ASSESSMENT OF CORRECTIVE MEASURES REPORT – DRAFT

Trimble Road Landfill (Permit #333),
Fort Pickett, Nottoway County, Virginia

Virginia Department of Environmental Quality - Piedmont Regional Office

Permittee:
Maneuver Training Center Fort Pickett
VAFM-E, Building T-232
Blackstone, Virginia 23824

USACE Contract: W912QR20D0008
Delivery Order: W912QR22F0180

Prepared for:

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DRAFT - Revision 1, October 2022

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

COMPLETION OF INDEPENDENT TECHNICAL REVIEW

Alliant Corporation on behalf of SERES has completed the ASSESSMENT OF CORRECTIVE MEASURES REPORT – DRAFT at Trimble Road Landfill (Permit #333), Fort Pickett, Nottoway County, Virginia. Notice is hereby given that an independent technical review that is appropriate to the level of risk and complexity inherent in the project, has been conducted as defined in the Quality Control Plan. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions was verified. This included review of assumptions; methods, procedures and material used in the analyses; alternatives evaluated; the appropriateness of data used and level obtained; and reasonableness of the results, including whether the deliverable meets the customer's needs consistent with law and existing United States Army Corps of Engineers (USACE) policy. Any comments resulting from the independent technical review have been resolved.

______________________________ 16 September 2022

Hunter Blair, Alliant Corporation
Independent Technical Review Team Leader

QUALIFIED GROUNDWATER SCIENTIST CERTIFICATION FORM

This Assessment of Corrective measures Report for the Trimble Road Landfill was completed in accordance with Virginia Solid Waste Groundwater Monitoring Regulations (9 VAC 20-81-260.C.1) for addressing groundwater contaminant plumes.

______________________________ 16 September 2022

James Wedekind, Commonwealth of Virginia CPG #2801002238
Alliant Corporation

ACRONYMS

ACL	Alternate Concentration Limit
ACM	Assessment of Corrective Measures
Alliant	Alliant Corporation
amsl	above mean sea level
ANG	Army National Guard
bgs	below ground surface
COC	constituent of concern
CAP	Corrective Action Plan
CASE	Corrective Action Site Evaluation
CVOC	chlorinated volatile organic compound
1,1-DCA	1,1-dichloroethane
cis-1,2-DCE	cis-1,2-dichloroethene
DUB	Disposal Unit Boundary
FASTC	Foreign Affairs Security Training Center
ft	feet
Ft. Pickett	Fort Pickett
Gilmore	Gilmore Engineering and Consulting, Inc.
GPS	Groundwater Protection Standard
Landfill	Trimble Road Landfill
LCRS	leachate collection and removal system
LFG	landfill gas
LFGCCS	landfill gas collection and control system
MC	methylene chloride
MNA	Monitored Natural Attenuation
MTC	Maneuver Training Center
NES	Nature and Extent Study
VANG	Virginia Army National Guard
µg/L	micrograms per liter
Osage	Osage of Virginia, Inc.
PCE	tetrachloroethene
PG	Professional Geologist
POTW	public- or private-owned treatment works
SCR	Site Characterization Report
SERES	SERES Engineering & Services, LLC
TCE	trichloroethene
U.S.	United States
USACE	United States Army Corps of Engineers
VAC	Virginia Administrative Code
VC	vinyl chloride
VDEQ	Virginia Department of Environmental Quality
VSWMR	Virginia Solid Waste Management Regulations
WMB	waste management boundary

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EXECUTIVE SUMMARY

SERES Engineering & Services, LLC, (SERES) was retained by the United States Army Corps of Engineers (USACE) Louisville District to perform an Assessment of Corrective Measures (ACM) study for the Trimble Road Landfill (the Landfill), Virginia Department of Environmental Quality (VDEQ) Permit #333 located at the Fort Pickett (Ft. Pickett) Maneuver Training Center (MTC), Nottoway County, Virginia. The ACM study has been completed in pursuit of compliance with Virginia Solid Waste Management Regulations (VSWMR) requirements found in 9 Virginia Administrative Code (VAC) 20-81-260.C, for submittal to the VDEQ.

This ACM Report has been formatted in accordance with VDEQ Submission Instructions for an ACM for Groundwater at Solid Waste Landfills (VDEQ 2012). VDEQ instructions specify the order of presentation, which includes an Executive Summary with a summary of technical findings as presented below.

Date of initial GPS exceedance: The first monitoring wells were installed in 1991 but groundwater analytical data are not available in the historical records for the site (Gilmore Engineering and Consulting, Inc. [Gilmore] 2012). Electronic data was first reported for samples collected on 01 June 2006, and these results indicated the exceedance of the Groundwater Protection Standards (GPS) for the following chlorinated volatile organic compound (CVOC) constituents:

- methylene chloride (MC; GPS 5 micrograms per liter [µg/L]): MW-2 (60 µg/L), MW-5 (16 µg/L),
- 1,1-dichloroethane (1,1-DCA; Alternate Concentration Limit [ACL] 2.8 µg/L): MW-2 (13 µg/L), MW-6 (9.2 µg/L), MW-7 (16 µg/L),
- tetrachloroethene (PCE; GPS 5 µg/L): MW-5 (74 µg/L), MW-11 (26 µg/L),
- vinyl chloride (VC; GPS 2 µg/L): MW-6 (4.8 µg/L), MW-7 (25 µg/L).

General location of all monitoring wells with GPS exceedances: The location of the above wells and all other monitoring wells that have exhibited GPS exceedances are within the facility boundary and presented in plume maps and cross sections in Section 2 of this ACM Report.

Constituents of concern that have exceeded the GPS: Table ES-1 summarizes the constituents that have exceeded their respective GPS at least once since assessment monitoring was initiated in 2006 in conjunction with the Corrective Action Plan approved by VDEQ on 05 May 2005.

Plume delineation summary, including trends: The extent of constituents exceeding their respective GPS listed in **Table ES-1** comprise a contaminant plume in groundwater that is fully delineated within the current monitoring program (Osage of Virginia, Inc. [Osage] 2008). Monitoring wells that historically have had the greatest number of GPS exceedances are MW-2, MW-5, MW-7, and MW-18. MW-3, MW-6, MW-10R, MW-11 MW-13R, MW-15, MW-15B have had far fewer exceedances. Monitoring wells downgradient of the Landfill that show few or no exceedances to the south and east that define the contaminant extent are MW-20, MW-22, MW-27, MW-09, and MW-23A.

Table ES-1. Summary of GPS Exceedances 2006 - 2022

WELL ID	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Cobalt	Lead	Mercury	Vanadium	1,1-DCA	1,2 DCE	Benzene	MC	Naphthalene	PCE	TCE	VC	BEHP	DMBA	alpha BHC	beta BHC	Total
MW-2				1		26				17			26	1			1					**72**
MW-3								2		14												**16**
MW-4							1															**1**
MW-5	1	1								26			20	1	33	32						**114**
MW-6			1			8				14	1						13					**37**
MW-7			1	10		26				28							32					**97**
MW-9					1	1			1													**3**
MW-10R						20											1					**21**
MW-11															12							**12**
MW-12R						3												1				**4**
MW-13R						5												1				**6**
MW-14																			1			**1**
MW-15										1					25	23						**49**
MW-15B						1		2		2					22	22						**49**
MW-17						2															1	**3**
MW-18						24				19		3	24		8	5				1		**84**
MW-19															3							**3**
MW-20						2																**2**
MW-21													1									**1**
MW-23A						1																**1**
MW-27						4																**4**
MW-28															10	11						**21**
Total	**1**	**1**	**2**	**11**	**1**	**123**	**1**	**4**	**1**	**121**	**1**	**3**	**71**	**2**	**113**	**93**	**47**	**2**	**1**	**1**	**1**	**601**

KEY

- ≤5 exceedances
- 6 ≤ 50 exceedances
- >50 exceedances

ACRONYMS

1,1-DCA = 1,1-dichloroethane
1,2 DCE = 1,2- dichloroethene
BEHP = bis 2-ethylhexyl phthalate
BHC = benzene hexachloride
DMBA = dimethylbenz(a) anthracene
MC = methylene chloride
PCE = tetrachloroethene
TCE = trichloroethene
VC = vinyl chloride

NOTE

Monitoring Wells with no exceedances: MW-1, MW-16, MW-22, MW-23B, MW-25, MW-26, and MW-29

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Similarly, unimpacted monitoring wells that define the vertical extent are MW-25, MW-26, MW-12R, and MW-23B. The nature and extent of groundwater contamination is discussed in more detail in Section 2.2 of this ACM Report.

Concentrations of "parent compound" PCE are decreasing as the compound is dechlorinated to trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE). Overall, the concentrations of CVOCs and cobalt indicate the plume is stable-to-decreasing due to natural attenuation of the constituents. It is also noted that cobalt is a naturally occurring metal that may be mobilized by acidic conditions created by bioactivity within the CVOC plume. A recent analysis of the plume extent is presented in Corrective Action Site Evaluation (CASE) Report #3 (USACE 2022) with an updated analysis provided in Section 2.2 of this ACM Report.

Risk assessment summary: A previous risk assessment (Engineering & Environment, Inc. 2002) identified no impacted or potentially impacted receptors. This conclusion has been supported by subsequent investigations (Gilmore 2015a; USACE 2020). The site is located within the 42,000-acre Ft. Pickett Army National Guard MTC. The nearest public drinking-water wells are located approximately three (3) miles west of the Landfill. Ft. Pickett is serviced by the Town of Blackstone public water utility. The water source for this system is a surface water intake on the Nottoway River near the southwestern boundary of Ft. Pickett approximately five (5) miles from the Landfill. The intake is upstream of the confluence of any runoff from the Landfill via Birchin Creek.

Existing or potential future risk to human health is unlikely because potential exposure pathways are incomplete. Contamination is confined to groundwater, which is not a source of potable water at Ft. Pickett. Ingestion or dermal absorption of dissolved-phase contamination is not possible given the existing and anticipated future land use scenarios. The closest structure is an indoor firing range located 750 feet southeast of the Landfill. Existing or potential risks to the environment are also considered low. The nearest down-gradient surface water body (Birchin Creek) is located approximately 600 feet southwest of the Landfill. Surface water from the creek was sampled on two occasions in 2018 with no Landfill-related constituents detected in the samples.

Future risks are also considered unlikely. Although portions of Ft. Pickett are being developed as part of the Foreign Affairs Security Training Center (FASTC), future usage will be consistent with the current use of the surrounding lands. Any future plume migration is adequately served by the existing monitoring network with sufficient buffer to provide over 40 years of travel time before reaching Birchin Creek and the limits of a new waste management boundary (WMB) proposed in Section 3.1.

This ACM evaluated five corrective measure alternatives. Each alternative would be effective in meeting the remedial objective of limiting exposure of constituents of concern to receptors. The selected corrective measure (Incorporation of Additional Buffer Zone via Petition for Alternate Point of Compliance) was therefore based on the technology that caused the least physical disturbance to the natural environment, at the lowest cost to the government while being equally or more protective than the alternatives.

Public meeting results: Public participation will be incorporated into the ACM process pursuant to VSWMR requirements found in 9 VAC 20-81-260.C.4 to ensure surrounding public stakeholder involvement in the evaluation and selection of an appropriate corrective measure. Main aspects of the public participation process included the following:

- Advertisement/public notification.
- Identification of public comment period and schedule requirements.
- Providing access to the public to review the ACM document.

Note to Reader *(to be removed after public comment is incorporated and prior to submittal to VDEQ)*

Results of the public meeting process including notification and comments received will be summarized in Appendix D of this report (i.e., pending completion of the public participation process listed above and conclusion of the public meeting and comment period - this draft document will be updated to summarize the results of that meeting). A response to each public comment is not required by regulation; however, responding appropriately to comments received (including those directly pertaining to proposed remedial alternatives included in this ACM Report as well as those related to other on-going environmental concerns not directly germane to the ACM process) will be completed to the extent practicable. In this manner, the community's concerns will be addressed and incorporated into the ACM process. Responses to public comments will be generated after submittal of the DRAFT ACM to VDEQ and review of the comments with VDEQ; and incorporated into the FINAL ACM report.

1. INTRODUCTION

This Assessment of Corrective Measures (ACM) Report was completed pursuant to Virginia Department of Environmental Quality (VDEQ) Solid Waste Management Regulations requirements, found in 9 Virginia Administrative Code (VAC) 20-81-260.C.3 and in accordance with the VDEQ Submission Instructions for ACM for Groundwater at Solid Waste Landfills (VDEQ 2012).

The Trimble Road Landfill (Landfill) is located approximately 1.4 miles southeast of the Blackstone Army Airfield/Allen C. Perkinson Municipal Airport within the confines of Army National Guard (ANG) Maneuver Training Center (MTC) Fort Pickett (Ft. Pickett). The Department of the Army was issued Solid Waste Management Permit #333 in August 1981 to operate the Trimble Road Landfill.

The disposal area accepted waste from 1981 until final receipt of waste in 1991. The Landfill entered post-closure care on 01 October 1993 (VDEQ 2009). Four unlined trenches were excavated for waste disposal at the Landfill with their bases above the water table. At the time of final closure, two separate engineered earthen cap systems (each consisting of a 24-inch clay layer with permeability of 1 x 10^{-7} cm/sec or less, a 6-inch drainage layer, and a 12-inch topsoil layer for vegetative growth) were installed over the waste mass areas. The larger area to the north is approximately 5.7 acres and the smaller area is approximately 2 acres.

Solid Waste Management Permit #333 was amended to incorporate a revised groundwater Monitoring Plan on 14 February 2001 and modified again in December 2001 to incorporate Alternate Concentration Limits (ACLs) for Groundwater Protection Standards (GPSs). The VDEQ was notified in February 2002 that monitoring results for constituents (predominately chlorinated volatile organic compounds [CVOCs]) at multiple wells exceeded the applicable GPSs, which initiated the groundwater corrective action process (Gilmore 2015b).

Additional monitoring wells were installed as part of a phased Nature and Extent Study in 2010 and 2011. Data collected from the additional wells indicated that concentrations of constituents that exceeded their GPS were no longer contained within the waste management boundary (WMB). VDEQ requested submittal of an ACM to be followed by a Corrective Action Plan (CAP) (Gilmore 2015b). Several remedial alternatives were evaluated in the ACM report to address this plume. The Virginia ANG (VANG) submitted the ACM to VDEQ on 18 February 2012, with a revision submitted on 11 July 2012. VDEQ advised VANG to move forward with the preparation and submission of a CAP and related Corrective Action Monitoring Plan (CAMP) in a letter dated 30 August 2012.

In 2012, VANG notified VDEQ of their intent to expand the WMB to reflect the full area of influence of the Landfill more accurately and to ensure future access to all monitoring wells, gas probes, and access roads for maintenance.

Additional site characterization activities were conducted in 2017 and 2018 to fully delineate the extent of the groundwater contamination. Data collected during these additional characterization activities resulted in the full vertical and horizontal delineation of the plume (i.e., for each constituent exceeding its respective GPS). The results of those efforts were presented in the Site Characterization Report (SCR) (USACE 2020).

The gas venting system was enhanced in 2017 with the installation of 16 additional passive gas vents screened within the waste mass. The results of these efforts were also presented to VDEQ in the SCR (USACE 2020). The SCR was approved by VDEQ via letter dated 04 January 2021.

1.1 Physical Setting

The Landfill is located within the confines of Ft. Pickett, which covers approximately 42,000 acres of very gently rolling hills of the Virginia Piedmont. A United States Geological Survey 7.5-minute topographic map of the area including the facility boundary of the Landfill is included on **Figure 1.1**. The Landfill is bounded to the northwest by Landfill Road and to the northeast by Trimble Road. The facility boundary for the Landfill encompasses approximately 75 acres.

Topography - The Landfill is located on a topographic high at an elevation of approximately 367 feet (ft) above mean sea level (amsl). The area slopes to the southeast and southwest away from a ridge running down the center of the two separate engineered caps over the former disposal units. The Disposal Unit Boundary (DUB) is shown on **Figure 1.2** and **Figure 1.3**.

Surface Drainage - A concrete-lined drainage swale conveys landfill runoff between the two capped areas (east to west) and discharges to a small (<1 acre) retention basin located to the west of the smaller waste disposal area. Surface runoff from the waste mass area flows south and west through natural drainage swales that drain to Birchin Creek.

One swale is located approximately 600 feet off the western and northwestern portion of the Landfill. The swale converges with a second swale south of the Landfill to join the main branch of Birchin Creek. Birchin Creek has its headwaters approximately 1.5 miles northwest of the Landfill and flows southeast past the site at an elevation of approximately 286 ft amsl, then over six (6) miles through uninhabited forest land of Ft. Pickett before emptying into Tommeheton Creek and subsequently converging with the Nottaway River.

Geology – Ft. Pickett is located within the Piedmont Physiographic Province of Virginia. The Piedmont can be described as a geologically complex region generally underlain by metamorphic and igneous rock of Precambrian and Paleozoic age. The geology of the Landfill site is typical of that observed in the surrounding areas. Bedrock, which consists of gneiss and granitic rocks, is primarily overlain by residual soil and saprolite (soils showing relict rock fabric and structures). The top of the bedrock generally slopes toward the south and southwest, which conforms to site topography.

In general, unstructured residual soils (red-brown to yellow-brown, sandy elastic silt to elastic silt with sand) overlie the soils showing variable relict textures indicative of saprolite (green-brown silt and white to light brown clayey sand to sand with clay) (Osage 2008a). Soils thin at lower topographic elevations around the incised stream channel of Birchin Creek and its tributaries.

Bedrock was encountered from 4 ft to 35 ft below ground surface (bgs) in borings advanced for the monitoring well network. The greater depths to bedrock are found in upland areas while shallow depths to rock occur near Birchin Creek. Bedrock crops out in several places along the creek bed in the site vicinity and is described as a highly deformed mass of black and white granite, granodiorite, schist, and gneiss. The rocks are intensely folded and fractured with a fabric that strikes north/south with a vertical dip in outcrops within Birchin Creek.

Plume constituents - Since the Landfill was used solely for the disposal of typical municipal waste, CVOCs detected in groundwater are likely derived from incidental disposal of solvent-based paints and degreasers. Cobalt detected in the groundwater is apparently derived from the release of the naturally-occurring metal from the soil, facilitated from the acidic nature of the groundwater undergoing anaerobic biotic degradation of the organic compounds found in the waste. The fate and transport of these constituents are discussed in more detail in Section 2.2.

1.2 Adjacent Land Use

All land adjacent to the Landfill is currently owned by the U.S. Government and operated by the VANG as Ft. Pickett (**Figure 1.2**). There are no current plans for closing or significantly changing the base ownership. Most of the 42,000 acres of Ft. Pickett is undeveloped forest used for field training and firing ranges. Ft. Pickett is secured with signage and fencing.

Approximately 4,000 acres of Ft. Pickett is developed with driving courses, training areas, barracks, vehicle staging and maintenance areas, and offices. There are no commercial or residential structures within the existing facility boundary or the immediate vicinity. The adjacent lands are primarily wooded, and their use is limited to occasional military training and hunting. The nearest structure is a newly constructed building located approximately 700 feet southwest that is used for weapons training for the U.S. Foreign Affairs Security Training Center (FASTC). There are no other current or future development plans for the Landfill property. The future use is summarized as follows:

> *The landfill area has been excluded from the proposed site and [the future development plan] does not include any development in this area. No use of groundwater near the plume is proposed; therefore, there would be no environmental health risk* (FASTC 2015)**.**

1.3 Onsite Aquifer Characteristics

Groundwater occurs within a single, unconfined aquifer consisting of sandy residual soil and saprolite with limited hydrogeologic communication with underlying fractured metamorphic rock (Gilmore 2012). Groundwater has a higher elevation than Birchin Creek surface water suggesting groundwater flow is toward and discharging into the creek. The bedrock water bearing zone is present in the rock, with interconnected horizontal and moderate yield vertical fractures (USACE 2020).

A potentiometric map, included as **Figure 1.4**, is based on groundwater elevation data collected during the March 2022 semi-annual sampling event. The water table generally conforms to the site topography, with semi-radial groundwater flow generally toward the south and southwest. Stabilized water level measurements collected from the groundwater monitoring well network indicate that the depth to water is approximately 15 feet on the upgradient (north), east, and west sides of the Landfill and as shallow as 5 feet further south near Birchin Creek. The water table appears to be above the top of bedrock over most of the site. Recharge of the groundwater table in the Piedmont is primarily by infiltration through the residual soil layers.

Based on recharge rates for wells within the monitoring network (0.5 – 0.75 gallons per minute recorded during purging activities), yield of the shallow, unconfined aquifer is considered low and is therefore not a potential source of drinking or industrial-related water (Gilmore 2015b).

There are no groundwater wells located on the Landfill other than the wells associated with the on-going monitoring program. All drinking water for Ft. Pickett is supplied by the Town of Blackstone via piped water from their Municipal Water Treatment Plant approximately one (1) mile to the west of the site. The water source for this system is a surface water intake on the Nottoway River near the southwestern boundary of Ft. Pickett approximately 5 miles from the Landfill. The intake is upstream of the confluence of any runoff from the Landfill via Birchin Creek.

1.4 Compliance Well Network

The groundwater monitoring network consists of 29 monitoring wells as listed in **Table 1.1**. Seven monitoring wells (MW-2, MW-3, MW-4, MW-5, MW-7, MW-9, and MW-18) are currently designated as compliance wells as defined in the Groundwater Monitoring Sampling and Analysis Plan (Osage 2008a). MW-1 and MW-6 were removed from the compliance monitoring program in 2012 by agreement with VDEQ (Gilmore 2015b). MW-4 is the upgradient (background) monitoring well. The other six compliance wells are located within close proximity to the waste mass. Detections of CVOCs and cobalt above the GPS at these wells triggered the need for plume delineation and remedy assessment at the Landfill. Constituents of concern (COCs) with concentrations exceeding their respective GPS have been detected in five of the compliance wells (MW-2, MW-5, MW-7, MW-9, and MW-18) in the last 10 monitoring events.

The Landfill permit requires compliance wells to be sampled semiannually for 9 VAC 20-81-250.C Table 3.1 Column A and B parameters (previous detections only) and annually for Table 3.1 Column B parameters. Sentinel and performance wells are sampled for a list of constituents based on an agreement with VDEQ. The list of constituents has not changed since 2008 and includes cobalt, 1,1-DCA, MC, PCE, TCE, and VC, as well as. parameters that are no longer considered COCs (arsenic, beryllium, cadmium, benzene, bis[2-ethylhexyl] phthalate, alpha and beta-BHC) (Gilmore 2012).

Methane is monitored in accordance with the Gas Management Plan (Osage 2008b). Landfill gas (LFG) is currently monitored and reported on a quarterly basis at a network of 10 gas probes (GP-1, GP-4 through GP-7, GP-9 through GP-13) around the perimeter of the closed Landfill and three interior probes (GP-2, GP-3, and GP-8). There has never been an exceedance of regulatory criteria in a compliance gas probe reported under the gas monitoring program.

Table 1.1 – Current Monitoring Network

Compliance Wells	Sentinel Wells	Performance Wells
MW-1	**MW-10R***	**MW-27***
MW-2*	MW-11	**MW-28* (deep)**
MW-3	**MW-12R* (deep)**	
MW-4 (Background)	**MW-13R***	
MW-5*	MW-14	
MW-6	**MW-15A***	
MW-7*	**MW-15B* (deep)**	
MW-9*	MW-16	
MW-18*	**MW-17**	
	MW-19	
	MW-20	
	MW-21*	
	MW-22	
	MW-23A	
	MW-23B (deep)	
	MW-25 (deep)	
	MW-26 (deep)	
	MW-29	

Notes:

1. **Bolded** indicates monitoring wells that are currently sampled
2. Wells with an asterisk (*) have at least one GPS exceedance within the past 5 years (10 monitoring events).
3. Deep monitoring wells are defined as wells measuring 55 feet more in depth.

1.5 Limitations

There are no known limitations on the quality or quantity of information included in this evaluation.

2. NATURE AND EXTENT STUDY

A Nature and Extent Study (NES) for the Landfill was submitted in 2002 (Engineering & Environment 2002), with an addendum to the report submitted in 2011 to document that the plume extended outside the monitoring system (Gilmore 2011). Additional subsurface characterization activity completed in 2017 and 2018 fully defined the extent of contamination and is summarized in the Site Characterization Report (SCR) (USACE 2020). The SCR was approved by VDEQ via letter dated 04 January 2021. A CASE Report that includes current constituent time/concentration graphs and updated plume maps was submitted to VDEQ in June 2022. These studies provide the necessary data to complete the ACM, and their findings are not repeated here as specified in the ACM Submission Instructions (VDEQ 2012). However, a brief summary of the key elements of the current conditions in groundwater is provided below for convenience.

2.1 COCs

The COCs for groundwater that consistently exceed their respective GPS are as follows:

- Cobalt
- 1,1-DCA
- MC
- PCE
- TCE
- VC

2.2 Plume Delineation

Groundwater constituents include PCE and associated degradation products (TCE, cis-1,2-DCE, and VC) that are, in part, co-mingled with other CVOCs (1,1-DCA and MC) and cobalt. The physical properties for these CVOCs are provided in **Table 2.1**. In sum, these CVOCs form the basis for the remedial action evaluated in the ACM. **Figure 2.1** illustrates the plume extents of the COCs present at concentrations that exceed their respective GPS. Compliance wells MW-2, MW-5, MW-7, and MW-18, sentinel wells MW-15A and MW-15B, and performance well MW-28 most commonly exhibit GPS exceedances and have elevated concentrations for several constituents. Unimpacted sentinel wells MW-29, MW-13R, and MW-20 define the plume extent. To the east, the downgradient plume extent is defined by sentinel wells MW-23A, MW-23B (vertical extent well), and MW-17, and to the south and southeast by compliance well MW-9 and sentinel wells MW-12R, MW-22, MW-25 (vertical extent well), MW-26, and MW-27. There have been no GPS exceedances reported in upgradient (background) monitoring well MW-4 to the north. Birchin Creek has been sampled on four occasions and detected no site-related constituents (USACE 2020).

Time/concentration graphs presented in **Appendix A** (Figures A.1, A.2, and A.3) show that concentrations of the "parent" CVOCs (1,1-DCE, MC, and PCE) and cobalt (Figure A.6) are decreasing, and the lateral and vertical plume extents have decreased when compared with plume maps presented in the NES (Gilmore 2011) and CAP (Gilmore 2015b). The extent of each of these individual plumes is discussed below.

- **1,1-DCA** has been detected at concentrations greater than the GPS (2.8 µg/L) over much of the area and within the current WMB (**Figure 2.2a and 2.2b**). The greatest concentrations of 1,1-DCA are found at MW-18 and MW-7, located at the west margin of the WMB. Concentrations of 1,1-DCA continue to decrease throughout the plume extent (see Figure A.1 in **Appendix A**). GPS exceedances of 1,1-DCA, which historically occurred at five wells (MW-2, MW-3, MW-5, MW-7, and MW-18), currently only occur at two locations (MW-7 and MW-18).

  A groundwater seep location (SW-4) located downslope and downgradient from MW-18 (**Figure 1.3**) was sampled twice in 2016 and one sample exceeded the GPS for 1,1-DCA. The exceedance has been discussed with VDEQ and it was agreed via letter from VANG to VDEQ dated 10 January 2020 that VANG would present an Interim Measures Work Plan to further investigate the seep. The work plan is included as **Appendix B**.

- **MC** is most frequently detected above the GPS (5 µg/L) at MW-2 and MW-18 located near the center of the Landfill. Overall concentrations of MC have decreased steadily (see Figure A.2 in **Appendix A**) reflecting the very short half-life (14-56 days) of this compound in groundwater (**Table 2.1**). Historically, MC exceeded the GPS at MW-5 through 2015, but concentrations progressively decreased, and the compound has not been detected at MW-5 since 2019. A recent exceedance of MC was detected for the first time at MW-21 in September 2020. The extent of MC in groundwater is shown on **Figures 2.3a** and **2.3b**.

- **PCE** is found primarily at the south end of the Landfill with GPS (5 µg/L) exceedances found at MW-5, MW-15, MW-15B, and MW-28 (**Figure 2.4a**). Historical concentrations of PCE have decreased at all of the wells (Figure A.3 in **Appendix A**). The vertical extent of PCE exceedances is found at MW-28, at a depth of approximately 70 ft bgs (250 ft amsl) (**Figure 2.4b**). Deeper downgradient wells MW-25 and MW-26 show no CVOC exceedances. This reflects the natural dechlorination of the compound via biotic and abiotic processes (Pivetz et al. 2013).

- **TCE** is a natural reductive dechlorination product of PCE. The extent of TCE is nearly identical to PCE, with GPS (5 µg/L) exceedances also noted at MW-5, MW-15A, MW-15B, and MW-28 (**Figure 2.5a**). The vertical extent of TCE is identical to that of PCE (**Figure 2.5b**). Concentrations of TCE have historically increased at most of these wells reflecting the production of the compound from its “parent” PCE but have stabilized in recent years (Figure A.3 in **Appendix A**). TCE is further naturally degrading to cis-1,2-DCE, as evidenced by increasing concentrations of that compound (Figure A.4 in **Appendix A**). This is important because cis-1,2-DCE is less toxic than TCE, as reflected in its GPS value (70 µg/L, Figure A.5 in **Appendix A**).

- **VC** was first detected in groundwater at concentration that exceeded the GPS (2 µg/L) in 2006 at MW-6 and MW-7. Although MW-6 is no longer included in the groundwater monitoring program, the concentration of VC in groundwater continues to exceed the GPS at MW-7. **Figure 2.6a** illustrates the horizontal extent and **Figure 2.6b** shows the vertical extent of VC in groundwater in March 2022. VC concentrations exceeding the GPS are restricted to the groundwater beneath the northern portion of the waste mass with lower concentrations detected occasionally at MW-2 and MW-5.

- **Cobalt** is a naturally occurring metal that is elevated most often and in higher concentrations in CVOC impacted wells in proximity to the landfill (i.e., MW-2, MW-7, and MW-18) (**Figure 2.7a**). It is suspected that the groundwater geochemistry at the impacted wells is undergoing biotic reductive dechlorination, which facilitates the mobilization of cobalt and other metals including arsenic and cadmium (but at concentrations lower than their respective GPSs). The lack of elevated cobalt concentrations at unimpacted downgradient wells furthest from the Landfill (i.e., MW-17, MW-21, MW-23B, MW-25, MW-26, and MW-29) supports this. Cobalt GPS exceedances do not extend to the deeper wells and exceedances are not found below 290 ft amsl (**Figure 2.7b**). Cobalt concentrations have periodically exceeded the GPS in wells with no other GPS exceedances (i.e., MW-10R, MW-12R, MW-13R, MW-17, MW-20, MW-23, and MW-27). Elevated cobalt concentrations at many of the wells with occasional exceedances of the GPS (MW-15B, MW-17, MW-20, MW-23, and MW-27) occurred only in the first sampling events and likely represent incomplete well development and/or aquifer disturbance from drilling. Figure A.6 (**Appendix A**) shows that cobalt concentrations at MW-2, MW-7, MW-10R, and MW-18 are generally stable.

Table 2.1 - Physical Properties of Organic Contaminants Detected in Groundwater exceeding GPS

Chemical	Specific Gravity (g/cc)	Aqueous Solubility (mg/L)	Vapor Pressure (mm Hg)	Henry's Law (atm-m3 mol)	Organic Carbon Partition Coefficient, log K_{oc} (ml/g)	Octanol/ Water Partition Coefficient, log K_{ow} (Unitless)	Vapor Density (g/L)	Water Diffusion Coefficient D_w (sq.cm/sec)	Est. Half-Life Groundwater (days)
1,1-DCA	1.18	5,060	182.1	0.0043	1.48	1.78	4.04	---	64-154
Methylene chloride	1.33	2,000	349	0.0902	0.94	1.3	1.89	1.1E-06	14-56
PCE	1.62	150	14	0.738	2.42	2.6	6.78	7.5E-06	360-720
TCE	1.46	1,100	57.8	0.410	2.1	2.53	5.37	8.3E-06	321-1653
Vinyl Chloride	0.908	2,763	2600	0.0278	1.99	1.36	2.16	1.23E-06	28-110

Notes:
--- = Value not provided
Sources:
Montgomery, J.H., and Welkom, L.M., 1990, Groundwater Chemicals Desk Reference, Lewis Publ., Chelsea, MI, 650p.
Howard, P.H., et. al., 1991, Handbook of Environmental Degradation Rates, Lewis Publ., Chelsea, MI, 725p
Default Physical and Chemical Parameters, Table E, of Appendix C, 35 IAC, Part 742, Tiered Approach to Corrective Action Objectives.

2.3 Aquifer Geochemistry

The primary COCs in groundwater (CVOCs and cobalt) are soluble and mobile in the environment. The CVOCs readily volatilize when exposed to the atmosphere and degrade naturally through biotic and abiotic processes of reductive dechlorination. Cobalt is a naturally occurring element and most soluble and mobile in groundwater under certain conditions. The dissolution and transport potential of cobalt is likely dependent on a reducing environment (i.e., low pH and low oxidation/reduction potential) that is present in groundwater near the waste mass (USACE 2022). Microbial processes associated with natural attenuation of CVOCs result in reduction of oxidation/reduction potential and pH that can increase solubility and decrease sorption for metals (Adamson and Newell 2014; Payne et al. 2009).

2.4 Summary

Groundwater impacts are limited in extent to an area within the 150m (492 ft) radius of the DUB. Concentrations of COCs are stable-to-decreasing throughout the plume and the plume shows no evidence of lateral or vertical growth. There are no current or anticipated groundwater users within over one mile from the site and all property in the surrounding area is owned by the Federal Government. Despite the very low risk posed by the groundwater plume at the Landfill, the ACM presented in Section 3 provides an assessment of technologies that are appropriate assuming further groundwater corrective action is required.

3. ASSESSMENT OF CORRECTIVE MEASURES

The ACM process includes identification and evaluation of multiple alternative remedies pursuant to compliance with VSWMR requirements found in 9 VAC 20-81-260.C.3.a and c, respectively.

3.1 Identification of Potential Corrective Measure Alternatives

VSWMR requirements found in 9 VAC 20-81-260 state that any corrective measure satisfies the following objectives:

- Be protective of human health and the environment.
- Attain the groundwater protection standard as specified pursuant to 9 VAC 20-81-250 A.6.
- Control the sources of releases to reduce or eliminate, to the maximum extent practicable, further releases of solid waste constituents into the environment that may pose a threat to human health or the environment.
- Comply with standards for management of waste.

Potential corrective measure alternatives that align with these requirements and may be used to address groundwater impacted primarily by CVOCs at the Landfill are presented in this section. Five corrective measure alternatives were evaluated as detailed below, and **Table 3.1** summarizes the remedial components of each alternative.

- Corrective Measure Alternative 1 - Incorporation of Additional Buffer Zone via Petition for Alternate Point of Compliance.
- Corrective Measure Alternative 2 - Corrective Measure Alternative 2 – Monitored Natural Attenuation (With and/or Without Upgraded Geosynthetic Cap System)
- Corrective Measure Alternative 3 – Source Control via Leachate/LFG Extraction
- Corrective Measure Alternative 4 – Enhanced Bioremediation
- Corrective Measure Alternative 5 – Source Removal/Disposal

Table 3.1. Remedial Action Components Summary of Corrective Measures Evaluated

No.	Alternative Name	Remedial Action Component				
			Source Control			
		Modified Waste Management Boundary	Monitored Natural Attenuation	Upgraded Geosynthetic Cap	Dual Landfill Gas (LFG) /Leachate Removal	Waste Exhumation
1	Incorporation of Additional Buffer Zone via Petition of Alternate Point of Compliance	☒				
2	Monitored Natural Attenuation with and/or without Upgraded Geosynthetic Cap System	☒	☒	☒		
3	Source Control via Leachate/LFG Extraction	☒		☒	☒	
4	Enhanced In-situ Bioremediation	☒				
5	Source Removal/Disposal					☒

Alternative 1 – Incorporation of Additional Buffer Zone via Petition for Alternate Point of Compliance. A portion of the CVOC plume extends beyond the current WMB that serves as the existing point of compliance. Modifying the WMB to extend no greater than 492 feet (150 meters) from the DUB will provide a buffer zone between the waste mass and new alternate point of compliance without requiring any further remedial response. The nearest potential receptor is Birchin Creek, which is located outside the proposed WMB. The proposed buffer extends approximately 225 feet from the creek. At the estimated groundwater flow rate of 10 feet per year (USACE 2022), the buffer zone should provide over 22 years of protectiveness assuming no retardation of the CVOC plume.

This alternative continues passive venting of LFG from within the waste mass for source zone control and incorporates additional passive buffer zone by expanding the facility's WMB outward from the DUB as shown on **Figure 3-1**. The proposed WMB is within the existing facility boundary and encompasses the lateral extent of COCs in any groundwater plume.

This alternative is supported by stable plume conditions, lack of any nearby potable groundwater receptors, existing in-place source control measures (existing final cap and passive landfill gas vents), and likelihood of achieving compliance within the facility's remaining post closure care and maintenance period (5-years remaining).

Alternative 2 – Monitored Natural Attenuation With/Without Upgraded Synthetic Cap System. Results of the previous Nature and Extent Study confirm natural attenuation of the various CVOCs is already occurring. Monitored Natural Attenuation (MNA) could be pursued in combination with previously referenced incorporation of additional passive buffer zone (and alternate point of compliance); or optional placement of an upgraded geosynthetic cap system for added source control to reduce downgradient plume migration potential in absence of incorporating additional buffer. The proposed MNA network is shown on **Figure 3-2**.

Alternative 3 – Source Control via Leachate/LFG Extraction. This alternative incorporates additional source control via a combined leachate collection and removal system (LCRS) and active landfill gas collection and control system (LFGCCS). Both leachate and LFG would be extracted using a dual-recovery system to reduce CVOC contaminant mass potentially leaching and/or migrating from the original waste trenches. It is assumed that extracted leachate would be disposed off-Site at a public or private owned treatment works (POTW), and landfill gas would only require limited treatment to allow discharge to the atmosphere (i.e., activated carbon train treatment of gas emissions with no gas-flare requirement). A conceptual plan is depicted on **Figure 3.3**.

Alternative 4 – Enhanced Bioremediation. Alternative 4 involves injection of bioremediation agents capable of stimulating biodegradation and biologically de-halogenating the target CVOCs in groundwater. Given that prior pilot-scale testing has indicated that bioremediation could be effective, treatment zones would be placed downgradient of the waste mass areas and along the west and south perimeter of the CVOC plumes. A concept of this alternative is provided on **Figure 3.4.** The bioremediation treatment could accelerate the degradation of the CVOCs and minimize further downgradient plume migration but could also increase anaerobic conditions resulting in increasing concentrations of VC.

Supplemental pilot testing would likely be required during the remedial design phase to assess and update the effectiveness of a specifically selected bioremediation additive within the treatment zone at the Landfill.

Alternative 5 – Source Removal/Disposal. Under this approach, the existing Landfill waste mass would be over-excavated and exhumed materials transported and disposed off-site at a permitted landfill facility. Temporary excavation dewatering (if any) may produce contaminated wastewater that would also require disposal or treatment at an off-site facility, presumably a POTW. A conceptual depiction of Alternative 5 is depicted on **Figure 3.5**.

Source removal would eliminate the available CVOC contaminant mass potentially leaching and/or migrating from the existing trench fills.

3.2 Detailed Evaluation of Corrective Measure Alternatives

The corrective measure alternatives were assessed relative to others in the same sub-category and assigned a numerical ranking (low to high benefit score from 1 to 5) for each evaluation criteria. VDEQ has established primary criteria for evaluating corrective measure alternatives pursuant to VSWMR found in 9 VAC 20-81-260.C.3. A brief description of the evaluation criteria is presented below.

- The performance, reliability, implementation ease, and potential impacts of appropriate potential corrective measures, including safety impacts, cross-media impacts, and control of exposure to any residual contamination. In the subsequent narrative, this is referred to as overall effectiveness.
- The time required to begin and complete the corrective measure – Approximately three (3) years remain in the facility's post closure care period (as discussed in the Introduction section of this report). It is important to the facility owner/operator that the corrective measure selected achieves compliance with the applicable GPS within this remaining period to enable subsequent application for termination of post-closure care after approximately 2025. Time required to begin and complete the remedy is measured in years including regulatory permitting, design, and implementation. Low scores may be attributable to extended durations for gaining regulatory approvals, followed by design or extended periods of operations and maintenance to achieve goals. High scores may be attributable to achieving compliance with established GPS within the remaining duration of the facility's prescribed post-closure care and maintenance period.
- The costs of corrective measure implementation – Net present value of life cycle costs including regulatory permitting, professional fees, capital, and operating expenses through the anticipated corrective action period are summarized in **Appendix C**. The alternative with the greatest life-cycle cost was designated a score of zero (0), while the alternative with the least life-cycle cost was designated a score of five (5). The remaining alternatives were ranked in order of life-cycle cost and scored accordingly.
- The institutional requirements (such as state or local permit requirements or other environmental or public health requirements) that may substantially affect implementation of the corrective measures. In the subsequent narrative, this is referred to as institutional requirements. Low scores may be attributable to difficulty in obtaining regulatory permits or approvals, while higher scores may be attributable to alternatives with relative ease of

gaining regulatory approval prior to implementation. In addition, although not a specific evaluation criterion, consideration was given to community views made available during the public comment period wherein affected public were provided opportunity to voice support and/or dissent toward the proposed alternatives. This reflects a measure of the community's expectations regarding the effectiveness, reliability, and success of a particular corrective measure.

3.3 Corrective Measure Alternatives Evaluated

Corrective measure feasibility evaluations were conducted to screen/eliminate ineffective or unfeasible alternatives. The corrective measures selected for further consideration were evaluated with respect to criteria specified by VSWMR and assessed relative to others and assigned a relative numerical ranking (low to high benefit score from 0 to 5) for each evaluation criterion.

Results of the detailed evaluation are summarized in **Table 3.2.** The preferred corrective measure is Alternative 1, which proposes incorporation of additional land buffer zone between the DUB and WMB, via a regulatory petition for an APC, and continued LFG venting.

4. CONCLUSIONS

Results of this ACM study indicate the preferred corrective measure is incorporation of additional land buffer between the existing disposal unit boundary and expanded WMB via a regulatory petition for an alternate point of compliance. This alternative continues passive venting of LFG from within the waste mass and incorporates additional passive buffer zone by expanding the WMB outward from the disposal unit boundary. The updated WMB will be maintained within the existing facility boundary and encompasses the lateral extent of COCs in each groundwater plume at the Landfill.

This alternative is supported by stable plume conditions, lack of any nearby potable groundwater receptors, existing in-place source control measures (existing final cap and passive landfill gas vents), and a likelihood of achieving compliance within the facility's remaining post closure care and maintenance period.

Public participation will be incorporated into the ACM process pursuant to VSWMR requirements found in 9 VAC 20-81-260.C.4 to ensure surrounding public stakeholder involvement in the evaluation and selection of an appropriate corrective measure. Results of the public meeting process including notification and comments received will be summarized in **Appendix D** of this report (i.e., pending completion of the public participation process and conclusion of the public meeting and comment period, prior to submittal to VDEQ).

VANG will proceed with preparation of the CAP that will provide the technical basis for implementation and the Corrective Action Monitoring Plan that specifies the strategy for documenting the groundwater quality during the corrective action period.

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Tables

Table 3.1
Alternatives Analysis Summary
Assessment of Corrective Measures Report
Fort Pickett, Virginia

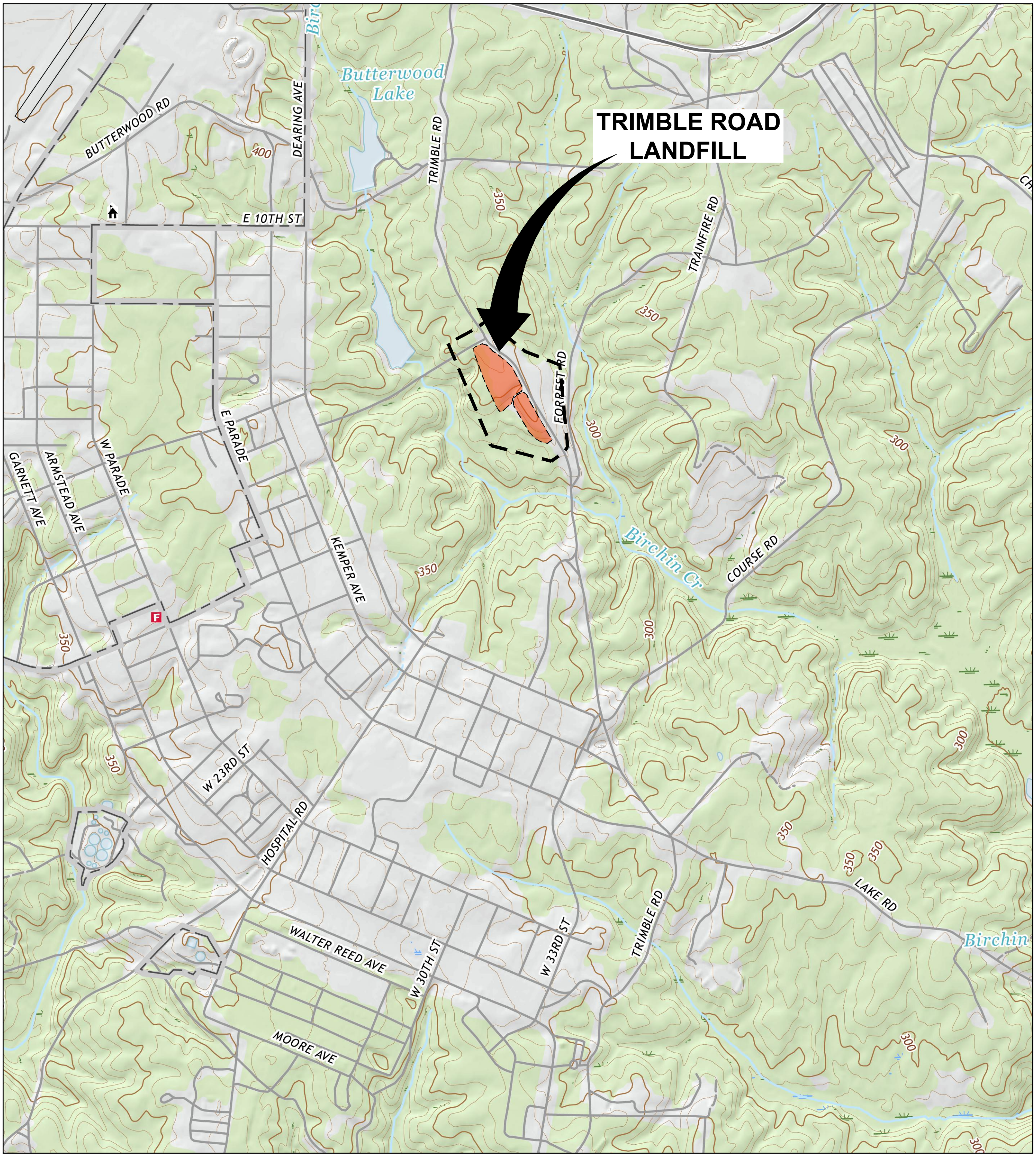
Seres Engineering & Services, LLC

Alternative			Criteria								Total Score	Ranking
			Overall Effectiveness		Time required to Begin and Complete the Remedy		Costs of Remedy Implementation		Institutional Requirements			
			The performance, reliability, implementation ease, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination.		Approximately three (3) years remain in the facility's post closure care period (as discussed in the Introduction section of this report). It is important to the facility owner/operator that the corrective action selected achieve compliance with the applicable groundwater protection standard (GPS) within this remaining period, to enable subsequent application for termination of PCC after approximately 2025. Time required to begin and complete the remedy is measured in years including regulatory permitting, design and implementation.		Net present value of life cycle costs include regulatory permitting, professional fees, capital and operating expenses through the anticipated corrective action period. The alternative with the greatest life-cycle cost was designated a score of zero (0), while the alternative with the least life-cycle cost was designated a score of five (5). Remaining alternatives were ranked in order of life-cycle cost and scored accordingly.		State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedies.			
No.	**Title**	**Description**	**Evaluation**	**Score**	**Evaluation**	**Score**	**Evaluation**	**Score**	**Evaluation**	**Score**		
1	Incorporation of Additional Buffer Zone via Petition for Alternate Point of Compliance (APC)	Incorporation of additional land buffer between the existing disposal unit boundary and expanded waste management boundary via a regulatory petition for an APC is the most practicable remedy for the groundwater impacts associated with the Landfill. This alternative continues LTM and passive venting of landfill gas (LFG) from within the waste mass and incorporates additional passive buffer zone by expanding the waste management boundary outward from the disposal unit boundary (DUB). The updated waste management boundary is maintained within the existing facility boundary and encompasses the lateral extent of constituents of concern (COCs) in any groundwater plume. The revised APC will be professionally surveyed to confirm the boundary is no further than 492 feet (150 meters) from the DUB. This alternative is included in Alternatives 2, 3 and 4 below.	Natural attenuation of COCs has been shown to be occurring in previous Site Characterization Report (SCR) and Corrective Action Site Evaluation (CASE) Report. Relocating the waste management boundary provides a high degree of performance and reliability, is simple to implement, avoids all potential impacts of implementing other alternative remedies. Establishment of the APC will provide a sufficient buffer between the current plume extent and the nearest receptor (Birchin Creek) of approximately 225 feet which provides over 22 years of advance notice in the case of continued plume migration. This estimate conservatively assumes no retardation and a groundwater velocity of 10 ft/yr. as presented annually to VDEQ (USACE 2022).	4	High level of confidence that establishing an APC will achieve targeted goals in a timely manner as there has been no evidence of plume migration during the past 16 years of monitoring. Comparison of existing COC concentrations to respective GPSs already show compliance at multiple locations in proximity to the existing waste management boundary. Time required to begin and complete the remedy is anticipated within 2 years of submittal of the variance request.	5	Estimated life-cycle cost is approximately $367,000 associated with updated surveying and regulatory permitting, on-going routine sampling, analysis and routine regulatory reporting to confirm the effectiveness of natural attenuation.	5	Requires submittal to Virginia Department of Environmental Quality (VDEQ) and their approval of a APC variance request, Corrective Action Plan (CAP), and Corrective Action and Monitoring Plan (CAMP).	4	18	1
2	Source Control via Leachate/LFG Extraction	This is similar to Alternative 1 with the addition of additional geochemical parameters to the standard LTM analyte list to fully evaluate the biotic and abiotic processes that are degrading the constituents that comprise the groundwater plume. MNA could be pursued in combination with previously referenced incorporation of additional passive buffer zone (and APC); or optional placement of an upgraded geosynthetic cap system for added source control to reduce downgradient plume migration potential in absence of incorporating additional buffer.	The addition of MNA to relocating the waste management boundary further increases the performance and reliability while maintaining ease of implementation limited to permitting and sampling/analysis and reporting of groundwater quality data. The technology has been proven to be reliable, simple and easy to implement with existing performance and sentinel wells in place, with no significant concerns regarding safety, cross-media or residual contamination.	4	High level of confidence natural attenuation will achieve targeted goals in a timely manner. Comparison of existing COC concentrations to respective GPSs already show compliance at multiple locations in proximity to the existing waste management boundary. Time required to begin and complete the remedy is anticipated within the remaining three (3) year duration of remaining post-closure care and maintenance period.	4	Estimated life-cycle cost is approximately $3,466,000 associated with regulatory permitting, design and construction of upgraded geosynthetic cap system, in conjunction with on-going sampling, analysis and routine regulatory reporting to confirm the effectiveness of natural attenuation.	3	Requires submittal to Virginia Department of Environmental Quality (VDEQ) and their approval of a APC variance request, Corrective Action Plan (CAP), and Corrective Action and Monitoring Plan (CAMP).	4	15	2
3	Source Control via Leachate/LFG Extraction	This is similar to Alternative 1 with the incorporation of both geosynthetic cap system and additional source control via a combined leachate collection and removal system (LCRS) and active LFG collection and control system (LFGCCS). Both leachate and LFG would be extracted using a dual-recovery system to reduce VOC contaminant mass potentially leaching and/or migrating from the original waste trenches. It is assumed that extracted leachate would be disposed off-site at a public or private owned treatment works (POTW), and LFG would only require limited treatment to allow discharge to the atmosphere (i.e., activated carbon train treatment of gas emissions with no gas-flare requirement). LTM would continue under this alternative as well.	Dual extraction technology has been proven to be reliable, simple and easy to implement within existing LFG passive venting. Concerns regarding pump and haul of leachate and/or thermal oxidation of actively extracted LFG are manageable with no significant concerns regarding safety, cross-media or residual contamination. Technology does not address the groundwater contamination currently in the aquifer	3	Addition of supplemental source control will accelerate compliance with GPS requirements by reducing contaminant load. Time required to begin the remedy is delayed due to procurement/construction. Time to complete the remedy is anticipated within an additional two (2) to three (3) years.	3	Estimated life-cycle cost is approximately $7,019,000 associated with permitting, design, construction as well as operations and maintenance.	2	Requires submittal to Virginia Department of Environmental Quality (VDEQ) and their approval of a APC variance request, Corrective Action Plan (CAP), and Corrective Action and Monitoring Plan (CAMP).	4	12	4

Table 3.1
Alternatives Analysis Summary
Assessment of Corrective Measures Report
Fort Pickett, Virginia

Alternative			Criteria								Total Score	Ranking
			Overall Effectiveness		**Time required to Begin and Complete the Remedy**		**Costs of Remedy Implementation**		**Institutional Requirements**			
			The performance, reliability, implementation ease, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination.		Approximately three (3) years remain in the facility's post closure care period (as discussed in the Introduction section of this report). It is important to the facility owner/operator that the corrective action selected achieve compliance with the applicable groundwater protection standard (GPS) within this remaining period, to enable subsequent application for termination of PCC after approximately 2025. Time required to begin and complete the remedy is measured in years including regulatory permitting, design and implementation.		Net present value of life cycle costs include regulatory permitting, professional fees, capital and operating expenses through the anticipated corrective action period. The alternative with the greatest life-cycle cost was designated a score of zero (0), while the alternative with the least life-cycle cost was designated a score of five (5). Remaining alternatives were ranked in order of life-cycle cost and scored accordingly.		State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedies.			
No.	**Title**	**Description**	**Evaluation**	**Score**	**Evaluation**	**Score**	**Evaluation**	**Score**	**Evaluation**	**Score**		
4	Enhanced Bioremediation	This alternative involves the injection of chemical and biological substances into the aquifer to enhance the level of bioactivity within the aquifer to complete dehalogenation of the chlorinated VOC (CVOC) plume. Delivery of the substrate to the subsurface uses traditional drilling techniques, typically direct push and/or use of existing wells. The materials would likely be injected into the saturated saprolite at the southern edge of the CVOC plume where concentrations of CVOCs are consistently greater than the GPS. The materials include substrate materials (such as lactate, molasses, whey) that serve as electron donors for the beneficial bacteria. In some instances, actual bacteria can be added as well if the local population appears to be lacking. LTM is anticipated over the remaining duration of post-closure care and maintenance and will be specified in a revised CAMP.	Enhanced bioremediation has proven to be effective in many cases for remediation of some CVOC plumes. The technology is much less effective in complex geologic environments including saprolite and jointed or fractured bedrock. Its reliability is uneven as it often requires repeated injections due to "rebound" as the material is used up and the contaminants continue to be released from the aquifer matrix. The technology is much less effective where the aquifer contains high organic carbon (including those near landfills). The technology also has been known to result in increased concentrations of undesirable breakdown products such as vinyl chloride. The technology is often used owing to its ease of implementation, and ability to be conducted safely with little impact to infrastructure.	4	Enhanced bioremediation would require procurement of an experienced subcontractor and the injection chemicals and equipment prior to conducting the injections. Each injection requires a mobilization and could be completed in one week. Each subsequent injection would require a similar timeframe. A remediation effectiveness report would be prepared to document the corrective actions taken and their effectiveness. These tasks would require an extensive time period to be completed and shown to be effective, anticipated over several years duration.	2	The estimated life cycle costs are $1,130,000 associated with permitting, design, chemical analytics in support of confirming aquifer geochemistry, procurement of an experienced specialty contractor, procurement of the (often proprietary) materials, mobilization of the drilling and injection equipment, including the likelihood of repeated injections (three assumed), as well as groundwater compliance monitoring.	4	If an infiltration gallery is used instead of direct push or use of existing wells, it would require an injection permit.	3	13	3
5	Excavation and Disposal	This alternative involves the complete removal of the landfill waste and thus removes the potential source of the groundwater plume. The waste mass (~101,000 cubic yards) would be removed using conventional excavation techniques; and earthen/soil materials from the existing cap system (~39,000 cubic yards) would be stripped, stockpiled on site and reused for site restoration. It is assumed exhumed waste would be transported to a nearby landfill facility, and liquid waste (if any) would be pumped and hauled to a local POTW. The final restored grades will be similar to original and provided with positive slope to promote stormwater drainage. The final surface will be provided with an adequate layer of topsoil and seeded with native grasses. Removal of the waste mass and restoring the excavation to surrounding grade elevations could additionally allow a future land use and/or development than what is currently envisioned. Groundwater quality monitoring is anticipated over the remainder of the post-closure care and monitoring period for nine (9) compliance monitoring wells and five (5) sentinel monitoring wells.	Waste excavation is an effective and permanent method of source control. It would permanently remove the source of both leachate and landfill gas, however it does not address residual groundwater contaminants that reside in the aquifer matrix nor will it mitigate further plume migration. Excavation will expose site workers to waste and degradation products including landfill gas and leachate. The process will also create fugitive emissions of dust, odor and noise, which would be managed through compliance measures to be developed in an operations plan. Personal protective equipment or other precautions would be necessary to prevent human health concerns. The open excavation would also pose a risk for increased infiltration, requiring the need for runoff and run-on control until such time final grades are restored.	5	Excavation would require preparation of plans and specifications for the safe removal before work could proceed.	1	Preliminary present value cost for complete source removal and APC monitoring approach ranges from approximately $7 to $8 million including permitting, design, construction, construction administration/construction management, and groundwater compliance monitoring.	1	Requires submittal and approval of plans and specifications for submittal for government approval outside of VDEQ.	2	9	5

Figures



REFERENCE: BASE MAP USGS 7.5. MIN. TOPO. QUAD., BLACKSTONE EAST, VA, 2019

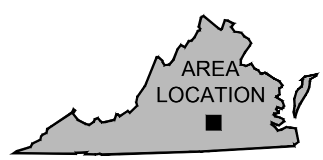
0 2000' 4000'

Approximate Scale: 1 in. = 2000 ft.

LEGEND:

LANDFILL CAP

BOUNDARY



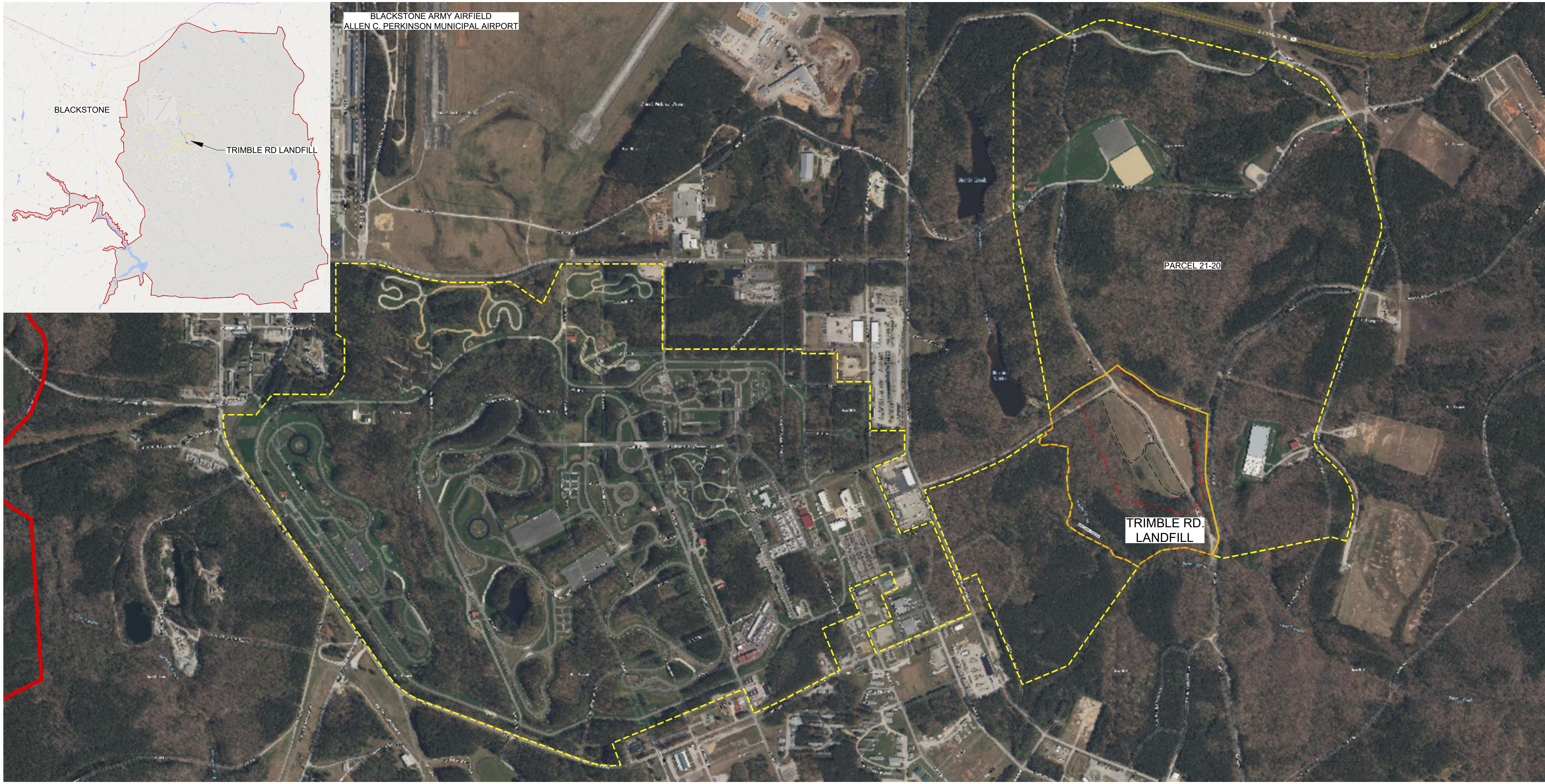
VIRGINIA

Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL,
FORT PICKETT, BLACKSTONE, VIRGINIA

VICINITY MAP

PROJECT NO.:	30145389	DATE:	AUGUST 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		1.1
CHECKED BY:	JPL		
APPROVED BY:	DAM		



LEGEND:

- FORT PICKETT PROPERTY LINE - DEPARTMENT OF DEFENSE
- PROPERTY LINE - FASTC (DEPARTMENT OF STATE)
- FACILITY BOUNDARY
- CURRENT WASTE MANAGEMENT BOUNDARY
- DISPOSAL UNIT BOUNDARY

SCALE IN FEET
0 600 1200 2400

N
W E
S

NOTE:

1. FASTC = FOREIGN AFFAIRS SECURITY TRAINING CENTER

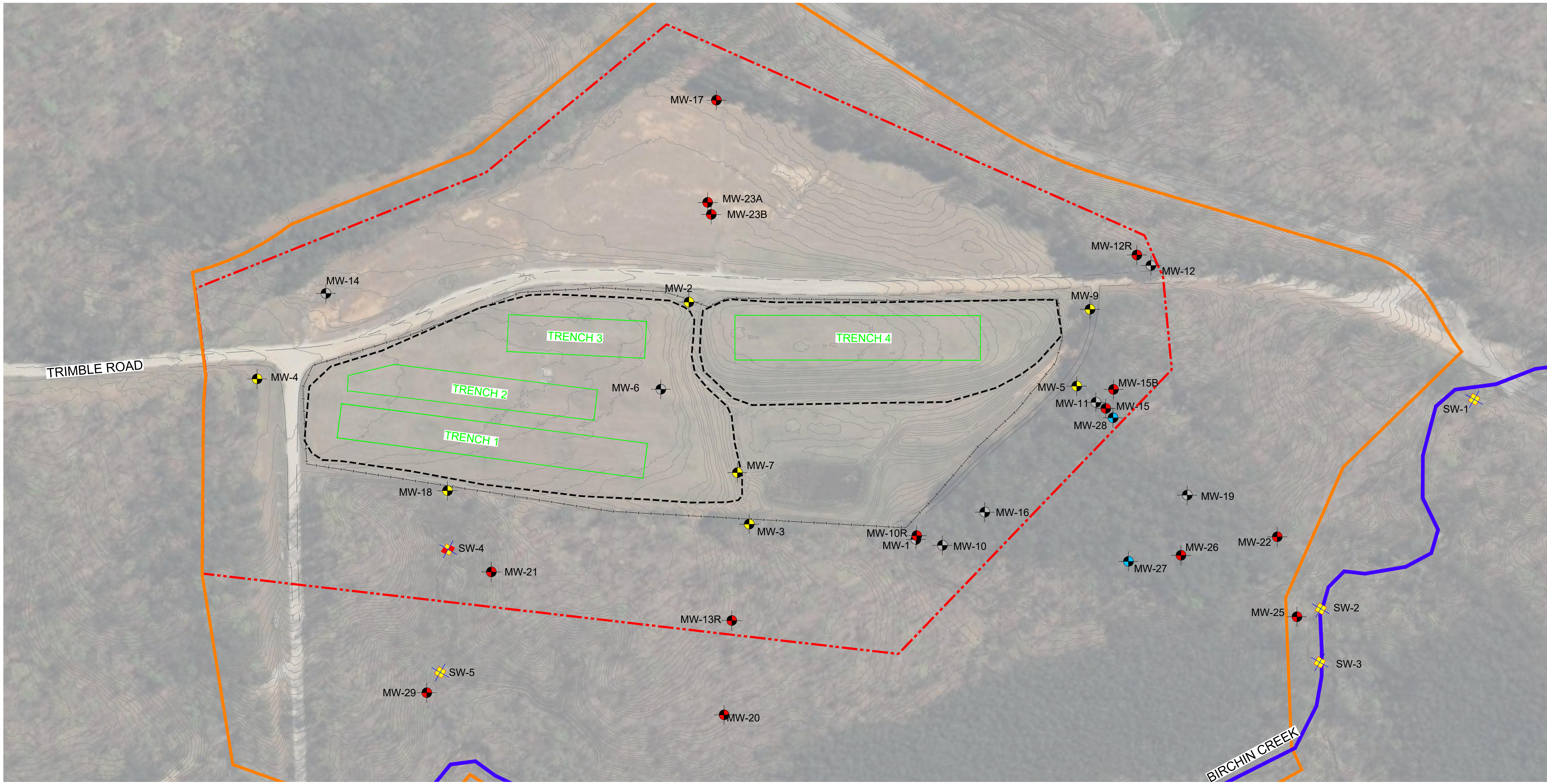
REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

SITE AREA SHOWING LANDFILL RELATIVE TO FASTC AND FORT PICKETT

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		1.2
CHECKED BY:	JPL		
APPROVED BY:	DAM		



LEGEND:

MW-2 COMPLIANCE MONITORING WELL
MW-1 SENTINEL MONITORING WELL
MW-27 PERFORMANCE MONITORING WELL
MW-6 ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)

SW-1 SURFACE WATER SAMPLING LOCATION
SW-4 GROUNDWATER (SEEP) SAMPLING LOCATION
CURRENT WASTE MANAGEMENT BOUNDARY
FACILITY BOUNDARY
DISPOSAL UNIT BOUNDARY

FENCE
BIRCHIN CREEK
TRENCH

SCALE IN FEET
0 100 200 400

N E S W

REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

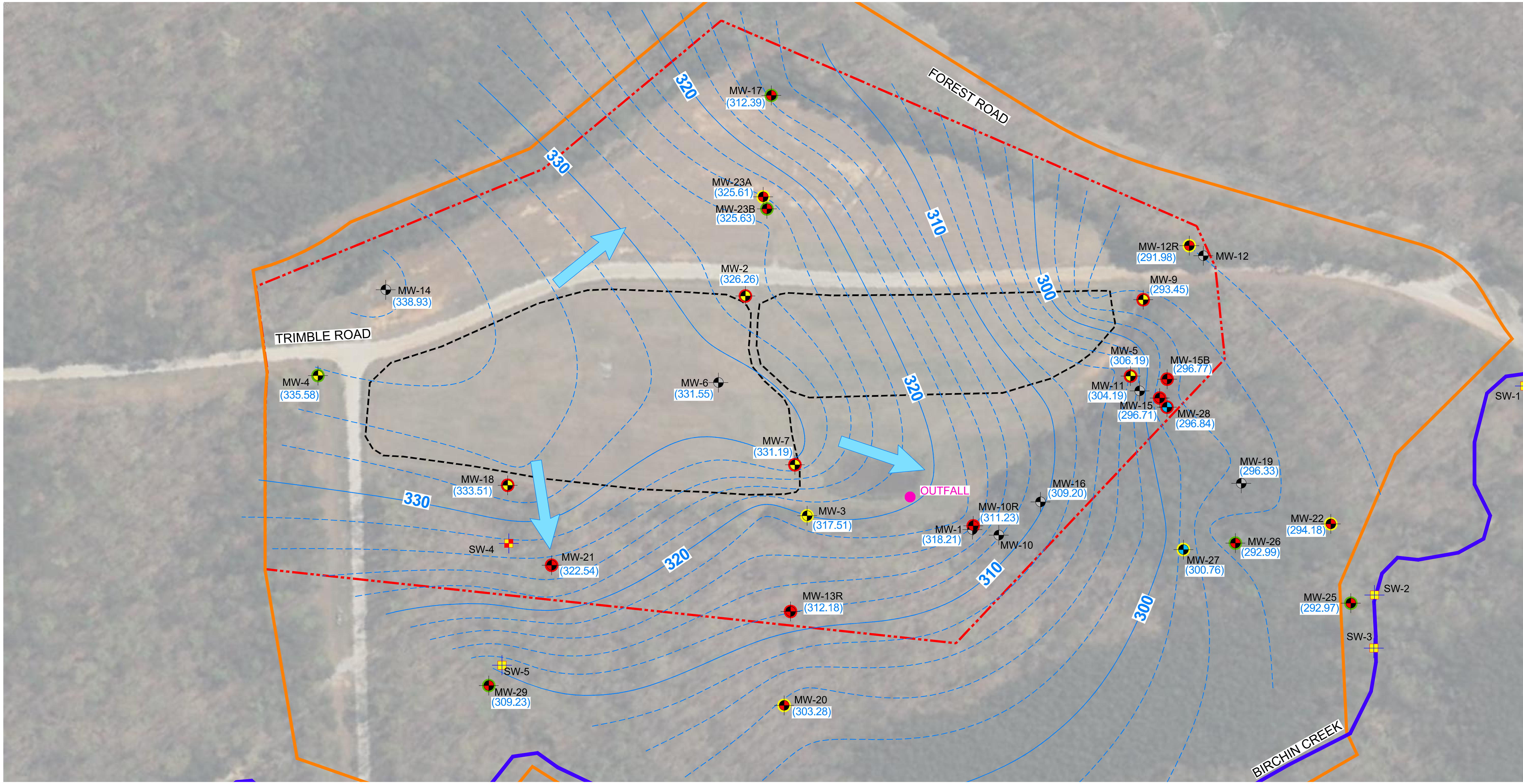
SITE FEATURES MAP

PROJECT NO.:	30145389
DESIGNED BY:	JPL
DRAWN BY:	BWM
CHECKED BY:	JPL
APPROVED BY:	DAM

DATE: SEPTEMBER 2022

DRAWING NUMBER:

1.3



LEGEND:

- MW-2 COMPLIANCE MONITORING WELL
- MW-1 SENTINEL MONITORING WELL
- MW-27 PERFORMANCE MONITORING WELL
- MW-6 ADDITIONAL SITE MONITORING WELL (NOT SAMPLED, MW-1, MW-2, MW-6, MW-27)
- SW-4 GROUNDWATER (SEEP) SAMPLING LOCATION
- WASTE MANAGEMENT BOUNDARY
- DISPOSAL UNIT BOUNDARY
- FACILITY BOUNDARY
- BIRCHIN CREEK
- (303.28) POTENTIOMETRIC SURFACE ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- POTENTIOMETRIC SURFACE ISOCONTOUR (2 FT. INTERVALS, DASHED)
- APPARENT DIRECTION OF GROUNDWATER FLOW
- STORMWATER POND OUTFALL
- SW-1 SURFACE WATER WITH SAMPLING LOCATION

SCALE IN FEET: 0 100 200 400

N E S W

REV. NO.	DATE	DESCRIPTION

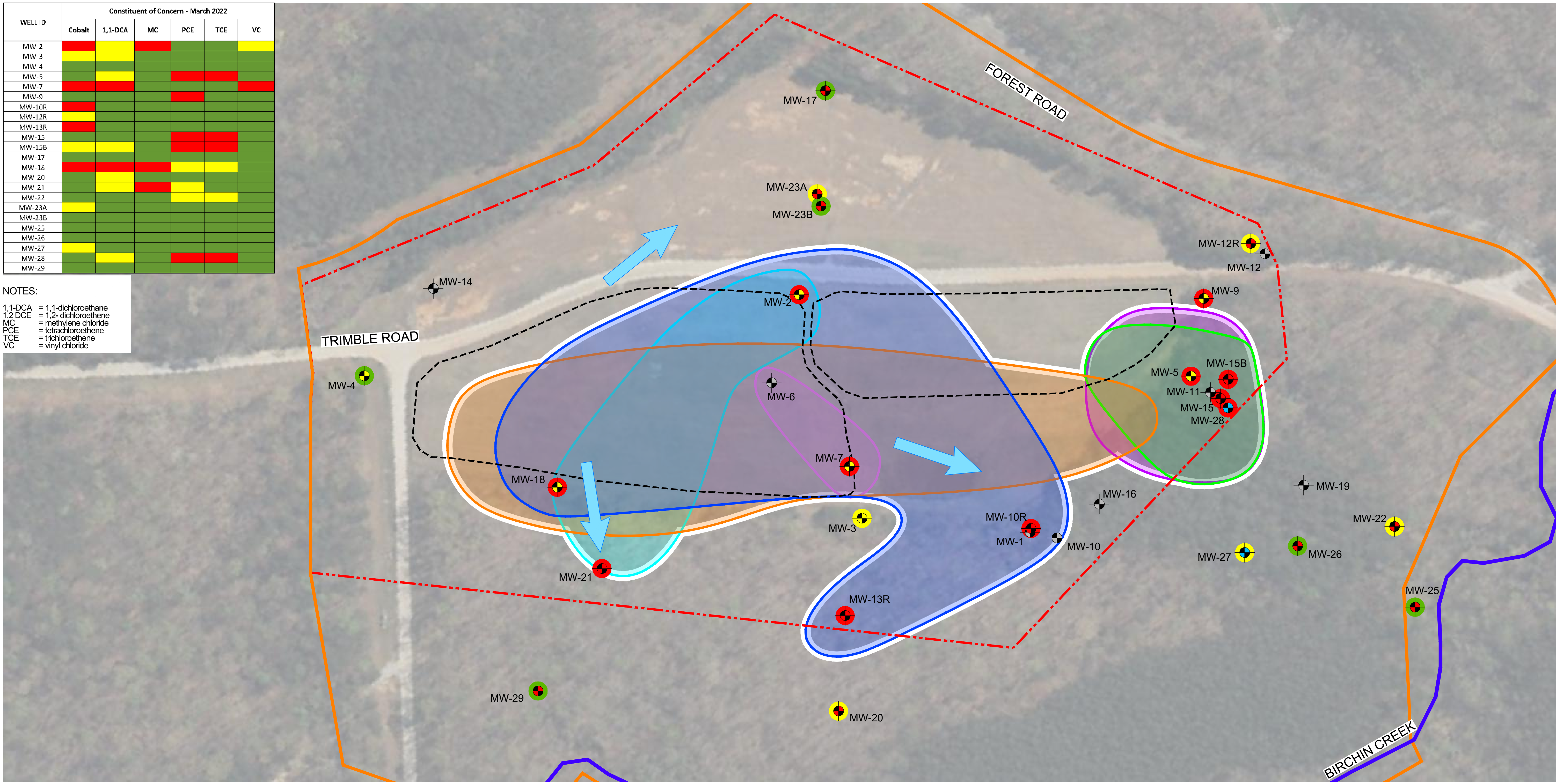
Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

GROUNDWATER POTENTIOMETRIC SURFACE MARCH 9, 2022

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		1.4
CHECKED BY:	JPL		
APPROVED BY:	DAM		

C:\Users\kdavis\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F01.4- GW POTENTIOMETRIC MAP-MARCH 2022.dwg LAYOUT: 1.4 SAVED: 9/16/2022 12:02 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/16/2022 3:04 PM BY: DAVIS, KATHI



LEGEND:

MW-2	COMPLIANCE MONITORING WELL
MW-1	SENTINEL MONITORING WELL
MW-27	PERFORMANCE MONITORING WELL
MW-6	ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)

- APPARENT DIRECTION OF GROUNDWATER FLOW
- NON-DETECT
- CONCENTRATION < GPS
- CONCENTRATION > GPS
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF VINYL CHLORIDE
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF TRICHLOROETHENE
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF TETRACHLOROETHENE
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF METHYLENE CHLORIDE
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF 1,1 DICHLOROETHANE
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF COBALT
- CURRENT WASTE MANAGEMENT BOUNDARY
- DISPOSAL UNIT BOUNDARY
- FACILITY BOUNDARY
- OUTER EXTENT OF EXCEEDANCE PLUMES

SCALE IN FEET
0 100 200 400

N E S W

NOTE:

1. GPS = GROUNDWATER PROTECTION STANDARD.

REV. NO.	DATE	DESCRIPTION

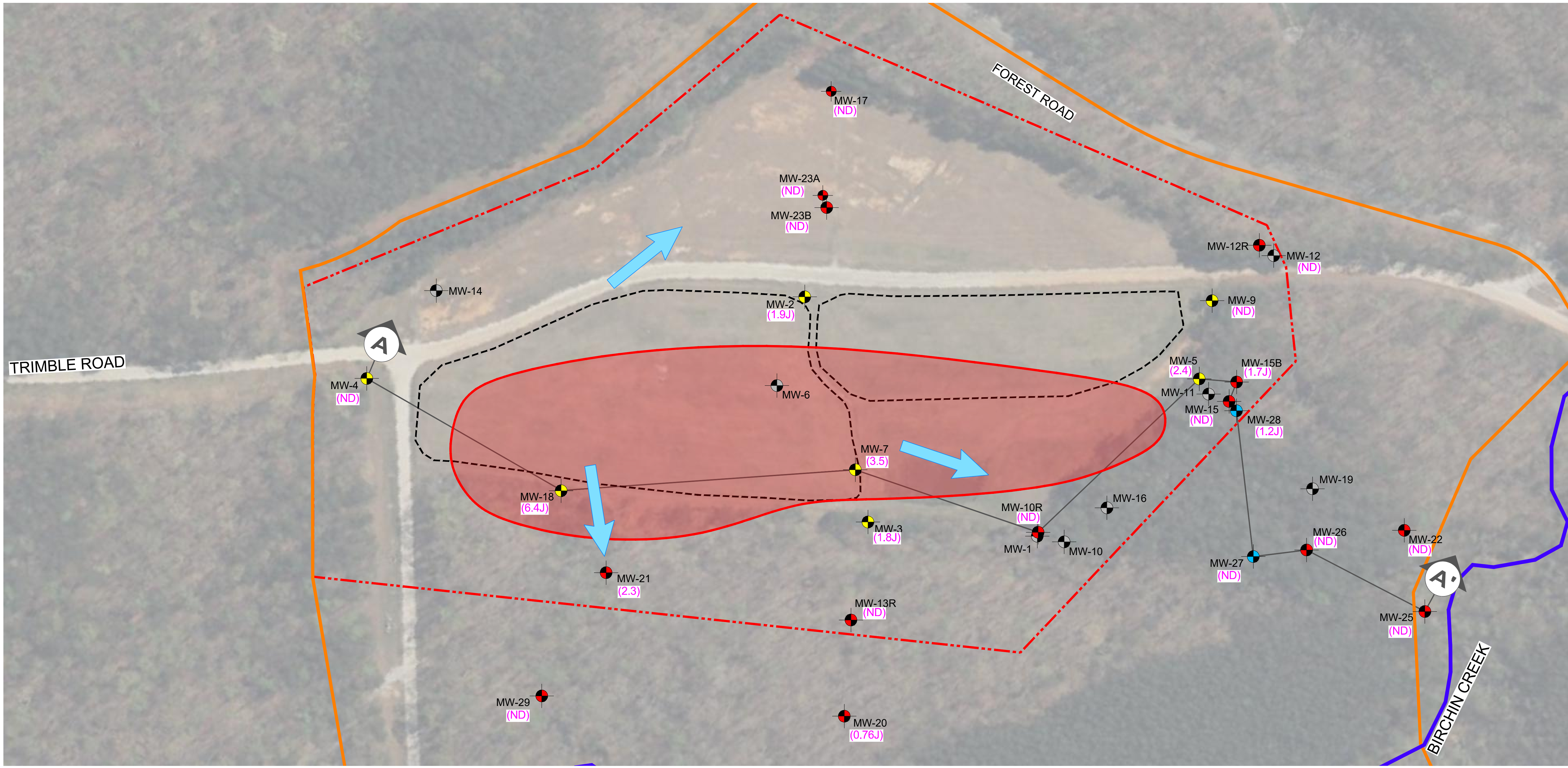
Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

PLUME EXTENTS OF GPS EXCEEDANCE MARCH 2022

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		2.1
CHECKED BY:	JPL		
APPROVED BY:	DAM		

C:\Users\jmeyer\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F02.1-PLUME EXTENTS.dwg LAYOUT: 2.1 SAVED: 11/8/2022 9:49 AM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 11/8/2022 9:49 AM BY: MEYER, JULIE (EAST WINDSOR)



LEGEND:

- MW-2 COMPLIANCE MONITORING WELL
- MW-1 SENTINEL MONITORING WELL
- MW-27 PERFORMANCE MONITORING WELL
- MW-6 ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
- BIRCHIN CREEK
- APPARENT DIRECTION OF GROUNDWATER FLOW
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF 1,1-DICHLOROETHANE
- CURRENT WASTE MANAGEMENT BOUNDARY
- FACILITY BOUNDARY
- DISPOSAL UNIT BOUNDARY
- (ND) 1,1-DICHLOROETHANE CONCENTRATION (ug/L)
- A' CROSS SECTION

SCALE IN FEET

0 100 200 400

N E S W

NOTES:

1. 1,1-DCA GPS = 2.8 ug/L
2. 1,1-DCA = 1,1-DICHLORETHANE
3. GPS = GROUNDWATER PROTECTION STANDARD
4. J = THE ANALYTE WAS POSITIVELY IDENTIFIED;HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.
5. ND = NON-DETECT
6. ug/L = MICROGRAMS PER LITER
7. PLUME EXTENT INCLUDES 1,1-DCA CONCENTRATION AT MW-6 OF 9.7 ug/L WHEN LAST SAMPLED NOVEMBER 2012.

REV. NO.	DATE	DESCRIPTION

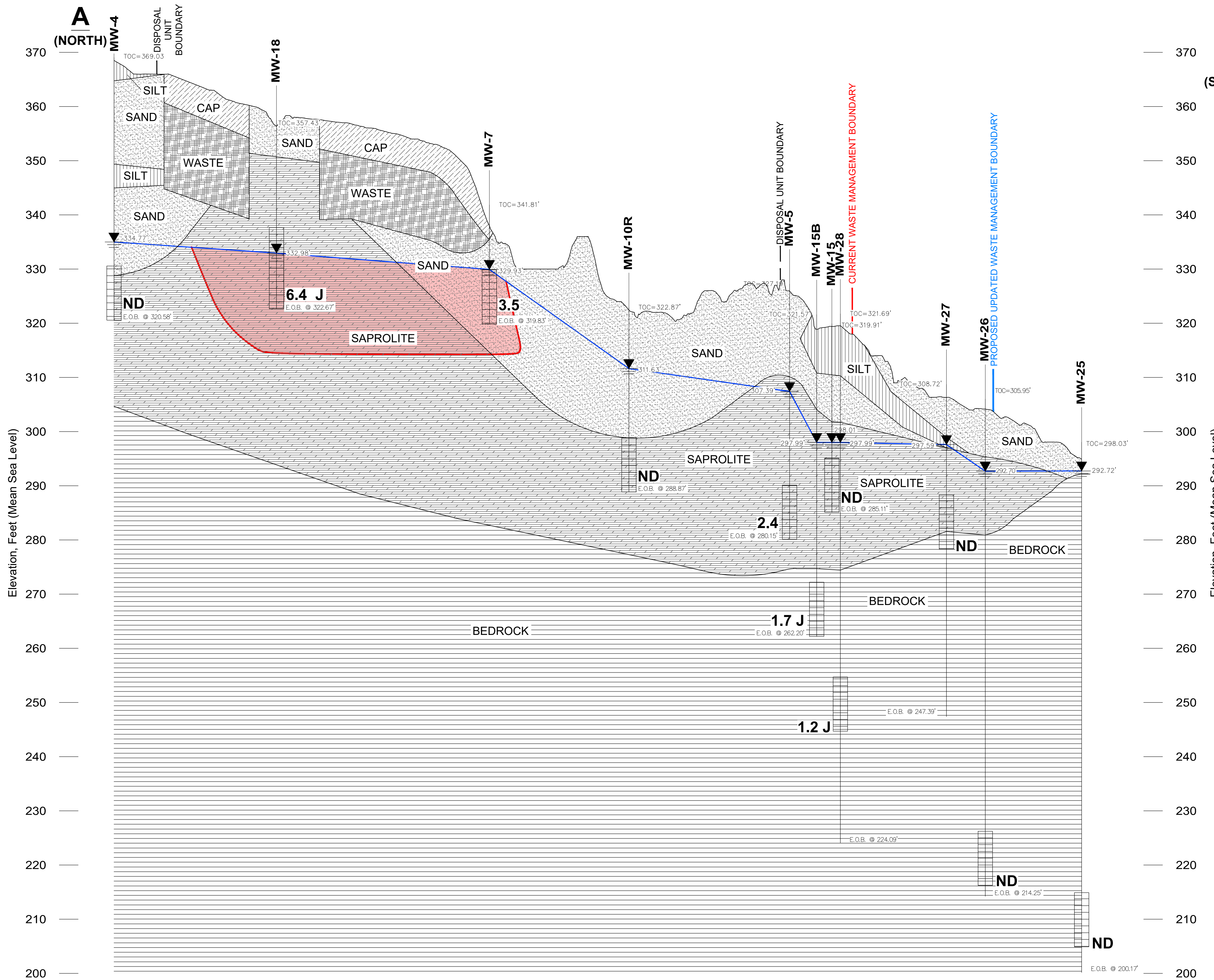
Seres Engineering & Services,LLC

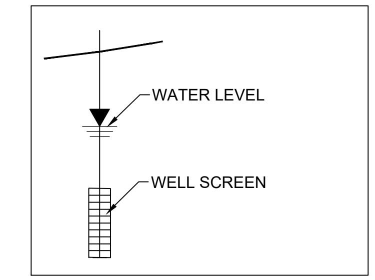
TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

1,1-DICHLOROETHANE CONCENTRATIONS IN GROUNDWATER - MARCH 2022

PROJECT NO.:	30145389
DESIGNED BY:	JPL
DRAWN BY:	BWM
CHECKED BY:	JPL
APPROVED BY:	DAM
DATE:	SEPTEMBER 2022
DRAWING NUMBER:	2.2A

C:\Users\jmeyer\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F02.2A-1,1 DICHLOROETHANE PLAN.dwg LAYOUT: 2.2A SAVED: 9/15/2022 6:30 PM ACADVER: 24.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ----
PLOTTED: 9/16/2022 12:15 PM BY: MEYER, JULIE

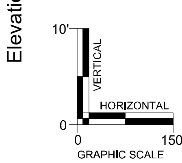




MONITORING WELL SCHEMATIC

LEGEND:

- COVER
- WASTE
- CLAY, SILTY CLAY, SANDY CLAY
- SILT, SANDY SILT, CLAYEY SILT
- SAND
- SAND AND GRAVEL
- SAPROLITE
- BEDROCK
- EXISTING TOPOGRAPHY (LIDAR)
- TOC — TOP OF CASING
- E.O.B. — END OF BORING
- GROUNDWATER ELEVATION
- X.X ug/L — CHEMICAL CONSTITUENT CONCENTRATION
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF 1,1 DCA



NOTES:

1. LITHOLOGY CONTAINED ON THIS DRAWING IS INTERPOLATED BETWEEN BORING LOCATIONS.
2. DESCRIPTIONS DEPICTED ON THIS DRAWING ARE GENERALIZED. THE COMPLETE DESCRIPTIONS ARE CONTAINED ON THE BORING LOGS.
3. EXISTING TOPOGRAPHY DEVELOPED FROM DIGITAL COAST DATA, 2014 USGS CMGP LIDAR: POST SANDY (VA).
4. WATER LEVEL DATA OBTAINED FROM MARCH 2020 SEMI-ANNUAL GROUNDWATER MONITORING REPORT, TABLE 1.1. (ALLIANT 2022)
5. GPS = GROUNDWATER PROTECTION STANDARD (2.8 ug/L)
6. ND = NOT DETECTED
7. ug/L = MICROGRAMS PER LITER
8. 1,1-DCA = 1,1 DICHLOROETHANE
9. J = ANALYTE WAS POSITIVELY IDENTIFIED; HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.

C:\Users\kdavis\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F02.2B-1,1 DICHLOROETHANE XSECT.dwg LAYOUT: 2.2B SAVED: 9/15/2022 12:08 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ----
PLOTTED: 9/15/2022 5:44 PM BY: DAVIS, KATHI

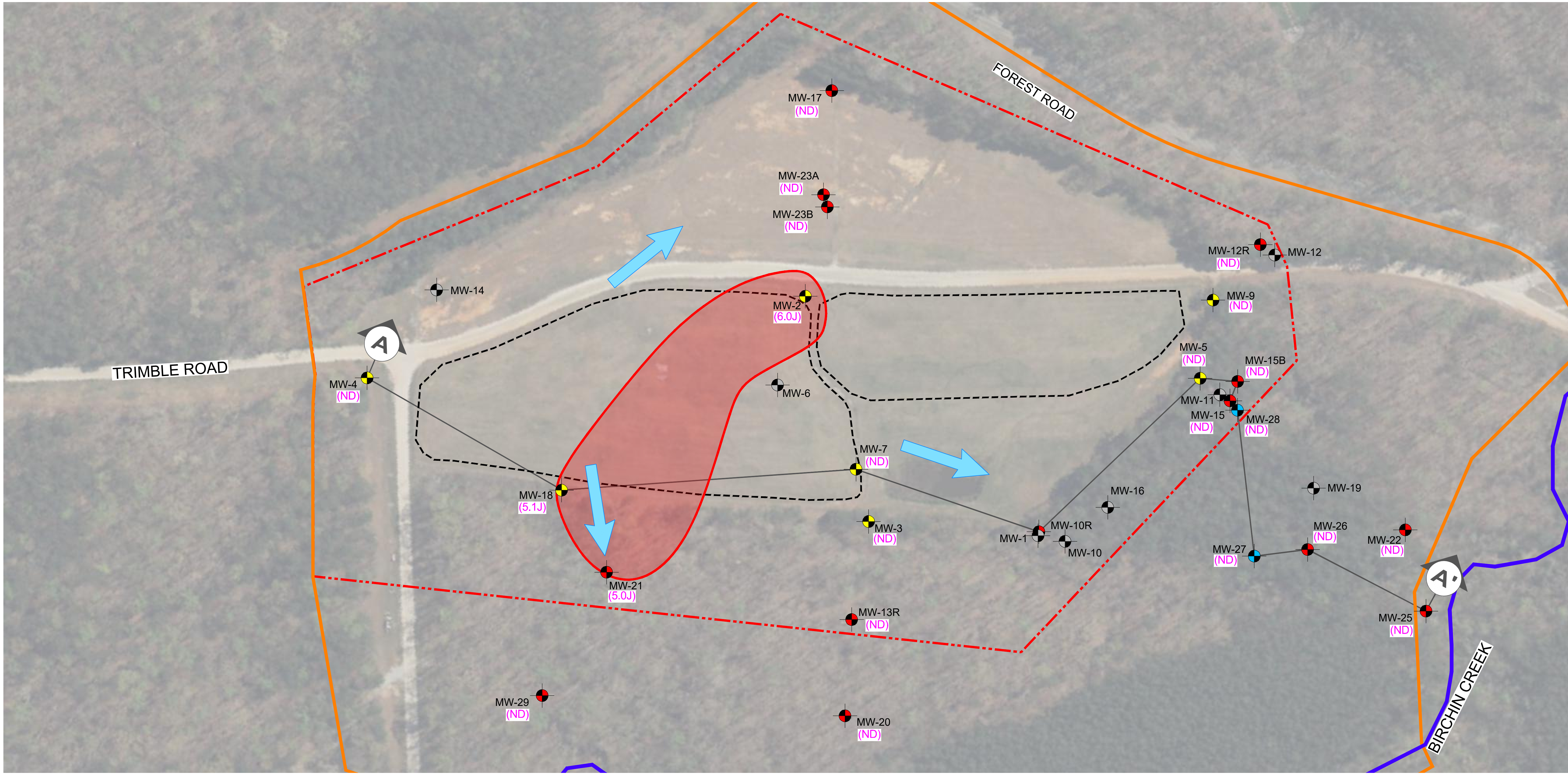
REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

CROSS SECTION A-A'
SHOWING EXTENT OF 1,1-DICHLOROETHANE GPS EXCEEDANCES IN GROUNDWATER

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		2.2B
CHECKED BY:	JPL		
APPROVED BY:	DAM		



LEGEND:

MW-2	COMPLIANCE MONITORING WELL
MW-1	SENTINEL MONITORING WELL
MW-27	PERFORMANCE MONITORING WELL
MW-6	ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
	BIRCHIN CREEK
	APPARENT DIRECTION OF GROUNDWATER FLOW
	INTERPRETED EXTENT OF GPS EXCEEDANCES OF METHYLENE CHLORIDE
	CURRENT WASTE MANAGEMENT BOUNDARY
	FACILITY BOUNDARY
	DISPOSAL UNIT BOUNDARY
(ND)	METHYLENE CHLORIDE CONCENTRATION (ug/L)
A'	CROSS SECTION

SCALE IN FEET

0 100 200 400

N E S W

NOTES:

1. METHYLENE CHLORIDE GPS = 5 ug/L
2. GPS = GROUNDWATER PROTECTION STANDARD
3. J = THE ANALYTE WAS POSITIVELY IDENTIFIED;HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.
4. ND = NON-DETECT
5. ug/L = MICROGRAMS PER LITER

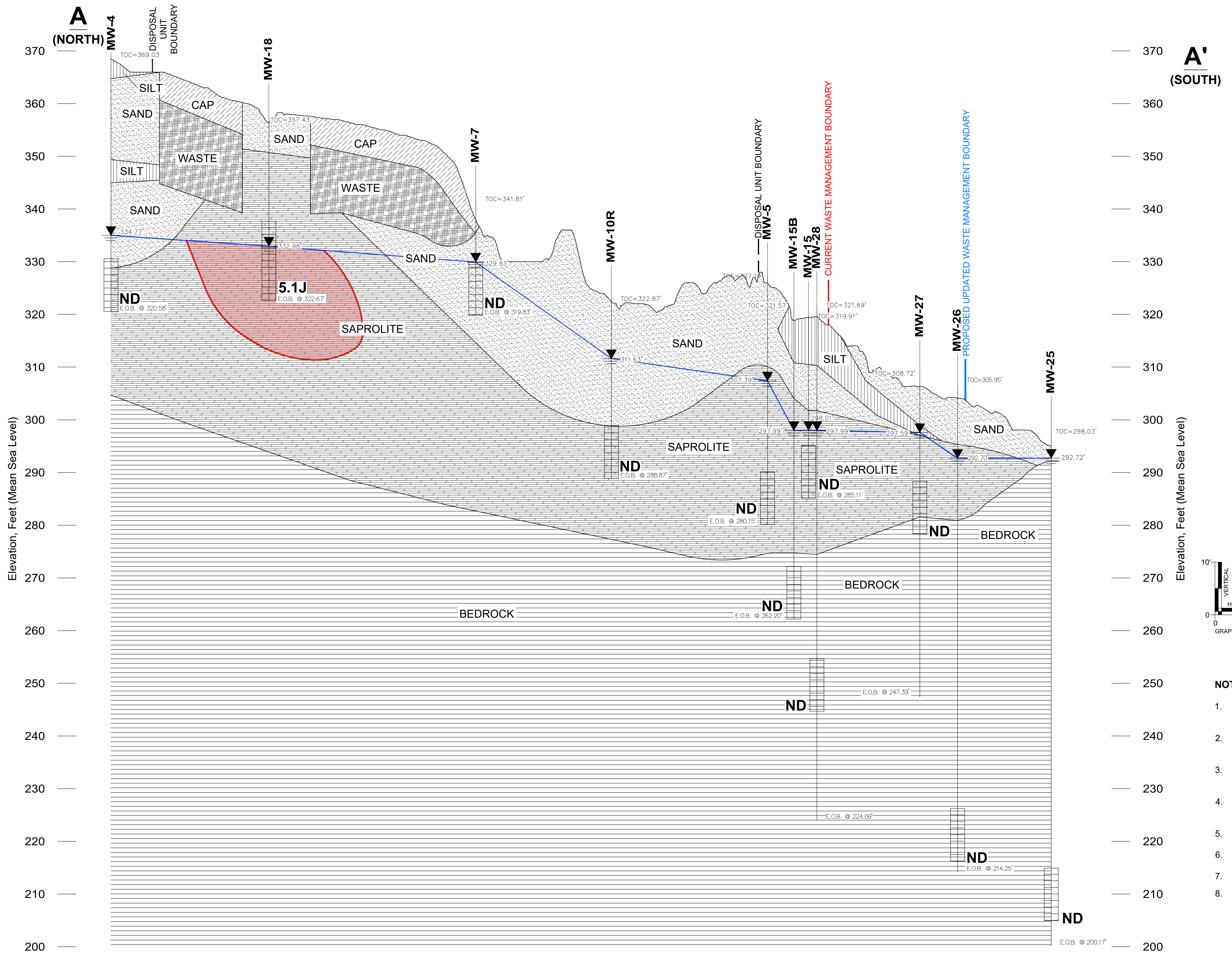
REV. NO.	DATE	DESCRIPTION

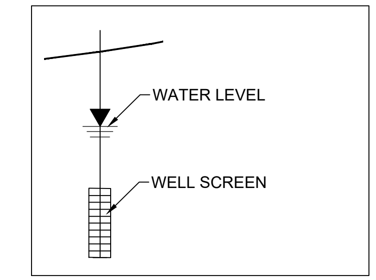
Seres Engineering & Services,LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

METHYLENE CHLORIDE CONCENTRATIONS IN GROUNDWATER - MARCH 2022

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		2.3A
CHECKED BY:	JPL		
APPROVED BY:	DAM		





MONITORING WELL SCHEMATIC

LEGEND:

- COVER
- WASTE
- CLAY, SILTY CLAY, SANDY CLAY
- SILT, SANDY SILT, CLAYEY SILT
- SAND
- SAND AND GRAVEL
- SAPROLITE
- BEDROCK
- EXISTING TOPOGRAPHY (LIDAR)
- TOC — TOP OF CASING
- E.O.B. — END OF BORING
- GROUNDWATER ELEVATION
- X.X ug/L — CHEMICAL CONSTITUENT CONCENTRATION
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF METHYLENE CHLORIDE

NOTES:

1. LITHOLOGY CONTAINED ON THIS DRAWING IS INTERPOLATED BETWEEN BORING LOCATIONS.
2. DESCRIPTIONS DEPICTED ON THIS DRAWING ARE GENERALIZED. THE COMPLETE DESCRIPTIONS ARE CONTAINED ON THE BORING LOGS.
3. EXISTING TOPOGRAPHY DEVELOPED FROM DIGITAL COAST DATA, 2014 USGS CMGP LIDAR: POST SANDY (VA).
4. WATER LEVEL DATA OBTAINED FROM MARCH 2020 SEMI-ANNUAL GROUNDWATER MONITORING REPORT, TABLE 1.1. (ALLIANT 2022)
5. GPS = GROUNDWATER PROTECTION STANDARD (5 ug/L)
6. ND = NOT DETECTED
7. ug/L = MICROGRAMS PER LITER
8. J = ANALYTE WAS POSITIVELY IDENTIFIED; HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.

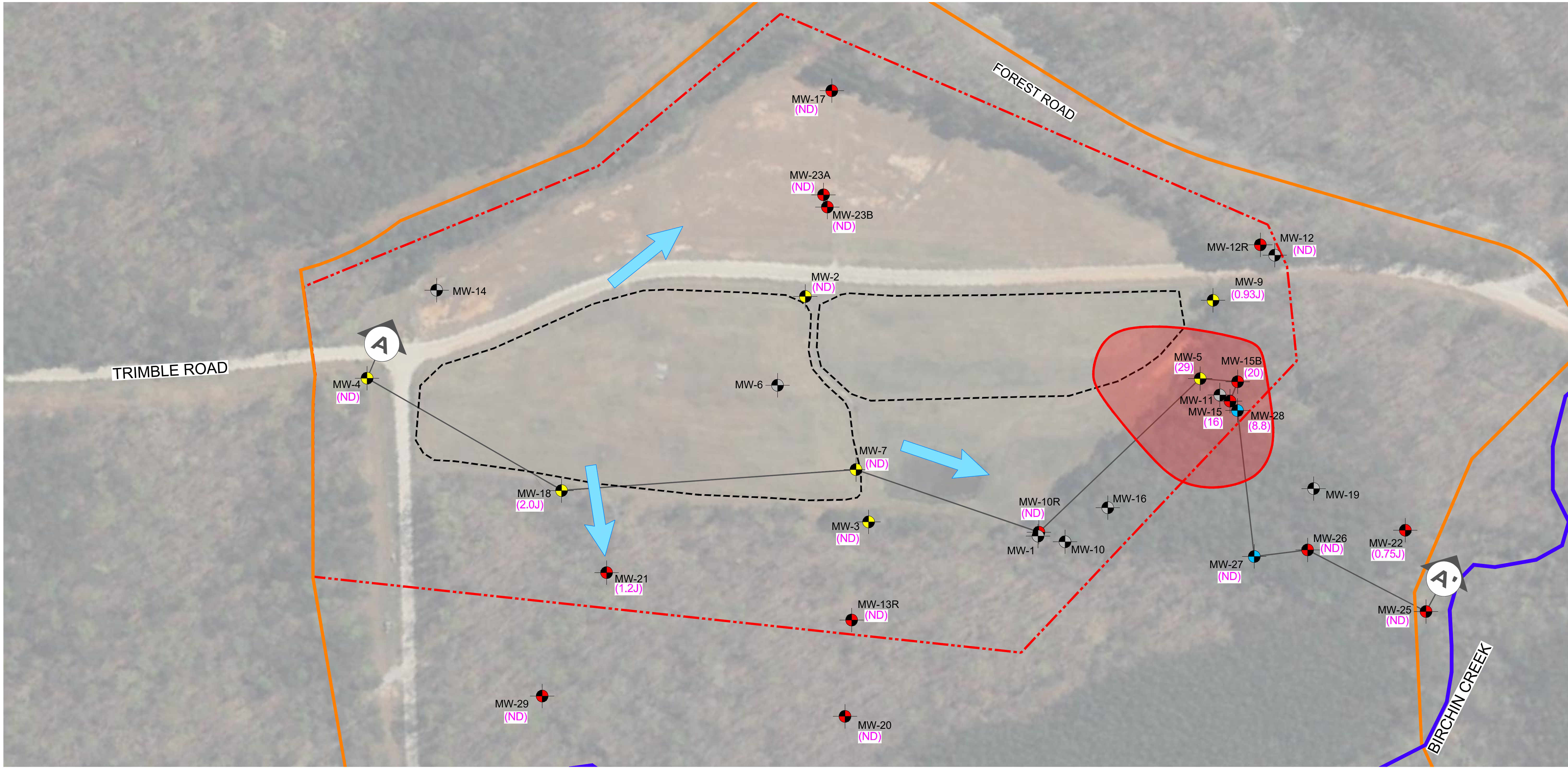
REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

**CROSS SECTION A-A'
SHOWING EXTENT OF METHYLENE CHLORIDE GPS EXCEEDANCES IN GROUNDWATER**

PROJECT NO.:	30145389
DESIGNED BY:	JPL
DRAWN BY:	BWM
CHECKED BY:	JPL
APPROVED BY:	DAM
DATE:	SEPTEMBER 2022
DRAWING NUMBER:	2.3B



LEGEND:

- MW-2 COMPLIANCE MONITORING WELL
- MW-1 SENTINEL MONITORING WELL
- MW-27 PERFORMANCE MONITORING WELL
- MW-6 ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
- BIRCHIN CREEK
- APPARENT DIRECTION OF GROUNDWATER FLOW
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF TETRACHLOROETHYLENE
- CURRENT WASTE MANAGEMENT BOUNDARY
- FACILITY BOUNDARY
- DISPOSAL UNIT BOUNDARY
- (ND) TETRACHLOROETHENE CONCENTRATION (ug/L)
- A' CROSS SECTION

SCALE IN FEET
0 100 200 400

N E S W

NOTES:

1. PCE GPS = 5 ug/L
2. PCE = TETRACHLOROETHENE
3. GPS = GROUNDWATER PROTECTION STANDARD
4. J = THE ANALYTE WAS POSITIVELY IDENTIFIED;HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.
5. ND = NON-DETECT
6. ug/L = MICROGRAMS PER LITER

REV. NO.	DATE	DESCRIPTION

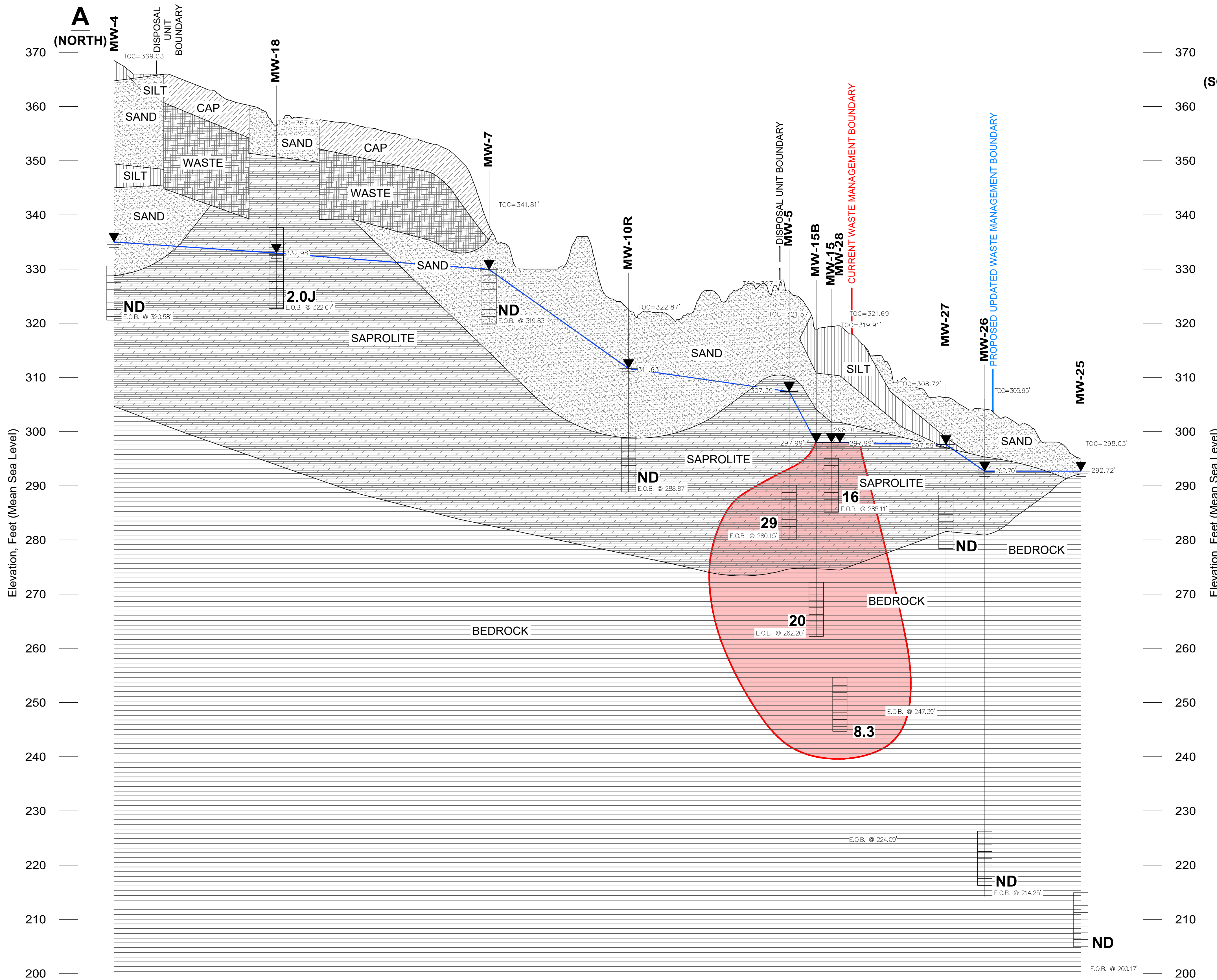
Seres Engineering & Services,LLC

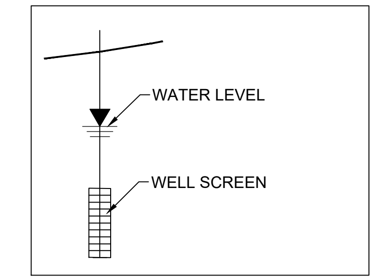
TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

TETRACHLOROETHENE (PCE) CONCENTRATIONS IN GROUNDWATER - MARCH 2022

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		2.4A
CHECKED BY:	JPL		
APPROVED BY:	DAM		

C:\Users\jmeyer\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F02.4A-TETRACHLOROETHYLENE PLAN.dwg LAYOUT: 2.4A SAVED: 9/16/2022 12:18 PM ACADVER: 24.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ----
PLOTTED: 9/16/2022 12:18 PM BY: MEYER, JULIE

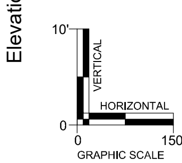




MONITORING WELL SCHEMATIC

LEGEND:

- COVER
- WASTE
- CLAY, SILTY CLAY, SANDY CLAY
- SILT, SANDY SILT, CLAYEY SILT
- SAND
- SAND AND GRAVEL
- SAPROLITE
- BEDROCK
- EXISTING TOPOGRAPHY (LIDAR)
- TOC — TOP OF CASING
- E.O.B. — END OF BORING
- GROUNDWATER ELEVATION
- X.X ug/L — CHEMICAL CONSTITUENT CONCENTRATION
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF PCE



NOTES:

1. LITHOLOGY CONTAINED ON THIS DRAWING IS INTERPOLATED BETWEEN BORING LOCATIONS.
2. DESCRIPTIONS DEPICTED ON THIS DRAWING ARE GENERALIZED. THE COMPLETE DESCRIPTIONS ARE CONTAINED ON THE BORING LOGS.
3. EXISTING TOPOGRAPHY DEVELOPED FROM DIGITAL COAST DATA, 2014 USGS CMGP LIDAR: POST SANDY (VA).
4. WATER LEVEL DATA OBTAINED FROM MARCH 2020 SEMI-ANNUAL GROUNDWATER MONITORING REPORT, TABLE 1.1. (ALLIANT 2022)
5. GPS = GROUNDWATER PROTECTION STANDARD (5 ug/L)
6. ND = NOT DETECTED
7. ug/L = MICROGRAMS PER LITER
8. J = ANALYTE WAS POSITIVELY IDENTIFIED; HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.
9. PCE = TETRACHLOROETHENE

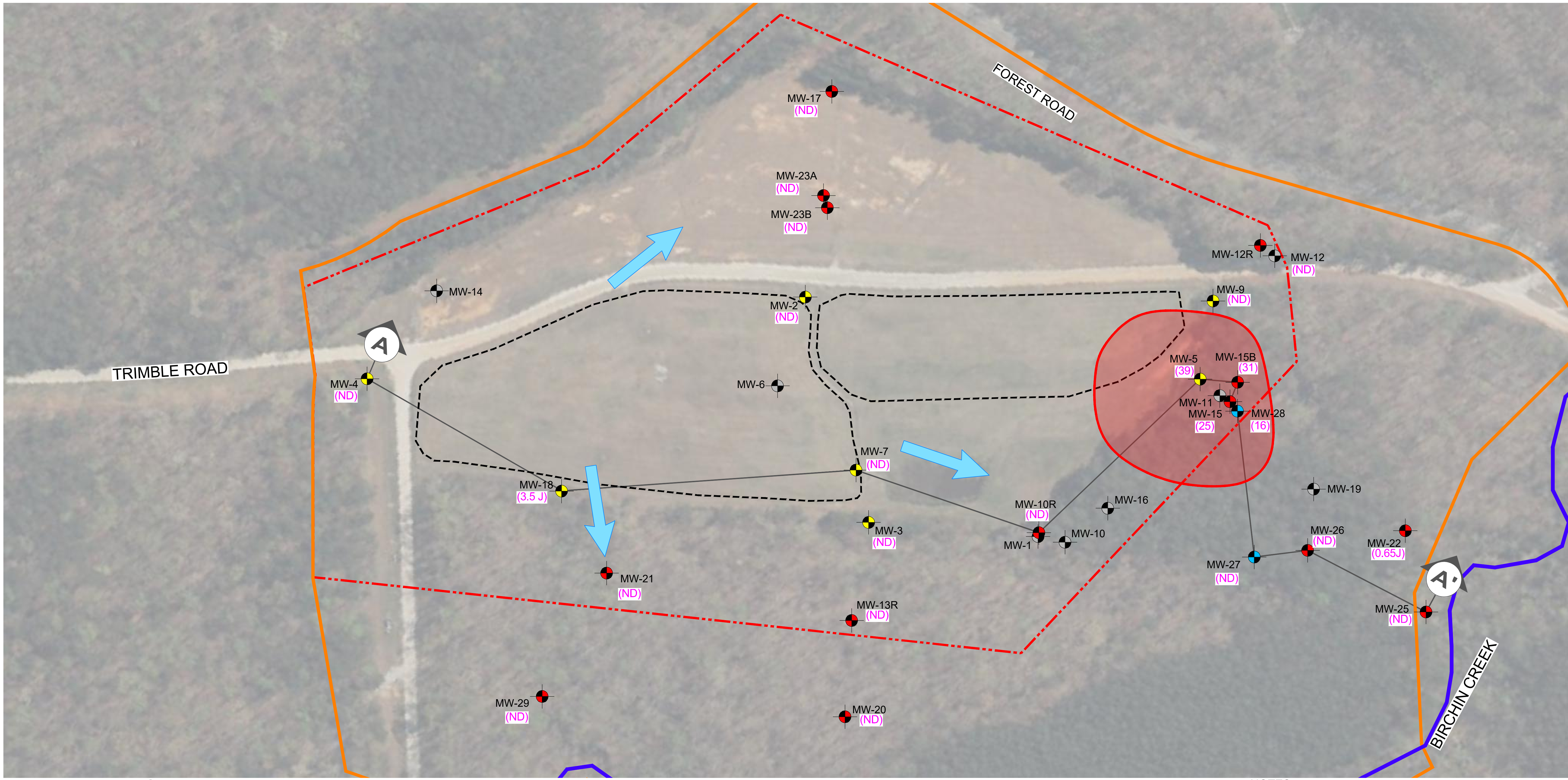
REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services,LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

CROSS SECTION A-A'
SHOWING EXTENT OF TETRACHLOROETHENE
GPS EXCEEDANCES IN GROUNDWATER

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		**2.4B**
CHECKED BY:	JPL		
APPROVED BY:	DAM		



LEGEND:

- MW-2 COMPLIANCE MONITORING WELL
- MW-1 SENTINEL MONITORING WELL
- MW-27 PERFORMANCE MONITORING WELL
- MW-6 ADDITIONAL SITE -MONITORING WELL (NOT SAMPLED)
- BIRCHIN CREEK
- APPARENT DIRECTION OF GROUNDWATER FLOW
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF TRICHLOROETHENE
- CURRENT WASTE MANAGEMENT BOUNDARY
- FACILITY BOUNDARY
- DISPOSAL UNIT BOUNDARY
- (ND) TRICHLOROETHENE CONCENTRATION (ug/L)
- A' CROSS SECTION

SCALE IN FEET: 0, 100, 200, 400

N E S W

NOTES:

1. TCE GPS = 5 ug/L
2. TCE = TRICHLOROETHENE
3. GPS = GROUNDWATER PROTECTION STANDARD
4. J = THE ANALYTE WAS POSITIVELY IDENTIFIED;HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.
5. ND = NON-DETECT
6. ug/L = MICROGRAMS PER LITER

REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services,LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

TRICHLOROETHENE (TCE) CONCENTRATIONS IN GROUNDWATER - MARCH 2022

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		**2.5A**
CHECKED BY:	JPL		
APPROVED BY:	DAM		

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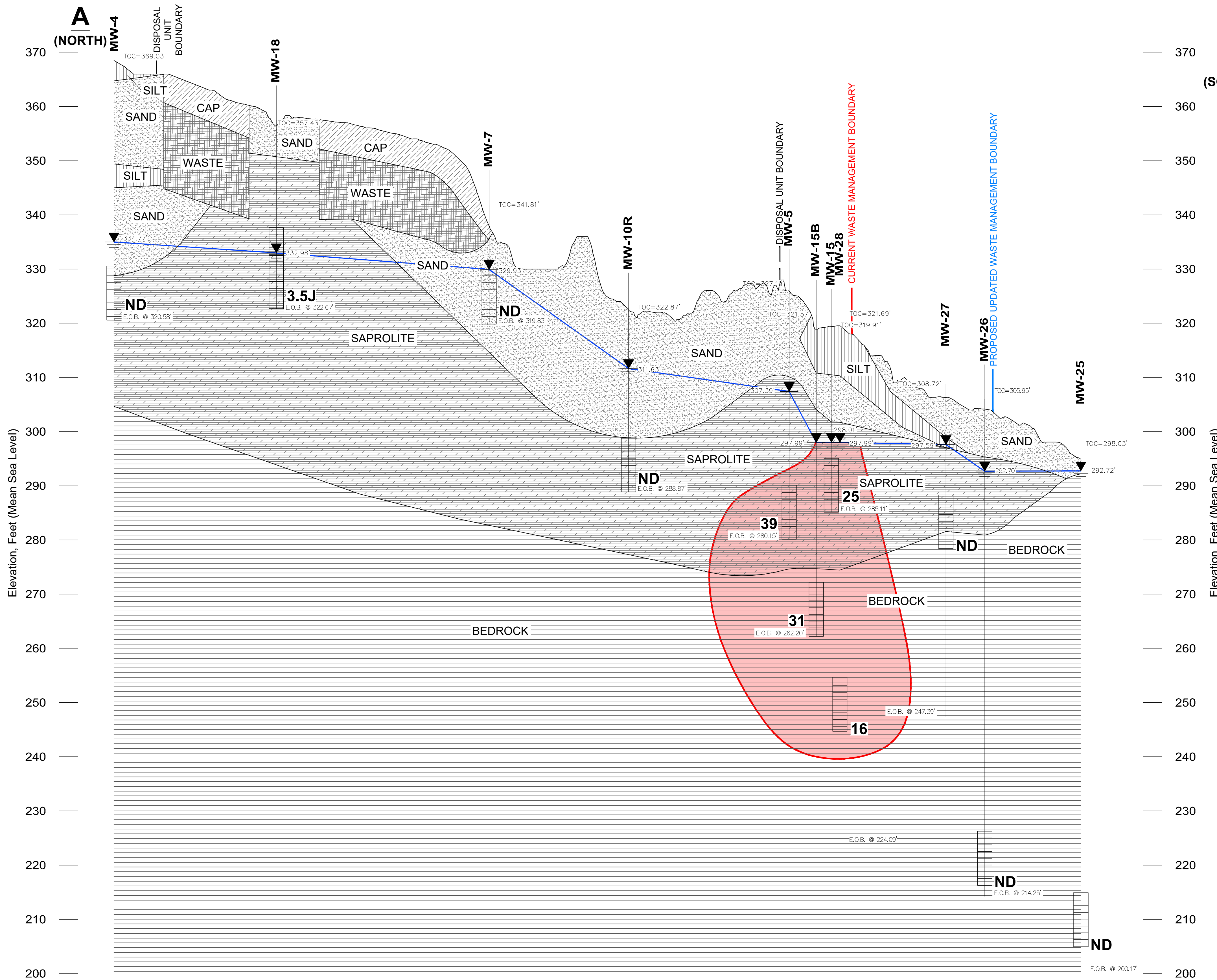
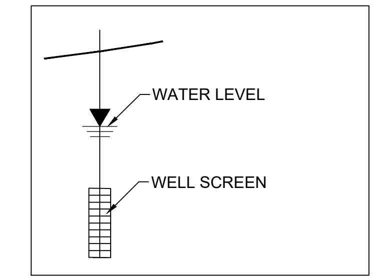
PLOTTED: 9/16/2022 12:20 PM BY: MEYER, JULIE

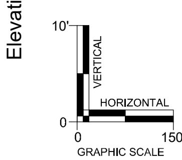




MONITORING WELL SCHEMATIC

LEGEND:

- COVER
- WASTE
- CLAY, SILTY CLAY, SANDY CLAY
- SILT, SANDY SILT, CLAYEY SILT
- SAND
- SAND AND GRAVEL
- SAPROLITE
- BEDROCK
- EXISTING TOPOGRAPHY (LIDAR)
- TOC — TOP OF CASING
- E.O.B. — END OF BORING
- GROUNDWATER ELEVATION
- X.X ug/L — CHEMICAL CONSTITUENT CONCENTRATION
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF TCE



NOTES:

1. LITHOLOGY CONTAINED ON THIS DRAWING IS INTERPOLATED BETWEEN BORING LOCATIONS.
2. DESCRIPTIONS DEPICTED ON THIS DRAWING ARE GENERALIZED. THE COMPLETE DESCRIPTIONS ARE CONTAINED ON THE BORING LOGS.
3. EXISTING TOPOGRAPHY DEVELOPED FROM DIGITAL COAST DATA, 2014 USGS CMGP LIDAR: POST SANDY (VA).
4. WATER LEVEL DATA OBTAINED FROM MARCH 2020 SEMI-ANNUAL GROUNDWATER MONITORING REPORT, TABLE 1.1. (ALLIANT 2022)
5. GPS = GROUNDWATER PROTECTION STANDARD (5 ug/L)
6. ND = NOT DETECTED
7. ug/L = MICROGRAMS PER LITER
8. J = ANALYTE WAS POSITIVELY IDENTIFIED; HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.
9. TCE = TRICHLOROETHENE

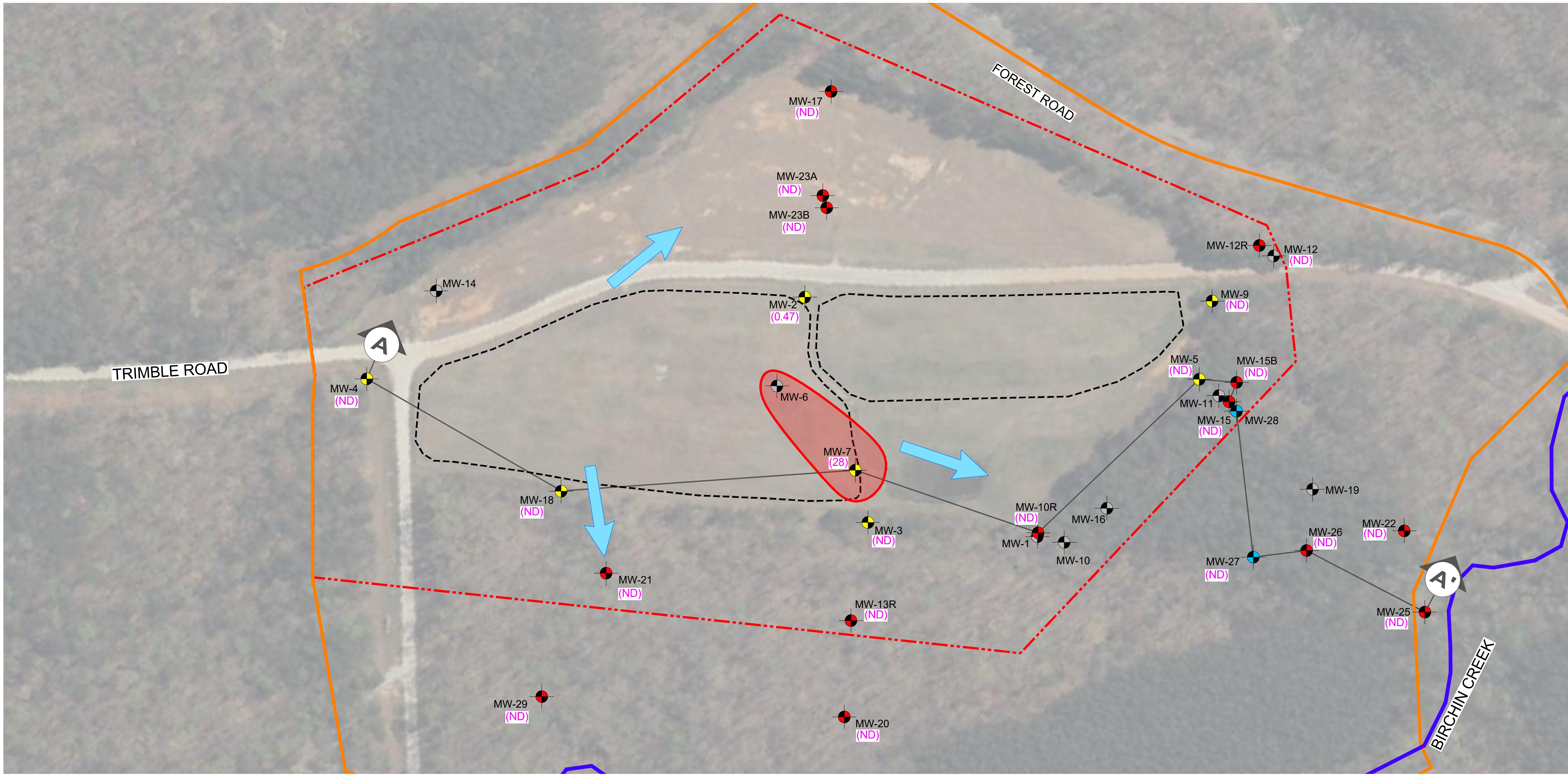
REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

CROSS SECTION A-A'
SHOWING EXTENT OF TRICHLOROETHENE
GPS EXCEEDANCES IN GROUNDWATER

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		2.5B
CHECKED BY:	JPL		
APPROVED BY:	DAM		



LEGEND:

- MW-2 COMPLIANCE MONITORING WELL
- MW-1 SENTINEL MONITORING WELL
- MW-27 PERFORMANCE MONITORING WELL
- MW-6 ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
- BIRCHIN CREEK
- APPARENT DIRECTION OF GROUNDWATER FLOW
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF VINYL CHLORIDE
- CURRENT WASTE MANAGEMENT BOUNDARY
- FACILITY BOUNDARY
- DISPOSAL UNIT BOUNDARY
- (ND) VINYL CHLORIDE CONCENTRATION (ug/L)
- A' CROSS SECTION

SCALE IN FEET
0 100 200 400

N E S W

NOTES:

1. VINYL CHLORIDE GPS = 2 ug/L
2. GPS = GROUNDWATER PROTECTION STANDARD
3. ND = NON-DETECT
4. ug/L = MICROGRAMS PER LITER
5. PLUME EXTENT INCLUDES CONCENTRATION OF VINYL CHLORIDE (4.8 uG/L) WHEN IT WAS LAST SAMPLED ON 11/13/2012.

REV. NO.	DATE	DESCRIPTION

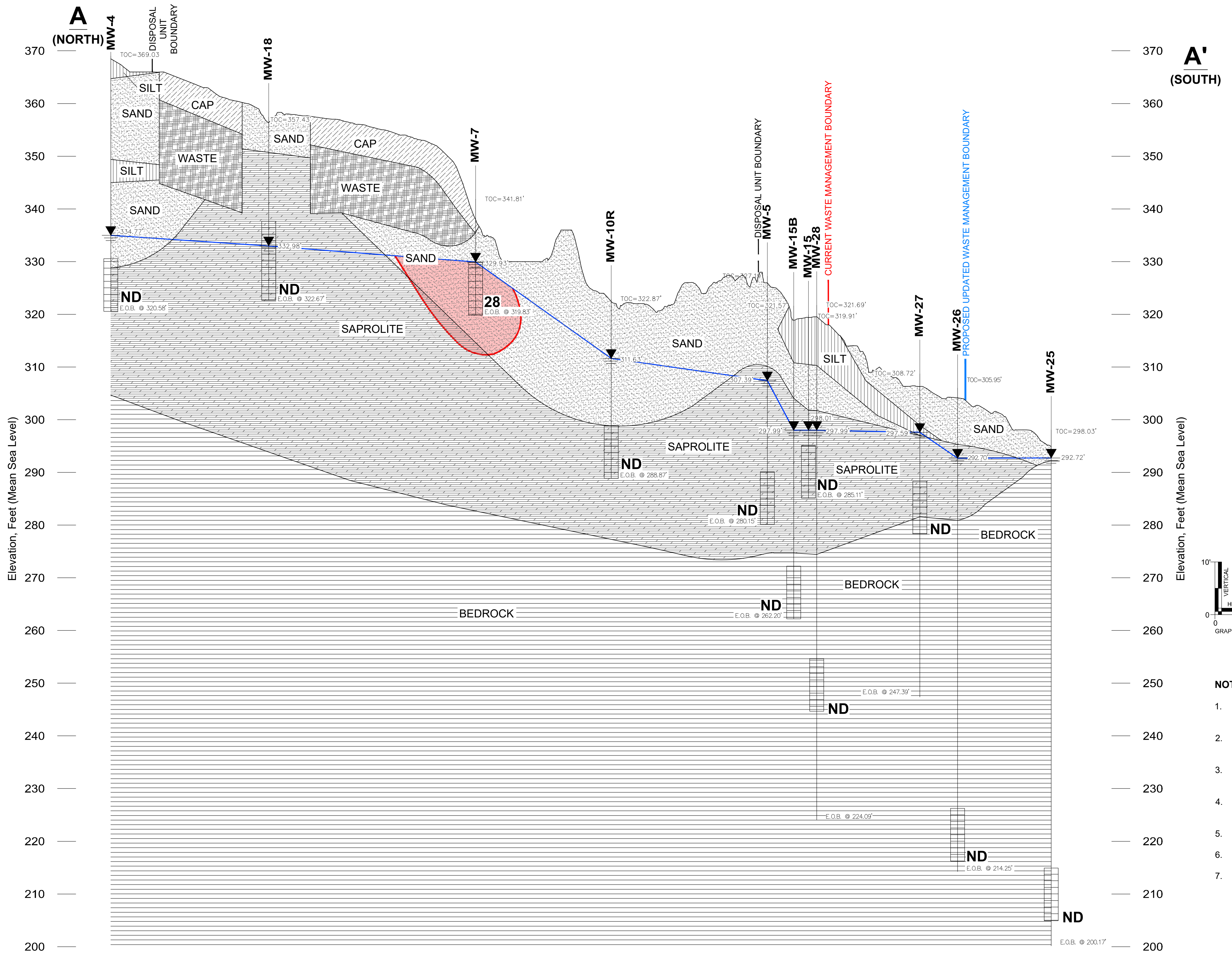
Seres Engineering & Services, LLC

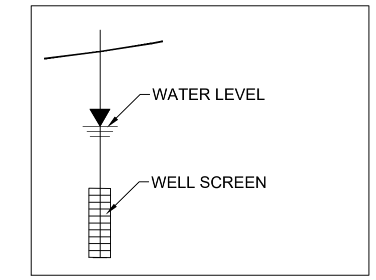
TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

VINYL CHLORIDE CONCENTRATIONS IN GROUNDWATER - MARCH 2022

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		2.6A
CHECKED BY:	JPL		
APPROVED BY:	DAM		

C:\Users\jmeyer\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F02.6A-VINYL CHLORIDE PLAN.dwg LAYOUT: 2.6A SAVED: 9/16/2022 12:22 PM ACADVER: 24.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/16/2022 12:22 PM BY: MEYER, JULIE





MONITORING WELL SCHEMATIC

LEGEND:

- COVER
- WASTE
- CLAY, SILTY CLAY, SANDY CLAY
- SILT, SANDY SILT, CLAYEY SILT
- SAND
- SAND AND GRAVEL
- SAPROLITE
- BEDROCK
- EXISTING TOPOGRAPHY (LIDAR)
- TOC — TOP OF CASING
- E.O.B. — END OF BORING
- GROUNDWATER ELEVATION
- X.X ug/L — CHEMICAL CONSTITUENT CONCENTRATION
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF VINYL CHLORIDE

GRAPHIC SCALE: VERTICAL 0–10'; HORIZONTAL 0–150'

NOTES:

1. LITHOLOGY CONTAINED ON THIS DRAWING IS INTERPOLATED BETWEEN BORING LOCATIONS.
2. DESCRIPTIONS DEPICTED ON THIS DRAWING ARE GENERALIZED. THE COMPLETE DESCRIPTIONS ARE CONTAINED ON THE BORING LOGS.
3. EXISTING TOPOGRAPHY DEVELOPED FROM DIGITAL COAST DATA, 2014 USGS CMGP LIDAR: POST SANDY (VA).
4. WATER LEVEL DATA OBTAINED FROM MARCH 2020 SEMI-ANNUAL GROUNDWATER MONITORING REPORT, TABLE 1.1. (ALLIANT 2022)
5. GPS = GROUNDWATER PROTECTION STANDARD (2 ug/L)
6. ND = NOT DETECTED
7. ug/L = MICROGRAMS PER LITER

REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

CROSS SECTION A-A'
SHOWING EXTENTS OF VINYL CHLORIDE
GPS EXCEEDANCES IN GROUNDWATER

PROJECT NO.:	30145389
DESIGNED BY:	JPL
DRAWN BY:	BWM
CHECKED BY:	JPL
APPROVED BY:	DAM
DATE:	SEPTEMBER 2022
DRAWING NUMBER:	**2.6B**

LEGEND:

- MW-2 COMPLIANCE MONITORING WELL
- MW-1 SENTINEL MONITORING WELL
- MW-27 PERFORMANCE MONITORING WELL
- MW-6 ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
- BIRCHIN CREEK
- APPARENT DIRECTION OF GROUNDWATER FLOW
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF COBALT
- CURRENT WASTE MANAGEMENT BOUNDARY
- FACILITY BOUNDARY
- DISPOSAL UNIT BOUNDARY
- (ND) COBALT CONCENTRATION (ug/L)
- A' CROSS SECTION

SCALE IN FEET

0 100 200 400

N E S W

NOTES:

1. COBALT GPS = 6 ug/L
2. GPS = GROUNDWATER PROTECTION STANDARD
3. J = THE ANALYTE WAS POSITIVELY IDENTIFIED;HOWEVER, THE REPORTED CONCENTRATION IS AN ESTIMATE.
4. ND = NON-DETECT
5. ug/L = MICROGRAMS PER LITER

REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services,LLC

TRIMBLE ROAD LANDFILL FORT PICKETT, BLACKSTONE, VIRGINIA

COBALT CONCENTRATIONS IN GROUNDWATER - MARCH 2022

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		2.7A
CHECKED BY:	JPL		
APPROVED BY:	DAM		

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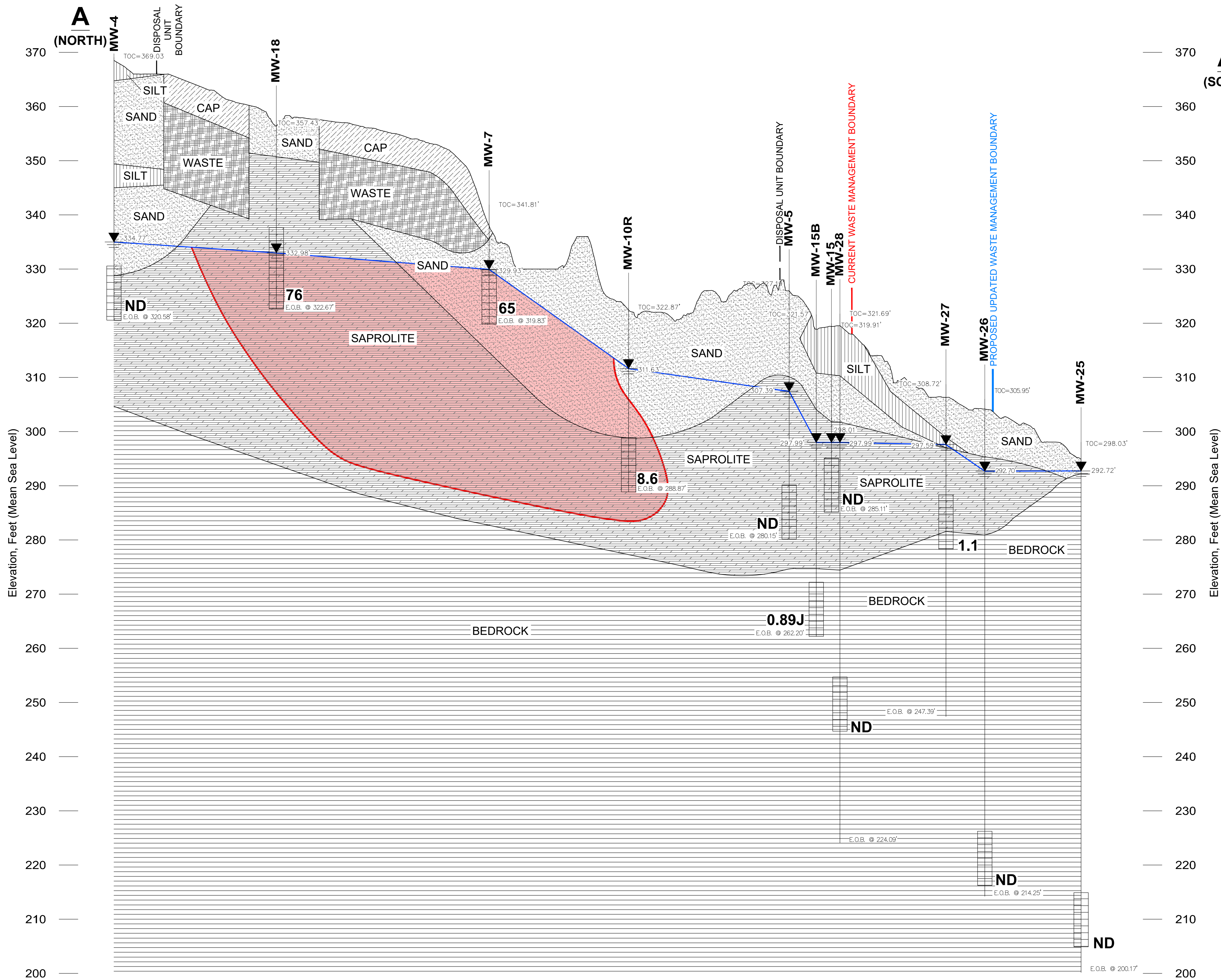
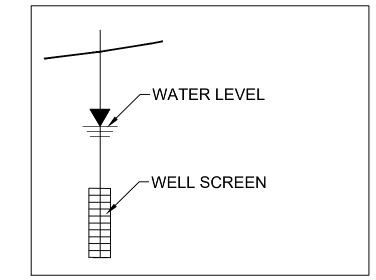




MONITORING WELL SCHEMATIC

LEGEND:

- COVER
- WASTE
- CLAY, SILTY CLAY, SANDY CLAY
- SILT, SANDY SILT, CLAYEY SILT
- SAND
- SAND AND GRAVEL
- SAPROLITE
- BEDROCK
- EXISTING TOPOGRAPHY (LIDAR)
- TOC — TOP OF CASING
- E.O.B. — END OF BORING
- GROUNDWATER ELEVATION
- X.X ug/L — CHEMICAL CONSTITUENT CONCENTRATION
- INTERPRETED EXTENT OF GPS EXCEEDANCES OF COBALT

NOTES:

1. LITHOLOGY CONTAINED ON THIS DRAWING IS INTERPOLATED BETWEEN BORING LOCATIONS.
2. DESCRIPTIONS DEPICTED ON THIS DRAWING ARE GENERALIZED. THE COMPLETE DESCRIPTIONS ARE CONTAINED ON THE BORING LOGS.
3. EXISTING TOPOGRAPHY DEVELOPED FROM DIGITAL COAST DATA, 2014 USGS CMGP LIDAR: POST SANDY (VA).
4. WATER LEVEL DATA OBTAINED FROM MARCH 2020 SEMI-ANNUAL GROUNDWATER MONITORING REPORT, TABLE 1.1. (ALLIANT 2022)
5. GPS = GROUNDWATER PROTECTION STANDARD (6 ug/L)
6. ND = NOT DETECTED
7. ug/L = MICROGRAMS PER LITER

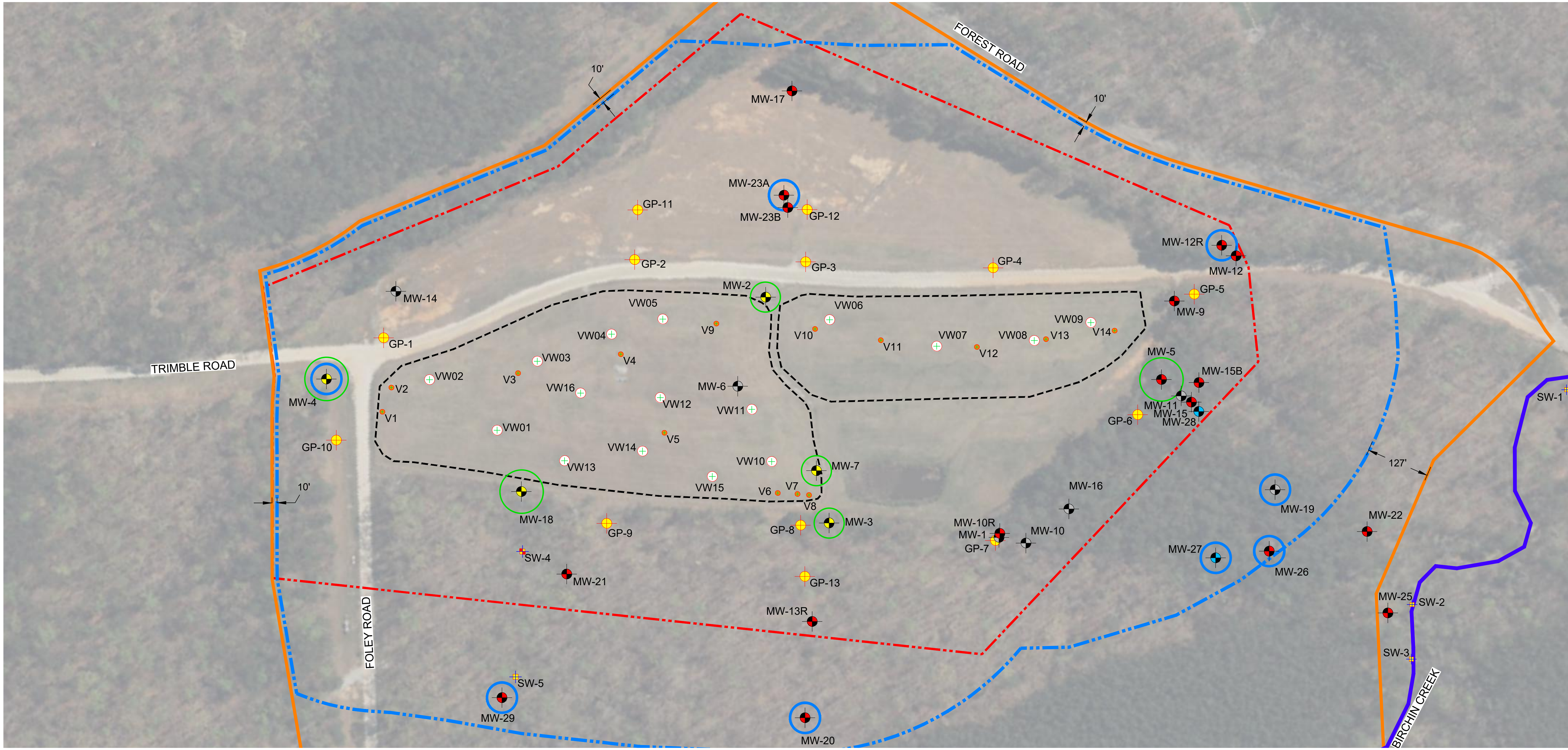
REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

CROSS SECTION A-A'
SHOWING EXTENT OF COBALT
GPS EXCEEDANCES IN GROUNDWATER

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		2.7B
CHECKED BY:	JPL		
APPROVED BY:	DAM		



LEGEND:

MW-2	COMPLIANCE MONITORING WELL
MW-1	SENTINEL MONITORING WELL
MW-27	PERFORMANCE MONITORING WELL
MW-6	ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
	CURRENT WASTE MANAGEMENT BOUNDARY
	PROPOSED UPDATED WASTE MANAGEMENT BOUNDARY
	FACILITY BOUNDARY
	DISPOSAL UNIT BOUNDARY
	GAS VENT WELL
GP-1	GAS PROBE
V01	GAS VENT
SW-01	SURFACE WATER SAMPLING LOCATION
SW-04	GROUNDWATER MONITORING LOCATION
	BIRCHIN CREEK
	EXISTING PERMITTED COMPLIANCE WELL LOCATION
	PROPOSED ALTERNATE POINT OF COMPLIANCE WELL LOCATION

SCALE IN FEET

0 100 200 400

N E S W

REV. NO.	DATE	DESCRIPTION

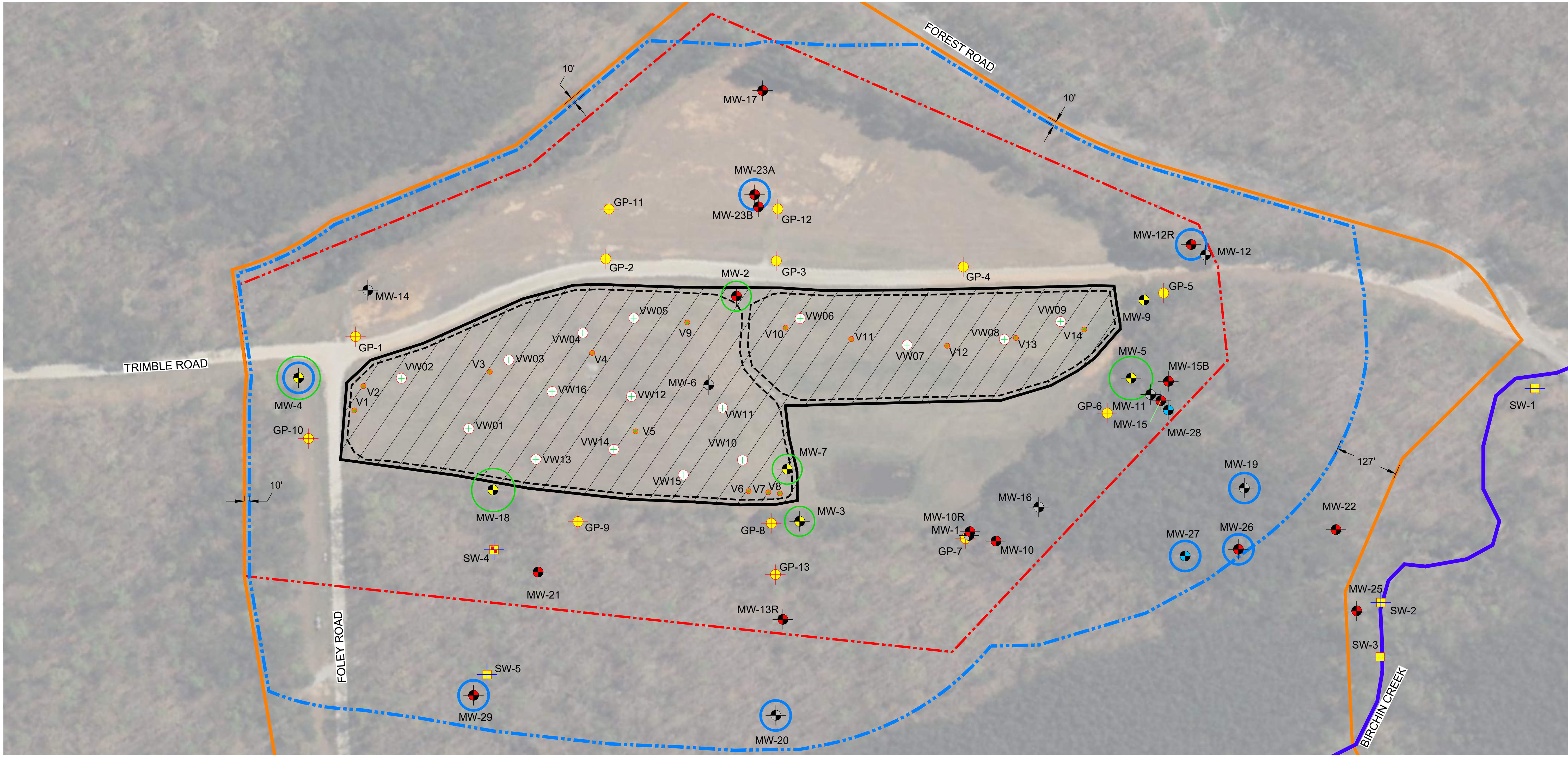
Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

ALTERNATIVE 1 - INCORPORATION OF ADDITIONAL BUFFER ZONE VIA PETITION FOR ALTERNATE POINT OF COMPLIANCE

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		3.1
CHECKED BY:	JPL		
APPROVED BY:	DAM		

C:\Users\kdavis\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F03.1-PASSIVE GAS VENTING CONCEPT.dwg LAYOUT: 3.1 SAVED: 9/16/2022 2:10 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ----
PLOTTED: 9/16/2022 2:10 PM BY: DAVIS, KATHI



LEGEND:

MW-02	COMPLIANCE MONITORING WELL
MW-01	SENTINEL MONITORING WELL
MW-27	PERFORMANCE MONITORING WELL
MW-6	ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
	GAS VENT WELL
SW-04	SURFACE WATER SAMPLING LOCATION
SW-04	GROUNDWATER MONITORING LOCATION
GP-1	GAS PROBE
V01	GAS VENT
	CURRENT WASTE MANAGEMENT BOUNDARY
	PROPOSED UPDATED WASTE MANAGEMENT BOUNDARY
	DISPOSAL UNIT BOUNDARY
	FACILITY BOUNDARY
	BIRCHIN CREEK
	EXISTING PERMITTED COMPLIANCE WELL LOCATION
	PROPOSED ALTERNATE POINT OF COMPLIANCE WELL LOCATION
	PROPOSED UPGRADED GEOSYNTHETIC CAP SYSTEM AREA

SCALE IN FEET
0 100 200 400

N E S W

REV. NO.	DATE	DESCRIPTION

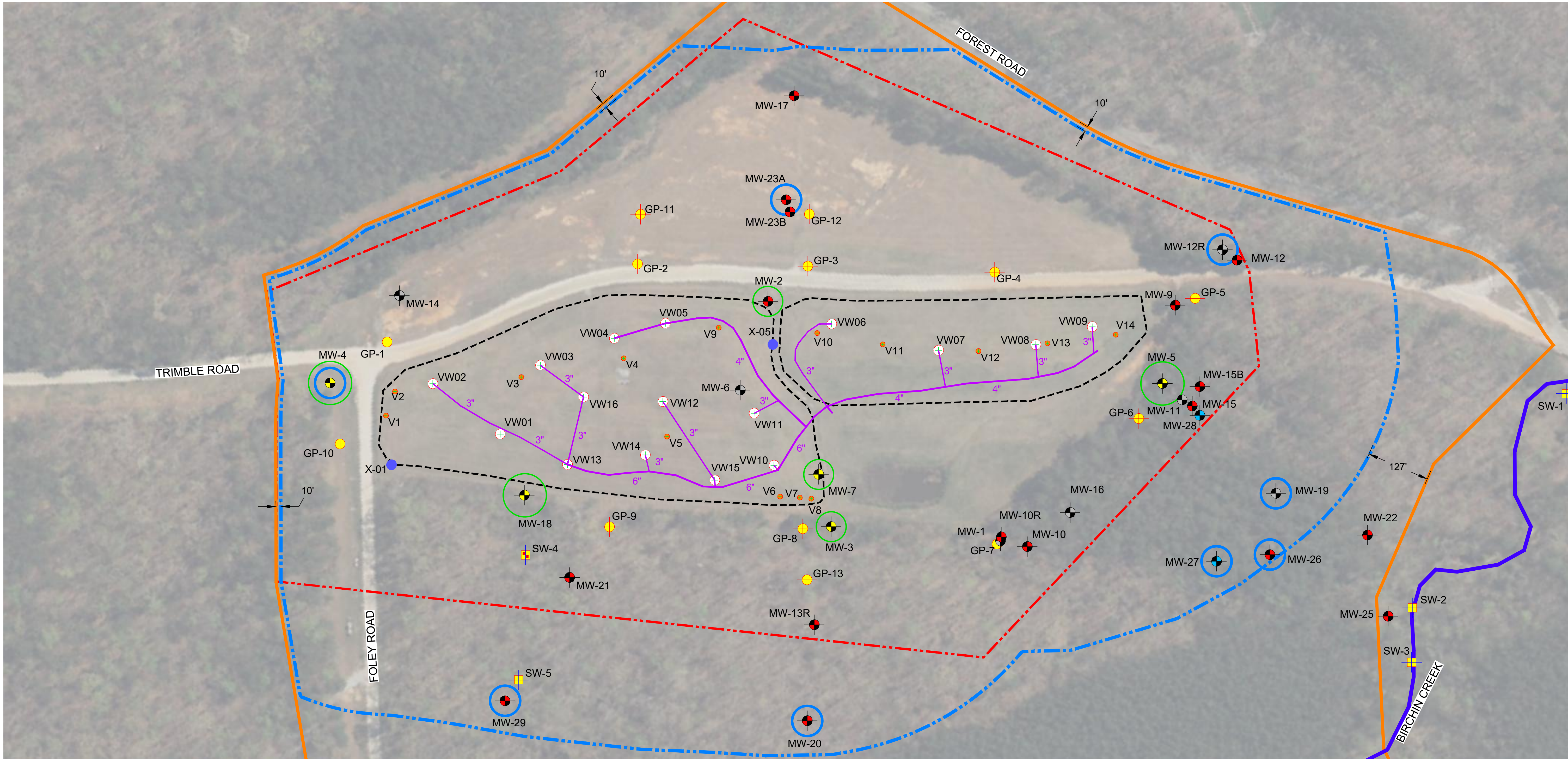
Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

ALTERNATIVE 2 - MONITORED NATURAL ATTENUATION (WITH AND/OR WITHOUT UPGRADED GEOSYNTHETIC CAP SYSTEM

PROJECT NO.:	30145389	DATE:	SEPTEMBER 2022
DESIGNED BY:	JPL	DRAWING NUMBER:	
DRAWN BY:	BWM		3.2
CHECKED BY:	JPL		
APPROVED BY:	DAM		

C:\Users\kdavis\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F03.2-ALT-2-MONITORED ATTENUATION.dwg LAYOUT: 3.2 SAVED: 9/16/2022 3:23 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/16/2022 3:24 PM BY: DAVIS, KATHI



LEGEND:

MW-2	COMPLIANCE MONITORING WELL
MW-1	SENTINEL MONITORING WELL
MW-27	PERFORMANCE MONITORING WELL
MW-6	ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
	GAS VENT WELL
SW-01	SURFACE WATER SAMPLING LOCATION
SW-04	GROUNDWATER MONITORING LOCATION
GP-1	GAS PROBE
V01	GAS VENT
	CURRENT WASTE MANAGEMENT BOUNDARY
	PROPOSED UPDATED WASTE MANAGEMENT BOUNDARY
	DISPOSAL UNIT BOUNDARY
	FACILITY BOUNDARY
	BIRCHIN CREEK
	APPARENT DIRECTION OF GROUNDWATER FLOW
	EXISTING PERMITTED COMPLIANCE WELL LOCATION
	PROPOSED ALTERNATE POINT OF COMPLIANCE WELL LOCATION
	LANDFILL GAS AND LEACHATE COLLECTION SYSTEM PIPING (INCLUDING 2" AIR & 3" FORCEMAIN)

SCALE IN FEET

0 100 200 400

N E S W

REV. NO.	DATE	DESCRIPTION

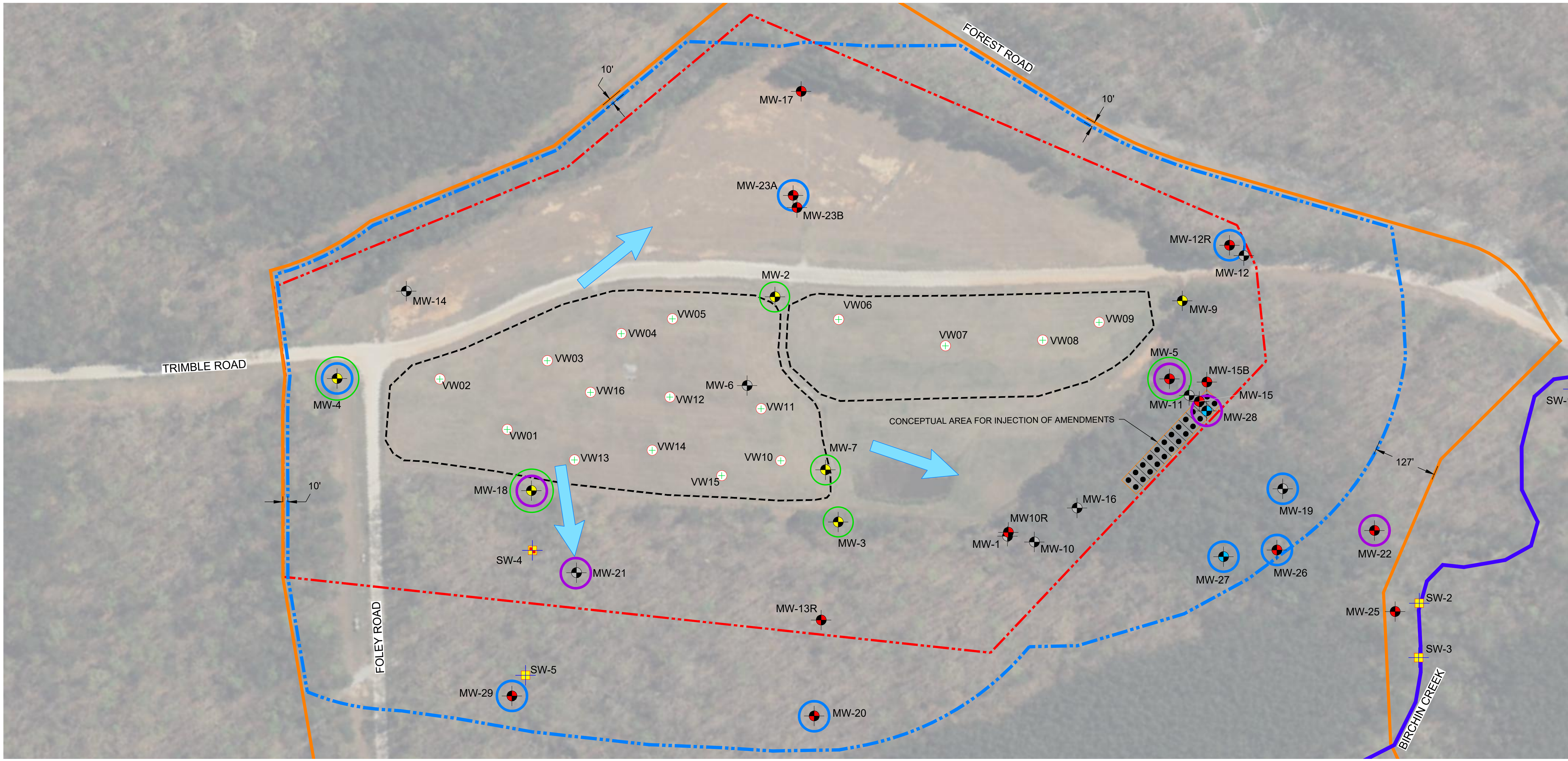
Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

ALTERNATIVE 3 - SOURCE CONTROL VIA LEACHATE/LANDFILL GAS EXTRACTION

PROJECT NO.:	30145389
DESIGNED BY:	JPL
DRAWN BY:	BWM
CHECKED BY:	JPL
APPROVED BY:	DAM
DATE:	SEPTEMBER 2022
DRAWING NUMBER:	3.3

C:\Users\kdavis\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F03.3-ALT-3-LEACHATE GAS EXTRACTION CONCEPT.dwg LAYOUT: 3.3 SAVED: 9/16/2022 2:14 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/16/2022 2:51 PM BY: DAVIS, KATHI



LEGEND:

- MW-2 COMPLIANCE MONITORING WELL
- MW-1 SENTINEL MONITORING WELL
- MW-27 PERFORMANCE MONITORING WELL
- MW-6 ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
- GAS VENT WELL
- SW-01 SURFACE WATER SAMPLING LOCATION
- SW-04 GROUNDWATER MONITORING LOCATION
- CURRENT WASTE MANAGEMENT BOUNDARY
- PROPOSED UPDATED WASTE MANAGEMENT BOUNDARY
- DISPOSAL UNIT BOUNDARY
- FACILITY BOUNDARY
- BIRCHIN CREEK
- APPARENT DIRECTION OF GROUNDWATER FLOW
- EXISTING PERMITTED COMPLIANCE WELL LOCATION
- PROPOSED ALTERNATE POINT OF COMPLIANCE WELL LOCATION
- EXISTING WELLS FOR BIOREMEDIATION MONITORING USE

SCALE IN FEET

0 100 200 400

N E S W

REV. NO.	DATE	DESCRIPTION

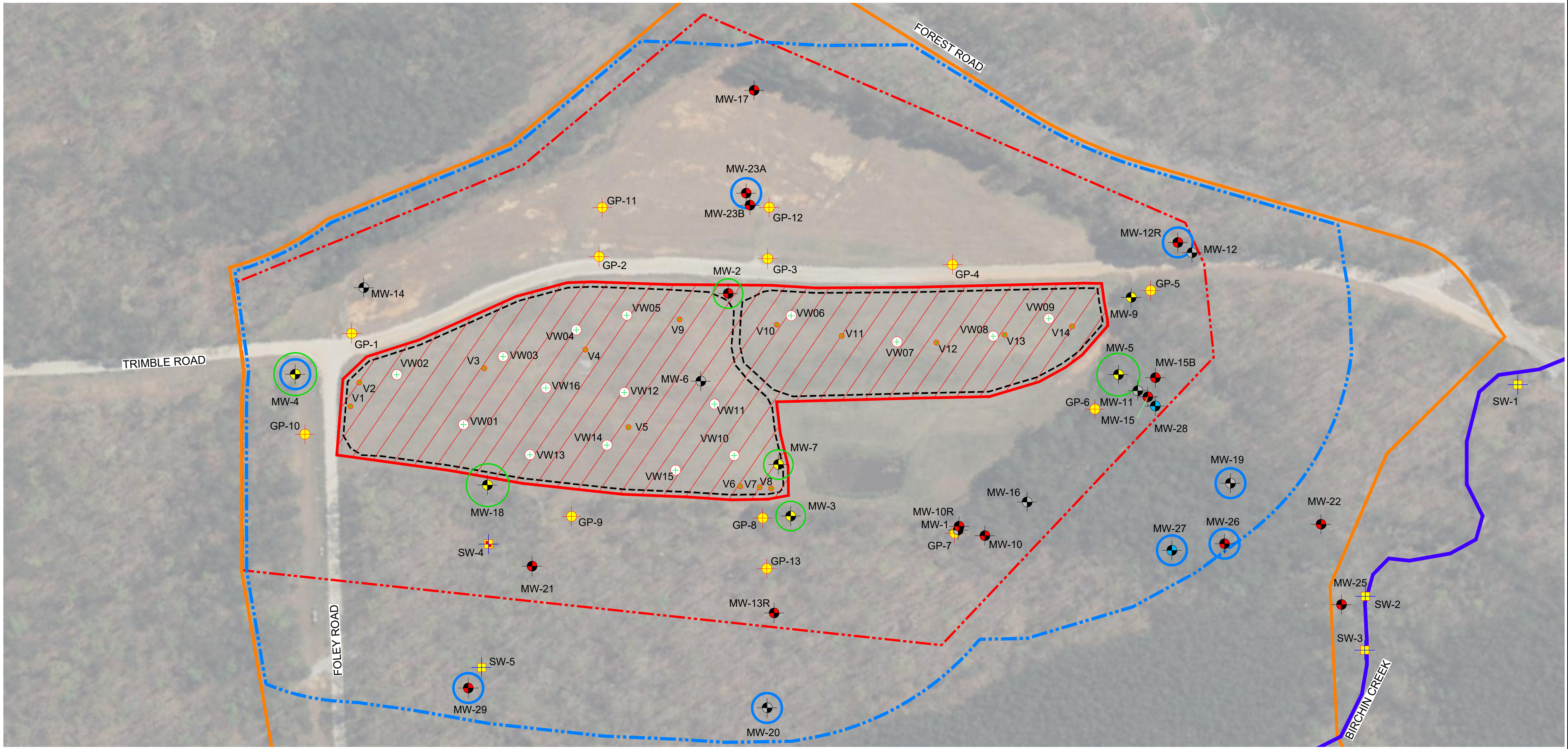
Seres Engineering & Services, LLC

TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

ALTERNATIVE 4 -
ENHANCED BIOREMEDIATION

PROJECT NO.:	30145389
DESIGNED BY:	JPL
DRAWN BY:	BWM
CHECKED BY:	JPL
APPROVED BY:	DAM
DATE:	SEPTEMBER 2022
DRAWING NUMBER:	3.4

C:\Users\kdavis\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F03.4-ALT-4-ENHANCED BIOREMEDIATION.dwg LAYOUT: 3.4 SAVED: 9/16/2022 2:02 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ----
PLOTTED: 9/16/2022 2:03 PM BY: DAVIS, KATHI



LEGEND:

MW-02	COMPLIANCE MONITORING WELL
MW-01	SENTINEL MONITORING WELL
MW-27	PERFORMANCE MONITORING WELL
MW-6	ADDITIONAL SITE MONITORING WELL (NOT SAMPLED)
	GAS VENT WELL
SW-04	SURFACE WATER SAMPLING LOCATION
SW-04	GROUNDWATER MONITORING LOCATION
GP-1	GAS PROBE TO BE DECOMMISSIONED
V01	GAS VENT
	CURRENT WASTE MANAGEMENT BOUNDARY
	PROPOSED UPDATED WASTE MANAGEMENT BOUNDARY
	DISPOSAL UNIT BOUNDARY
	FACILITY BOUNDARY
	BIRCHIN CREEK
	EXISTING PERMITTED COMPLIANCE WELL LOCATION
	PROPOSED ALTERNATE POINT OF COMPLIANCE WELL LOCATION
	SOURCE (WASTE MASS) EXCAVATION AREA

SCALE IN FEET
0 100 200 400

N E S W

REV. NO.	DATE	DESCRIPTION

Seres Engineering & Services, LLC

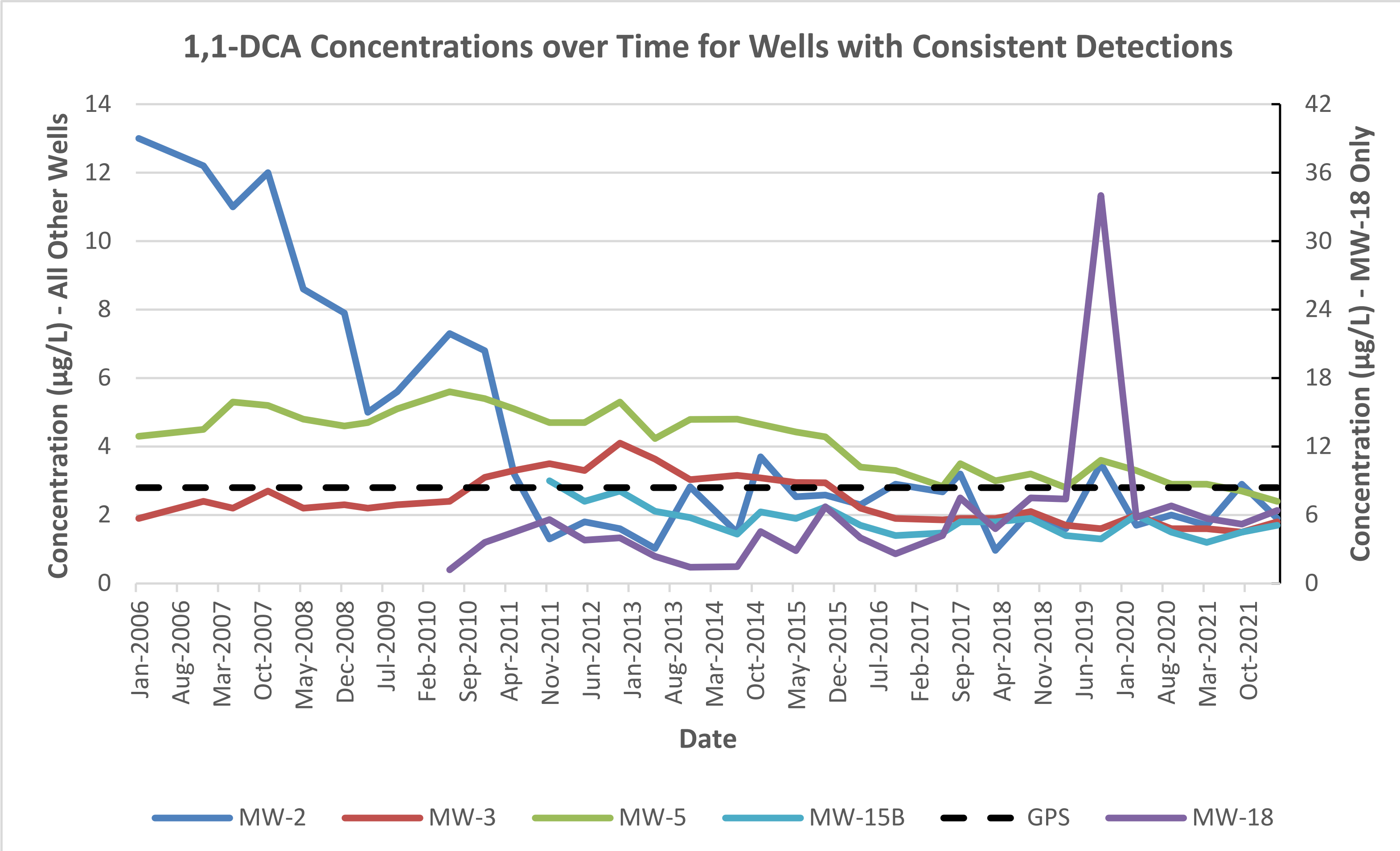
TRIMBLE ROAD LANDFILL
FORT PICKETT, BLACKSTONE, VIRGINIA

ALTERNATIVE 5 - SOURCE REMOVAL/DISPOSAL

PROJECT NO.:	30145389
DESIGNED BY:	JPL
DRAWN BY:	BWM
CHECKED BY:	JPL
APPROVED BY:	DAM
DATE:	SEPTEMBER 2022
DRAWING NUMBER:	3.5

C:\Users\kdavis\ACCDocs\Arcadis\AUS-USACE-FORT PICKETT-BLACKSTONE Virginia\Project Files\2022\01-In Progress\01-DWG\GWM-F03.5-ALT-5-SOURCE REMOVAL.dwg LAYOUT: 3.5 SAVED: 9/16/2022 2:00 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/16/2022 2:00 PM BY: DAVIS, KATHI

Appendix A – Time/Concentration Graphs



Notes:

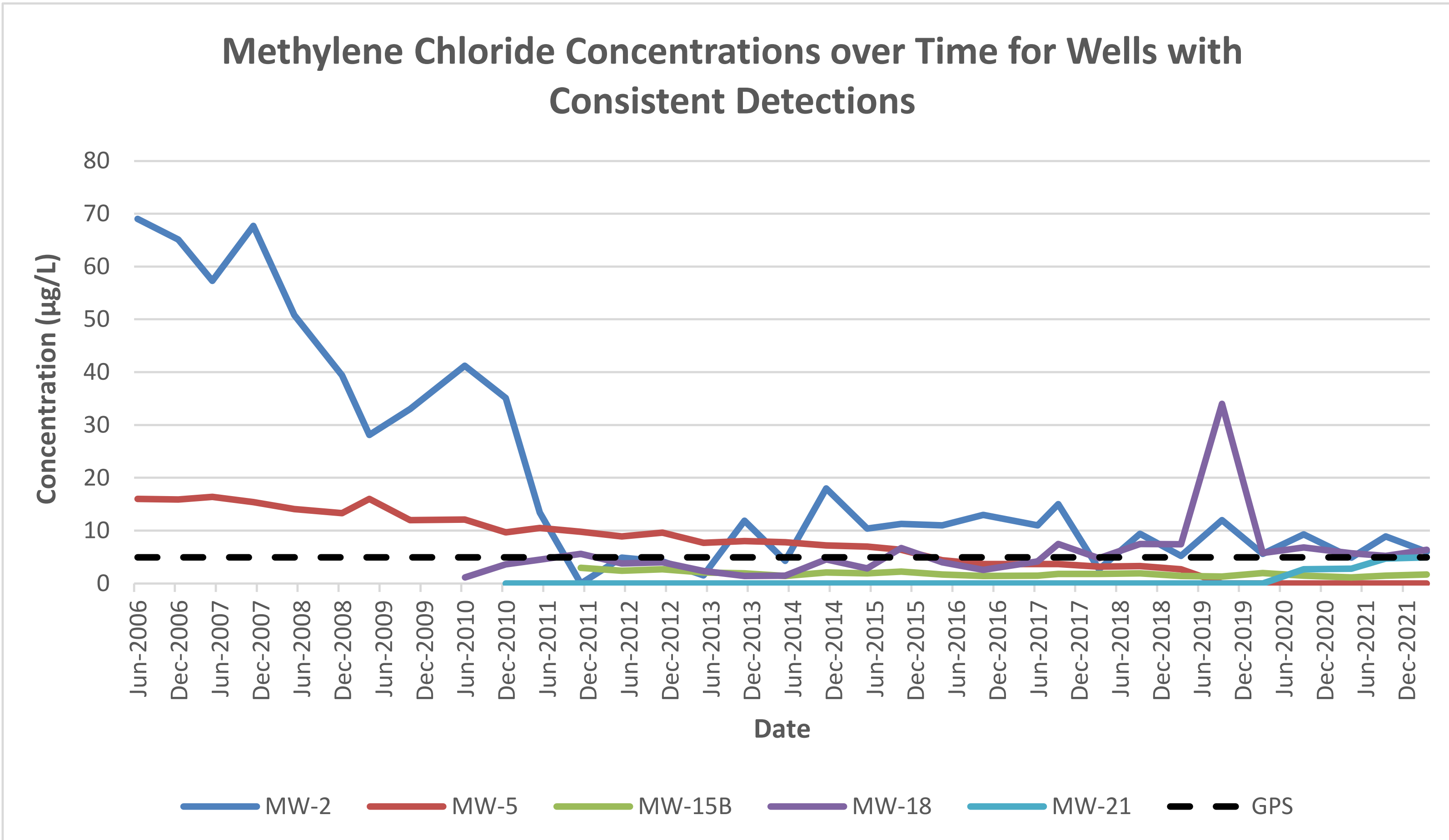
The vertical concentration axis for MW-18 only is shown on the right. The concentration axis for all other wells is shown on the left.

1,1-DCA = 1,1-dichloroethane
GPS = groundwater protection standard
µg/L = micrograms per liter

Fort Pickett, Virginia
Assessment of Corrective Measures Report

Seres Engineering & Services, LLC

Appendix A
Figure A.1
1,1-DCA Concentrations over Time for Wells with Consistent Detections

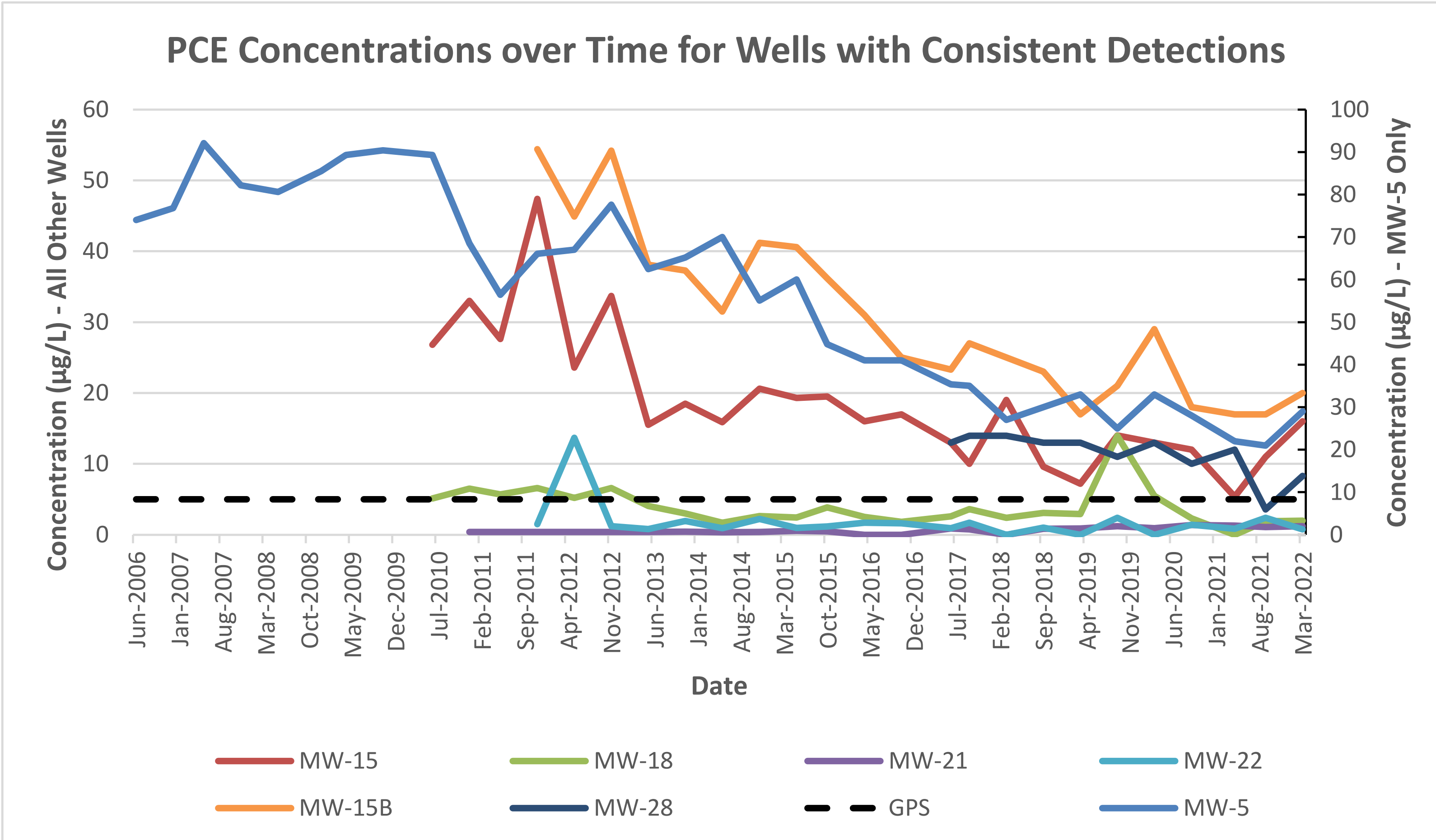


Notes:
GPS = groundwater protection standard
µg/L = micrograms per liter

Fort Pickett, Virginia
Assessment of Corrective Measures Report

Seres Engineering & Services, LLC

Appendix A
Figure A.2
Methylene Chloride Concentrations over Time for Wells with Consistent Detections



Notes:

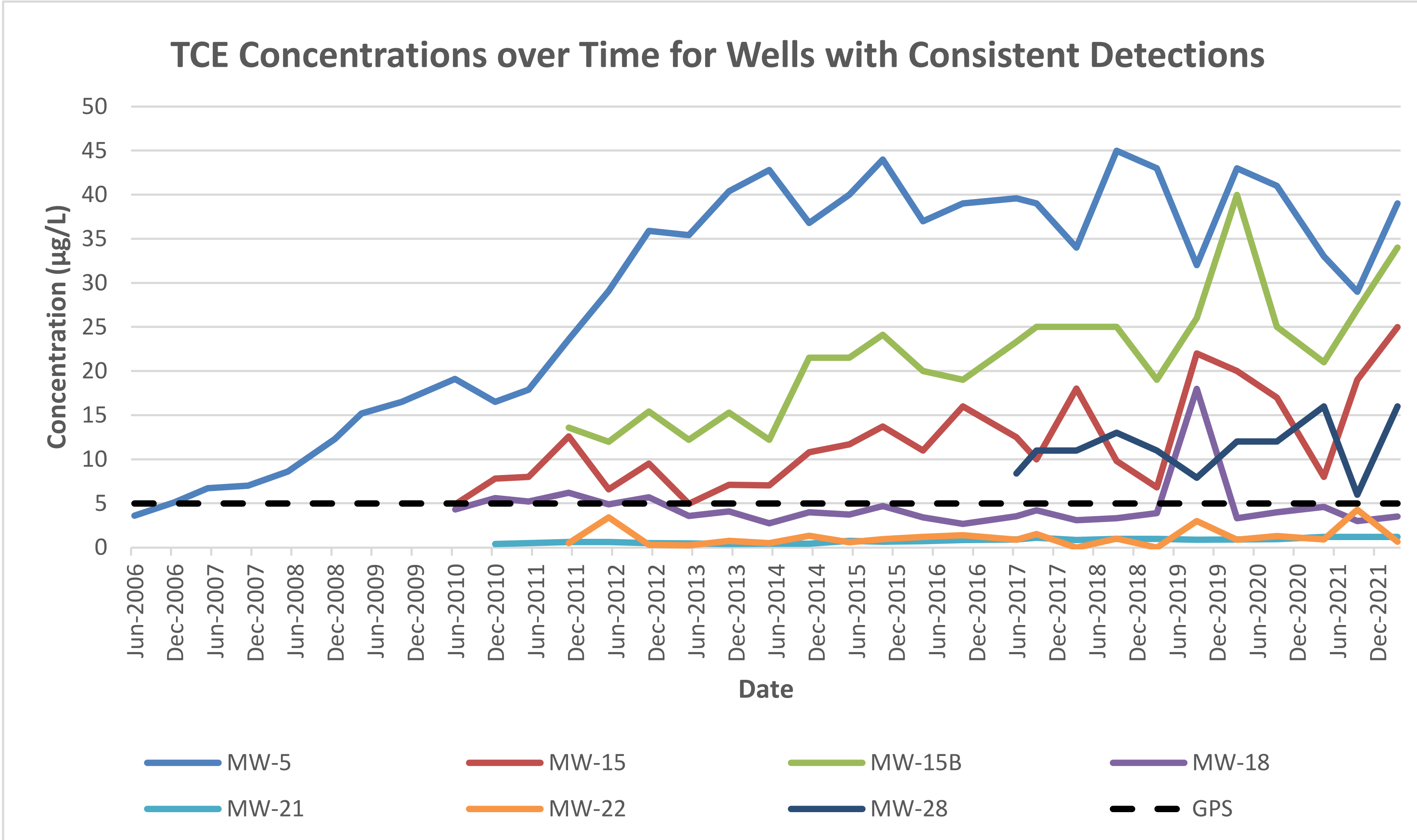
The vertical concentration axis for MW-5 only is shown on the right. The concentration axis for all other wells is shown on the left.

GPS = groundwater protection standard
PCE = tetrachloroethene
µg/L = micrograms per liter

Fort Pickett, Virginia
Assessment of Corrective Measures Report

Seres Engineering & Services, LLC

Appendix A
Figure A.3
PCE Concentrations over Time for Wells with Consistent Detections

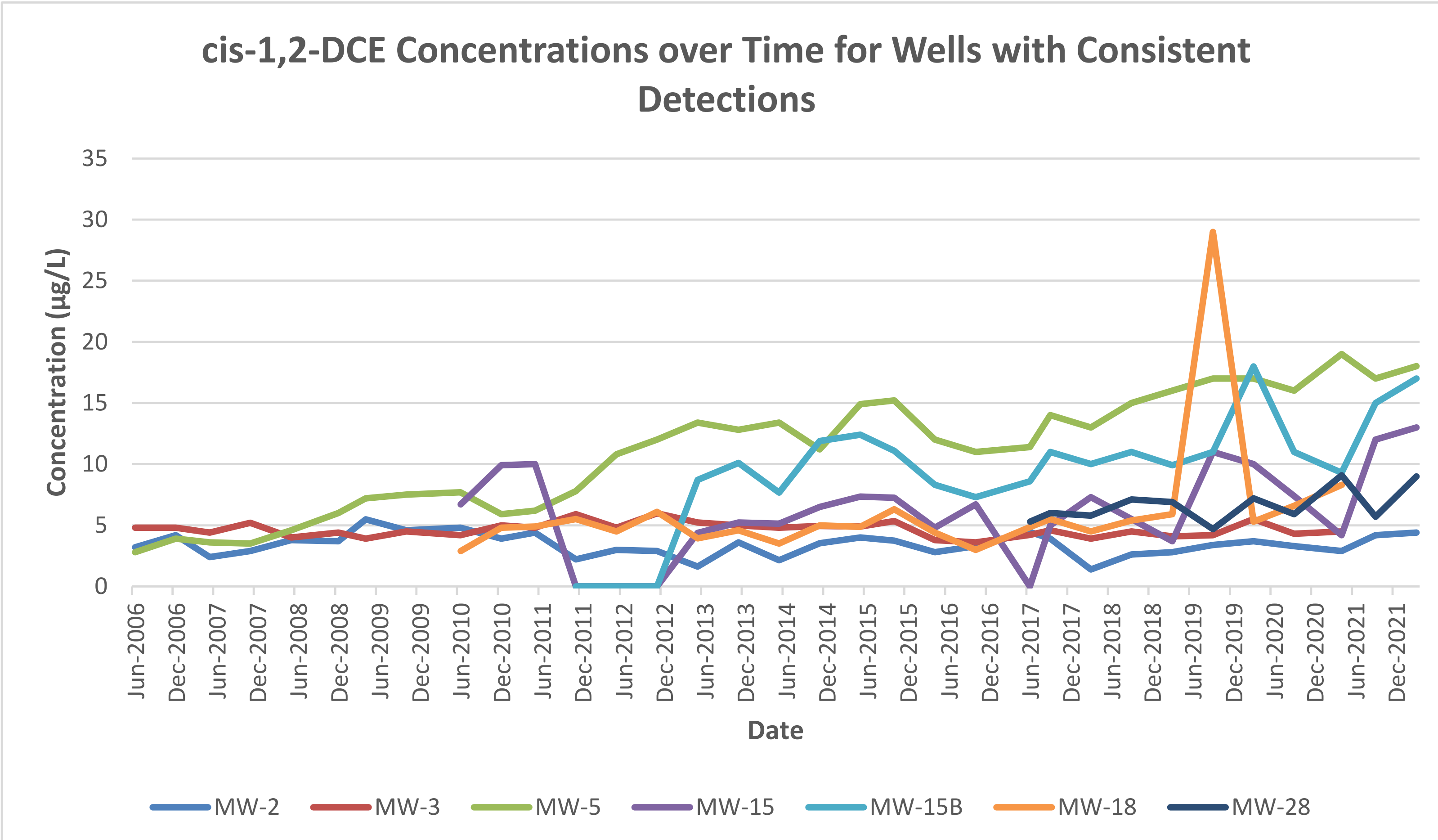


Notes:
GPS = groundwater protection standard
TCE = trichloroethene
µg/L = micrograms per liter

Fort Pickett, Virginia
Assessment of Corrective Measures Report

Seres Engineering & Services, LLC

Appendix A
Figure A.4
TCE Concentrations over Time for Wells with Consistent Detections



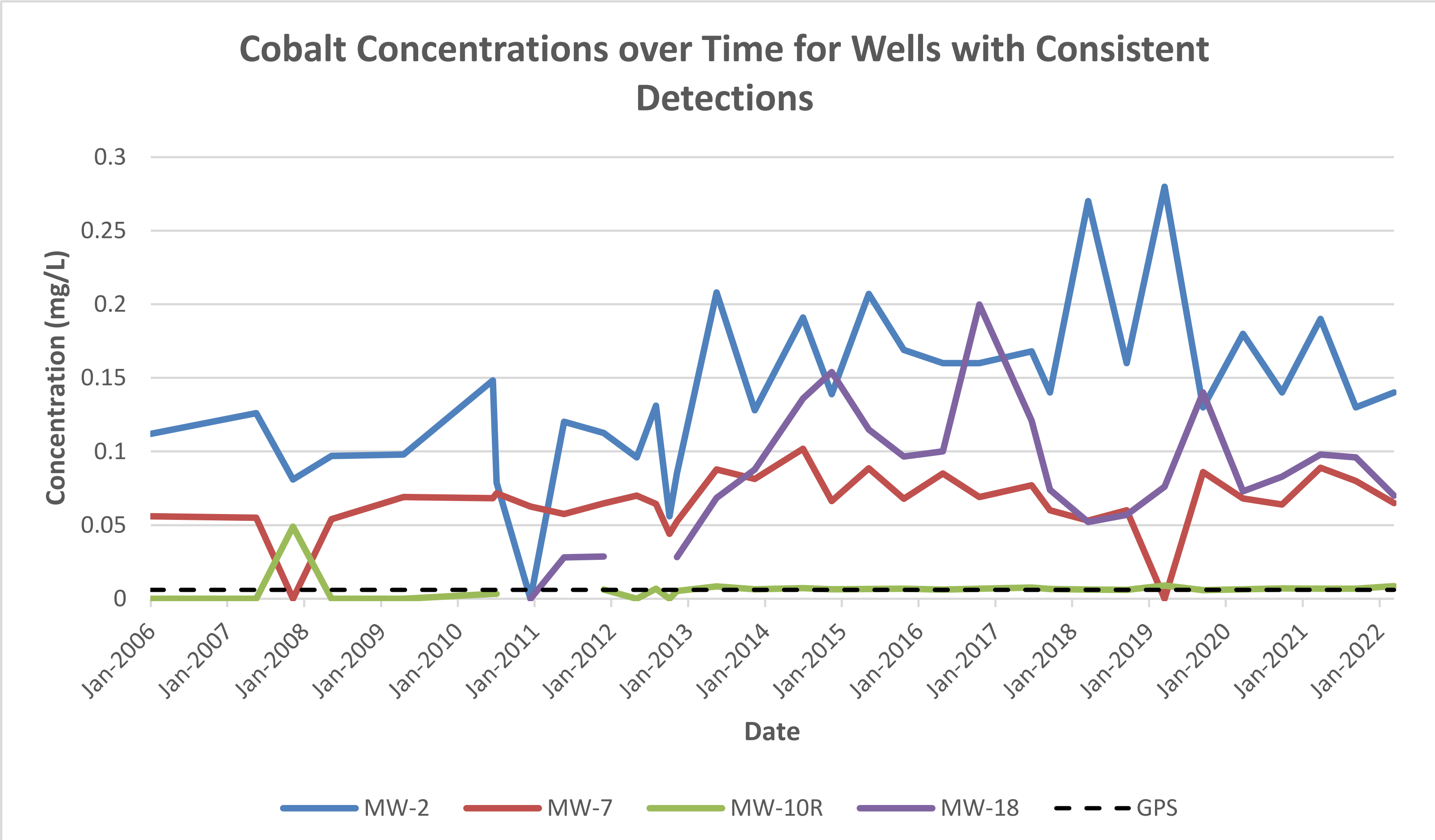
Notes:
The groundwater protection standard for cis-1,2-DCE is 70 µg/L (not shown on axis limits).

cis-1,2-DCE = cis-1,2-dichloroethene
µg/L = micrograms per liter

Fort Pickett, Virginia
Assessment of Corrective Measures Report

Seres Engineering & Services,LLC

Appendix A
Figure A.5
cis-1,2-DCE Concentrations over Time for Wells with Consistent Detections



Notes:
GPS = groundwater protection standard
mg/L = milligrams per liter

Fort Pickett, Virginia
Assessment of Corrective Measures Report

Seres Engineering & Services, LLC

Appendix A
Figure A.6
Cobalt Concentrations over Time for Wells with Consistent Detections

Appendix B – Interim Measures Work Plan for SW-4

INTERIM MEASURES WORK PLAN FOR SW-4

1.0 INTRODUCTION

This interim measures work plan has been prepared to address an exceedance of 1,1-dichloroethane (1,1-DCA) at a surface water sampling location SW-4 during the April/May 2016 semi-annual groundwater event at the Trimble Road Landfill at Fort Pickett, Virginia (the Landfill). Following their review of the Site Characterization Report, the Virginia Department of Environmental Quality (VDEQ) requested that an interim measures work plan be prepared and indicated that the plan could be submitted within the Evaluation of Corrective Measure report (Virginia Army National Guard 2020).

2.0 SURFACE WATER SAMPLING

Surface water characterization sampling was previously conducted at the Trimble Road Landfill to evaluate interactions between surface water and groundwater (Alliant Corporation 2016a, 2016b). Surface water sampling was performed during semi-annual groundwater compliance events in April/May 2016, October 2016, and September 2017. Surface water sampling was conducting during the semi-annual groundwater compliance event to evaluate whether contaminant flux from discharge of groundwater from the Landfill to surface water at Birchin Creek was occurring. Surface water sampling locations are shown on **Figure 1.3** (Site Features Map) of this Assessment of Corrective Measures Report.

Three surface water sample locations (SW-1, SW-2 and SW-3) were established in Birchin Creek downgradient of the southern edge of the groundwater plume as part of the Technical Planning Process (TPP). In addition, field inspections for seeps around the waste boundary of the Landfill were also conducted and a seep was identified west of monitoring well MW-18, near an unnamed wet-weather tributary of Birchin Creek[1]. The unnamed wet-weather tributary has eroded a small channel into the ground surface exposing the seep. Field observations noted that the seep may represent groundwater discharging at the ground surface. It was decided as part of the TPP to establish a surface water sampling location (SW-4) at the seep to determine if impacted groundwater was discharging to surface water from this feature. Surface water location SW-5 was subsequently established in the intermittent drainage downstream from SW-4 and sampled in October 2016 after analytical results from SW-4 seep samples indicated detections of volatile organic compounds (VOCs, including chlorinated VOCs [CVOCs]). SW-5 was established to define the downstream extent of the impact at a location above the confluence of the unnamed wet-weather tributary with Birchin Creek. Samples could not be collected from SW-4 and SW-5 in September or November 2017 because the locations were dry.

[1] The unnamed wet-weather tributary is not identified as a wetland on the National Wetlands Inventory map.

3.0 SURFACE WATER SAMPLING RESULTS

VOCs were detected in samples from the surface water locations established in 2016 at SW-4 (April/May and October 2016) and SW-5 (October 2016). Surface water location SW-4 had detections of the following VOCs in at least one of the 2016 sampling events that were performed in April and October:

- tetrachloroethene (PCE)
- trichloroethene (TCE)
- cis-1,2-dichloroethene (cis-1,2-DCE)
- 1,2-DCE (total)
- 1,1-DCA
- dichlorodifluoromethane
- benzene
- methyl tert butyl ether (MTBE)

There are no action levels currently established for surface water under the existing VDEQ Fort Pickett Trimble Road Landfill Permit #333. Of the VOC detections in SW-4 in 2016, groundwater protection standard (GPS) exceedances were limited to 1,1-DCA in May 2016, when the concentration was reported at 3.1 micrograms per liter (μg/L), slightly exceeding the GPS value of 2.6 μg/L. 1,1-DCA was reported to be 2.4 μg/L at SW-4 in October 2016.

Surface water samples from SW-5 had an estimated detection of 1,3,5-trimethylbenzene of 0.31 J μg/L (the J qualifiers indicates an estimation) the one time it was sampled in October 2016. 1,3,5-trimethylbenzene was not detected in upstream surface water samples at SW-4 or in groundwater at monitoring well MW-18. No CVOCs were detected at SW-5.

Surface water samples were not collected during the first semi-annual monitoring event in 2017. Dry conditions in September through November 2017 prevented re-collection of surface water samples at the SW-4 (seep) and SW-5 sampling locations. Surface water sampling was limited to SW-1, SW-2 and SW-3 in September 2017.

Measured groundwater elevations at the nearest upgradient groundwater monitoring well (MW-18) and nearest downgradient monitoring well (MW-21) are summarized below in **Table B-1** for comparison with the sampling conducted (or attempted to be conducted) at SW-4. These data indicate that the seep identified at SW-4 is intermittent, with no discharge occurring in September/November 2017 when the groundwater table was approximately 1-2 feet lower than the previous sampling events. Field notes for the April/May 2016 semi-annual sampling event further indicate that even when samples were able to be collected, flow from the seep was too low to measure (less than 1 gallon per minute; Alliant Corporation 2016c).

TABLE B-1 - GROUNDWATER ELEVATIONS			
Monitoring Well	Sampling Event (elevation in feet above mean sea level)		
	April/May 2016	October 2016	Sept/Nov 2017
MW-18 (upgradient)	334.41	333.37	332.30
MW-21 (downgradient)	323.30	321.70	320.81

Notes:
1. Elevation of SW-4 is 326.57 feet above mean sea level, and elevation of SW-5 is 313.94 feet above mean sea level.

Evaluation of the surface water sampling performed to date indicates that the seep surface water location SW-4 (located downslope and hydraulically downgradient of MW-18) is impacted with low-level detections of CVOCs and daughter breakdown products, suggesting that groundwater impacted by the Landfill is migrating downgradient. However, the seep is intermittent, depending on fluctuations in the elevation of the groundwater table. The impacts observed at SW-4 were not observed at SW-5, which is located approximately 230 feet downstream of SW-4.

4.0 PROPOSED INTERIM MEASURES

Given that the seep at SW-4 is intermittent and only a single exceedance of the GPS for 1,1-DCA was recorded, the following interim measure is proposed:

Quarterly inspections and sampling of surface water at SW-4 and SW-5 will be performed, consistent with the sampling frequency identified in VDEQ Guidance (VDEQ 2008). Sampling activities would be performed in conjunction with the semi-annual groundwater monitoring events and/or quarterly landfill gas monitoring events. Surface water samples at SW-4 and SW-5 will be collected (if water is present at the time of the sampling event) and submitted for laboratory analysis. Initially, the samples will be analyzed for VOCs (United States Environmental Protection Agency Method SW 8260B). If the first two quarters of sampling indicate that 1,1-DCA is the only contaminant of concern (i.e., if concentrations of the other analyzed constituents are less than their respective GPSs), the list of analytes for which surface water samples will be submitted for laboratory testing would be reduced to 1,1-DCA only.

Flow rates from the sampling locations will be measured (if flow is sufficient to be measured) using a graduated container and a stopwatch. A staff gauge will be installed at the sampling locations to facilitate recording of water levels. Field observations of the sampling locations and the unnamed wet-weather tributary will be documented in log sheets. Depth to water measurements will also be collected from MW--18, MW-21, and MW-29. These data will be correlated with the presence/absence of groundwater discharge at SW-4 and SW-5.

Sampling results and analysis will be included in the annual groundwater monitoring report submitted to VDEQ.

If two sequential quarters of surface water sampling indicate concentrations of 1,1-DCA exceed the GPS (2.8 µg/L), additional interim measures will be investigated and evaluated.

5.0 REFERENCES

Alliant Corporation. 2016a. *Site Characterization Work Plan, Supplemental Characterization Investigation and Evaluation of Alternate Corrective Measures, Fort Pickett (Trimble Road) Sanitary Landfill, Virginia.* 15 September.

Alliant Corporation. 2016b. *Abbreviated Work Plan, Detection Gas Monitoring and Groundwater Detection/Corrective Action Monitoring at Trimble Road Sanitary Landfill (Permit #333), Fort Pickett, Nottoway County, Virginia.* 21 April.

Alliant Corporation. 2016c*. April 2016 Semiannual Groundwater and Surface Water Monitoring Event Report at Trimble Road Sanitary Landfill (Permit #333), Fort Pickett, Nottoway County, Virginia.* 12 September.

Virginia Army National Guard. 2020. *Letter to Virginia Department of Environmental Quality, Response to Comments on Site Characterization Report, Fort Pickett Sanitary Landfill (Permit #333)*. 10 January.

Virginia *Department* of Environmental Quality (VDEQ). 2008. *Waste Guidance Memorandum No. 01-2008/ Water Guidance Memorandum No. 08-200, Surface Water Impacts at Solid Waste Landfills.* 22 February.

Appendix C – Cost Tables

APPENDIX C
PRELIMINARY COST ESTIMATE -
CORRECTIVE MEASURES
ALTERNATIVE 1

TABLE C-1

PRELIMINARY COST ESTIMATE - CORRECTIVE MEASURES ALTERNATIVE 1

Incorporation of Additional Buffer Zone via Petition for Alternate Point of Compliance

Fort Pickett Landfill, Blackstone, VA

COMPONENT COST DESCRIPTION	UNIT COST		QUANTITY	TOTAL
One-Time Expenditures				
Well Maintenance and Repairs	$5,000	Lump Sum	1	$5,000
Land Survey Services (New Landfill Boundary, Legal desc., Monitoring Well Verification)	$10,000	Lump Sum	1	$10,000
			Sub-Total:	**$15,000**
Annual Project Management				
Project Management and Coordination	$10,390	Lump Sum	1	$10,390
			Sub-Total:	**$10,390**
Annual Professional Engineering & Consulting Services				
Preparation of Semi-Annual Groundwater Monitoring Reports	$10,000	Lump Sum	2	$20,000
Preparation of Annual Groundwater Monitoring Report	$10,000	Lump Sum	1	$10,000
Quarterly Landfill Gas Monitoring Events and Reports	$5,000	Per Quarter	4	$20,000
			Sub-Total:	**$50,000**
Annual Groundwater Sampling[1,2]				
Sampling Crew and Equipment Mobilization (Semi-Annual Basis)	$2,200	Per Mob.	2	$4,400
Health and Safety (Plan Compliance and Personal Protective Equipment)	$200	Per Event	2	$400
Groundwater Sampling and Field Data Collection	$4,000	Per Event	2	$8,000
Groundwater Sampling Pumps and Disposable/Expendable Supplies	$6,000	Per Event	2	$12,000
			Sub-Total:	**$24,800**
Annual Sub-Contracted Laboratory Services[1]				
Volatile Organic Compound (VOC) Analysis	$60	per sample	30	$1,800
Semi-Volatile Organic Compound (SVOC) Analysis	$160	per sample	30	$4,800
Metals Analysis	$95	per sample	30	$2,850
Pesticides/Herbicides/Other Parameters Analysis	$155	per sample	30	$4,650
			Sub-Total:	**$14,100**
SUBTOTAL YEAR-1 COST:				**$114,290**
TOTAL YEAR-1 COST - Assumes 15% contingency				**$131,434**
YEAR-2 COST (i.e., minus One-Time Expenditures) - Assumes 15% contingency, 3% annual inflation, 1% discounted rate				**$116,445**
YEAR-3 COST (i.e., minus One-Time Expenditures) Assumes - 15% contingency, 3% annual inflation, 1% discounted rate				**$118,750**
TOTAL COST (rounded):				**$366,600**

NOTES:

1) Assumes 14 wells (9 compliance wells and 5 sentinel wells) are sampled for each semi-annual event and analysis of 1 quality assurance/quality control VOC sample.

2) Assumes 2-year monitoring plan (Post-Alternate Point of Compliance [APC] approval); includes contractor labor, equipment, materials, sub-contracted lab services, and reporting costs.

Cost Estimating Factors: Corrective Measures Alternative 1
Assumes monitoring of 9 compliance wells and 5 sentinel wells. Assumes a 15% contingency cost on total estimate for each year, after 3% inflation and 1% discounted rate. Scope of items included in cost estimate are: • Land survey services (for defining new facility boundary and APC submittal) • Site access/logistics coordination • Project management • Health & safety compliance • Sampling equipment rental and purchase of disposable/expendable supplies • Quarterly landfill gas monitoring and reporting • Semi-annual groundwater sampling and analysis (VOCs, Metals and monitored natural attenuation [MNA] parameters) • Semi-annual groundwater sampling reports • Annual MNA and APC compliance groundwater evaluation reports

APPENDIX C
PRELIMINARY COST ESTIMATE -
CORRECTIVE MEASURES
ALTERNATIVE 2

TABLE C-2

PRELIMINARY COST ESTIMATE - CORRECTIVE MEASURES ALTERNATIVE 2
Monitored Natural Attenuation (MNA) with and/or Without Upgraded Geosynthetic Cap System
Ft. Pickett Landfill, Blackstone, VA.

COMPONENT COST DESCRIPTION	UNIT COST		QUANTITY	TOTAL
One-Time Capital Expenditures - Geosynthetic Cap System				
Subgrade Preparation, flexible geomembrane (40 mil), composite drainage net, vegetative support soil, topsoil, vegetation and stormwater drainage	$250,000	Per. Acre	9	$2,250,000
Regulatory Permitting, Design, Construction Administration/Construction Management & Regulatory Certification of Upgraded Cap System	$450,000	Lump Sum	1	$450,000
Land Survey Services (New Landfill Boundary, Legal desc., Monitoring Well Verification)	$10,000	Lump Sum	1	$10,000
Well Maintenance and Repairs (In Year 2)	$5,000	Lump Sum	1	$5,000
			Sub-Total:	**$2,715,000**
Annual Project Management				
Project Management and Coordination	$8,890	Lump Sum	1	$8,890
			Sub-Total:	**$8,890**
Annual Professional Engineering & Consulting Services				
Preparation of Semi-Annual Groundwater Monitoring Reports	$10,000	Lump Sum	2	$20,000
Preparation of Annual Groundwater Monitoring Report	$10,000	Lump Sum	1	$10,000
Quarterly Landfill Gas Monitoring Events and Reports	$5,000	Per Quarter	4	$20,000
			Sub-Total:	**$50,000**
Annual MNA Groundwater Sampling Costs[1,2]				
Sampling Crew and Equipment Mobilization (Semi-Annual Basis)	$2,200	Per Mob.	2	$4,400
Health and Safety (Plan Compliance and Personal Protective Equipment)	$200	Per Event	2	$400
Groundwater Sampling and Field Data Collection	$4,000	Per Event	2	$8,000
Groundwater Sampling Pumps and Disposable/Expendable Supplies	$6,000	Per Event	2	$12,000
			Sub-Total:	**$24,800**
Annual Sub-Contracted Laboratory Services[1]				
Volatile Organic Compound (VOC) Analysis	$60	per sample	30	$1,800
Semi-Volatile Organic Compound (SVOC) Analysis	$160	per sample	30	$4,800
Metals Analysis	$95	per sample	30	$2,850
Pesticides/Herbicides/Other Parameters Analysis	$155	per sample	30	$4,650
			Sub-Total:	**$14,100**
SUBTOTAL YEAR-1 COST:				**$2,812,790**
TOTAL YEAR-1 COST - Assumes 15% contingency				**$3,234,709**
YEAR-2 COST (i.e., minus One-Time Expenditures) - Assumes 15% contingency, 3% annual inflation, 1% discounted rate				**$114,685**
YEAR-3 COST (i.e., minus One-Time Expenditures) Assumes - 15% contingency, 3% annual inflation, 1% discounted rate				**$116,956**
TOTAL COST (rounded):				**$3,466,400**

NOTES:

1) Assumes 14 wells (9 compliance wells and 5 sentinel wells) are sampled for each semi-annual event and analysis of 1 quality assurance/quality control VOC sample.

2) Assumes 2-year monitoring plan (Post-Alternate Point of Compliance [APC] approval); includes contractor labor, equipment, materials, sub-contracted lab services, and reporting costs.

Cost Estimating Factors: Corrective Measures Alternative 2

Assumes monitoring of 9 compliance wells and 5 sentinel wells.
Assumes a 15% contingency cost on total estimate for each year, after 3% inflation and 1% discounted rate.

Scope of items included in cost estimate are:

- Land survey services (for defining new facility boundary and APC submittal)
- Site access/logistics coordination
- Project management
- Health & safety compliance
- Surveying locations and measuring point elevations
- Sampling equipment rental and purchase of disposable/expendable supplies
- Quarterly landfill gas monitoring and reporting
- Semi-annual groundwater sampling and analysis (VOCs, Metals and monitored natural attenuation [MNA] parameters)
- Semi-annual groundwater sampling reports
- Annual MNA and APC compliance groundwater evaluation reports

APPENDIX C
PRELIMINARY COST ESTIMATE -
CORRECTIVE MEASURES
ALTERNATIVE 3

TABLE C-3

PRELIMINARY COST ESTIMATE - CORRECTIVE MEASURES ALTERNATIVE 3
Source Control - Leachate & Landfill Gas Extraction

Ft. Pickett Landfill, Blackstone, VA.

COMPONENT COST DESCRIPTION	UNIT COST		QUANTITY	TOTAL
One-Time Capital Expenditures				
Subgrade Preparation, flexible geomembrane (40 mil), composite drainage net, vegetative support soil, topsoil, vegetation and stormwater drainage	$250,000	Per. Acre	9	$2,250,000
Supplemental Dual Recovery Landfill Gas (LFG)/leachate collection and removal system (LCRS)				
HDPE Piping (Including labor and materials to install/construct above ground)	$100,301	Lump Sum	1	$100,301
Various LFG & Leachate Equipment (including labor and materials to install/construct)	$236,000	Lump Sum	1	$236,000
Construction Equipment Mobilization (10% of materials and equip costs from above)	$33,630	Lump Sum	1	$33,630
Electrical work, road crossing, pipe stabilization/supports, fittings, flanges, reducers, tees, tie-ins, etc.	$ 55,489.71	Lump Sum	1	$55,490
Regulatory Permitting, Design, Construction Administration/Construction Management & Regulatory Certification of Upgraded Cap System & LFG/LCRS	$450,000	Lump Sum	1	$535,084
Land Survey Services (New Landfill boundary, Legal desc., Monitoring well verification)	$10,000	Lump Sum	1	$10,000
Well Maintenance and Repairs	$5,000	Lump Sum	1	$5,000
			Sub-Total:	**$3,225,505**
System Decommissioning/Removal (In Final Year)	**$20,000**	**Lump Sum**	**1**	**$20,000**
			Sub-Total:	**$20,000**
Annual Project Management				
Project Management and Coordination	$84,909	Lump Sum	1	$84,909
			Sub-Total:	**$84,909**
Annual Professional Engineering & Consulting Services				
Preparation of Semi-Annual Groundwater Monitoring Reports	$10,000	Lump Sum	2	$20,000
Preparation of Annual Groundwater Monitoring Report	$10,000	Lump Sum	1	$10,000
Quarterly Landfill Gas Monitoring Events & Reports	$13,000	Per Quarter	4	$52,000
			Sub-Total:	**$82,000**
Annual Groundwater Sampling[1]				
Sampling Crew and Equipment Mobilization (Semi-Annual Basis)	$2,200	Per Mob.	2	$4,400
Health and Safety (Plan Compliance and Personal Protective Equipment)	$200	Per Event	2	$400
Groundwater Sampling and Field Data Collection	$4,000	Per Event	2	$8,000
Groundwater Sampling Pumps and Disposable/Expendable Supplies	$6,000	Per Event	2	$12,000
			Sub-Total:	**$24,800**
Annual Sub-Contracted Laboratory Services[1]				
Volatile Organic Compound (VOC) Analysis	$60	per sample	30	$1,800
Semi-Volatile Organic Compound (SVOC) Analysis	$160	per sample	30	$4,800
Metals Analysis	$95	per sample	30	$2,850
Pesticides/Herbicides/Other Parameters Analysis	$155	per sample	30	$4,650
			Sub-Total:	**$425,421**
Annual Operations and Maintenance				
Leachate Transport	$0.10	Per Gallon	754,670	$75,467
Leachate Disposal	$0.30	Per Gallon	754,670	$226,401
Spent granular activated carbon (GAC) Materials Disposal and GAC Replentishment Costs	$5,000	Per Year	3	$15,000
			Sub-Total:	**$316,868**
SUBTOTAL YEAR-1 COST:				**$336,868**
TOTAL YEAR-1 COST - Assumes 15% contingency				**$4,806,429**
YEAR-2 COST (i.e., minus One-Time Expenditures) - Assumes 15% contingency, 3% annual inflation, 1% discounted rate				**$1,095,367**
YEAR-3 COST (i.e., minus One-Time Expenditures) Assumes - 15% contingency, 3% annual inflation, 1% discounted rate				**$1,117,057**
TOTAL COST (rounded):				**$7,018,900**

NOTES:

1) Assumes 14 wells (9 compliance wells and 5 sentinel wells) are sampled for each semi-annual event and analysis of 1 quality assurance/quality control VOC sample.

2) Detailed costs for APC Monitoring Component (Ref. to Table C-1)

3) Assumes estimated leachate can be transported and disposed to an approved POTW within 50 miles of Site.

4) Assumes LF gas can be vented to atmosphere with only an activated carbon train treatment.

5) Assumes 3-year Monitoring Plan; includes contractor labor, equipment, materials, sub-contracted lab services, and reporting costs.

Estimated Base Quantities and Calcs.	
ESTIMATE OF VOLUME OF LANDFILL LEACHATE TO BE REMOVED	
Avg. Depth of Leachate on Landfill Floor =	1.0 ft
Landfill Footprint Size =	7.72 acres
" " =	336,283 sq.ft.
Volume of Waste+Leachate (1-ft x 336,283 sq.ft.) =	**336,283 cu.ft.**
Calculate Leachate Portion of Volume based on waste porosity of 30% =	x 0.30
Estimate TOTAL Leachate Volume to be Removed =	**100,885 cu.ft.**
Convert Volume to Gallons =	x 7.4805 gallons /cu.ft.
Estimate of TOTAL Leachate Volume to be Removed =	**754,670 galllons**

APPENDIX C
PRELIMINARY COST ESTIMATE -
CORRECTIVE MEASURES
ALTERNATIVE 4

TABLE C-4

CONCEPTUAL COST ESTIMATE - CORRECTIVE MEASURES ALTERNATIVE 4
Enhanced Bioremediation

Trimble Road, Blackstone, VA.

COMPONENT COST DESCRIPTION	UNIT COST		QUANTITY	TOTAL
One-Time Capital Expenditures				
Well Maintenance and Repairs	$5,000	Lump Sum	1	$5,000
Supplemental Injection Event (Materials & Labor)	$169,781	Lump Sum	1	$169,781
Bioremediation Pilot-Scale Injections and Data Collection	$50,000	Lump Sum	1	$50,000
Full-Scale Bioremediation Plan Design & Corrective Action Plan	$15,000	Lump Sum	1	$15,000
Bioremediation Implementation [3]				
Injection Well Installation and In Situ Bio-Remediation Injections)				
Mobilization/Demobilization for Injection Well Installation	$5,000	Lump Sum	1	$5,000
Drill-rig equipment & labor	$2,000	Per Day	15	$30,000
2" PVC screen, 40-slot w/ pea gravel filter pack	$12	Per Foot	375	$4,500
2" flushthreaded bottom end cap	$10	Each	75	$750
2" PVC riser, portland cement seal	$8	Per Foot	2,625	$21,000
Flushmount protective cover w/ concrete pad	$120	Each	75	$9,000
Soil cuttings disposal (non-hazardous)	$150	Per Drum	75	$11,250
Per-diem (2-person crew)	$250	Per Day	15	$3,750
Bioremediation Injectant(s)				
ORC Advanced™ or HRC™	$8.00	Per lb.	37,500	$300,000
Injection Event				
Injection trailer, compressor, pumps, mixers, hoses, tanks, and 3-man crew	$2,500	Per Day	8	$18,750
Per-diem (3-person crew)	$375	Per Day	8	$2,813
			Sub-Total:	**$646,594**
Annual Project Management				
Project Management and Coordination	$12,070	Lump Sum	1	$12,070
			Sub-Total:	**$12,070**
Annual Professional Engineering & Consulting Services				
Preparation of Semi-Annual Groundwater Monitoring Reports	$10,000	Lump Sum	2	$20,000
Preparation of Annual Groundwater Monitoring Report	$10,000	Lump Sum	1	$10,000
Quarterly Landfill Gas Monitoring Events and Reports	$5,000	Per Quarter	4	$20,000
			Sub-Total:	**$50,000**
Annual Groundwater Compliance Sampling and Analysis [1,2]				
Sampling Crew and Equipment Mobilization (Semi-Annual Basis)	$2,200	Per Mob.	2	$4,400
Health and Safety (Plan Compliance and Personal Protective Equipment)	$200	Per Event	2	$400
Groundwater Sampling and Field Data Collection	$4,000	Per Event	2	$8,000
Groundwater Sampling Pumps and Disposable/Expendable Supplies	$6,000	Per Event	2	$12,000
			Sub-Total:	**$24,800**
Annual Sub-Contracted Laboratory Services[1]				
Volatile Organic Compound (VOC) Analysis	$60	per sample	30	$1,800
Semi-Volatile Organic Compound (SVOC) Analysis	$160	per sample	30	$4,800
Metals Analysis	$95	per sample	30	$2,850
Pesticides/Herbicides/Other Parameters Analysis	$450	per sample	30	$13,500
			Sub-Total:	**$22,950**
Operations & Maintenance Costs (Over Remaining Post-Closure Care Period)[4]				
Bioremediation field engineering & oversight documentation	$1,500	Per Day	25	$37,500
			Sub-Total:	**$793,914**
SUBTOTAL YEAR-1 COST:				**$336,868**
TOTAL YEAR-1 COST - Assumes 15% contingency				**$869,876**
YEAR-2 COST (i.e., minus One-Time Expenditures) - Assumes 15% contingency, 3% annual inflation, 1% discounted rate				**$128,794**
YEAR-3 COST (i.e., minus One-Time Expenditures) Assumes - 15% contingency, 3% annual inflation, 1% discounted rate				**$131,344**
TOTAL COST (rounded):				**$1,130,000**

NOTES:

1) Assumes 14 wells (9 compliance wells and 5 sentinel wells) are sampled for each semi-annual event and analysis of 1 quality assurance/quality control VOC sample.

2) Detailed Costs for Alternate Point of Compliance (APC) Monitoring Component (Ref. to Table C-1)

3) Assumes 75 injection points (1 injection per 400 sq. ft. of treatment area), average depth of 40 ft., and 500 pounds of injectant per well point.

4) Assumes 3-year Monitoring Plan (Post-APC Approval); includes contractor labor, equipment, materials, sub-contracted lab services, & reporting costs.

APPENDIX C
PRELIMINARY COST ESTIMATE -
CORRECTIVE MEASURES
ALTERNATIVE 5

TABLE C-5

PRELIMINARY COST ESTIMATE - CORRECTIVE MEASURES ALTERNATIVE 5
Source Removal (Waste Mass Excavation/Disposal)
Ft. Pickett Landfill, Blackstone, VA.

COMPONENT COST DESCRIPTION	UNIT COST		QUANTITY	TOTAL
1st Year - Professional Engineering & Consulting Services				
Land Survey Services (New Landfill Boundary, Legal desc., Monitoring Well Verification)	$10,000	Lump Sum	1	$10,000
Project Management for Source Removal/Restoration & Alternate Point of Compliance (APC) Monitoring	$5,000	Lump Sum	1	$5,000
Development of Source Removal/Restoration Design & Plans	$35,000	Lump Sum	1	$35,000
Preparation of Semi-Annual Groundwater Monitoring Reports	$10,000	Lump Sum	2	$20,000
Preparation of Annual Groundwater Monitoring Report	$10,000	Lump Sum	1	$10,000
Quarterly Landfill Gas Monitoring Events & Reports	$13,000	Per Quarter	4	$52,000
			Sub-Total:	**$132,000**
1st Year - APC Groundwater Sampling and Analysis [1 & 2]				
Semi-Annual Groundwater Sampling Event	$12,400	Per Event	2	$24,800
Semi-Annual Groundwater Sample Analyses	$14,100	Per Event	2	$28,200
			Sub-Total:	**$53,000**
2nd Year - Landfill Waste Mass Excavation/Disposal and Restoration Implementation[3, 4, 5 & 6]				
Landfill Waste Mass Excavation/Transportation & Disposal Costs				
Excavation Equipment & Materials Mobilization/Demobilization	$5,000	Lump Sum	1	$5,000
Install & Maintain Stormwater and Soil Erosion Controls	$5	Per Lin. Ft.	4,000	$20,000
Overburden/Cover Stripping, Handling and Stockpiling	$4	Per Cu. Yd.	38,827	$155,308
Waste Mass Excavation/Loading	$5	Per Cu. Yd.	100,950	$504,750
Waste Transportation/ Off-Site Disposal	$46	Per Ton	68,685	$3,144,257
Excavation Dewatering and Leachate Control	$0.25	Per Gallon	754,670	$188,668
Waste Water (Leachate) Transportation/Disposal	$0.40	Per Gallon	754,670	$301,868
			Sub-Total:	**$4,319,850**
Site Backfill and Restoration Costs				
Stockpiled Soil Backfill Handling and Placement	$4	Per Cu. Yd.	38,827	$155,308
Additional Clean Backfill Materials, Importation and Placement	$30	Per Cu. Yd.	62,123	$1,863,690
Restoration Grading & Seeding	$5,000	Per Acre	7.00	$35,000
			Sub-Total:	**$2,053,998**
2nd Year - Site Monitoring, APC Sampling & Analyses [1 & 2]				
Semi-Annual Groundwater Sampling Event	$12,400	Per Event	2	$24,800
Semi-Annual Groundwater Sample Analyses	$14,100	Per Event	2	$28,200
Quarterly Landfill Gas Monitoring Events & Reports	$5,000	Per Quarter	4	$20,000
			Sub-Total:	**$73,000**
2nd Year - Professional Engineering & Consulting Services				
Source Removal & Restoration Field Engineering & Oversight	$1,800	Per Day	91	$163,032
Preparation of Corrective Action Site Evaluation (CASE) Report (For Corrective Measure Implementation)	$50,000	Lump Sum	1	$50,000
Preparation of Semi-Annual Groundwater Monitoring Reports	$10,000	Per Event	2	$20,000
Preparation of Annual Groundwater Monitoring Report	$10,000	Per Year	1	$10,000
			Sub-Total:	**$243,032**
Operations & Maintenance Costs (Over Remaining PCC Period)[7]				
Semi-Annual Groundwater Monitoring & Reporting	$78,000	Per Year	3	$234,000
Annual Groundwater Monitoring Report	$10,000	Per Year	3	$30,000
Well Maintenance and Repairs (In Year 4)	$5,000	Lump Sum	1	$5,000
			Sub-Total:	**$269,000**
	Corrective Measure Alternative 5 Total:			**$7,143,880**
	Contingency Costs (15%):			*$1,071,582*
	Corrective Measure Alternative 5 Cost w/Contingency:			**$8,215,462**

NOTES:

1) Assumes 14 wells (9 compliance wells and 5 sentinel wells) are sampled for each semi-annual event and analysis of 1 quality assurance/quality control VOC sample.
2) Detailed costs for APC Monitoring Component (Ref. to Table C-1)
3) Assumes landfill solid and liquid wastes can be transported and disposed within ~10 miles of Site.
4) Assumes source of clean soil backfill materials are readily available within ~10 miles of Site.
5) Assumes a waste disposal and backfill importation process rate of ~1,800 cubic yards per day.
6) For waste volume conversion to tons, assumed compacted in-place dentity of 1,500 lbs per cubic yard.
7) Assumes 3-year APC Monitoring Plan; includes contractor labor, equipment, materials, sub-contracted lab services, and reporting costs.

Cost Estimating Factors: Corrective Measures Alternative 5

- Excavation and Temporary Stockpiling of Exisiting Clean Cap Materials
- Complete Waste Mass Excavation, Transportation and Off-Site Landfill Disposal
- Excavation Dewatering and Leachate Transportation and Disposal at a POTW
- Clean Backfill Materials, Placement and Rough Grading
- Final Grading and Surface Restoration Seeding
- Land survey services (for facility boundary expansion and APC submittal)
- APC variance request preparation and approval by Virginia Department of Environmental Quality (VDEQ)
- Landfill Permit modification preparation and approval by VDEQ
- Site access/logistics coordination
- Project management
- Health and Safety
- Field observation and documentation of excavation and restroration activities,
- Purge water containment, analysis, and disposal,
- Surveying locations and measuring point elevations,
- Semi-annual groundwater sample collection and analysis
- Semi-annual groundwater sampling reports
- Annual groundwater evaluation reports
- Quaterly landfill gas monitoring and reporting

Appendix D – Public Meeting Notice and Comments

PUBLIC MEETING NOTICE AND COMMENTS

Provide a summary of the public meeting actions held to advertise the draft results of the ACM including, if applicable, any formal responses to public comment received during the process. In the **"Draft Final" version of the report submitted to Virginia Department of Environmental Quality,** this **Appendix D** will contain a copy of the below notice, proof of public notice issuance, and a compendium of public comments received during the public review period.

EXAMPLE DRAFT TEXT PLACEHOLDER:

The following presents the text of the public notice that will be printed in the **November 16, 2022** and **November 23, 2022** editions of the **Blackstone Courier Record**.

Public Notice – Assessment of Corrective Measures

PURPOSE OF NOTICE: To acquaint the public with the technical aspects of the Assessment of Corrective Measures (ACM) Report for the Trimble Road Landfill, a closed solid waste landfill in Blackstone, Virginia operating under a permit from the Virginia Department of Environmental Quality (VDEQ), to inform the public of how the provisions set out in 9 Virginia Administrative Code (VAC) 20-80-310 of the Virginia Solid Waste Management Regulations will be met, to identify issues of concern, and to facilitate communication and establish dialogue between the United States Army Corps of Engineers (USACE) and persons who may be affected by the facility. This notice initiates a public comment period that will last 30 days through **December 16, 2022**.

PUBLIC COMMENT PERIOD: **November 16, 2022 to December 16, 2022**.

PERMIT NUMBER: #333.

FACILITY NAME AND LOCATION: The Trimble Road Landfill is located approximately 1.4 miles southeast of the Blackstone Army Airfield/Allen C. Perkinson Municipal Airport within the confines of Fort Pickett, Nottoway County, Blackstone, Virginia.

DESCRIPTION: The closed Trimble Road Landfill is undergoing the assessment as a result of on-site exceedances of groundwater protection standards for various chlorinated volatile organic compounds and cobalt. The report includes an evaluation of corrective measures to be undertaken to mitigate the risk of these exceedances to the public.

HOW TO COMMENT: During the public comment period, the Draft ACM Report may be reviewed and commented on by all interested parties. Persons may review the Draft ACM Report online at **https://va.ng.mil/Programs-Resources/Environmental-Program/**. The public is encouraged to join the USACE and their representatives at a public meeting to discuss the Draft ACM Report. The meeting will be held on **Tuesday, 06 December 2022**, in the conference room of **Blackstone Readiness Center (Drill Floor), 1008 Darvills Rd Blackstone, Virginia 23824**. The meeting will take place from **6:30 pm to 7:30 pm Eastern Standard Time**.

The session will comprise a public workshop at which USACE personnel and their representatives will explain the report and answer questions. The purposes of the public meeting are to: 1) acquaint the public with the technical aspects of the Draft ACM Report and how the Draft ACM Report meets the standards of the applicable regulations administered by the VDEQ, 2) identify issues of public concern, and 3) continue the dialogue between the USACE and persons who are interested in the closed landfill facility. Public comments can be submitted to Mr. Previn Melvin, whose contact information is listed below:

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