated source areas identified during previous studies.
- Groundwater data downgradient of suspected contaminant sources.

5.3.4.2. Preparation: The steps listed in Section 5.3.1 shall be completed prior to sample collection using low flow methods. The following additional preparatory steps shall be completed:

1. The Sample Team Leader will obtain any necessary excavation permits and, if necessary, contact a local underground utility locating service to perform a utility clearance for all borehole locations.
2. If MEC hazards are present, the MEC Escort shall practice anomaly avoidance (see Section 5.2.4).

5.3.4.3. Groundwater Sampling: Following the preparatory actions described above, the Sample Team shall complete the following steps to collect Hydropunch groundwater samples:

1. Hydropunch groundwater samples will be collected using a Geoprobe® or similar direct push drill rig operated by an appropriately licensed driller.
2. The driller will assemble the groundwater sampling device:

   (a) The sampling device will consist of a 52-inch rod with 1.5 inch outside diameter (OD) and alloy steel encasing a stainless steel screen (1–inch OD and 0.004–-inch slot opening).
   (b) An expendable drive point is placed in the lower end of the sampler sheath while a drive head is attached to the top.
   (c) Alternate sampling equipment may be utilized based on direct push equipment in use.

3. The driller will thread the groundwater sampler onto the leading end of the probe rod and drive into the surface with the direct push rig, adding probe rods as needed until the target sample depth is reached

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4. The driller will then use extension rods with a screen push adapter to release the expendable point breaking the seal and allowing water to fill through the screen and into the sampler.
5. The tool string and sheath may be retracted the full length of the screen or as little as a few inches if a small sampling interval is required.
6. Groundwater samples are obtained with a peristaltic pump using 0.25–inch OD polyethylene tubing down the probe rod string into the stainless steel screen and pumping the water to the surface. A bailer may be used for retrieving groundwater from depths greater than 25 feet.
7. If the sample water is muddy, purging of the well may be conducted to attempt to get a less turbid sample. Verify in the approved work plan if purge water needs to be containerized and treated as IDW.
8. Collected Groundwater directly into laboratory provided sample containers. Measure and record water quality parameters if required by the approved work plan.
9. Arrange the sample containers in the order of use. VOCs first, if required, SVOCs second, if required, followed by all other samples.
10. Label each sample container with sample ID, date, time, analysis, and other information required on the sample label. Immediately place the filled containers in the coolers(s) on ice.
11. Record sample types, amounts collected, time, and date of collection in the field logbook and on the monitoring well purge and sample log (**Exhibit 1**).
12. Hole abandonment will consist of filling the bore hole with bentonite product or grout. If the bore hole collapses during the removal of the rods the remainder of the open hole will be grouted to ground surface.
13. Perform post-sampling activities (Section 5.3.5).

5.3.5. Post Sampling Activities for Groundwater Sampling

The following steps shall be completed once groundwater sample collection is complete:

1. The Sample Team Leader or designee will confirm the required samples have been collected, including necessary QC samples as specified in the approved work plan.
2. The Sample Team Leader or designee shall record the sample location GPS coordinates.
3. The Sample Team will decontaminate reusable sampling equipment as described in Section 5.4 or as specified in the approved work plan.
4. The Sample Team Leader or designee shall complete the CoC and other required documentation (see Section 5.2.1) and prepare the sample for shipment (see Section 5.2.2). *One trip blank per cooler is required if groundwater is to be analyzed for VOCs*. Trip blanks will be supplied by the laboratory and will be analyzed only for VOCs. Other QC samples will be collected as specified in the approved work plan.

5.4. Sampling Equipment Decontamination

5.4.1 Disposable equipment shall be used wherever possible to limit the potential of cross-contamination. However, if reusable equipment is used (e.g. direct push tooling or cutting shoes), unless otherwise specified in the approved work plan, sampling equipment will be decontaminated using the following process:

1. Decontamination shall be conducted in an uncontaminated area free of dust.
2. Wash equipment with tap/potable water and laboratory-grade detergent (Alconox™ only). A scrub brush will be used to remove any dirt and/or surface film.
3. Rinse equipment thoroughly with tap water.
4. Rinse equipment thoroughly with ASTM Type II water.
5. Remove excess water and allow equipment to dry.
6. Wrap equipment in aluminum foil, shiny side out.

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5.4.2 If required by the Waste Management Plan in the approved work plan, sampling equipment decontamination water shall be containerized for subsequent chemical analysis and for proper disposal of decontamination water. Equipment blanks shall be collected as specified in the approved work plan.

6. REFERENCES

Reference Title (Author)	Brief summary of relevance to this procedure
ASTM Practice D 6771-02 :Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations. American Society for Testing and Materials, February 2002.	This practice covers the method for purging and sampling wells and devices used for ground-water quality investigations and monitoring programs known as low-flow purging and sampling.

7. EXHIBITS

Exhibit 1: Low-Flow Groundwater Purge and Sample Log

Exhibit 2: HydraSleeve™ Sample Log

Exhibit 3: Direct Push (Hydropunch) Groundwater Sample Log

8. REVISION HISTORY

Rev.	Date	Summary of Changes	Reason for Revision
00	02/18/15	Initial Release	n/a
01	11/08/17	Clarification to low flow sampling techniques (Section 5.3.2.4, Steps 5-7); minor text corrections	Periodic review

EXHIBIT 1

LOW-FLOW GROUNDWATER PURGE AND SAMPLE LOG

Project No.:	Site ID:	
Installation:	Log Book No.	Pages:
Contractor:	Sampler(s)	
Purge Start Date: / / Time:	Purge End Date: / / Time:	
Weather: Wind mph Precipitation:	Air Temperature: °F	
Well Labeled: Y/N [ ] Well Secure: Y/N [ ]	Comments:	
PID SN:	Well Headspace (PID mu) Odor	
Water Level Instrument:	Serial No.:	
SWL beginning (BTOC):	WL After pump install (BTOC):	Max Drawdown (inches):
Well Casing 2” 4” 6” Other:	Borehole diameter:	Sandpack length (L): ft.
Screen Length:	Parameters Measured With:	
Water Column height (h): ft.	Total Purge Vol. Gallons	
Purge Method:	Max Purge Rate: L/min	Sampling Flow Rate: mL/min
Pump Type: Pump Vol.:	Tubing Material:	Vol./ft: Total ft.:
Flow-Through Cell Vol.:	Total Pump + Tubing + Cell Vol.:	
Casing radius:______(in)/12 = ______ **r** (decimal ft)	Borehole radius:_____(in)/12 = _____ r (decimal ft)	
Well Casing Vol. = 3.14 x **r**(______)^2 x h(______) x 7.48 (conversion from ft^3 to gal.) = gallons		
Sandpack Vol. = 3.14 x r(_____)^2 x L(_____) x 7.48 – Well Casing Vol.(_____above) x 0.3 = gallons		
Total Well Vol. = Well Casing Vol. (______above) + Sandpack Vol. (______above) = gallons		
Depth of pump inlet (BTOC) and rational:		

PURGE CYCLE

Actual Time	Elapsed Time	Volume Purged (gals)	Depth to Water (ft)	Depth of Pump Intake (ft)	Temp (°F)	pH	DO	ORP mV	Conductivity (µmhos/cm)	TDS ppm	Turbidity (NTU)	Comments

SAMPLE

Actual Time	Elapsed Time	Volume Purged (gals)	Depth to Water (ft)	Depth of Pump Intake (ft)	Temp (°F)	pH	DO	ORP mV	Conductivity (µmhos/cm)	TDS ppm	Turbidity (NTU)	VOC Collection Flow Rate

Sample Type:	Sample No.	
Sample Equipment	Sample Filtered: Yes [ ] No [ ]	Filter Type/Size:
Equipment Rinsate Sample No.:	Sample Equipment Decon: Date: by:	
Comments:		
Discharge Water Disposition:	Drum Number:	
Prepared by: Date: / /	Reviewed by: Date: / /	

PURGE CYCLE (CONTINUED)

Actual Time	Elapsed Time	Volume Purged (gals)	Depth to Water (ft)	Depth of Pump Intake (ft)	Temp (°F)	pH	DO	ORP mV	Conductivity (µmhos/cm)	TDS ppm	Turbidity (NTU)	Comments

EXHIBIT 2

HYDRASLEEVE SAMPLE LOG

HYDRASLEEVE DEPLOYMENT

Project No.:	Well LOCID:	
Installation:	Log Book No.	Pages:
Contractor:	Sampler(s):	
HS Deployment Date: / / Time:	Weather: Wind Dir: , at ~___mph; Air Temp: °F	
Well Labeled: Y/N [ ] Well Secure: Y/N [ ]	Comments:	
PID SN:	Well Headspace (PID mu): Odor:	
Water Level Instrument:	Serial No.:	
SWL (ft BTOC):	Measured Well Depth (ft BTOC):	Reported Well Depth (ft BTOC):
Sediment Thickness (ft):	Number of Hydrasleeves deployed in well:	Tether Line Material: ☐Polypropylene Rope ☐Stainless steel
Type of Tether Weight:	Total Weight used (oz.):	
Sleeve bag length (in):	HS bag volume (ml):	Depth to top of sleeve (ft BTOC):
Bottom Weighted: Y/N [ ]	Top Weighted: Y/N [ ]	

HYDRASLEEVE RETRIEVAL AND SAMPLE

Well LOCID:	Hydrasleeve Retrieval Date:	Retrieval Time:
Log Book No.	Pages:	
Was ALL Deployed Equipment Retrieved (Line, Bags, Weights): Y/N [ ] if NO, Explain:		
Comments on Well and Hydrasleeve Tether Assembly Condition:		
Weather: Wind Dir: , at ~______mph; Precipitation:	Air Temperature: °F	
Sample No. (FIELDSAMPID):	Sample Date: / /	Sample Time:
Sampler (s):	Sample Beg. Depth (ft BTOC):	Sample Ending Depth (ft BTOC):
Sample Collection Method: ☐Discharge Tube ☐Other (explain):		
Approximate Volume of Excess Sample Water After Sampling (ml):		
Excess Sample Water Placed in Container: Y/N [ ]	Container Number:	
SWL Following Sampling (ft BTOC):	Sample Equipment Decon Date: by:	
Decon Water Placed in Drum: Y/N [ ]	Drum Number:	
Prepared by: Date: / /	Reviewed by: Date: / /	

EXHIBIT 3

DIRECT PUSH (Hydropunch) GROUNDWATER SAMPLE LOG

Sample ID:	Page 1 of ____	
Project:	SWMU: Nearest IDF:	
Installation:	Log Book No.:	Log Book Pages:
Contractor:	Sampler Name:	
Direct Push Subcontractor:	Driller Name:	
Drill Start Date: / / Drill Start Time:	Drill End Date: / / Time:	
Sample Date: / / Sample Time:	Water Parameters Measured : YES NO	
Sample Depth (Ft BGS):	Approx Depth to Water (Ft BGS):	
Sample Method: Peristaltic Pump Bailing Other______________________________		
Purge Water Disposition IDW Drum No.:		

WATER PARAMETERS

Time	Volume Removed (gal.)	Turbidity (NTUs)	Clarity/Color	DO (mg/l)	ORP (mV)	Temp. (ºC)	pH	CONDUCTIVITY (mS/cm)	Remarks:

Water Quality Meter	Turbidity Meter
Type/Model:	Type/Model:
Serial No. :	Serial No. :
Calibration Date: / /	Calibration Date: / /

NOTES/REMARKS

Procedure # ENV-04	Title: MONITORING WELL DEVELOPMENT	Revision # 00
Effective Date: 02/18/15	**Approved By:** Thomas Mills, PG	**Last Reviewed/Revised:** 02/18/15

1. PURPOSE

The purpose of this SOP is to describe the general methods to be employed when developing monitoring wells prior to groundwater sample collection. Proper development procedures are necessary to assure the quality and integrity of the samples.

2. RESPONSIBILITIES

Role	SOP-specific Responsibilities
Site Manager	Responsible for ensuring that the work is performed in conformance with this procedure and that the field personnel understand and perform activities in accordance with this SOP.
Field Geologist or Environmental Scientist	Responsible for continuous monitoring of development activities, collecting water quality data and determining that the development is complete.

3. RELEVANT DEFINITIONS

Term	Definition
None	Not applicable.

4. REQUIRED EQUIPMENT

Equipment	Brief Description of Function and Purpose
Development Tools	Submersible pump, bailer, and surge block /swabbing tool.
Logbook	For documentation of the sampling activities.
GPS Unit	To record coordinates of collected sample locations.
Water Level Indicator	To measure depth to static water level and total depth of well.
Water Quality Meter	To measure water quality parameters: Temperature, pH, conductivity, turbidity, DO, and ORP or as specified in the approved work plan.
Photo-ionization Detector (PID)	To measure volatile compounds at the wellhead.

Procedure # ENV-04	Title: MONITORING WELL DEVELOPMENT	Revision # 00
Effective Date: 02/18/15	**Approved By:** Thomas Mills, PG	**Last Reviewed/Revised:** 02/18/15

5. PROCEDURE

5.1. Health and Safety

All elements of this procedure will be conducted in accordance with the approved site safety and health plan, including but not limited to specified requirements for training, personal protective equipment (PPE), exposure monitoring and air sampling, etc. The UXOSO or designated representative will review the relevant site-specific activity hazard analyses (AHAs) prior to implementing this SOP.

5.2. General Requirements

5.2.1. Documentation

5.2.1.1. The Field Geologist or designee shall complete the attached well development log (**Exhibit 1**) or project-specific form. Information to document includes:

- Total depth of well and the static water level from top of the well casing, before and immediately after pumping/development.
- Method used for well development including description (size, type, make, etc.) of all equipment used during development.
- Time spent developing the wells by each method and typical pumping rate(s).
- Volume and physical characteristics of the purged water including written descriptions of water clarity, color, particulates, and odor.
- Readings of turbidity, pH, conductivity, and temperature taken before, during, and after well development.

5.2.1.2. The Field Geologist or designee shall record daily activities, instrument bump check and/or calibration activities, groundwater parameters, and any other notable details in the Field Sampling Logbook and/or project specific forms. The Field Geologist or designee shall also record the sample locations using a GPS unit (e.g., Trimble® GeoXT™ or similar) and document sample coordinates in the Field Sampling Logbook. The Field Geologist or designee shall record other information as specified in the approved work plan.

5.3. Well Development

Monitoring wells are developed to remove or minimize the near-well-bore formation damage caused by drilling and the addition of well drilling fluids, and to remove fines from the filter pack. New wells shall not be developed for 48 hours after completion when a cement bentonite grout is used to seal the annular space, but shall be developed within seven days of well installation or as otherwise specified in the approved work plan.

5.3.1. Preparation for Well Development

The following steps shall be completed when preparing for well development:

1. The Field Geologist shall review the applicable section(s) of the work plan to confirm the details of the activity to be conducted.
2. The Field Team shall don clean gloves before each sample.
3. The Field Team shall calibrate all necessary equipment and document the calibration(s) on an equipment calibration form.
4. The Field Team shall arrange the required sampling equipment for convenient use. If onsite decontamination is required, arrange the necessary supplies in a nearby but separate location, away from the wellhead. All equipment entering the well will be decontaminated.

5.4. Well Development

The following steps shall be completed when during well development:

1. Open well and collect PID reading (if required in approved work plan). Measure depth to static water level and total depth of the well using an electronic water level meter. Record these measurements into the project specific log or electronic form or application.
2. Calculate five well volumes of standing water in the well bore using the following:
   (a) **4-inch diameter wells:** well bore water column height (ft.) x 0.65 x 5 (volumes) = gallons of water to be removed.
   (b) **2-inch diameter wells:** well bore water column height (ft.) x 0.16 x 5 (volumes) = gallons of water to be removed.
   (c) **Volume of water in the filter pack:** 5 volumes x well bore column water height (ft.) x (R12-R22) x 3.14 x .3, where R1 is the borehole radius and R2 is the well screen radius. This assumes 30 percent porosity.
   (d) **If water was added during the drilling process:** 5 times the volume of water added should be removed from the well during development.
   (e) **If the filter pack was installed as a slurry:** five times the amount of water used in the slurry should be removed from the well.
   (f) All calculations shall be recorded on the well development log.
3. If light non-aqueous phase liquids (LNAPLs) are suspected, use a clear bailer to collect water from the surface of the well. If the well contains LNAPL, measure and record it using an oil-water interface meter. The monitoring well will not be developed if separate phase liquids are present.
4. Begin development by bailing, and swabbing (using a loose fitting surge block) to surge the water to pull sediment into the well.
5. Use a bottom-opening bailer to remove water and to reduce the turbidity level. Once turbidity level has been lowered to an appropriate level begin pumping using a submersible pump.
6. Start the pumping from the bottom of the well, but periodically move it up and down within the screened zone to ensure adequate development of the entire filter pack. Keep the pumping rate constant and record and collect drawdown measurements.
7. Record water quality parameters (temperature, pH, conductivity, and turbidity or as specified the work plan) at the start of the development and after every borehole volume removed from the well.
8. Continue development until the water is clear (turbidity ≤10 NTUs) or three consecutive turbidity readings are within 10% and the other field parameters (temperature, pH, and conductivity) have stabilized (pH ±0.2 units, temperature± 1º Centigrade, and conductivity 10%).
9. If field parameters have not stabilized after five borehole volumes of water have been removed, the Field Geologist will contact the Site Manager to determine further action.
10. Record the final water level, and note the drawdown rate and pumping rate used. If static water level not recovered to the initial water level, another static water level measurement should be collected in 24 hours.

5.4.2. Post Development Activities

The following steps shall be completed once well development is complete:

1. The Field Team Leader or designee shall close and lock the well.
2. The Field Team Leader or designee shall properly store and label purge water, and record the total volume removed from the well during development.

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3. The Field Team Leader or designee shall decontaminate reusable equipment following procedures outlined in Section 5.5 or as specified in the approved work plan.

5.5. Equipment Decontamination

5.5.1 Disposable equipment shall be used wherever possible to limit the potential of cross-contamination. However, if reusable equipment is used, unless otherwise specified in the approved work plan, equipment will be decontaminated using the following process:

1. Wash equipment with tap/potable water and laboratory-grade detergent (e.g., Alconox™). A scrub brush will be used to remove any dirt and/or surface film.
2. Rinse equipment thoroughly with tap water.
3. Rinse equipment thoroughly with ASTM Type II water.
4. Remove excess water and allow equipment to dry.
5. Wrap equipment in aluminum foil, shiny side out.

5.5.2 If required by the Waste Management Plan in the approved work plan, sampling equipment decontamination water shall be containerized for subsequent chemical analysis and for proper disposal of decontamination water. Equipment blanks shall be collected as specified in the approved work plan.

6. REFERENCES

Reference Title (Author)	Brief summary of relevance to this procedure
None.	Not applicable.

7. EXHIBITS

Exhibit 1: Well Development Log

8. REVISION HISTORY

Rev.	Date	Summary of Changes	Reason for Revision
00	02/18/15	Initial Release	n/a

WELL DEVELOPMENT LOG

Site ID:	Well No.:		Page 1 of 2
Installation: Seneca Army Depot		Location:	
Project No.:	Client/Project:		
Development Subcontractor:		Drillers:	
Start Date:	Completion Date:	Casing Dia.: 4 inch	Dev. Rig:
Developed by:	Log Book No.:	Pages:	Well Vol.:

Development method:

- Bailing
- Surging
- Bailing
- Pumping

Equipment:

- SMEAL development rig
- 10 foot long, 3.5 inch diameter stainless steel 3 gallon bailer
- Loose fitting surge block with a rubber disc
- 3 inch grundfose pump
- Solinist 500 foot water level meter / model 101 #

Date Stabilized Groundwater Depth Measured: ________/_______/_______. Pre-Dev. SWL ______________ ft.
Pre-Dev Total Depth ____________ ft. Post-Dev. SWL: _____________ ft. Post-Dev. Total Well Depth: ____________ ft.
Silt Removed: __________ inches. Range and average discharge rate: ________________ gpm.
Total quantity of water removed: ___________ gals. Maximum drawdown during pumping _______ ft. at ______ gpm.
Disposition of discharged water:

Purge Data

Total depth __________ - Depth to water ______________ = Column Height (ft.)_____________ x Gal/ft *______ = Well Volume __________ + Water Added ____________ = _________ x Number of Volumes to be purged __________ = Required purge Volume _________. Actual purge Volume ________

* PURGE CALCULATIONS: π(BOREHOLE RADIUS^2)- π(WELL RADIUS^2)

9-inch ID borehole with 4.5-inch ID well = 2.47 gallons / foot

Time	Volume Removed (gal.)	Water Level (ft TOC)	Turbidity (NTUs)	Clarity/ Color	DO mg/l	ORP mV	Temp. ºC	pH	Conductivity (mS/cm)	Remarks:

Calibration: Date / Time /

Water quality meter: YSI 556 / #16512

Ph: 7.00 / 4.00 / Conductivity: 1.413 mS/cm / ORP : 240 mV /

Turbidity meter: Hach 2100p 800 NTUs / 100 NTUs / 20 NTUs / <0.1 NTUS /

WELL DEVELOPMENT LOG (CONT.)

Site ID:	Well No.:	Page 2 of 2
Installation: Seneca Army Depot	Location: Sanitary Waste Landfill	

Time	Volume Removed (gal.)	Water Level (ft TOC)	Turbidity	Clarity/ Color	D.O. mg/l	ORP mV	Temp. ºC	pH (.)	Conductivity (mS/cm)	Remarks:

COMMENTS: ____

____

____

____

____

____

____

Appendix B – Historical Aerial Photo

SENECA ARMY DEPOT ACTIVITY
Ash Landfill Groundwater Investigation

FIGURE B1 - Ash Landfill
Historical (April 1969) Aerial Photo

1 in = 200 ft	December 2018

Path: P:\PIT\Projects\Huntsville WERS\Seneca LTM, TO 23\02 - GIS\AshLandfill\1_4_Dioxane\Appendix B1_Ash_Hist_Aerial.mxd

Appendix C – Response to Comments

U. S. ARMY ENGINEERING AND SUPPORT CENTER - HUNTSVILLE

CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

Draft 1,4 Dioxane Work Plan_ Aug 2018

- ☐ SITE DEV & GEO
- ■ ENVIR PROT& UTIL
- ☐ ARCHITECTURAL
- ☐ STRUCTURAL
- ☐ MECHANICAL
- ☐ MFG TECHNOLOGY
- ☐ ELECTRICAL
- ☐ INST & CONTROLS
- ☐ SAFETY
- ☐ ADV TECH
- ☐ ESTIMATING
- ☐ SPECIFICATIONS
- ☐ SYSTEMS ENG
- ☐ VALUE ENG
- ☐ OTHER

REVIEW: Draft
DATE: 08 Nov 2018
NAME: Bob Morse, EPA

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.	Section 2.1	Section 2.1 indicates that the Ash Landfill is composed of five (5) historic SWMU's, including the Non-Combustible Fill Landfill. Suggest adding monitoring well MW-60, which is located within the vicinity of the Non-Combustible Fill Landfill to the sampling event for this investigation. In addition, any wells installed to monitor specific SWMU impacts should be added to this sampling event.	Monitoring well MW-60 was added to the list of wells to be sampled. Figure 3 and workplan text was updated to include MW-60 where relevant.
2.	Section 3.1	Section 3.1 indicates that one round of sampling will be conducted at eight (8) existing MWs within the upper overburden aquifer. Are there any wells installed into the bedrock aquifer? If yes, then suggest sampling any deep wells.	Deeper, bedrock wells were removed after the Remedial Investigation at Ash Landfill. Paired well vertical connection tests conducted during the RI indicated that there was a very small drawdown in the shallow wells screening in the till/weather shale when water was purged from their respective paired deep wells screened in the competent shale. During vertical connection tests at well clusters, it was determined that the vertical connection between wells within the competent shale aquifer was greater than the connection between the till/weathered shale and competent shale aquifers. The results indicated that the till/weathered shale is connected, although not significantly, to the competent shale aquifer below it. The conclusion of the RI was that this poor connection may be the result of bedding plane fractures and joints which are tightly packed with silt and clay in the upper portions of the shale aquifer.
3.	Section 3.1	Section 3.1 indicates that the GW samples will be collected from eight (8) existing wells due to their location within the former chlorinated solvent plume. Suggest also looking at current and historical data for elevated 1,1,1 TCA concentrations to evaluate possible 1,4 dioxane detections. Wells that exhibit or exhibited elevated 1,1,1 TCA	The historical concentrations were reviewed and five detections of 1,1,1 TCA were noted. Four of the detections were estimated and occurred in well MWT-24 in Rounds 1, 2, 6, and 8 of LTM. The fifth detection exceeded the applicable screening level and was observed

ACTION CODES
A - ACCEPTED/CONCUR
D - ACTION DEFERRED
W - WITHDRAWN
N - NON-CONCUR
VE - VE POTENTIAL/VEP ATTACHED

CEHND FORM 7 (Revised)
15 Apr 89

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

U. S. ARMY ENGINEERING AND SUPPORT CENTER - HUNTSVILLE | CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

Draft 1,4 Dioxane Work Plan_ Aug 2018

☐ SITE DEV & GEO
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☐ INST & CONTROLS
☐ SAFETY
☐ ADV TECH
☐ ESTIMATING
☐ SPECIFICATIONS
☐ SYSTEMS ENG
☐ VALUE ENG
☐ OTHER

REVIEW: Draft
DATE: 08 Nov 2018
NAME: Bob Morse, EPA

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
		concentrations should be added to this investigation to confirm the possible presence of 1,4 dioxane.	at PT-18A in Round 11. Both of these wells, MWT-24 and PT18A, are included in the work plan as proposed wells for 1,4-dioxane sampling.
4.			

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U. S. ARMY ENGINEERING AND SUPPORT CENTER - HUNTSVILLE

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DESIGN REVIEW COMMENTS

Draft 1,4 Dioxane Work Plan_ Aug 2018

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- ☐ ADV TECH
- ☐ ESTIMATING
- ☐ SPECIFICATIONS
- ☐ SYSTEMS ENG
- ☐ VALUE ENG
- ☐ OTHER

REVIEW: Draft
DATE: 06 Nov 2018
NAME: Melissa Sweet, NYSDEC

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.	Section 3.1	Groundwater Sampling Locations: What is the reasoning behind sampling monitoring wells PT-20 rather than 22, which is a groundwater monitoring well with an established analytical history. Please add PT-22 to the list of wells to be sampled.	Sampling will be moved from PT-20 to PT-22. Figure 3 and the text were updated.
2.	Section 3.1	Groundwater Sampling Locations: Please add MWT-23 to the list of wells to be sampled for 1,4-dioxane. Past analytical results show elevated levels of DCA in this well. 1,4-dioxane can be seen together with DCA.	Monitoring well MWT-23 was added to the list of wells to be sampled. Figure 3 and the text were updated.
3.	Section 3.4, Table 2	The revised work plan shall define Project Action Limit as referenced in Table 2 and the EPA Health Advisory Level of 0.35 microgram per liter should be considered an action limit in addition to the regional screening level.	The EPA Health Advisory will be used for comparison and risk analysis; however, this value is not promulgated and may not drive decision making for future actions.
4.	Section 4	Data should also be reported in the form of an NYSDEC EDD.	1,4-dioxane will be reported in NYSDEC EDD format. This statement was added to Section 4: Reporting and can also be found in Addendum 1 to the Final UFP-QAPP, Table 36.1.
5.	Appendix A	Groundwater Sampling SOP Section 5.4.1 and Monitoring Well Development SOP, Section 5.5.1: These sections prescribe Liquinox as a possible detergent for decontamination of sampling materials. However, Liquinox should not be used because it has trace levels of 1,4-dioxane.	Section 3.2 of the work plan, SOP ENV-02, Section 5.4.1 and SOP ENV-04, Section 5.5.1 were updated to note that Liquinox shall not be used for decontamination. Alconox will be used for decontamination.

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15 Apr 89

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