Presented by:

Cleanup Action Plan and Compliance Monitoring for the Closed Landfill

ASOTIN COUNTY REGIONAL LANDFILL

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ASOTIN COUNTY REGIONAL LANDFILL

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The intent of this document is to provide rationale and justification for transitioning the Closed Landfill from detection and assessment monitoring conducted under WAC 173-351-430/440 since 1998 and 2008, respectively, to site-specific cleanup actions and related performance and compliance monitoring, supporting two overarching objectives: (1) groundwater remedial actions under Model Toxics Control Act (MTCA), WAC 173-340-515, *Independent Remedial Actions* (IRA), and (2) groundwater monitoring for Post-Closure Care of WAC 173-304, *Minimum Functional Standards for Solid Waste Handling*. The narrative below explains the document organization for key sections and related stand-alone sampling plans included via appendixes.

Section 1 of this document provides the document's purpose and objectives, along with site description, and summary of site conditions. Asotin County is performing groundwater remediation actions for the Closed Landfill at the Asotin County Regional Landfill (ACRL) under Model Toxics Control Act (MTCA), per WAC 173-340-515, *Independent Remedial Actions (IRA)*. According to the IRA process, the site owner (i.e., Asotin County) performs remedial actions without Washington State Department of Ecology ("Ecology") oversight or approval, and not under an agreed order or consent decree. However, under the IRA rules, Ecology may provide informal advice and assistance (technical consultations and their opinion) to owners required to conduct remedial actions. ACRL has been collaborative with the agencies and is seeking Ecology's opinion of this CAP and related elements.

This document is provided under the IRA rules to meet the substantive requirements of a Cleanup Action Plan (CAP) and Compliance Monitoring Plan (CMP) for the Closed Landfill at the ACRL. The objectives of the CAP are to establish the remedial activities and define the data needs for the CMP. Key elements of the CAP are in Section 2 of this document to establish the following under WAC 173-340-380:

- A general description of the proposed cleanup action;
- A summary of the rationale for selecting the proposed alternative;
- Cleanup standards and remediation levels;
- Schedule for implementing the cleanup action and related expectation for achieving cleanup levels and related restoration timeframe;
- Institutional controls; and
- Applicable laws or regulations.

To assess the goals and progress of the CAP, the CMP is established in Section 3 of this document to provide data to evaluate the effectiveness of remedial action towards meeting established cleanup levels for the established contaminants of concern (COCs). The CMP is comprised of monitoring and reporting of two media, including landfill gas as the main source or source mechanism impacting uppermost groundwater, and groundwater quality downgradient of the closed landfill. Landfill gas data are needed to evaluate effectiveness of extracting and contracting the vapor-phase source plume beneath the closed landfill in the vadose zone, while groundwater data assess the impacted media and will be routinely monitored and evaluated for relative changing conditions, and progress towards achievement of groundwater cleanup levels.

Based on the rationale and explanations provided in the CAP and CMP (Sections 2 and 3), stand-alone Sampling and Analysis Plans (SAPs) for each media are included in appendices of this document. The groundwater monitoring SAP is provided in Appendix C, and the landfill gas monitoring SAP is provided in Appendix D. The reporting for both landfill gas and groundwater data are provided in Section 4.

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Table of Contents

Acronyms/Abbreviations

ACHD	Asotin County Health District
ACRL	Asotin County Regional Landfill
bgs	below ground surface
CAP	Cleanup Action Plan
cm/sec	centimeter per second
COC	constituent of concern
CMP	Compliance Monitoring Plan
CSM	conceptual site model
DQO	data quality objective
DTW	depth to water
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
EIM	environmental information management
FD	field duplicate
FS	feasibility study
GCL	geosynthetic clay liner
HDPE	high-density polyethylene
IRA	Independent Remedial Actions
IDW	Investigative derived waste
LCS	leachate control system
LCRS	leachate collection and recovery system
LGW	Landfill gas extraction well
MCL	maximum contaminant level
MK	Mann-Kendall
MM	millimeter
MS	matrix spike
MSD	matrix spike duplicate
MSW	municipal solid waste
MTCA	Model Toxics Control Act
PCE	tetrachloroethylene
PD	percent difference
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RI	remedial investigation
SAP	sampling & analysis plan
SC	specific conductance
SOP	standard operating procedure
TCE	trichloroethene
TL	tolerance limit
USEPA	United States Environmental Protection Agency
VE	Vapor extraction
VOC	volatile organic compound
WAC	Washington Administrative Code

1.0 Introduction

This section presents the purpose and objectives, site description, regulatory coordination, and project organization.

1.1 Purpose and Objectives

The purpose of this document is to provide the team with project information commensurate with a Cleanup Action Plan (CAP) for the Closed Landfill groundwater remediation project at the Asotin County Regional Landfill (see **Figure 1**). This document also provides functional details for a related compliance monitoring plan; effectively a combined Sampling & Analysis Plan (SAP) and quality assurance project plan (QAPP), to provide data to support the goals and objectives of evaluating the progress towards cleanup/remedy as established from the CAP. In 2008, the Closed Landfill formally shifted from detection-phase monitoring to assessment-phase groundwater monitoring due to the presence of volatile organic compounds (VOCs), namely perchloroethylene (PCE) and trichloroethylene (TCE), routinely detected in uppermost groundwater at downgradient wells since inception of the groundwater monitoring program in 1997.

To address the contamination in uppermost groundwater, the Asotin County has indicated to Ecology they will perform groundwater remediation actions under Model Toxics Control Act (MTCA), per WAC 173-340-515, *Independent Remedial Actions (IRA)*. Per the IRA process, the site owner performs remedial actions without department (Ecology) oversight or approval, and not under an order, agreed order, or consent decree. However, under the IRA rules, the Department (that is, Ecology) may provide informal advice and assistance (technical consultations) to owners required to conduct remedial actions. Having implemented assessment-phase groundwater monitoring, remediation activities, contaminants of concern, characterized the vertical and lateral extent of groundwater contamination, and cleanup levels, the County is transitioning to compliance monitoring to assess and guide ongoing cleanup activities, as documented herein by the CAP.

The following WAC rules are considered applicable for the Closed Landfill groundwater remediation project:

- WAC 173-351-430/440, Detection and Assessment Monitoring (justification and rationale for terminating these requirements for the Closed Landfill).
- WAC 173-340-380, Cleanup Action Plan per MTCA.
- WAC 173-340-410, Compliance Monitoring per MTCA (Subpart 1c, Confirmational Monitoring).
- WAC 173-340-820, Sampling & Analysis Plan per MTCA.
- WAC 173-304-490, Groundwater Monitoring Requirements under Minimum Functional Standards for Solid Waste Handling.

Note this document is intended to replace or supersede prior Ecology-approved sampling plans for detection monitoring of both the Closed Landfill and the Active Landfill, most recently as document in the *Groundwater Monitoring Plan for the Asotin County Regional Landfill* (CH2M HILL 2014). Since inception of groundwater monitoring in 1997, the facility has performed 'multi-unit' groundwater monitoring and reporting to Ecology for both the Closed Landfill and the Active Landfill, under the provisions of WAC 173-351 for solid waste, and following a single SAP.

This updated plan is specific to the requirements for the Closed Landfill under compliance monitoring during cleanup activities, and separate guidance documents will be used to administer the monitoring and reporting requirements for the Active Landfill which is under detection monitoring per WAC 173-351-430.

This approach allows goal specific monitoring for the Closed Landfill and cleanup, while allowing the Active Landfill monitoring approach specific to detection-phase monitoring.

Subsequent sections of this document describe the key information and procedures to support the objectives and content for the CAP (Section 2), compliance monitoring plan rationale and design for both groundwater and landfill gas as the monitored media (Section 3), data management, analysis, and reporting for both groundwater and landfill gas (Section 4), and references (Section 5).

1.2 Site Description

Figure 1 presents the vicinity and site location maps for the facility. ACRL is in Asotin County, which is located in the southeastern corner of Washington State. ACRL is located approximately 3 miles southwest of the City of Clarkston. The landfill area occupies 76.5 acres within the southern portion of Section 36, Township 11N, Range 45E, Willamette Meridian. The site address is 2901 6th Avenue, Clarkston, Washington, 99403.

Figure 2 shows the site features and the approximate boundaries of the two different waste units at ACRL. The facility includes the Closed Landfill and Active Landfill (Cells A-D). The original landfill consists of an unlined waste disposal area located in the western half of the site (referred to as the “Closed Landfill”). The Closed Landfill received waste from approximately 1975 to 1991 and was officially closed in 1993 under the requirements of the *Minimum Functional Standards for Solid Waste Handling*, WAC 173-304. This figure also shows a cross-section line (see subsurface conditions described in Section 1.3 as shown in **Figure 3**).

The following sections provide background information about the Closed Landfill and the Active Landfill.

1.2.1 Closed Landfill

The closed landfill received waste from approximately 1975 until 1991; closure of the landfill occurred from 1991 to 1993. The closed landfill was operational prior to the regulatory requirements enacted in 1988 under WAC 173-304, which prescribes a bottom liner system and leachate collection system. Therefore, the closed landfill was not constructed with a bottom liner system and thus does not collect leachate from the bottom of the waste unit. Leachate, according to WAC 173-351, is “a liquid that has passed through or emerged from solid waste and contains soluble, suspended or miscible materials removed from such waste.” Mitigation of mobilized constituents from the waste materials within the closed landfill is accomplished through engineering controls consisting of a low-permeability soil cap and enhanced by a stormwater management plan to minimize the potential for precipitation to infiltrate through the buried wastes.

During closure, the landfill was covered (capped) with a minimum of 2 feet of native soils, and then graded to collect and divert stormwater off of the cover to the natural drainage pathway along Dry Creek. The cover material was obtained from construction (excavation of native soils) of the first Active Landfill Cell (Cell A). During subsequent construction of Active Landfill Cells B and C, additional cover material was placed over the Closed Landfill to reduce the cover slopes for potential reclamation of the area as usable space for recreation or County business. Positive stormwater drainage was maintained to the Dry Creek drainage area. This work resulted in thickening the soil cover (up to 50 feet in some locations) using low permeability native materials. These materials have provided effective diversion of precipitation away from the cover and underlying wastes.

In addition to the cover and stormwater management, the Closed Landfill has an active gas extraction system installed along the southern margin of the landfill to prevent potentially explosive gas (i.e., methane gas) migration to nearby residential houses, and to withdraw contaminant vapors to support the (interim) remedy for the groundwater remediation project under tper MTCA. The gas extraction system includes nine vertical landfill gas wells (LGWs) screened within the southern margin of the closed landfill waste materials (extraction gas wells shown as “LGW” -01 through -09 on **Figure 4**). Additional details of the groundwater remediation project for the Closed Landfill are described in the (*draft) Remedial Investigation and Feasibility Study for Asotin County Regional Landfill* (CH2M HILL 2010).

Two soil borings were advanced in the interior of the Closed Landfill during the remedial investigation activities for evaluation of potential source conditions including interior gas monitoring points for future evaluation. Both soil borings extended to the bottom of waste and did not encounter saturated conditions, indicating the effectiveness of the soil cover system. Landfill gas included methane and volatile organics (VOCs), including PCE and TCE. The soil borings were completed as vapor sampling points for future monitoring to assist with additional remedial investigation evaluations, or potentially to convert them into future extraction points. However, because of boring complications, the diameter of the wells had to be reduced from 4 inches to 1 inch in diameter, which no longer provided a reasonable means for gas extraction.

1.2.2 Active Landfill

The active landfill includes four cells (Cells A-D) that employ both a composite bottom liner system and leachate collection and recovery system (LCRS), compliant with WAC 173-351-200. The purpose of the LCRS is to control leachate head build-up on the bottom liner system to less than 12 inches in accordance with WAC 173-351-300, and to transmit leachate to a central collection point for proper disposal/treatment. Each individual cell has a separate LCRS that collects and transmits leachate to a central lift station where it is conveyed to the sanitary sewer and eventually treated at the Clarkston Wastewater Treatment Plant, following the requirements of the Waste Discharge Permit.

Additional details of the active landfill design and associated groundwater monitoring are provided separately in the *Groundwater Monitoring SAP for Active Landfill at the Asotin County Regional Landfill* (Great West 2023) as a companion to this document.

1.3 Site Conditions

The hydrogeology of the site was initially characterized during the preliminary site characterization studies in the early 1990s. In 2010, the site conditions were refined in support of the remedial investigation for the closed landfill, and furthermore in 2012 in relation to the expansion of the active cell area for Cell D. The following provides a summary of the primary hydrogeologic characterization efforts which support the closed landfill remediation project and related monitoring design.

- **Howard Consultants, 1990.** *Report, Hydrogeologic Analysis and Monitoring Well Construction for the Asotin County Regional Landfill, Asotin County, Washington*. This characterization effort included the installation of nine groundwater monitoring wells (including MW-01, -02, -03, -04, -05, -06, -07, -08, and -08A) and a geophysical survey. Based on the site investigation work, the report included a hydrogeologic assessment and development of hydrogeologic cross-sections. As stated in the report, “the site conditions at the landfill suggest an area of higher hydraulic conductivity in the area of MW-04, and MW-07/-03, which should be the preferential pathway for contaminant movement.” In addition, the report stated that “the present locations (of the aforementioned monitoring wells) allow effective monitoring of any potential leachate plume from the landfill.”

- **Howard Consultants, 1992.** *Preliminary Hydrogeologic Assessment Report for the Construction of Additional Groundwater Monitor Wells at the Asotin County Landfill, Asotin County, Washington*. This report was prepared as requested by the Ecology in response to low-level detections of tetrachloroethylene (PCE) observed in MW-05. This report consisted of five elements including 1) literature review and beneficial use survey, 2) development of a conceptual model of the site, 3) a complete monitoring scheme with maps and proposed well locations, 4) site reconnaissance to assess well placement, and 5) records review to identify potential sources of contamination from the closed landfill. This report included groundwater quality results from seven wells, including MW-01, -02, -03, -04, -05, -06, and the deep Bovay well. Recommendations in this report led to the installation of four additional monitoring wells to assess the observed contamination, including MW 05A, MW-09, MW-10, and MW-11.

- **Asotin County, 1994.** *Supplemental Geologic and Hydrogeologic Study, Asotin County Landfill, Asotin County, Washington*. This report was completed by Asotin County in accordance with the Stipulated Agreed Order dated June 28, 1994. This report presented an interpreted hydrogeologic summary of the regional and local hydrogeology. The report also included groundwater quality results from twelve monitoring wells (and the seep) sampled during 1993-1994. Conclusions in the report confirmed that low-level detections of volatile organic compounds (VOCs), namely PCE and trichloroethene (TCE), exceeded MTCA Method A cleanup levels in three wells (MW-05, -09, and -10). The report noted that the observed VOC concentrations showed evidence of decline, likely because of the implementation of the institutional controls and LCS. The report recognized that continued groundwater quality monitoring was appropriate for the closed landfill and that further study would be completed as additional groundwater sampling events were performed.

- **CH2M HILL, 1995.** *Summary Technical Memorandum, Hydrogeologic Assessment and Monitoring Well Installation, Asotin County Landfill, Asotin County, Washington*. This study was performed by Asotin County and CH2M HILL in conjunction with Ecology to bring the facility into full compliance with the State of Washington Criteria for Municipal Solid Waste Landfills, WAC 173-351. This characterization effort included advancing four exploratory borings, two of which were converted into resource protection monitoring wells for expansion of the active cell area (MW-12, MW-13). This study also included decommissioning of the Bovay well, slug tests, soil properties testing, and development of hydrogeologic cross-sections. Key conclusions from this study noted that the groundwater monitoring system at the site appeared to be designed to detect landfill-derived constituents of concern (COCs) from the existing (closed) and future expansion cells (active cells).

- **CH2M HILL, 2007**. *Demonstration Evaluation: Asotin County Regional Landfill Groundwater Monitoring Program, Asotin County, Washington*. An evaluation was performed in 2007 to identify or differentiate the inferred source of contamination between the closed landfill and the active cells. Results from the evaluation were submitted to Ecology and support ACRL's hypothesis that the closed landfill was the source of contamination and not the new/active cells designed and operated under WAC 173-351. Following submittal of this report, Ecology met with ACRL in January 2008 to discuss the report findings. It was agreed by all parties that the source of contamination was from the closed landfill and not from the active cell area.

- **CH2M HILL, 2010**. *Draft Remedial Investigation and Feasibility Study Report for Asotin County Regional Landfill.* The remedial investigation (RI) helped to characterize the site to support a focused feasibility study (FS); the purpose of the FS was to develop, evaluate, and select a cleanup action under MTCA for the closed landfill groundwater remediation project.

- **CH2M HILL, 2012**. *Groundwater Monitoring Well Installation Data Summary Report for Cell D Expansion as Asotin County Regional Landfill.* This report summarized the subsurface conditions and installation of two new (supplemental) groundwater monitoring wells (identify wells) to support additional monitoring related to the expansion of the active cell area (i.e., Cell D).

- **Great West, 2021**. *Field Investigation Data Summary Report for the Asotin County Regional Landfill – Closed Landfill Groundwater Remediation Project*. This document summarized the subsurface conditions, well installation details, and groundwater quality results for three new wells (identify wells) installed downgradient of the Closed Landfill to characterize the nature and extent of contamination.

Based on the above site characterization studies, the uppermost geologic units at the site consist of the following four distinct lithologic units listed from ground surface downward:

- **Soil horizon (loess).** The loess deposits mantle the ground surface in the vicinity of the landfill and consist of a thin sequence (up to 20 feet thick) of fine-grained silt to silty sand. This unit appears to be absent in the vicinity of Dry Creek, possibly because of erosion. This unit is not saturated.

- **Gravel Unit.** The Gravel Unit consists of an interbedded, interfingered, heterogeneous mixture of poorly graded gravel and sand with varying amounts of silt and clay. The Gravel Unit ranges in thickness from approximately 100 to 200 feet. Depending on site topography, this unit is saturated at depths ranging from approximately 60 to 140 feet below ground surface (bgs). It is the primary water bearing zone targeted by the ACRL monitoring network (that is, it represents the uppermost monitorable groundwater unit per WAC 173-351-405).

- **Clay Unit.** The Clay Unit beneath the Gravel Unit in the vicinity of the landfill is approximately 40 to 60 feet thick. This distinctively light-colored (typically white to yellow-tan) fine-grained unit effectively acts as an aquitard and promotes the development of saturated conditions in the overlying heterogeneous Gravel Unit.

- **Basalt Unit.** The Columbia River Basalt Unit beneath the Clay Unit underlies the site at depth. The basalt unit is encountered at depths of approximately 200 to 250 feet bgs in the vicinity of the landfill.

Saturated conditions and shallow groundwater (first water) occur beneath the closed landfill within the interbedded and interfingered Gravel Unit. Although heterogeneous in its character, this Gravel Unit (including significant interbeds of sand, silt, and clay) serves as the primary hydrostratigraphic unit for purposes of groundwater monitoring at ACRL. Depending on site topography and vertical relief, the depth to shallow groundwater in the vicinity of the landfill varies from approximately 40 to 160 feet bgs. Saturated thickness of the Gravel Unit is up to 60 feet, but the water-bearing characteristics can vary considerably because of the distinct lithologic variability that occurs vertically within the Gravel Unit.

Figure 3 is a hydrogeologic cross-section from south to north through the closed landfill and extending north of the closed landfill along the Dry Creek drainage. This figure was developed and presented to Ecology in the *Field Investigation Data Summar Report for Closed Landfill at Asotin County Regional Landfill* (Great West 2021). This section shows the generalized conditions for the primary lithologic units described above, along with the approximate depth and configuration of the closed landfill waste trenches, thickness of cap/soil cover, and the groundwater monitoring wells along this section line.

For reference, **Appendix A** includes boring and as-built logs for the closed landfill groundwater monitoring wells (Appendix A.2), and the gas extraction probes/wells (Appendix A.3). The recent 2021 field exploration, and quarterly groundwater monitoring reports submitted to the department include groundwater flow maps which consistently demonstrate an inferred and generalized groundwater flow direction to the north.

2.0 Cleanup Action Plan (CAP)

This section provides information to meet the intent of a CAP per WAC 173-340-380, within the context of the IRA of MTCA. The CAP is precursor to the functional procedures of environmental monitoring provided in the CMP via subsequent sections and appendixes of this report. A CAP includes the following elements as summarized in this section:

- A general description of the proposed cleanup action;
- A summary of the rationale for selecting the proposed alternative;
- Cleanup standards and remediation levels;
- Schedule for implementing the cleanup action and related expectation for achieving cleanup levels and related restoration timeframe;
- Institutional controls; and
- Applicable laws or regulations.

The site owner (Asotin County) has completed focused site work to support the selection of a preferred cleanup action, establish a project timeline/schedule, and technical evaluations to establish cleanup standards/remediation levels. This information has been submitted to the ACHD and Ecology and is summarized herein to substantiate the CAP framework.

The *draft Remedial Investigation / Feasibility Study (RI/FS) Report* (CH2M HILL 2010) was issued to Ecology in 2010. The draft RI/FS report summarized the field investigation and findings from work completed for the Closed Landfill in 2009. The focused remedial investigation (RI) for the Closed Landfill characterized the site conditions with respect to the source areas and mechanisms impacting shallow groundwater. That report led to the technical evaluations in the FS, which evaluated several remedial action alternatives. The FS recommended vapor extraction of landfill gas (vapor-phase contaminants in the vadose zone beneath the Closed Landfill waste trenches) as the preferred alternative (see **Appendix A.1** for the Executive Summary from the RI/FS Report [CH2M HILL 2010]). As described in the draft RI/FS Report, the remedy selection evaluated three alternatives using MTCA criteria, consisting of: (1) No Additional Action: Institutional Controls and Containment, (2) Source Removal by VE, Institutional Controls, and Containment, and (3) Groundwater Control and Treatment, Institutional Controls, and Containment. Based on the MTCA evaluation criteria and results from the focused RI, the FS resulted in recommendations for Alternative 2, consisting of source removal and containment by VE, as the proposed cleanup remedy.

Recommendations from the FS led to a Pilot Study investigation completed in 2010 to help with final design of long-term operation of a vapor extraction (VE) system. Since completion of the Pilot Study, the Asotin County has maintained, monitored, and submitted year-end annual reports to Ecology and ACHD regarding performance of the VE system in meeting the long-term goals/objectives of cleanup levels in groundwater. Since 2012, VE system operations, monitoring, and reporting of VE data have been conducted in accordance with the *Work Plan for Interim Remedial Actions at the Closed Landfill for Asotin County Regional Landfill* (CH2M HILL 2012), which was submitted to Ecology.

In addition to the above work focused towards key elements of the CAP, focused technical evaluations have been completed in response to Ecology's concerns on Nitrate, as summarized in the *Asotin County Reginal Landfill Technical Demonstration for Nitrates in Groundwater and Potential Alternative Sources* (Jacobs and Great West 2020); and to address Ecology comments a successive effort in the *Asotin County Reginal Landfill Technical Demonstration for Nitrates in Groundwater and Potential Alternative Sources, Addendum No. 1* (Jacobs and Great West 2022). From these technical evaluations, the site data support that elevated concentrations of nitrate could be a result of dumping wastewater sludge into unlined waste trenches in the 1970's through early 1980's. However, since these historic waste disposal activities have ceased, and considering the closed landfill has been capped since 1993, suggests that the present-day concentrations of nitrate, which exhibit seasonal fluctuations in shallow groundwater, could represent a combination of sources, such as residual nitrate sources from the landfill, combined with potential alternative sources of nitrate identified within the drainage. As noted from the nitrates assessment, current land use activities, such as 47 permitted residential septic systems, and cattle grazing, may also be a source for nitrate within the Dry Creek drainage. As a conservative approach, sampling for and including nitrate is also a COC for this CAP.

In addition, a field investigation was completed to characterize the downgradient nature and extent of contamination for the established COCs. Details of well installation and groundwater quality sampling were submitted to Ecology in the *Field Investigation Data Summary Report for the Asotin County Regional Landfill – Closed Landfill Groundwater Remediation Project* (Great West 2021). Results from the investigation confirmed that groundwater quality concentrations were below cleanup levels for PCE, TCE, and Nitrate in MW-23 and MW-24, located roughly 1/3 and ½-mile, respectively, downgradient of the closed landfill. A copy of this field investigation technical memorandum is provided in **Appendix A.4** (Great West, 2021).

In summary, based on prior work as presented above, the core elements of the CAP framework are listed below.

- **Proposed Cleanup Action**. The proposed cleanup action is VE of source contaminant vapors in the vadose zone beneath the waste trenches and monitored natural attenuation (MNA). Specifically, for PCE and TCE, continued operation and monitoring of the closed landfill VE system, which has been active since 2010, and is demonstrated to be extracting contaminant source vapors beneath the soil cap, and limiting or mitigating the source mechanism transport of contaminated vapors into uppermost groundwater; contaminant vapors are extracted, controlled, and routed to the permitted flare station for thermal destruction. For nitrate, engineering controls such as capping the landfill to limit or impede vertical infiltration through the waste trenches, and MNA are the proposed cleanup action. Routine monitoring of both landfill gas and groundwater concentrations will provide data to track progress of the cleanup action in meeting remediation goals for these COCs.

- **Rationale for Selected Remedy**. The rationale for selection of VE and MNA is based on the technical evaluations and details in the draft RI/FS Report (CH2M HILL 2010), the Pilot Study (CH2M HILL 2012), and most recently in the *2022 Year-End Vapor Extraction Data Report for the Closed Landfill Groundwater Remediation Project at the Asotin County Regional Landfill* (Great West 2023). As described above, **Appendix A.1** includes a copy of the Executive Summary in the draft RI/FS Report, summarizing the site conditions and rationale for the selected remedy, based on the site conditions and technical evaluations of the FS evaluating three different alternatives. The hazardous substances at the closed landfill are the former wastes placed in the landfill, consisting of sewage sludge and municipal solid waste. The types of hazardous substances identified in vadose zone and/or in shallow groundwater from RI characterization are methane and VOCs such as PCE and TCE. The estimated volume of waste material is estimated to be approximately 1 million cubic yards, considering the former trench thicknesses of up to 30 ft and the plan-view area of the landfill. A focused ecological and human health receptors evaluation per MTCA Chapter 173-340-7491, WAC was performed in the draft RI/FS Report (CH2M HILL 2010). Measures to prevent or limit migration of or exposure to these hazards are operation of the VE system as focused source removal, MNA, and institutional controls (ICs).

- **Cleanup Levels or Remediation Goals**. Goals of the groundwater remediation project are to continue operation of the VE System to remove contaminant source vapors and achieve groundwater cleanup levels in uppermost groundwater in downgradient wells associated with monitoring of the Closed Landfill; actual wells and points of compliance are described in the next bullet and in the SAP in Section 3. The following are the COCs and related groundwater quality cleanup levels:

- PCE, cleanup level in uppermost groundwater of 5 µg/L.
- TCE, cleanup level in uppermost groundwater of 4 µg/L.
- Nitrate, cleanup level in uppermost groundwater of 10 mg/L.

These groundwater cleanup levels consider the receptors, exposure pathways, and land use through the site. These values consider the information collected in the RI/FS and through operations and monitoring performed ongoing during remedial activities. PCE and TCE exposure is represented through direct contact associated with potential subsurface work or groundwater extraction. Nitrate exposure is primarily through ingestion of groundwater. Non-carcinogenic impacts from PCE, TCE, and nitrate are to different organ systems, therefore the hazard quotient of 1 for each is not additive and the cleanup levels meet this standard. For the carcinogenic impact from PCE and TCE, the combined increased cancer risk does not exceed the standard of 1×10^{-5} increased cancer risk and these cleanup levels meet this standard.

- **Monitoring Design and Points of Compliance:** The existing VE system will be optimized in the 2024-2025 timeframe to include the installation of additional extraction points at key areas to expand spatial coverage of VE and vapor containment. **Appendix B** shows the locations for expanding the current VE system; consisting of four new VE probes located in the inferred historic source areas located north of LGW-7,LGW-8, and LGW-9; and two additional extraction locations (or new probes) via connecting in existing interior probes GP-LGW-10 and GP-LGW-11. Rationale or justification for the west end locations is to target inferred former historic waste disposal areas as described in the draft RI/FS Report (and supported from ongoing VE sampling of LGWs); whereas rationale for selection of interior locations at GP-LGW-10 and GP-LGW-11, is to target contaminant vapors which are inferred to be influencing groundwater concentrations at MW-07 and MW-06, showing limited or no demonstrable effect from operation of the VE system since 2012. The monitoring design includes monitoring of landfill gas probes (LGW-01 through LGW-09; plus new installations) and the combined closed landfill gas station to assess performance of the VE system at removing contaminant source vapors; and the monitoring of uppermost groundwater for the designated groundwater monitoring wells. The new/proposed monitoring locations, as shown in **Appendix B**, will be monitored for at least 1 year to determine if the flow and concentration of contaminant vapors warrant continued extraction and long-term monitoring. MTCA groundwater points-of-compliance are wells screened in uppermost groundwater downgradient of the closed landfill (see **Appendix C** for monitoring design of groundwater; and **Appendix D** for monitoring design of landfill gas).

- **Schedule to Achieve Cleanup Levels and Restoration Timeframe**. In the short-term (within the next 5 years), expansion of the existing VE system will occur with the addition of at least four to six additional extraction points, implemented to enhance VE source removal and to achieve cleanup levels in groundwater (as noted in bullet above). A Work Plan will be submitted to Ecology prior to initiation of field activities to solicit their opinion on the plan for expansion of the current VE system (as described above and shown in concept in **Appendix B**). Optimization efforts and installations to expand the VE system will include a Work Plan to Ecology, preliminary and final design of the system, contractor work, and system commissioning of new VE withdrawal points completed and commissioned within a 5-year period by late fall of 2028.

  In the longer-term (beyond the 5-year horizon), to date, the latest 2022 and the 2023 Year-end VE Data Reports (respectively, Great West 2022 and 2023) provide the most current and comprehensive vapor-phase and groundwater data analysis to provide insight on the potential schedule to achieve cleanup levels. Consistent with the draft RI/FS Report, the observations in the latest 2022 and 2023 VE System evaluation support that the selected remedy of ongoing VE remains to be an effective technology to continue to remove contaminant source vapors while controlling the landfill gas plume. Performance monitoring of VE System in tandem with MNA is showing positive effects in reducing groundwater contaminant concentrations at the majority of downgradient wells, however, concentrations are still elevated above cleanup levels. Once the vapor extraction system is expanded and operated for 5 years, the corresponding performance monitoring data can be used to estimate the remediation timeframe (time to achieve cleanup levels). Annually over the long-term, VE data summary reports evaluating VE System data and groundwater quality concentrations will continue to be the basis in which to evaluate remedy performance, track progress at achieving cleanup levels in groundwater, and to make decisions on whether future additional optimization of VE system is necessary.

- **Institutional Controls**. Asotin County owns the land where the groundwater plume is located and controls all access to the property. Motorized access into the Closed Landfill area is controlled by fences and gates, barricades (such as eco-blocks and jersey barriers), and / or steep terrain. The landfill facility is routinely monitored for unauthorized access and vandalism by security checks of the perimeter to check that all fencing and gates and barricades are intact. Groundwater monitoring wells are also locked. Drinking water is provided to the landfill facility and surrounding properties by the Asotin Public Utility District (PUD) Municipal Water Supply. Since Asotin County obtains water from the PUD, and considering they own the land, the County will not allow drilling or construction of potable water supply wells on the property which encompasses the areas impacted downgradient of closed landfill. The County secured and adopted a property Deed Restriction (Resolution No 24-30) effective November 25, 2024, which prohibits the installation of new potable water supply wells on portions of Section 36 owned by Asotin County.

- **Financial Assurance**. The facility is an active landfill and includes both an active municipal solid waste disposal area operated under WAC 173-351, and the closed landfill which was formally closed under the WAC 173-304 rules. The financial model for the entire facility relies upon waste disposal fees (revenue) and associated funding designated to cover activities under the Operations Plan and the long-term funding needed for Closure/Post-Closure Care. The financial model was reviewed in concert with the concept plan and costs to expand the VE system (as described in bullets above) to develop the timeline necessary to implement the activities within a 5-year period, and to continue with routine operations/ maintenance and monitoring over the long-term (next 35 years). Financial assurance for the Closed Landfill CAP for both capital improvements to expand the VE system (as shown in **Appendix B**), and for routine long-term operations and maintenance is from a dedicated reserve account that the County has established for the Closed Landfill (see **Appendix B** for financial assurance cost information related to both capital improvements and long-term contribution schedule).

- **Applicable Laws or Rules**. As noted in Section 1, the following are applicable laws/rules for the Closed Landfill groundwater remediation project:

    - State Environmental Policy Act (SEPA) and WAC 197-11-340, Determination of Non-Significance (DNS) [RCW 43.21C]. The entire facility operates under a municipal solid waste permit, issued by the jurisdictional health authority, that is, the Asotin County Health Department. As part of that permit, it recognizes the landfilling and environmental compliance and monitoring activities for both the active landfill, and the closed landfill. As part of permit approvals, a State Environmental Policy Act (SEPA) was completed as required per WAC 197-11-340(2), and the lead agency (Asotin County Public Planner/Building Inspector) determined the operating activities did not have a probable significant adverse impact and issued a Determination of Nonsignificance (DNS) letter, dated November 11, 1997. The permitted activities include those activities required for the closed landfill, such as operating the landfill gas system and environmental monitoring. The DNS review letter was published on August 14, 1997 and can be made available upon request.

    - WAC 173-351-200(4) and (5) *Operating Criteria – Explosive Gases Control*; and WAC 173-400 and 173-460, *General Regulations for Air Pollution Control*. Landfill gas is generated from both the active and closed landfill. Landfill gas generation from the active landfill is extracted and controlled for methane gas as required under WAC 173-351-200(4), *Explosive Gases Control*. Destruction of landfill gas is controlled from the permitted flare station, which extracts and thermally destroys landfill gases from both the closed and active landfill with 99 percent efficiency, as described and in accordance with the permit (Approval Order Number 18AQ-E039) approval letter from Ecology dated October 8, 2018. This project/activity included a new enclosed flare station which replaced their older/original candlestick flare, and Asotin County issued a DNS letter dated August 3, 2018. This project was posted for public comment by the County planner and no comments were received. Long-term operation and monitoring of the closed landfill VE system falls within the permitted activities of this DNS correspondence.

- Occupational Safety and Health Administration (OSHA). Applicable standards federally-mandated under OSHA are applicable to site work to govern work practices to ensure public health and safety, specifically 1910.120 regarding HAZWOPER and corrective actions involving cleanup operations at sites.

- WAC 173-351-430/440, Detection and Assessment Monitoring. Detection monitoring for site-wide multi-unit facility began in 1998 for the Closed Landfill. Initiation of assessment monitoring began in 2008 and the County has completed numerous years of expanded monitoring, characterized nature and extent of contamination, and is currently conducting groundwater remediation of MTCA under IRA. Since no new wastes have been placed in the Closed Landfill, the expanded suite of assessment monitoring list of constituents is no longer considered a requirement, and future monitoring will be performed to satisfy the data needs per MTCA for the selected CAP and included focused set of monitoring wells and parameters (see rationale in Section 3).

- WAC 173-304-490, Groundwater Monitoring Requirements under Minimum Functional Standards for Solid Waste Handling. Parameters needed to satisfy this rule for Post-Closure Care monitoring and reporting have been performed to date under the combined multi-unit monitoring program per WAC 173-351, with quarterly and annual reports submitted to Ecology since 1998. This updated SAP includes specific parameters required under WAC 173-304-490 to verify conditions are below the MCLs of WAC 173-200.

- WAC 173-340-515, Independent Remedial Action. Data needs to satisfy this rule would include landfill gas (vapor-phase) concentrations and vapor flow rates from operation of the VE System; coupled with continued collection of groundwater quality data/ continued groundwater monitoring of a focused suite of parameters and wells to track remedy progress towards achievement of cleanup levels, and groundwater quality to satisfy post-closure care monitoring of WAC for solid waste facilities (see rationale for wells, parameters, and frequency in Section 3).

- WAC 173-340-410, Compliance Monitoring Requirements of MTCA. The CAP will need confirmational monitoring to confirm the long-term effectiveness of interim and final cleanup actions. Per the compliance monitoring requirements, the facility will follow the site-specific SAP for each media being tested.

- WAC 173-340-820, Sampling and Analysis Plan(s) (SAPs). For the IRA program, stand-alone SAPs have been developed in this document for each media, including groundwater, and landfill gas/contaminant vapors. The SAPs specify procedures to ensure sample collection, handling, and analysis will result in data of sufficient quality to evaluate effectiveness of remedial actions and meet the substantive intent of WAC 173-340-820 [provided in **Appendix C** for groundwater monitoring and **Appendix D** for landfill gas monitoring].

In summary, the intent of this CAP is to provide rationale and justification to terminate the detection and assessment phase monitoring that has been performed for the Closed Landfill since 1998 and 2008, respectively, and to transition environmental monitoring to meet the objectives of the CAP, and related compliance monitoring activities under the MTCA IRA.

2.1 History of Closed Landfill and Regulatory Coordination

Since 1997, Asotin County has performed routine quarterly and annual reporting for both the Closed Landfill and Active Landfill, under the requirements of WAC 173-351-410 through 430. This program is referred to as the 'Detection Monitoring Program' and includes the constituents listed in Appendices I and II of WAC 173-351. The Detection Monitoring Program is intended to identify an increase in groundwater concentration above background, and to support whether a potential release or impacts to groundwater have occurred. By comparison, 'Assessment Monitoring' is conducted to identify those COC that have impacted groundwater and supported identification of the data needs towards tracking changing conditions or improvements in groundwater quality to evaluate progress of a remedial strategy in achieving cleanup levels. This CMP has been developed to support current goals and objectives of groundwater remediation for the Closed Landfill.

In January 2008, Asotin County and its consultants met with Ecology and ACHD to discuss the status of the groundwater monitoring program and issues related to observed contamination from the Closed Landfill. In March 2008, Ecology issued a letter to Asotin County necessitating a shift of the program into Assessment Monitoring, prescribed under WAC 173-351-440. Groundwater samples for Assessment Monitoring constituents were first collected in February and May 2008, and the results submitted in the May 2008 quarterly report. Subsequent Assessment Monitoring has been completed in 2009, 2010, 2011, 2012, 2013. The program then shifted to once per four years per request from Asotin County and thus sampled in 2017, and most recently in 2021. Assessment Monitoring results are submitted to the agencies in the annual groundwater monitoring reports. Monitoring to date has not identified any new constituents of concern from the expanded suite.

In November 2008, ACRL issued a Letter of Intent to Ecology and ACHD outlining the plan to conduct Assessment Monitoring in parallel with site cleanup actions for the Closed Landfill under WAC 173-351, *Criteria for Municipal Solid Waste Landfills*; and WAC 173-340-515, MTCA *Independent Remedial Action*. Cleanup actions for the Closed Landfill under MTCA Independent Remedial Action have been in process since completion of the 2010 RI/FS Report via operation of the VE System.

In June 2013, ACRL updated their groundwater monitoring program in response to changes to WAC 173-351 regulations as detailed in the agency-approved *Groundwater Monitoring Plan Addendum No. 1 for Asotin County Regional Landfill* (CH2M HILL 2013a).

In October 2013, ACRL expanded the active cell well network to provide supplemental monitoring for Cell D as detailed in the agency-approved *Groundwater Monitoring Plan Addendum No. 2 for Asotin County Regional Landfill* (CH2M HILL 2013b).

In October of 2013, ACRL submitted a memorandum to Ecology and ACHD that requested changes (reductions) to the monitoring frequency for Assessment Monitoring as detailed in the memorandum titled *Assessment Monitoring at Asotin County Regional Landfill* (CH2M HILL 2013c).

From inception of the facility detection monitoring plan in 1998, the Asotin County has conducted routine quarterly monitoring and submittal of groundwater monitoring reports for both the Closed Landfill and the Active Landfill, under the framework of WAC 173-351-430, *Detection Monitoring*. Since 2008, the facility has performed routine quarterly monitoring to satisfy the requirements of WAC 173-351-440, *Assessment*

Monitoring. To date, the Active Landfill remains under detection-phase monitoring and reporting, and the Closed Landfill has conducted assessment monitoring of the expanded list of constituents (Appendix III of 173-351-990 of WAC), which has not identified any ‘new’ contaminants beyond the list of parameters cited in Appendices I and II. As such, the goal of the CMP and updated SAP is to provide separate monitoring plans and approaches to the monitoring goals and related requirements between the closed landfill and active cells; specifically, the goal for active cells is to continue with detection-phase monitoring per WAC 173-351-430; whereas the goal for the closed landfill is to evaluate the performance of the selected remedy and related changes in groundwater quality in achieving cleanup levels, for the COCs.

Project goals, data needs, and monitoring design specific to the Closed Landfill groundwater remediation project are included in this plan; whereas, the goals and data needs for the Active Landfill are included in a separate plan. In April 2023, the most recent year-end data summary report for the MTCA groundwater remediation project was submitted to the agencies in the *2022 Year-End Vapor Extraction Data Report for the Closed Landfill Groundwater Remediation Project at the Asotin County Regional Landfill* (Great West 2023). This report included the most current summary of VE System operation, technical evaluation of VE System monitoring and performance, and groundwater results focused on the contaminants of concern. This document also included a comprehensive history of Closed Landfill groundwater remediation project, which is utilized in the planning of this CAP and SAP. This guidance document has been developed with the assumption that Asotin County, its consultant and regulators have a general understanding of the extensive site history and hydrogeologic conditions for implementing and executing this plan.

2.2 Project Team Roles and Responsibilities

The Project Distribution List (located at the front of this document) shows the project organization and key points of contact for ACRL’s monitoring program. Asotin County is the site owner/operator and is responsible for making sure that environmental monitoring and reporting are conducted in accordance with the CMP and SAP (part of this document). The ACHD is responsible that site activities (including monitoring and reporting) are conducted in accordance with state and federal regulations, most notably the post-closure care groundwater monitoring requirements of WAC 173-304-490/173-351-410. Ecology is the lead agency for MTCA to verify progress for the groundwater remediation project under WAC 173-340-515, IRA.

Asotin County administers the financial and technical aspects of the site monitoring and reporting activities. ACRL staff are responsible for performing the routine field sampling and data collection. Asotin County has relied on consulting support from Jacobs Engineering (formerly CH2M HLL) and currently Great West Engineering to support landfill gas sampling, environmental monitoring data management, and development of data/monitoring reports. Groundwater quality samples are submitted to and tested by Anatek Labs Inc., with testing facilities in Spokane (WA) and Moscow (ID). Both labs are approved by the National Environmental Laboratory Accreditation Conference and Ecology, and laboratory certification described in **Appendix C** (groundwater samples). Landfill gas samples are submitted to and tested by ALS Environmental, with certification as described in **Appendix D** (landfill gas samples).

2.3 Health and Safety

Sampling will be performed by ACRL staff or County-designated personnel or consultants who are familiar with environmental sampling, site-specific conditions at the landfill, and potential hazards. Training will be provided to all project personnel to ensure compliance with the site-specific health and safety plan and technical competence in performing the work effort. Field workers will conform to all site safety instructions and wear the proper personal protective equipment when collecting and handling groundwater and vapor-phase landfill gas samples.

2.4 Project Schedule

As noted under the rationale for the CAP, additional VE System operation and monitoring is needed to control source vapors, contract the source plume in the vadose zone, and to achieve resultant improvements in groundwater concentration downgradient of the Closed Landfill. As such, an additional 20 or up to 30 more years of VE systems operation and monitoring is anticipated for the restoration timeframe to achieve cleanup levels. Over this period, routine performance monitoring of landfill gas, along with compliance monitoring of groundwater will be performed as outlined in Section 3.

3.0 Compliance Monitoring Plan (CMP)

This section describes the compliance monitoring rational and related data quality objectives (DQOs) to support the CAP goals and objectives, including the media to be monitored, and then for each media the rationale and design (plan) for data needs/parameters, monitoring locations, and monitoring frequency. Functional details of routine monitoring activities, standard methods/procedures, and quality assurance/ control are provided in separate appendixes, respective of compliance groundwater monitoring (**Appendix C**) and landfill gas monitoring (**Appendix D**). The compliance monitoring plans in the appendices for each media are considered the effective SAPs with appropriate quality assurance and quality control (thus, a combined SAP and QAPP procedural document).

3.1 Data Needs / Data Quality Objectives

The DQO process is a series of steps developed by the United States Environmental Protection Agency (USEPA) that helps guide project managers and regulators to plan for the most resource-effective acquisition of environmental data (EPA QA/G 4, 2006). Ecology has adopted a similar approach as described in *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology 2004)*. The DQO process is used to establish performance and acceptance criteria that serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals and objectives of environmental monitoring plans. The DQO process was used as a guide to help with rationale for the compliance monitoring, to select the type and quality of data needed for this monitoring plan as described in the following text.

The media to monitor to support the CAP goals and objectives include (1) <u>vapor-phase landfill gas</u> concentrations and vapor-phase flow rates from the combined landfill gas extraction system, and (2) <u>groundwater quality concentrations</u> for a focused set of parameters, monitoring network locations, and monitoring frequency. The vapor-phase landfill gas concentrations are the primary source of contamination from the landfill mobilizing in vapor-phase into uppermost groundwater, and the justification of source removal via extraction of landfill gas, and related monitoring landfill gas is developed from and supported by the RI/FS Report (CH2M HILL 2009), the Pilot Study (CH2M HILL 2012), and ongoing year-end VE data summary reports, most recently in the *2023 Year-End VE Data Report for Closed Landfill Groundwater Remediation Project at Asotin County Regional Landfill* (Great West 2024). Monitoring uppermost groundwater is the impacted media and these data are needed to (1) track progress of remedy with respect to groundwater concentrations achieving cleanup levels for primary and secondary contaminants of concern, as is required under WAC 173-340-515, IRA; and also (2) required under Post-Closure Care groundwater monitoring per WAC 173-304/351 and related evaluations of groundwater concentrations compared to the MCLs of WAC 173-200*, Water Quality Standards for Groundwater in the State of Washington*.

Table 1 presents the data needs/data uses for the two media to be monitored, including groundwater and landfill gas monitoring, to support the CAP goals and objectives. Details on the full parameter list, monitoring locations, and frequency are provided below.

3.2 Rationale for Locations, Parameters, and Monitoring Frequency

3.2.1 Groundwater

Locations: **Table 2 and Figure 2** show the groundwater monitoring program well network. The wells are grouped into "<u>performance</u>" set of wells immediately up and downgradient of the landfill; and another group of wells designated as "<u>protection</u>" further downgradient from the landfill within Dry Creek drainage preferential flow zone to confirm the lateral extent of contamination plume. The **performance wells** will be monitored on a semi-annual frequency and consists of two upgradient wells (MW-1 and -11), and ten downgradient wells (MW-3, -4, -5, -6, -7, -9, -10, -14s, -14d, and -15), which exhibit the highest and consistent detections of primary COCs. The **protection wells** will be monitored on an annual frequency and consists of three wells (MW-22, -23 and -24) further north and downgradient, which from initial characterization exhibit groundwater quality concentrations which are below primary COCs, and non-detect for Nitrate. The furthest downgradient well, MW-22, has been 'dry' since installation and will continually be checked annually in the spring for presence of groundwater and designated as 'water level only'. If sufficient water is identified in MW-22, then groundwater quality samples will be collected.

Parameters: The groundwater quality parameters consist of two groundwater quality groups, including 'general chemistry' or parameters under WAC 173-304, plus the full list of VOCs. This parameter list includes the COCs (that is, PCE, TCE, and nitrate) to support the MTCA IRA program, and also the required parameters for Post-Closure Care monitoring under WAC 173-304, *Minimum Functional Standards for Solid Waste Handling*. **Appendix C** groundwater monitoring SAP/QAPP provides tables showing the full suite of parameters, methods, and criteria (if applicable).

Monitoring Frequency: **Table 2** summarizes the monitoring wells and respective monitoring frequency. The monitoring frequency initiated in 1998 was quarterly to support the objectives of routine detection monitoring specified under WAC 173-351-430, to test for a 'statistically-significant change of condition over background.' However, given the long period of record with quarterly data initiated back in 1998, coupled with a restoration timeframe expected to require at least 20 but likely upwards of 30 more years, is supportive of the following sampling frequency:

- For the **performance wells** (listed in **Table 2** and shown in **Figure 2**; which consists of two upgradient wells and ten downgradient wells), perform routine semi-annual monitoring, sample / test for the full parameter list under WAC 173-304 list plus VOCs. This list includes PCE, TCE, and Nitrate.

- For the **protection wells** (MW-23, MW-24, and if water is present, MW-22), annual sampling in spring seasonal high-water period for WAC 173-304 list plus VOCs (as above, includes PCE, TCE, and Nitrate). The annual frequency considers the relative low groundwater flow velocity from the source area, relatively low concentrations below cleanup levels, and that more frequent measurements will be collected upgradient near source area and from the performance network wells.

Note that "semi-annual" sampling is twice per year, with the spring event occurring during the months of April, May, or June and the fall event occurring during the months of October, November, or December. From review of the site hydrograph (as provided in prior groundwater monitoring reports to the agencies), the spring period typically represents seasonal high groundwater elevations, and would be intended to monitor seasonal high groundwater quality conditions; whereas the fall event would monitor seasonal low groundwater levels and related groundwater quality conditions. The approach for semi-annual monitoring will assess potential seasonal fluctuations in groundwater quality synoptic with seasonal high and low water levels, allow for annually updating trend analysis of changing conditions given a long period of historic observations, and support with comparing recent semi-annual groundwater quality data to cleanup levels and/or MCLs per WAC 173-200 criteria.

Appendix C provides the groundwater monitoring sampling and analysis plan (SAP) with quality assurance/quality control (QA/QC) procedures, including functional details of groundwater monitoring to meet the CAP goals and objectives.

Annual reports will provide the team with an opportunity to evaluate current conditions and progress towards achieving the cleanup goals and objectives. At least once every five years, the parameter suite, monitoring well locations, and frequency of the groundwater monitoring program will be re-evaluated, based on conditions observed from the most recent / latest 5-year monitoring period and data evaluations, and considering the goals and objectives of MTCA cleanup and solid waste rules under Post-Closure Care monitoring status.

3.2.2 Landfill Gas

Locations: **Table 3** and **Figure 4** identify the landfill gas VE system monitoring design and locations. The monitoring network consists of the following:

- Closed Landfill Station (CLF): this station represents the combined flow from extraction of landfill gas from the active LGWs flow-field (active withdrawal points LGW-1 through LGW-9). Gas flow and contaminant vapor concentration data are used to estimate annual mass removal quantities / rates from the groundwater remediation system.

- Individual Landfill Gas Extraction Points (LGW-1 through LGW-9): represent vapor extraction conditions / withdrawal points for individual gas well locations screened in buried and capped waste trenches within the interior of the closed landfill, to help optimize extraction of contaminant source vapors from higher concentration areas. These wells are equipped with QED gas monitoring wellheads, which include valves that can adjust flow rates from being 100 percent open, to a closed condition; and also have quick-connect ports with orifice plates to optimize measurements of gas flow rate, temperature, and composition using a handheld gas meter.

- Interior Probes (IGP-10 and -11): locations monitored to assess interior gas concentrations and the amount of vacuum induced; these probes will also be connected into the VE system and may be converted in the future active withdrawal point to optimize the extraction system (see plan in Appendix B layout).

- Flare Station: represents the combined flow from both the Closed Landfill and Active Landfill areas; the flare station is monitored to assess overall operation of the extraction system and thermal destruction; gas flow rate is continuously monitored and controlled at the flare station using either a constant flow or withdrawal vacuum set point; the gas composition is also monitored at the flare station using the handheld gas meter.

Parameters: The landfill gas sampling parameters include field-measured parameters of fixed gases using a handheld landfill gas meter to obtain gas flow rates and concentrations of methane, oxygen, and carbon dioxide; and laboratory-analyzed parameters tested for fixed gases (methane, oxygen, carbon dioxide) and the full toxics suite via Method TO-15 (Volatile Organic Compounds [VOCs]). The methane and oxygen readings help to optimize the landfill gas extraction system with respect to flow rates and capture zone areas; whereas the TO-15 toxics suite includes the primary VOC parameters such as PCE, TCE, vinyl chloride, and refrigerants (Freon 11 and 12) used to evaluate ongoing source removal of contaminant vapors (which with flow and concentration data can be quantified into estimated pounds per day source removal rates and quantities). **Appendix D** provides the landfill gas sampling plan tables showing the full suite of landfill gas parameters.

Monitoring Frequency: Field-measured readings from the Closed Landfill gas monitoring stations at the LGWs are collected <u>monthly</u>; and then Summa Canister laboratory samples are collected <u>quarterly</u> and tested for fixed gases (methane, oxygen, and carbon dioxide) and TO-15 (full toxics suite of VOCs). Quarterly sampling frequency is considered effective for tracking potential changes in flow and/or source vapor concentrations over the duration of restoration period, and to estimate contaminant mass removal estimates on an annual basis to support objectives of CAP and/or to optimize the LFG extraction system, as needed.

The above monitoring design for the landfill gas extraction system was developed from review of the most recent *2022 Year-End Vapor Extraction Data Report for the Closed Landfill Groundwater Remediation Project at the Asotin County Regional Landfill* (Great West 2023) and the original *VE Monitoring Work Plan* (CH2M HILL 2012). As noted in the latest 2022 VE Data Report, the configuration and monitoring of the VE System under normal or typical operation is explained below:

- Flare Station is where the blower system is connected to withdraw landfill gas from both the Closed Landfill and the Active Landfill; includes digital readout for combined flow rates, temperature of flare (for thermal destruction), and an access port for the handheld gas meter to monitor gas composition (methane, oxygen, and carbon dioxide).

- Closed Landfill Station is where the combined gas from LGW-1 thru 9 is monitored, to measure gas flow rates from the Closed Landfill using a digital meter, and quick-connect ports to the main-line to check landfill gas concentration using a handheld gas meter, and to obtain grab samples of landfill gas (i.e., Summa samples) on a quarterly basis.

- Landfill Gas Wells (LGW's): LGW-1 through LGW-9, equipped with QED wellheads to monitor flow rates, and to obtain field readings via GEM of landfill gas composition, and quick-connect ports to collect landfill gas samples (Summa samples) to quantity gas composition and toxics concentration. The flow values for LGW-7 and LGW-9 are cyclically adjusted to optimize collection of landfill gas, and to minimize collection of oxygen (assumed atmospheric); the individual flow valves are typically configured as follows (in percent open):

    - LGW-1: 100% (fully open)
    - LGW-2: 20-50% (varies depending on gas composition and flow rate)
    - LGW-3: 100% (fully open)
    - LGW-4: 50% (half-way open)
    - LGW-5: 0% (typically closed, due to elevated oxygen levels)
    - LGW-6: 100% (fully open)
    - LGW-7: 0% and 20% (open and closed in cycles; opposite of LGW-9)
    - LGW-8: 40% (partially open)
    - LGW-9: 0% and 20% (open and closed in cycles; opposite of LGW-7)

- Interior Gas Probes (IGPs): two probes referenced as IGP-10 and IGP-11, completed/screened in the interior of the landfill adjacent to refuse. The probes can be used to monitor passive vacuum, configured to measure/sample landfill gas concentration (with vacuum pump), and will be included for active vapor extraction to determine if these locations are viable long-term extraction probes (See Section 2 and Appendix B).

Appendix D provides functional details of landfill gas monitoring sampling plan (SAP) and related QA/QC to meet the CAP goals and objectives.

4.0 Data Management, Analysis, and Reporting

This section includes data management, analysis, and reporting for both media, including groundwater in Section 4.1, followed by landfill gas in Section 4.2.

4.1 Groundwater Data Management, Analysis, and Reporting

4.1.1 General Data Management

The following is a list of data management steps / procedures:

- ***Data Recording:*** Field observations and field-measured data will be recorded on dedicated field forms (or in a field logbook) to provide a record of field activities. All field data that are transferred (hand-entered) into electronic databases (for example, the field parameters) will be subjected to a review by a second person to check entries in order to help minimize data entry errors. A check for completeness of field records (logbooks, field forms, databases, and electronic spreadsheets) and samples will be conducted by the field team leader to ensure that all requirements for field activities have been fulfilled, complete records exist for each activity, and the procedures specified in this plan have been executed. Field documentation will provide sufficient technical information to confirm the data for a given event is complete.

- ***Data Reduction:*** Data collected for ACRL's monitoring program will be reviewed by the field sampling leader to determine if the qualitative parameters of representativeness and comparability have been achieved. In general, the review will be accomplished by comparing the COC and field logbook entries with the sampling requirements herein.

- ***Data Storage and Archives:*** Upon receipt of the electronic data from the laboratory, the data files will be reviewed by Asotin County (or County's designated consultants) prior to uploading to the electronic project database. Groundwater data for each sampling event will be uploaded into the master database. Each successive round of quarterly monitoring data will be compared against historical conditions. If the reported concentrations of a given sample from a specific location are inconsistent with historical data, then efforts will be made to determine (1) if the data reflect an actual change in environmental conditions at that sampling point, or (2) if the integrity of the sample was potentially compromised during collection, preservation, shipping, or analysis. Conversely, if some level of analyte historically present in samples from a specific location is no longer present, then similar efforts will be made to verify if the non-detect is valid. Asotin County, with support from its designated consultant(s) will determine if the data meet project goals. If the data do not meet project goals, then the need for additional sampling will be discussed with the regulatory agencies and resolved accordingly.

Data generated as part of ACRL's groundwater monitoring program will be handled and reviewed in accordance with the procedures presented above. All collected data for all parameters will undergo the following three stages of review:

1. In the field by the field team leader during and immediately after sample collection with the methods and procedures described in the respective SAPs.
2. At the laboratory by the project chemist (Anatek) according to the standard operating procedures for the analyte-specific methodology (listed in the tables of **Appendix C**).
3. Outside the laboratory by ACRL's designated data manager via the data assessment criteria described in this plan.

All analytical data received from the laboratory will be transferred directly from the laboratory's electronic data deliverable (EDD) into the project database that is maintained by the data management specialist. Electronic copies of the original data reports for each event received from the laboratory will be archived onsite and filed chronologically. The testing laboratory retains hard copies for 5 years and electronic copies indefinitely.

Electronic copies of the original analytical data reports for each sampling event will be submitted to the agencies along with each of the quarterly reports. Groundwater monitoring analytical data will also be uploaded into Ecology's Environmental Information Management (EIM) database within 60 days of receipt of the quarterly analytical results, which is consistent with the requirements under WAC 173-351-430 for detection monitoring.

4.1.2 Analysis and Reporting

This section presents guidance on reporting of ACRL's groundwater monitoring results (Compliance Monitoring) for the Closed Landfill, to support assessment of progress towards cleanup levels for MTCA IRA; and to support assessment of groundwater quality under Chapter WAC 173-340-410, as compared against the cleanup levels for the COCs and the maximum contaminant levels under WAC 173-200, *Water Quality Standards for Groundwater in the State of Washington.* Procedures for statistical analysis are based on a review of the historic groundwater conditions, methodologies presented in prior reports, and per EPA's Unified Guidance in their *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, EPA 530/R-09-007, March 2009* (EPA 2009).

<u>Annual reports</u> will be prepared with the procedures below, which is consistent with annual reporting required under Chapter 173-304, and is supportive of the goals for the Closed Landfill groundwater remediation project. The following provides guidance for the information and methods for developing annual groundwater reports to meet the objectives for the closed landfill groundwater remediation project under MTCA, and to meet the substantive intent of groundwater monitoring/reporting per Post-Closure Care for WAC 173-304.

- ***Groundwater Levels:*** Field readings of the initial (static) DTW measurement will be obtained from wells during each sampling event. The static DTW measurements will be converted into groundwater elevations using the surveyed reference elevations (top of casing) listed in **Table 2**. The vertical datum is the top of PVC rim in NAVD88. Depth to water (and subsequent groundwater elevations) will be recorded to the nearest hundredth of a foot (i.e., +/- 0.01 foot). Well locations found to be "dry" will be reported accordingly to maintain a complete sampling record for each event.

- ***Hydraulic Gradient and Estimated Groundwater Seepage Velocity:*** Hydraulic gradient and groundwater seepage velocity will be calculated each event using the static groundwater levels (described above), converted into groundwater elevations. Groundwater flow velocity estimates will be calculated using the following formula (Fetter 1994; and per Ecology 2018):

$$v = \frac{K_a i}{n_e}$$

where:

v = estimated groundwater seepage velocity (length per time); calculated each quarter based on the measured groundwater levels.

K_a = horizontal hydraulic conductivity estimated 150 ft/day for closed landfill well network; these estimates of hydraulic conductivity are based on slug tests performed during the initial hydrogeologic investigations (CH2M HILL 1995).

i = horizontal hydraulic gradient (ft/ft; dimensionless); calculated value using the event-specific quarterly groundwater elevations. Consistent with previous reports, the hydraulic gradient is calculated from wells MW-11 (upgradient well) and MW-05 (downgradient) for the closed landfill area.

n_e = effective porosity (dimensionless) assumed at 25 percent, which is a representative value of 'mix sand and gravel' material cited from Fetter (1994) which is common for uppermost gravel unit at the site.

- ***Groundwater Flow Map:*** Static groundwater elevations measured each event will be used to generate a groundwater elevation contour and groundwater flow map for the closed landfill. Groundwater elevations will be contoured on a plan view map to illustrate the inferred direction of groundwater flow. The inferred groundwater elevation contours and groundwater flow direction will be developed in a manner consistent with the groundwater flow maps presented in recent annual reports to Ecology and following the general approach in the *Field Investigation Data Summary Report for the Asotin County Regional Landfill – Closed Landfill Groundwater Remediation Project* (Great West 2021).

- ***Data Quality Assessment:*** A qualitative assessment of data quality will be performed each sampling event and will consider the field and lab procedures of this plan. A quantitative assessment of the sampling data quality will include the following:

    - A review of the case narrative in the laboratory reports to determine the potential for laboratory errors or deviations from the analytical methodology as provided in the laboratory data packages.

    - An assessment of the Field Duplicate sample (FD) result against the parent sample as described below.

    FD samples collected during each sampling event will be evaluated as a supplemental means to assess data quality or repeatability from field or lab methods. Analytical results from the parent sample (P) and the respective FD sample are used to calculate a relative percent difference (RPD) for detected results using the following formula (from WA Ecology, 2016):

    $$RPD = \frac{|P - FD|}{(P + FD)/2} \cdot 100\%$$

    Notes: (1) the calculation is not performed if either the parent sample or duplicate was below the method reported limit (non-detect). (2) RPD values less than 20% are considered reasonable to support data quality objectives of this SAP (personal communication with Anatek).

- ***Comparison of Groundwater Quality Results to Cleanup Levels and MCLs:*** For the established cleanup levels under MTCA, individual groundwater quality observations from each sample event will be compared the COCs PCE (5 ug/L), TCE (4 ug/L), and Nitrate (10 mg/L). For Post-Closure Care groundwater monitoring/reporting specified under WAC 173-304, groundwater quality observations will be compared to maximum contaminant levels (MCLs) per WAC 173-200, *Water Quality Criteria for Groundwater Quality in the State of Washington* (Ecology 2022). See Section 2.1 for a summary of the respective cleanup levels and MCLs.

- ***Statistical Analyses:*** Statistical analyses will be performed for each round of sampling to evaluate changing conditions (such as trends) and progress towards cleanup levels. Key assumptions have been developed to help guide the methods and to enhance consistency in the reporting process as described below.

    - **General Approach.** The statistical testing procedure(s) will follow an intra-well approach given the degree of spatial and temporal variability between upgradient and downgradient wells; inter-well testing is not appropriate given the spatial and temporal variability at ACRL.

    - **Trend Testing**. Trend testing is a typical statistical test to assess changing conditions in groundwater quality datasets; such as tracking improvements (decreasing concentrations) in groundwater quality towards achievement of cleanup levels. The recommended trend test is the Mann Kendall (MK) method, which is supported by statistical software such as Sanitas for Groundwater (software) or other statistical software. The time interval in which to administer the trend test is recommended to include the most recent 4 or 5-year period (typically minimum of at least 8 to 10 recent observations), which is a "moving window" as future data are obtained, and the test is then providing the most recent indication of recent changing conditions. The trend test procedure is recommended to include at least 7-8 detected concentrations over the period of interest, which is consistent with EPA Unified Guidance (EPA 2009).

      Note that once concentrations begin to approach cleanup levels, the data evaluation procedure and statistical analysis techniques will be re-evaluated and updated to demonstrate levels are below established cleanup levels.

- ***Schedule:*** The recommended reporting schedule is annually to document the goals and objectives of cleanup action with respect to evaluating long-term changes and compare the data to project specific cleanup levels for primary COCs. The annual reporting frequency is considered reasonable given that the Closed Landfill was closed in 1993 with engineering controls such as low-permeability cap, and no additional wastes placed after 1991. Submittal of annual reports will be consistent with WAC 173-340-410 compliance monitoring, and WAC 173-304 reporting requirements during post-closure care period; and the owner/operator would notify the Department if needed should any emerging or increasing conditions be identified from the semi-annual sampling events. Annual reports will be prepared and shared with Ecology within 60 days of receipt of the fall semi-annual sampling event; this timeframe is consistent with WAC 173-351-430 (Detection Monitoring) for the active landfill, and to the extent practicable/possible, the owner intents to submit annual reports for both the closed landfill and the active cells within the 60-day schedule in a common timeframe.

4.2 Landfill Gas Data Management, Analysis, and Reporting

4.2.1 General Data Management

- ***Data Recording:*** Field observations and field-measured data will be recorded on dedicated field forms (or in a field logbook) to provide a record of field activities. **Appendix D** provides a field form for recording data from routine landfill gas monitoring visits. Field documentation will provide sufficient technical information to confirm the data for a given event is complete. A check for completeness of field records (logbooks, field forms, databases, and electronic spreadsheets) and samples will be conducted by the field team leader to ensure that all requirements for field activities have been fulfilled, complete records exist for each activity, and the procedures specified in this plan have been implemented. All field data that are transferred (hand-entered) into electronic databases (for example, the field parameters) will be subjected to a review by a second person to check the entered data in order to minimize data entry errors.

- ***Data Reduction:*** Data collected for ACRL's monitoring program will be reviewed by the field sampling leader to determine if the qualitative parameters of representativeness and comparability have been achieved. In general, the review will be accomplished by comparing the COC and field logbook entries with the sampling requirements herein.

- ***Data Storage and Archives:*** Upon receipt of the electronic data from the laboratory, the data files will be reviewed by ACRL (or ACRL's designated consultants) prior to updating the master database. Once reviewed, landfill gas data from each sampling event will be compared to previous/historical conditions. If the reported concentrations of a given sample from a specific location are grossly inconsistent with previous or historical data, then efforts will be made to determine (1) if the data reflect an actual change in environmental conditions at that sampling point, or (2) if the integrity of the sample was potentially compromised during collection, preservation, shipping, or analysis. Conversely, if some level of analyte historically present in samples from a specific location is no longer present, then similar efforts will be made to confirm that change in concentration. ACRL, with support from its' designated consultants) will determine if the data meet project goals. If the data do not meet project goals, then the need for additional sampling will be discussed with the site owner and resolved accordingly.

Data generated in support of the Closed Landfill groundwater remediation project will handled and reviewed in accordance with the procedures outlined in the previous text. All collected data for all parameters will undergo the following three stages of review:

1. In the field by the field team leader during and immediately after sample collection with the methods and procedures described in this plan.
2. At the laboratory by the project chemist (ALS Environmental) according to the standard operating procedures for the analyte-specific methodology (listed in the tables of this SAP).
3. Outside the laboratory by ACRL's designated data manager (subcontractor support) via the data assessment criteria described in this plan.

All analytical data received from the laboratory will be transferred directly from the laboratory's EDD into the project database that is maintained by the data management specialist. Electronic copies of the original data reports for each event received from the laboratory will be archived onsite and filed chronologically. The testing laboratory retains e-copies indefinitely and can archive hardcopy upon request.

Electronic copies of the original analytical data reports for each sampling event will be submitted to Ecology along with each annual report as noted below.

4.2.2 Analysis and Reporting

The groundwater quality data will be included and reported in tandem with the landfill gas data, into an <u>annual data summary report</u>, submitted to Ecology within 60-days of receipt of the closed landfill data (for both groundwater quality and landfill gas data). The core landfill gas VE System data analysis and reporting will include:

- Mechanical system performance and operation;
- System flows and induced vacuum at active withdrawal well locations;
- Induced vacuum at passive monitoring probes and area of influence;
- Estimates of soil pore volume exchange;
- Field-measured landfill gas concentrations for methane, carbon dioxide, and oxygen;
- Laboratory-measured vapor concentrations for contaminants of concern; and
- Estimates of contaminant mass removal from VE operation.

Details or examples of VE System data analysis, methods, calculations, and reporting can be found in the latest *2023 Year-End VE Data Summary Report for the Closed Landfill Groundwater Remediation Project at the ACRL* (Great West 2024).

In addition to the above annual report, the landfill gas data will be uploaded into Ecology's Environmental Information Management (EIM) database in accordance with WAC 173-34-840(5), *Sampling Data*; and per Ecology's Publication 16-09-050.

5.0 References

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TABLES

Table 1. Data Needs and Data Uses - Groundwater and Landfill Gas
Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill
Asotin County Regional Landfill, near Clarkston, Washington

Media	Parameter/Data	Sample Locations	Sample Frequency	Data Need/Rationale
Groundwater	Field (DTW, pH, Temp Cond) and Laboratory-analyzed Testing of VOCs plus WAC 173-304 Suite.	**See Figure 2. Performance Well Group:** near field wells (two upgradient [1, 11]; and 10 downgradient [10, 5, 9, 4, 3, 7, 6; plus 14s, 14d, and 15]).	Semi-annual; spring and fall (twice per year)	Data need for both primary and secondary suite at wells nearest landfill "performance well group" over long-term; semi-annual frequency to track changing conditions and evaluate progress towards cleanup levels.
	Field (DTW, pH, Temp Cond) and Laboratory-analyzed Testing of VOCs plus WAC 173-304 Suite.	**Protection Well Group:** further north and downgradient along Dry Creek (Wells MW-23 and MW-24)	Annual; spring event (once per year)	Initial characterization sampling of these wells demonstrate concentrations below cleanup levels for PCE, TCE, and non-detect for nitrate; annual checks to confirm conditions remain below cleanup levels.
	Field DTW WL Check	Protection Well, check DTW (Well MW-22)	Annual; during spring event	Well MW-22 has been dry since installation; annual check for presence of water
Media	**Parameter/Data**	**Sample Locations**	**Sample Frequency**	**Data Need/Rationale**
Landfill Gas	Field Readings GEM (temp., vacuum, gas flow rate, methane, CO2, O2)	**See Figure 4.** Flare, CLF, LGW-1 through LGW-9, and interior probes GP-LGW-10, GP-LGW-11 (13 monitoring locations)	Monthly	Field readings to verify landfill gas composition (such as O2, CH4), and to obtain flow rates for estimates needed for mass removal calculations.
	Lab parameters tested via ASTM-1946 (O2, CH4, CO) & TO-15 Full Toxics Suite via Summa Samples	CLF, source area extraction probes LGW-7, LGW-8, LGW-9; plus new proposed extraction probes (see locations shown in Appendix B).	Quarterly	Quarterly quantification of landfill gas concentration from laboratory testing of gas samples, including PCE, TCE, and VC to assess source area gas composition and to be used to calculate annual mass removal estimates. Once installed, the new extraction probes as shown in Appendix B will be sampled to assess whether these wells have flow and contaminant concentrations that warrant continued vapor extraction and support long-term monitoring.

Notes:
DTW = static depth to groundwater (measured in feet below top of casing).
Groundwater analytical suite includes broad suite of VOCs as listed in Appendix I of WAC 173-351-990, plus the WAC 173-304 Suite (see Appendix C tables for complete list of parameters).
See Figure 2 for groundwater monitoring wells; see Figure 4 for landfill gas monitoring locations.

Table 2. Groundwater Monitoring Well Network

Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill

Asotin County Regional Landfill, near Clarkston, Washington

Well	Positional Coordinates X Coordinate	Positional Coordinates Y Coordinate	Date Completed	Boring Depth (ft bgs)	Ground Elevation (ft msl)	Elevation, Top-of-Casing (ft toc)	Screen Length (ft)	Screen Top (ft bgs)	Screen Bott. (ft bgs)	Screen Top (ft Elev.)	Screen Bott. (ft Elev.)	Gradient	Comments:
Performance Well Group: Semi-Annual Monitoring Frequency.													
MW-1	400526.702	2494111.487	1190	170	1275.60	1276.63	18	149	167	1128	1110	Upgradient	
MW-11	400519.340	2493887.844	1993	170	1279.20	1280.47	10	155	165	1124	1114	Upgradient	
MW-03	401885.208	2494646.139	1990	99	1154.90	1156.35	10	88	98	1067	1057	Downgradient	Screened at base of uppermost groundwater, companion to MW-07
MW-04	401764.227	2494171.056	1990	65	1154.00	1155.07	20	44	64	1110	1090	Downgradient	Mainly sample for nitrate; typically ND or low for volatiles.
MW-05	401509.649	2493442.613	1990	91	1189.40	1191.16	20	70	90	1119	1099	Downgradient	
MW-06	401923.775	2495086.868	1990	87	1175.40	1176.82	20	65	85	1110	1090	Downgradient	Between closed and active landfill, observed contamination from CLF
MW-07	401896.654	2494655.653	1990	50	1154.60	1155.95	15	33	48	1121	1106	Downgradient	Shallow screen interval, companion to MW-03
MW-09	401680.747	2493772.709	1993	99	1192.30	1193.65	10	85	95	1107	1097	Downgradient	
MW-10	401252.185	2493136.543	1993	88	1191.80	1193.22	10	75	85	1117	1107	Downgradient	
MW-14S	402377.328	2494792.510	3/26/2009	20	1121.10	1123.30	10	10	20	1111	1101	Downgradient	Shallow screen interval, companion to MW-14d
MW-14D	402382.584	2494793.584	3/25/2009	79	1121.10	1123.33	13	58	71	1063	1050	Downgradient	Screened at base of uppermost groundwater, companion to MW-14s
MW-15	402903.413	2495247.487	3/27/2009	39	1100.50	1102.71	5	7.5	12.5	1093	1088	Downgradient	Often dry, sample if enough water (greater than 1 ft).
Protection Well Group: Annual Monitoring Frequency													
MW-23	403327.4486	2495802.932	6/4/2021	45	1076.6	1079.11	15	22	37	1055	1040	Downgradient	Sample to verify concentrations remain below cleanup levels; annual frequency.
MW-24	404057.1859	2496417.690	6/3/2021	125	1044.1	1046.85	20	100	120	944	924	Downgradient	Sample to verify concentrations remain below cleanup levels; annual frequency.
MW-22	406020.8094	2497054.419	12/8/2020	78	975.0	977.5	10	56	68	919	907	Downgradient	Typically Dry; check for water, if present collect sample

Notes:

"--" Not available and/or not measured.

"ft" = feet

ft bgs = feet below ground surface

ft TOC = feet below top of casing (surveyed reference point)

ft Elev. = feet Elevation

Coordinates are in NAD83 State Plane Zone, US Foot

See Figure 3 Cross-section for depiction of screen interval depths in uppermost groundwater.

Table 3. Landfill Gas Monitoring Design
Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill
Asotin County Regional Landfill, near Clarkston, Washington

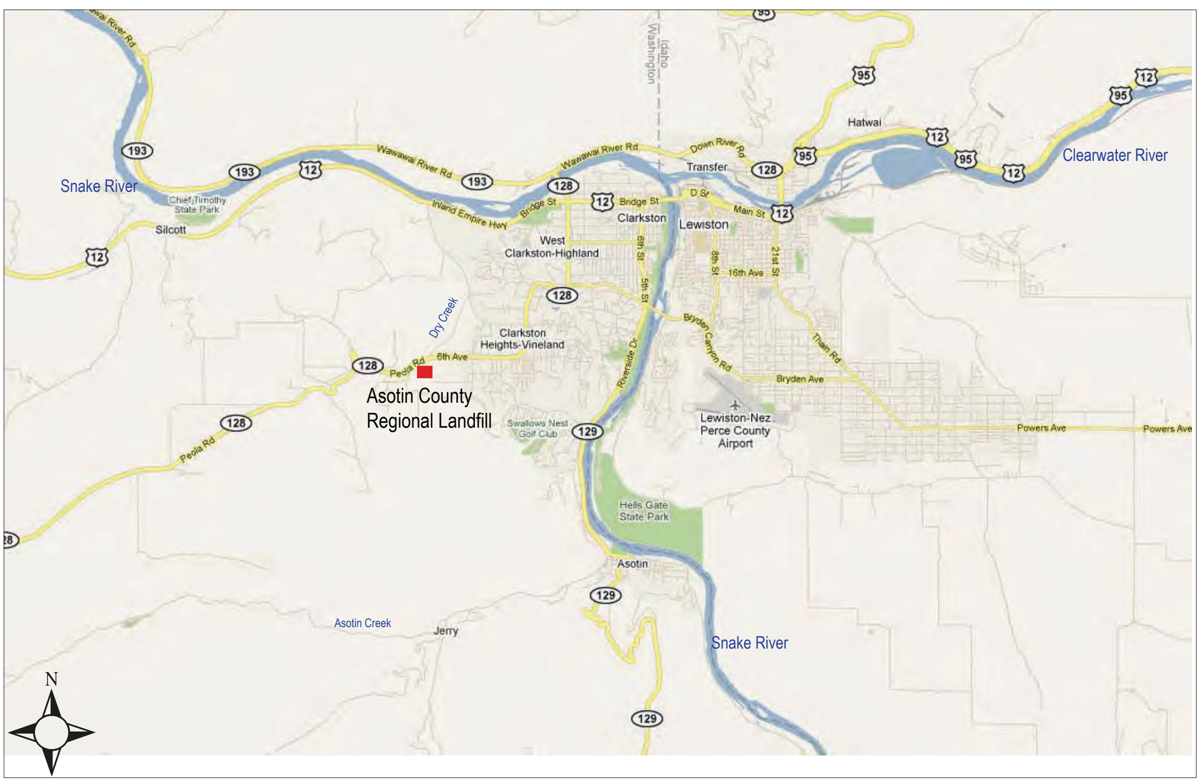
Monitoring Staion	Data Needs / Data Types Air Flow Rate CFM	Pressure/ Vaccum PSI (inches)	Gas Temprature (Degrees F)	Field Gas percentage (%)	Laboratory Landfill Gas percentage (%)	Laboratory Landfill Gas ug/m^3	Valve Position (% open)	Comments
Flare Station	Yes, digital readout	Yes, digital readout	Yes, digital readout	Yes, GEM meter	--	--	NA	Combined gas from active and closed landfill
Closed Landfill Station	Yes, digitial readout	NA	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	NA	Landfill gas from Closed Landfill; active LGWs.
LGW-1	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	100	
LGW-2	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	20-50	Valve back, minimal toxic vapors.
LGW-3	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	100	
LGW-4	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	50	Valve back, minimal toxic vapors.
LGW-5 (closed/inactive)	--	--	--	--	--	--	0	High oxygen, typically closed valve.
LGW-6	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	100	
LGW-7	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	20	Elevated oxygen, target lower flow rates
LGW-8	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	40	Target source extraction area
LGW-9	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	20	Cyclic operation, elevated oxygen, high conc.
Existing Passive Monitoring Probes - To Be Converted into Active Extraction Wells and Tested for VOCs to Determine if location is effective for Long-Term Vapor Extraction								
GP-LGW-10 (interior gas probe)	NA, passive probe	Yes, GEM meter	NA, passive probe	NA, passive probe	NA, passive probe	NA, passive probe	NA	Interior/passive gas probe (SEE NOTE 2)
GP-LGW-11 (interior gas probe)	NA, passive probe	Yes, GEM meter	NA, passive probe	NA, passive probe	NA, passive probe	NA, passive probe	NA	Interior/passive gas probe (SEE NOTE 2)
Future Planned Landfill Gas Extraction Wells - See Map in Appendix B.								
LGW-12T (screened in waste trench)	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	TBD	Proposed vapor extraction well, screened in waste trench (SEE NOTE 3).
LGW-12V (screened in vadose zone)	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	TBD	Proposed vapor extraction well, screened in vadose zone soils (SEE NOTE 3).
LGW-13T (screened in waste trench)	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	TBD	Proposed vapor extraction well, screened in waste trench (SEE NOTE 3).
LGW-13V (screened in vadose zone)	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	TBD	Proposed vapor extraction well, screened in vadose zone soils (SEE NOTE 3).

Notes:
1. See Figure 4 for monitoring locations; and Appendix D (Landfill Gas Monitoring SAP) for parameters and test methods for laboratory-analyzed parameters.
2. Interior passive probes will be connected to active withdrawal and monitored to assess if flows and contaminant concentrations warrant long-term extraction (See map in Appendix B).
3. Future expansion of the vapor extraction system described in Section 2 and shown in Appendix B (will consist of 4 new gas probes in west end shown as LGW-12T, LGW-12V, LGW-13T, LGW-13V; plus GP-LGW-10 and GP-LGW-11).

FIGURES

VICINITY MAP

SITE LOCATION MAP



0 2 4 MILES

SCALE 1 INCH = 2 MILES

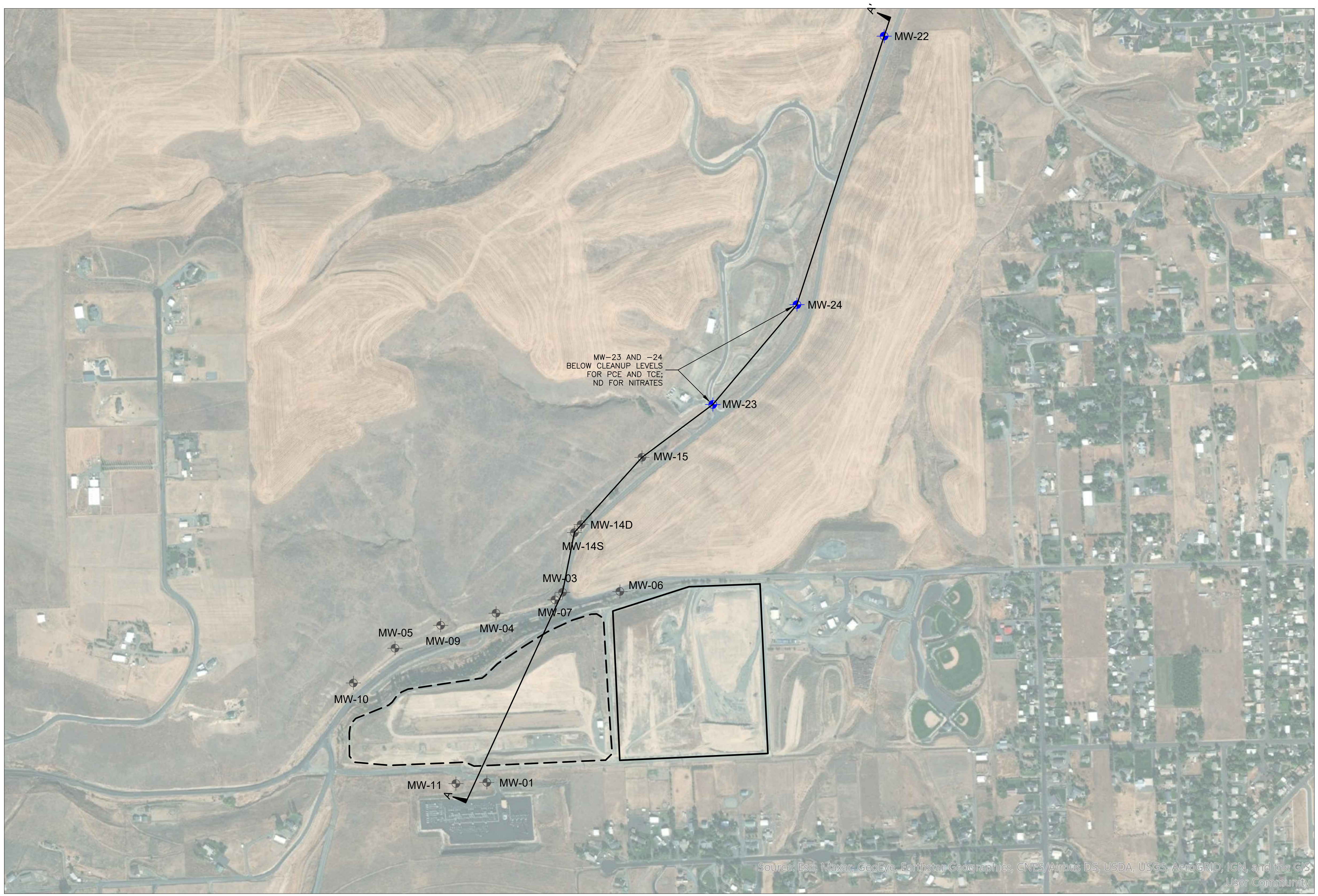
GreatWest ENGINEERING

Figure 1. Location Map

Cleanup Action Plan and Compliance Monitoring for Closed Landfill

Asotin County Regional Landfill

Source: Modified from the draft RI/FS Report (CH2M 2009).



LEGEND

- PERFORMANCE WELLS – SEMI–ANNUAL MONITORING FREQUENCY
- PROTECTION WELLS – ANNUAL MONITORING FREQUENCY (SPRING). NOTE, CHECK FOR WATER IN MW–22.
- CLOSED LANDFILL BOUNDARY
- ACTIVE LANDFILL BOUNDARY
- CROSS–SECTION LINE

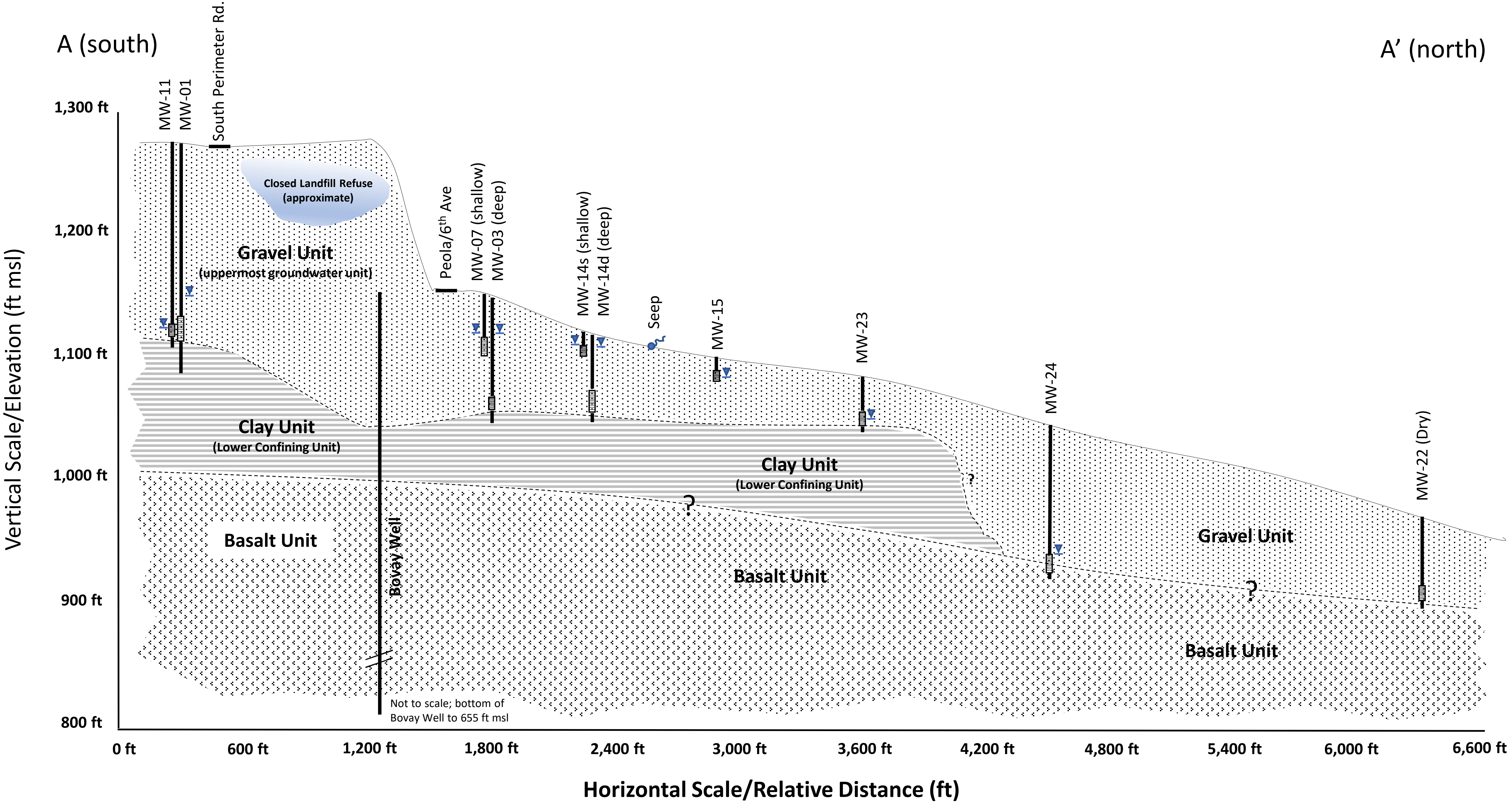
0 375 750
SCALE IN FEET

NORTH

GreatWest
ENGINEERING

Figure 2. Site Map, Monitoring Well Locations, and Cross-Section Line
Cleanup Action Plan and Compliance Monitoring for Closed Landfill
Asotin County Regional Landfill

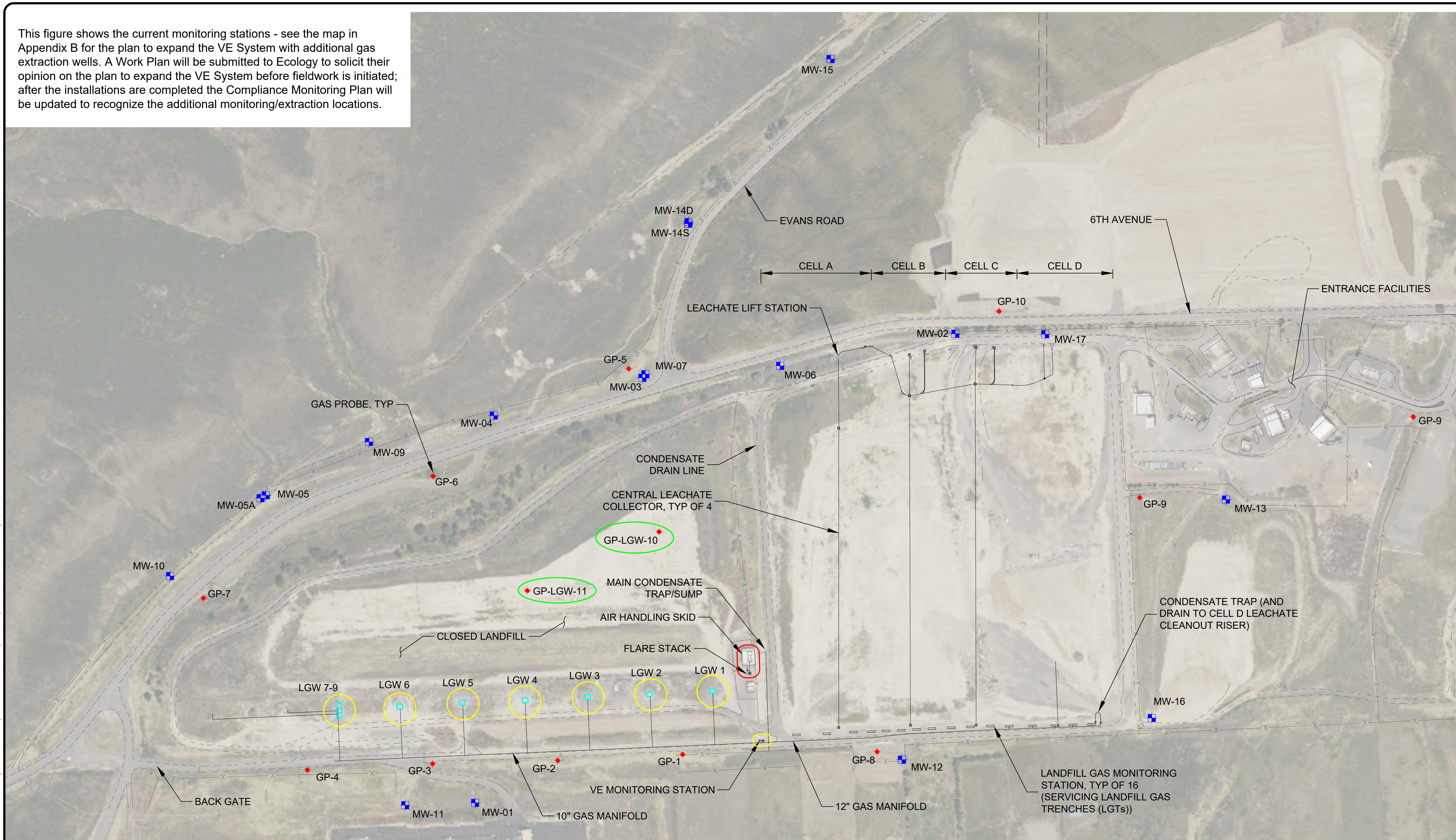
\\EgnyteDrive\greatwesteng\Shared\Boise Projects\4-17110-Asotin County SW Services\CADD 4-17110 Cell E ER\Exhibits\CLF Drilling - Access Agreement\CLF Wells.dwg



Source: Field Investigation Data Report for Asotin County Regional Landfill (Great West 2021).

Figure 3. Generalized Hydrogeologic Cross-section A-A' (South to North)
Cleanup Action Plan and Compliance Monitoring for Closed Landfill
Asotin County Regional Landfill

This figure shows the current monitoring stations - see the map in Appendix B for the plan to expand the VE System with additional gas extraction wells. A Work Plan will be submitted to Ecology to solicit their opinion on the plan to expand the VE System before fieldwork is initiated; after the installations are completed the Compliance Monitoring Plan will be updated to recognize the additional monitoring/extraction locations.



LEGEND

GROUNDWATER MONITORING WELL
GAS PROBE
LANDFILL GAS (VERTICAL) WELL (LGWs)
ACTIVE LANDFILL GAS EXTRACTION WELLS (LGW–1 THRU 9), QED STYLE.
CLOSED LANDFILL COMBINED MONITORING STATION; FLOW FROM ALL ACTIVE LGWs.
FLARE STATION, COMBINED FLOW FROM ACTIVE AND CLOSED LANDFILL, THERMAL DESTRUCTION.
INTERIOR GAS MONITORING PROBES.

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ENGINEERING

Figure 4. Site Map, VE System Layout, and Monitoring Stations
Cleanup Action Plan and Compliance Monitoring for Closed Landfill
Asotin County Regional Landfill

Y:\Shared\Bose Projects\4–17110–Asotin County SW Services\CADD 4–17110 EM\Exhibits\4–17110–EM–FIG01.dwg

APPENDIX A

Existing Site Evaluations and Site Data

A.1 Executive Summary from RI/FS Report (CH2M HILL 2010)

Executive Summary

Asotin County Regional Landfill (ACRL) is a 76- acre facility located in the southeastern corner of Washington State. ACRL currently administers a closed waste unit (referred to as the 'closed landfill') and an active waste disposal area at the facility.

In 1989, low-level groundwater contamination was identified in the immediate area downgradient of the closed landfill and was reported to Ecology. Since 1990, in cooperation with Ecology, ACRL has conducted hydrogeologic investigations and groundwater monitoring related to the closed landfill. Groundwater contamination associated with the closed landfill is attributed to unregulated waste disposal activities that occurred from about 1975 to 1985. Asotin County is currently conducting groundwater cleanup actions voluntarily under the *Independent Remedial Action* of the Model Toxics Control Act (MTCA), Chapter 173-340-515, Washington Administrative Code (WAC). The Washington State Department of Ecology (Ecology) administers cleanup actions of MTCA.

As part of the MTCA cleanup process, a remedial investigation (RI) and feasibility study (FS) are conducted in support of development and evaluation of cleanup action alternatives. This report presents the findings from a focused RI and FS conducted for ACRL.

The FS evaluation process includes a preliminary screening of remedial technologies, development of cleanup action alternatives consisting of one or more remedial technologies, and a detailed evaluation of cleanup action alternatives to identify a preferred alternative. Key factors influencing development of applicable and appropriate alternatives include site hydrogeology, nature of contamination, and considering the landfill is a permitted facility. The FS evaluation process is supported by the updated Conceptual Site Model (CSM) and Potential Receptors evaluation (discussed below).

Based on the FS screening efforts, a focused list of technologies were retained for further consideration and were combined into three cleanup action alternatives. The following three alternatives were evaluated in a detailed evaluation process using MTCA criteria.

- **Alternative 1—No Additional Action: Institutional Controls and Containment -** The No Additional Action alternative typically is defined as not taking any additional proactive steps to effect a site cleanup and generally is included as a baseline for comparison purposes. ACRL has a vegetated soil cover, landfill gas extraction system, and fencing installed as part of landfill closure activities.

- **Alternative 2—Source Removal and Treatment, Institutional Controls, and Containment -** Alternative 2 assumes (1) mass removal and treatment of site contaminants of concern (COCs) by Soil Vapor Extraction (SVE); (2) continuance of existing institutional controls to prevent exposure to contamination; and (3) maintenance of existing landfill cap to prevent migration of contaminants by percolating infiltrated precipitation.

- **Alternative 3—Groundwater Control and Treatment, Institutional Controls, and Containment -** Alternative 3 assumes (1) engineering control and treatment of contaminated groundwater by groundwater pumping, air stripping of pumped groundwater, and vapor phase carbon adsorption of the air stripper exhaust; (2) continuance of existing institutional controls to prevent exposure to contamination; and (3) maintenance of existing landfill cap to prevent migration of contaminants by percolating infiltrated precipitation.

Based on the detailed evaluation process, Alternative 2 (Source Removal and Treatment, Institutional Controls, and Containment), is the preferred cleanup action alternative for the site.

The FS was performed based on the MTCA process and considering site-specific conditions as described in the updated CSM. The updated CSM compiled existing data with new information learned from a focused RI performed in 2009. The objective of the RI was to characterize the nature and extent of contamination to assist with evaluation and selection of a cost-effective cleanup action alternative.

Key elements of the focused RI consisted of (1) subsurface characterization at eight new locations to complement the existing site monitoring network; (2) installation of and subsequent testing of three new groundwater monitoring wells; and (3) installation of and subsequent testing of five new landfill gas monitoring probes. The 2009 RI included a focused sampling program using existing monitoring locations and newly installed monitoring locations to assess the nature and extent of contamination.

The following CSM elements are simplified below in this executive summary to capture key concepts; a more detailed CSM description is presented in the main body of this report.

- The inferred source area of contaminants are covered (capped) within former waste trenches located within the boundaries of the closed landfill area; the primary source materials of concern include industrial sludge and sewage treatment plant effluent pumped into former waste trenches during early landfill operations over a 10-year span from about 1975 to1985.

- Spatial assessment of landfill gas concentrations of the COC are elevated in the westernmost portion of closed landfill. Landfill gas concentrations extend laterally and vertically from the source area (i.e., western portion of closed landfill), but the landfill gas concentrations are relatively low in areas outside the boundaries of the closed landfill. Historic knowledge of landfilling activities, combined with observed field conditions and contamination, suggest a focused source area located in the westernmost portion of the closed landfill.

- Mobilization of the contaminants from the (former) waste trenches to shallow groundwater may include transport mechanisms such as landfill gas dispersion, infiltration of gravity-driven leachate, or a combination of both. Based on available data, the predominant source mechanism currently impacting shallow groundwater is believed to be landfill gas effect/mobilization to shallow groundwater.

- Once the contaminants are in groundwater, the hydraulic properties of the shallow groundwater unit then dictate the contaminant mobilization further downgradient of the landfill. Groundwater flow direction from the closed landfill is predominantly to the north with a slight north-northeasterly shift immediately north of the landfill aligned with the Dry Creek drainage.

- Groundwater concentrations of the COC are elevated in wells completed within materials that are interpreted to represent a paleochannel (subsurface preferential groundwater flow zone). The paleochannel influences contaminant migration and correlates with locations along the Dry Creek drainage.

A Potential Receptors evaluation was performed to compliment the RI/FS evaluations. The Potential Receptors evaluation included an assessment of ecological and human health exposure and inferred risk. Based on the ecological evaluation criteria and findings, the ecological risk is qualified as low and the site is recommended for exclusion of subsequent ecological risk evaluation.

To assess potential human exposure, a residential well inventory and associated testing of residential water-quality was performed in a focused area downgradient of the landfill. Based on the residential sampling results and the current understanding of site conditions, the human receptors evaluation concluded that there are no known exposure scenarios related to human contact with groundwater that has been impacted by the closed landfill.

The CSM and Potential Receptors evaluation were used to identify data gaps and associated data needs to support the MTCA cleanup process. Interim actions are recognized under the MTCA cleanup process to address data gaps that are needed in support of selecting and optimizing the long-term cleanup action alternative. Interim actions are recommended for the site in support of (1) adequate characterization of the extent of contamination; (2) selecting and optimizing a long-term cleanup action alternative; and (3) development of a cleanup action plan. Based on these considerations, two interim actions are recommended:

Interim-Action #1: Conduct a supplemental RI to further characterize the extent of shallow groundwater contamination. The extent of shallow groundwater contamination is needed to confirm the CSM and support implementation of the remedy.

Interim-Action #2: Conduct a pilot study of the preferred cleanup action alternative (Alternative 2, Source Removal via Landfill Gas Extraction) from the existing landfill gas extraction system. A pilot study from the existing landfill gas extraction system is needed to select and optimize the final design for long-term landfill gas extraction and treatment.

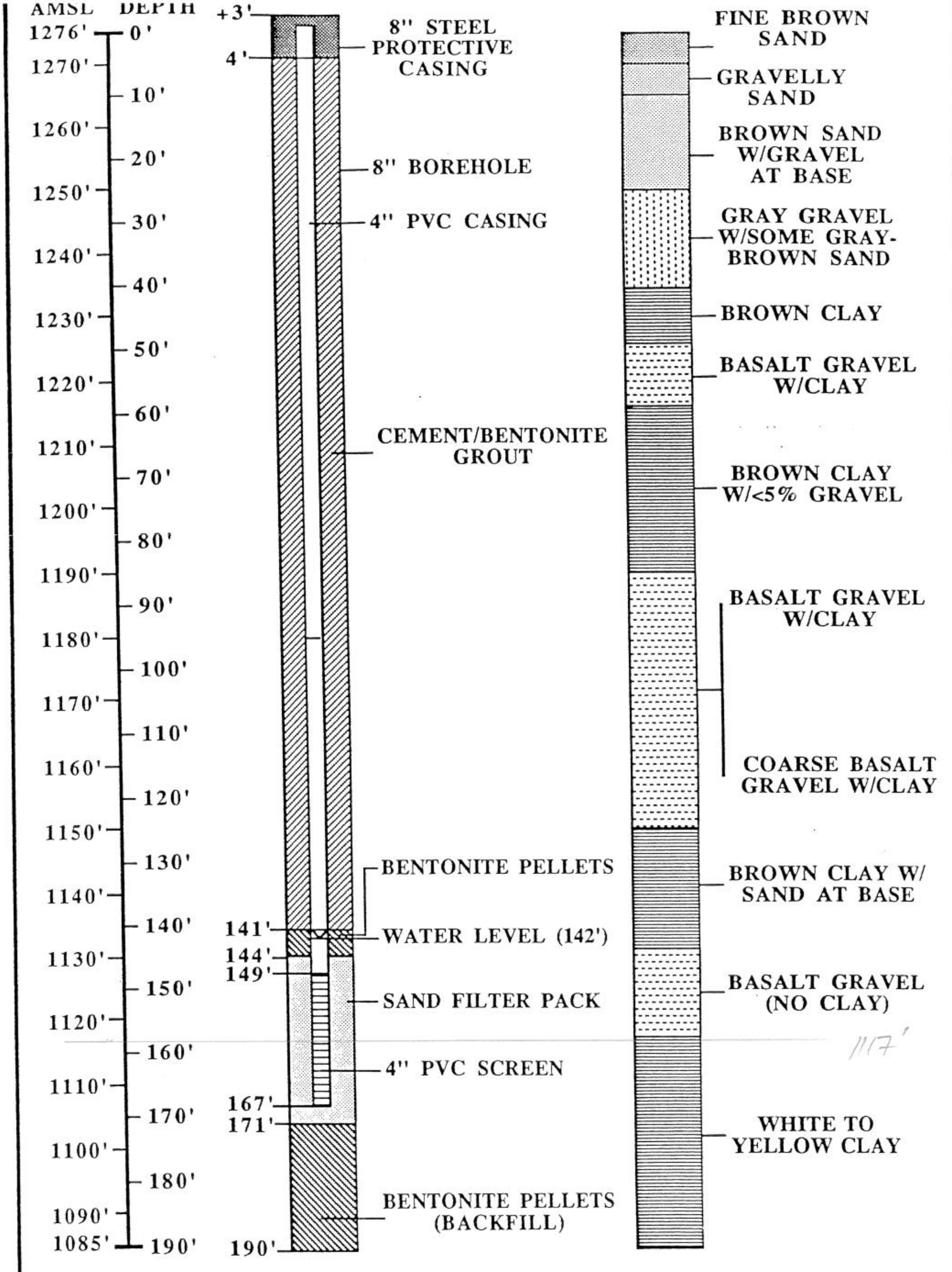
A.2 Boring/Groundwater Well Logs & Well Completion Diagrams

TABLE 5-1
Subsurface Investigation Inventory
Remedial Investigation and Feasibility Study Report

Location ID	Investigation Type	General Location	Install Date	Ground Surface Elevation (ft msl)	TOC Elevation (ft msl)	Boring Depth (ft)	Borehole Diameter (in)	Screen Interval, Top (ft bgs)	Screen Interval, Bottom (ft bgs)	Screen Elevation, Top (ft msl)	Screen Elevation, Bottom (ft msl)	Screen Soil/Material Type	Comments
--- Borings and Monitoring Wells ---													
MW-01	Monitoring Well	UG Closed LF	1990	1275.6	1276.63	190	8	149	167	1128	1110	Basalt gravel & top of white-yellow clay	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-02	Monitoring Well	DG Active Cells	1990	1196.2	1197.65	142	8	99	119	1097	1077	Clayey sand and gravel	Active WAC 173-351 Monitoring Well for Active Cells.
MW-03	Monitoring Well	DG Closed LF	1990	1154.9	1156.35	107	8	88	98	1067	1057	Black basalt gravel	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-04	Monitoring Well	DG Closed LF	1990	1154.0	1155.07	103	8	44	64	1110	1090	Gravel	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-05	Monitoring Well	DG Closed LF	1990	1189.4	1191.16	137	8	70	90	1119	1099	Med-coarse yellow, quartz sand	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-05A[a]	Monitoring Well	DG Closed LF	1993	1190.1	1191.23	112	8	98	108	1092	1082	Clayey sand	Inactive groundwater monitoring well (used for WL meas.)
MW-06	Monitoring Well	DG Closed LF	1990	1175.4	1176.82	160	8	65	85	1110	1090	Brown clay & silt	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-07	Monitoring Well	DG Closed LF	1990	1154.6	1155.95	48	8	33	48	1121	1106	Brown clay	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-08	Monitoring Well	DG; NE of Active Cells	1990	1192.9	1193.77	324	12	287	297	906	896	Fractured basalt	Inactive groundwater monitoring well (used for WL meas.)
MW-08A	Monitoring Well	DG; NE of Active Cells	1990	1192.9	1193.77	324	12	50	60	1143	1133	Sand & Brown clay (dry)	Inactive groundwater monitoring well (used for WL meas.)
MW-09[a]	Monitoring Well	DG Closed LF	1993	1192.3	1193.65	99	8	85	95	1107	1097	Sand	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-10[a]	Monitoring Well	DG Closed LF	1993	1191.8	1193.22	88	8	75	85	1117	1107	Yellow sand	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-11[a]	Monitoring Well	UG Closed LF	1993	1279.2	1280.47	170	8	155	165	1124	1114	Unknown (log not available)	Active WAC 173-351 Monitoring Well for Closed Landfill.
MW-12 (B-2)	Monitoring Well	UG Active Cells	3/7/1995	1259.2	1262.34	250	Unknown	145	165	1114	1094	Silty Gravel (GM)	Active WAC 173-351 Monitoring Well for Active Cells.
MW-13 (B-3)	Monitoring Well	XG Active Cells	3/10/1995	1192.5	1195.61	200	Unknown	150	160	1042	1032	Lean clay to clayey gravel	Active WAC 173-351 Monitoring Well for Active Cells.
MW-14S (upper zone)	Monitoring Well	DG; near groundwater seep	3/26/2009	1121.1	1123.30	20	2	10	20	1111	1101	Silty Gravel (GM)	Well completed during April 2009 RI.
MW-14D (lower zone)	Monitoring Well	DG; near groundwater seep	3/25/2009	1121.1	1123.33	79	2	58	71	1063	1050	Fine-med clean, white-yellow quartz sand	Well completed during April 2009 RI.
MW-15	Monitoring Well	DG; north of groundwater seep	3/27/2009	1100.5	1102.71	39	2	7.5	12.5	1093	1088	Sandy-silty Gravel (GW-GM)	Well completed during April 2009 RI.
BOVAY (abandoned)	Monitoring Well	North of Closed LF	Unknown	1163	NA	504	Unknown	476	486	687	677	Porous Basalt	Preliminary hydrogeologic characterization (abandoned)
HCl-1 (abandoned)	Boring	Active Cell Area	4/25/1989	Unknown	NA	150	Unknown	NA	NA	NA	NA	NA	Preliminary hydrogeologic characterization (abandoned)
B-1 (abandoned)	Boring	Active Cell Area	3/27/1995	~1229	NA	275	Unknown	NA	NA	NA	NA	NA	Geotechnical boring (abandoned)
B-4 (abandoned)	Boring	Active Cell Area	3/14/1995	~1190	NA	260	Unknown	NA	NA	NA	NA	NA	Geotechnical boring (abandoned)
-- Landfill Gas Monitoring Probes and Landfill Gas Extraction Wells --													
LGW-01	Gas Extraction Well	Closed LF Interior	11/1/1995	1270	NA	46	26	21	45	1249	1225	Completed in refuse/waste trench	Refuse interval 10-44 ft bgs (34 ft thick)
LGW-02	Gas Extraction Well	Closed LF Interior	11/7/1995	1270	NA	37	24	24	36	1246	1234	Completed in refuse/waste trench	Refuse interval 12-35 ft bgs (23 ft thick)
LGW-03	Gas Extraction Well	Closed LF Interior	11/7/1995	1270	NA	41	24	28	40	1242	1230	Completed in refuse/waste trench	Refuse interval 12-40 ft bgs (28 ft thick)
LGW-04	Gas Extraction Well	Closed LF Interior	11/7/1995	1270	NA	33	26	20	32	1250	1238	Completed in refuse/waste trench	Refuse interval 6-31 ft bgs (25 ft thick)
LGW-05	Gas Extraction Well	Closed LF Interior	11/6/1995	1270	NA	33	26	21	33	1249	1237	Completed in refuse/waste trench	Refuse interval 8-32? ft bgs (>24 ft thick).
LGW-06	Gas Extraction Well	Closed LF Interior	11/8/1995	1270	NA	44	26	30	40	1240	1230	Completed in refuse/waste trench	Refuse interval 10-40 ft bgs (30 ft thick).
LGW-07	Gas Extraction Well	Closed LF Interior	11/2/1995	1270	NA	21	26	14	20	1256	1250	Completed in refuse/waste trench	Refuse interval 7-19 ft bgs (12 ft thick).
LGW-08A/08	Gas Extraction Well	Closed LF Interior	11/8/1995	1270	NA	34	26	21	32	1249	1238	Completed in refuse/waste trench	Refuse interval 7-32 ft bgs (25 ft thick)
LGW-09	Gas Extraction Well	Closed LF Interior	11/1/1995	1270	NA	40	26	27	38	1243	1232	Completed in refuse/waste trench	Refuse interval 8-38 ft bgs (30 ft thick).
GP-LWG-10	Gas Monitoring Probe	Closed LF Interior	4/3/2009	1271.6	NA	75	6	29	69	1243	1203	Completed in refuse/waste trench	Refuse interval 30-71.5 ft bgs (41.5 ft thick)
GP-LWG-11	Gas Monitoring Probe	Closed LF Interior	4/8/2009	1276.1	NA	78	6	27	77	1249	1199	Completed in refuse/waste trench	Refuse interval 25-78+ ft bgs (refusal at 78 ft bgs)
GP-LWG-12 (abandoned)	Abandoned Gas Probe	Closed LF Interior	4/8/2009	1279	NA	28	6	NA	NA	NA	NA	NA	Refuse interval 22-?? ft bgs (borehole abandoned 4/8/2009)
GP-01D	Gas Monitoring Probe	S. of Closed LF	4/24/1995	1270	NA	30	4	26	30	1244	1240	Basalt Gravel	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-01S	Gas Monitoring Probe	S. of Closed LF	4/24/1995	1270	NA	17	4	11	15	1259	1255	Silt	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-02D	Gas Monitoring Probe	S. of Closed LF	4/25/1995	1270	NA	28	4	24	28	1246	1242	Basalt Gravel	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-02S	Gas Monitoring Probe	S. of Closed LF	4/25/1995	1270	NA	15	4	11	15	1259	1255	Silt	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-03D	Gas Monitoring Probe	S. of Closed LF	4/25/1995	1270	NA	20	4	16	20	1254	1250	Silty Sand	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-03S	Gas Monitoring Probe	S. of Closed LF	4/25/1995	1270	NA	10	4	6	10	1264	1260	Sandy Silt	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-04D	Gas Monitoring Probe	S. of Closed LF	4/28/1995	1235	NA	21	4	17	21	1218	1214	Not shown on log	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-04S	Gas Monitoring Probe	S. of Closed LF	4/28/1995	1235	NA	10	4	6	10	1229	1225	Silt	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-05	Gas Monitoring Probe	N. of Closed LF	3/12/2009	1145.7	NA	20	6	4.5	19.5	1141	1126	Silt & silty gravel	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-06	Gas Monitoring Probe	N. of Closed LF	3/11/2009	1160.9	NA	31	6	5	30	1156	1131	Silt & silty gravel	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-07	Gas Monitoring Probe	N. of Closed LF	3/11/2009	1191.6	NA	31	6	5	30	1187	1162	Silty gravel and basalt slump block/rock	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-08	Gas Monitoring Probe	S. of Active Cells	3/16/2009	~1260	NA	79.5	6	9	79	1251	1181	Silty/clayey Gravel	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-09	Gas Monitoring Probe	E. of Active Cells	3/9/2009	~1170	NA	39.5	6	4	39	1166	1131	Silty sand and silty gravel	Perimeter gas monitoring probe per Ch. 173-351-200 WAC
GP-10	Gas Monitoring Probe	N. of Active Cells	3/12/2009	~1195	NA	40	6	4.5	39.5	1191	1156	Mixture of Silt Sand, Silt, and Gravel.	Perimeter gas monitoring probe per Ch. 173-351-200 WAC

Notes:
[a] - Actual boring logs not available - information shown based on available tabulated data.
Site investigation locations shown in Figure 5.2
Boring logs and well/probe completion details (when applicable) provided in Appendix C;
Information tabulated in Table 5-1 based on interpretted information from logs; elevations, depths, and completion detail rounded to nearest foot and is approximated.
UG = Upgradient; XG = cross-gradient; DG = downgradient; LF = landfill; WL = water level.

MW-01



MW-1 Geology and Construction Details

HOWARD CONSULTANTS, INC.
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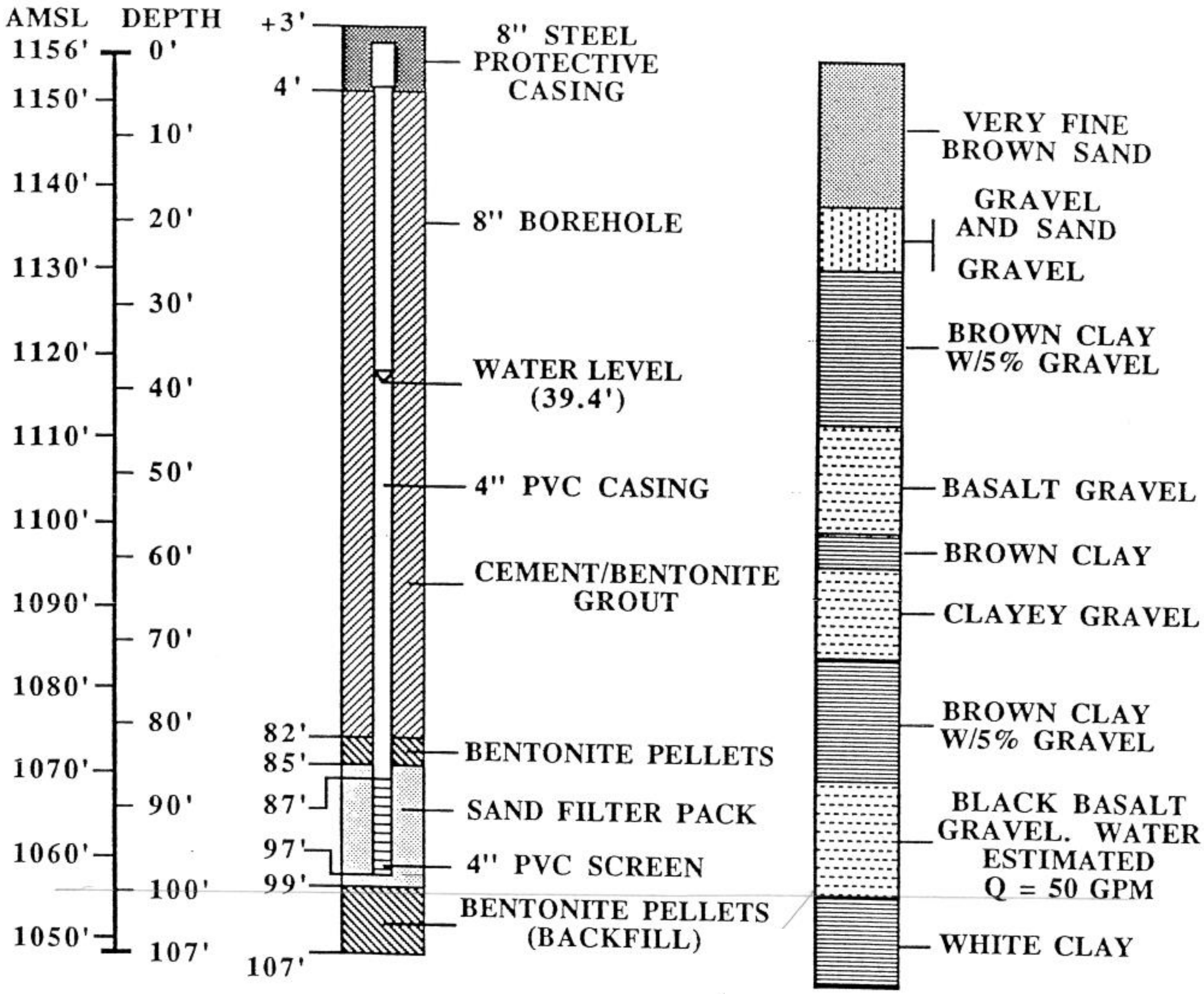
PLATE 11

MW-03



MW-3 Geology and Construction Details

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CONSULTING GEOTECHNICAL ENGINEERS

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BY ______ DATE ______
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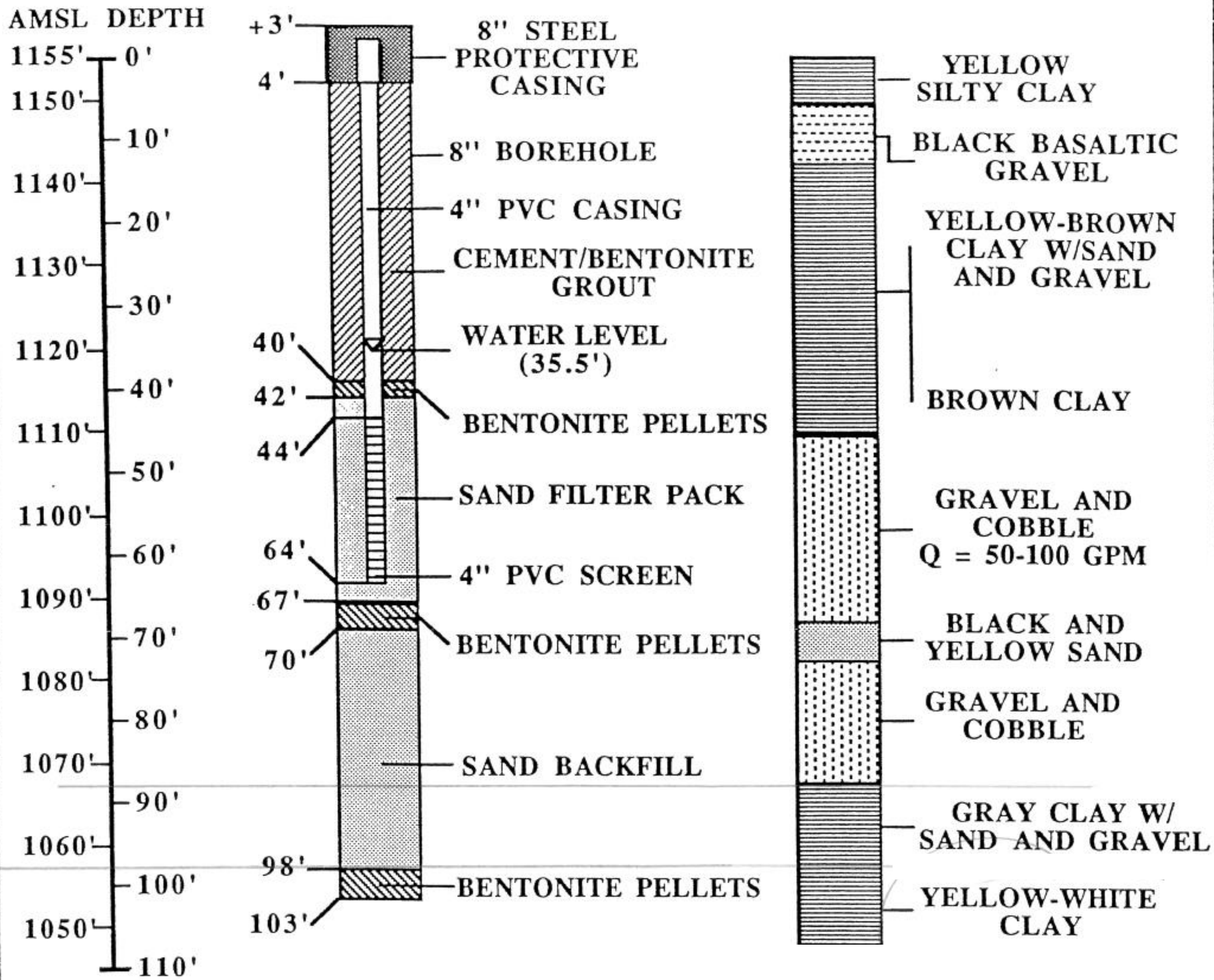
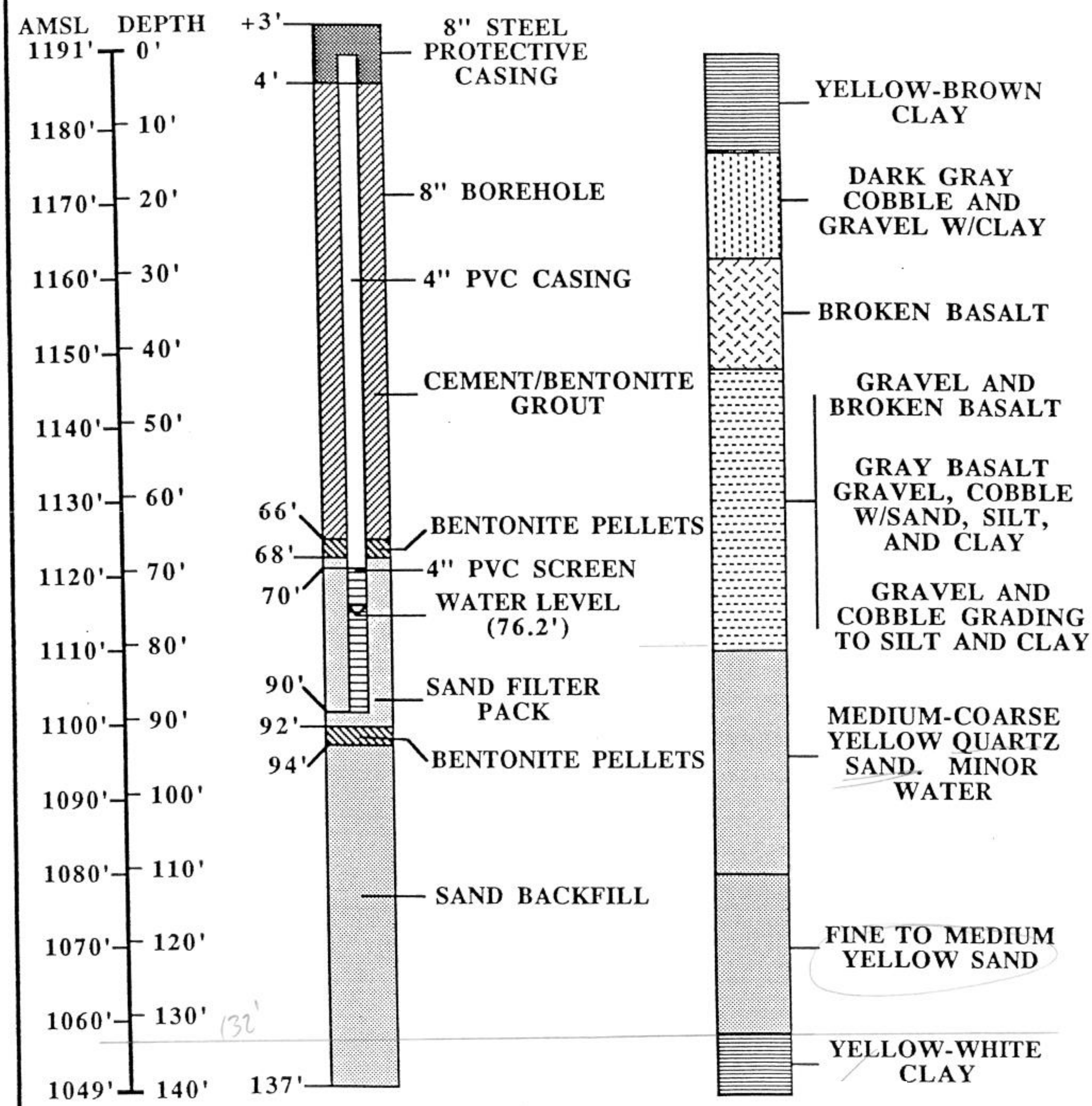
MW-04



MW-4 Geology and Construction Details

HOWARD CONSULTANTS, INC.
CONSULTING GEOTECHNICAL ENGINEERS

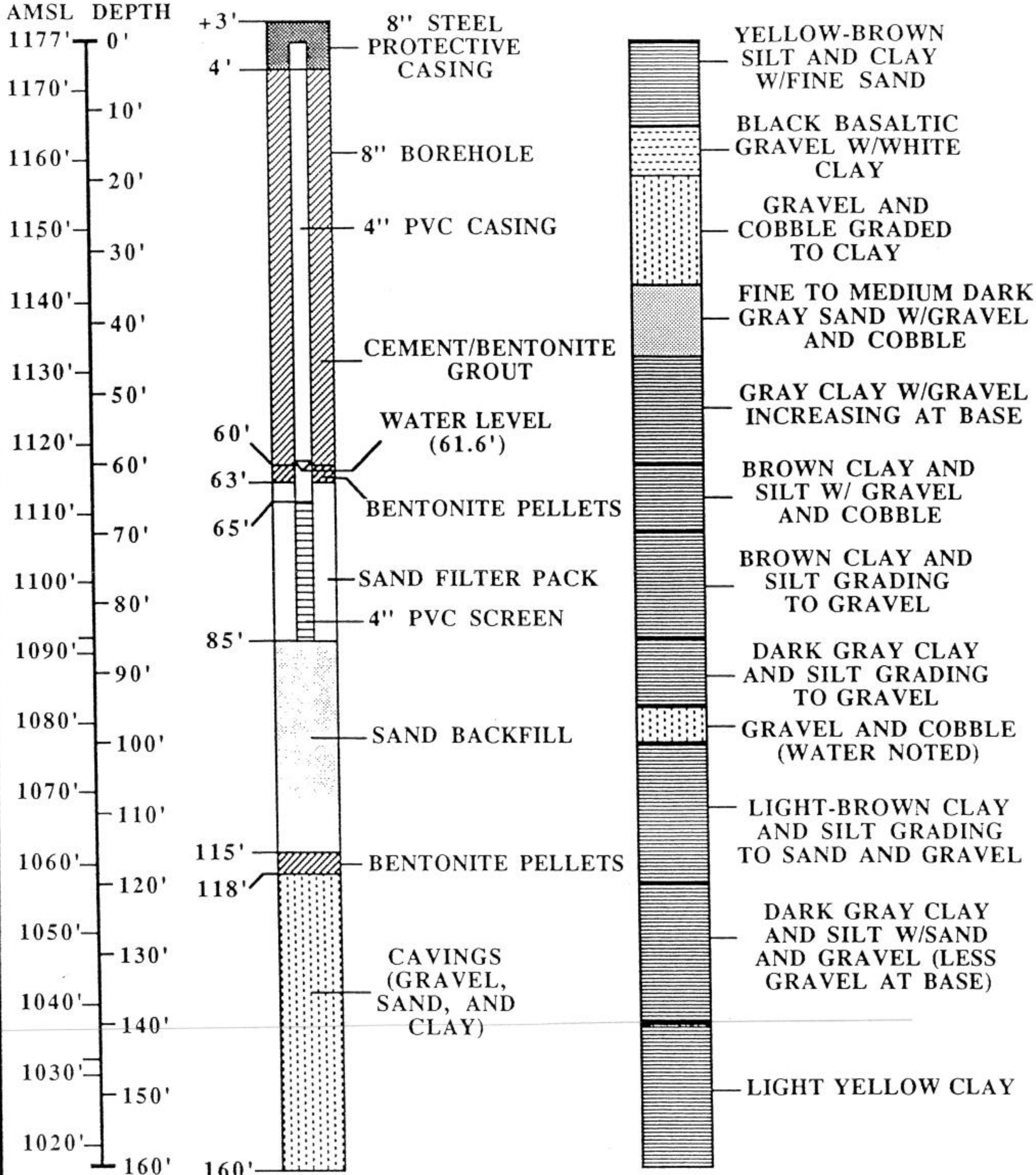
MW-05



MW-5 Geology and Construction Details

HOWARD CONSULTANTS, INC.
CONSULTING GEOTECHNICAL ENGINEERS

MW-06



MW-6 Geology and Construction Details

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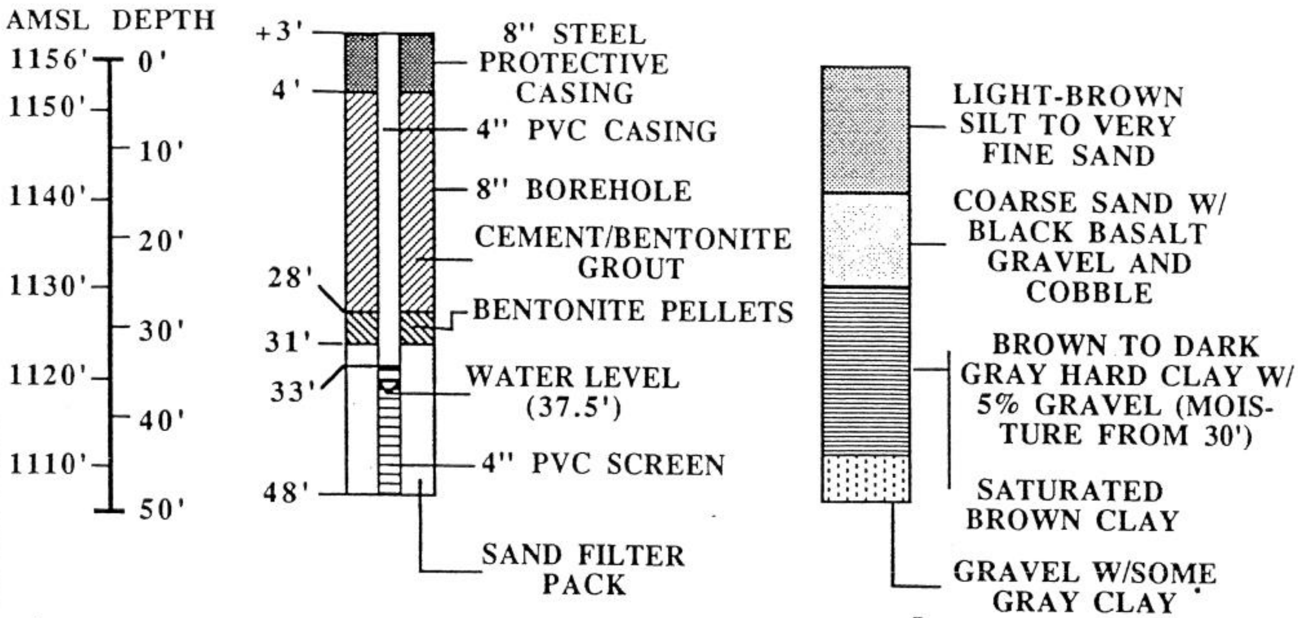
MW-07



MW-7 Geology and Construction Details

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BY ____ CHECKED BY ____ DATE ____

MW-14S

CH2MHILL

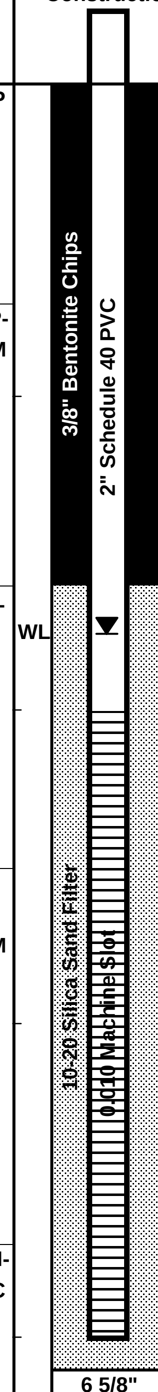
SOIL BORING / WELL LOG

PAGE: 1 OF 1

BORING NO: **MW-14S**
PROJECT NO: **331908.08.A2.03**
PROJECT NAME: Asotin County Regional Landfill Remedial Investigation
LOCATION: Between seep and MW-07, west of Evans Rd.
DRILLING CONTRACTOR: Budinger
TOC ELEVATION: 1123.30
GROUND ELEVATION: 1121.14
START DATE: 3/26/2009
END DATE: 3/26/2009
LOGGER: C. Sauer
DRILLING EQUIPMENT: Mobile B-57 Air rotary w/downhole hammer
BORING DIAMETER (inches): 6 5/8
TOTAL DEPTH (ft): 20
SWL: 10.97 ft btc
SWL DATE: 5/27/2009

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description (soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading)	Comments (drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other)	Soil Profile
0					AIR CUTTINGS: Sandy **GRAVEL** w/ trace silt, dry, brown sand w/gray angular basalt gravel **(GP)**	START: 08:00	GP
3.5	SPT-1	3.5-3.7	4/18	62/2" **(R)**	Well Graded **GRAVEL** w/ 20% brown sand and trace silt, angular-vesicular-basalt gravel, 1/4 to 1.5-inch dia., very dense, gray and brown, dry **(GP-GM)**		GP-GM
8.5	SPT-2	8.5-9.5	12/10	41 30/4" **(30/4)**	**SILT** w/ 10% sub-rounded gravel & trace fine sand, clay nodules, slightly moist, hard, light brown to tan w/dark streaks. Gravel in silt matrix **(ML)**		ML
10						Decrease in dust from 10-11 ft	
12.5						Cuttings moist to wet, sandy SILT w/ gravel observed from 12.5-14.5 ft	
13.5	SPT-3	13.5-14.2	10/9	26 50/3" **(50/3)**	Silty **GRAVEL** w/ 10% brown sand, wet, very dense, 20-30% silt, angular basalt gravels 1/4 to 2-inch dia. Trace ML & CL zones **(GM)**		GM
15						Gravelly, wet cuttings from 15-16 ft	
17						Rougher drilling; Cobble/boulder	
18						Softer drilling action	
18.5	SPT-4	18.5-18.8	3/3	50/3" **(R)**	Poor Recovery: Silty/clayey **GRAVEL**, w/ 5% sand, wet, very dense, angular basalt gravels in clay/silt matrix. 50-60% Gravel **(GM-GC)**		GM-GC
20.5						TD ~20.5 ft on 3-26-09	

Well Construction



MW-14D

CH2MHILL

SOIL BORING / WELL LOG

BORING NO: **MW-14D**
PROJECT NO: **331908.08.A2.03**
PROJECT NAME: Asotin County Regional Landfill Remedial Investigation
LOCATION: Between seep and MW-07
DRILLING CONTRACTOR: Budinger
TOC ELEVATION: 1,123.33
GROUND ELEVATION: 1,121.14
START DATE: 3/19/2009
END DATE: 3/24/2009
LOGGER: R. Greer
DRILLING EQUIPMENT: Mobile B-57 Air rotary w/downhole hammer
BORING DIAMETER (in): 6 5/8
SWL: 13.10 ft btc
TOTAL DEPTH (ft): 79.5
SWL DATE: 5/27/2009

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description: soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments: drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
0					AIR CUTTINGS: Sandy **GRAVEL** w/ trace silt, dry, brown sand w/gray angular basalt gravel	START: 13:30 -Moderate/easy advancement AIR: ND's, O2: 20.9%	GP	3/8" Bentonite Chips (0–10 ft)
3.5	SPT-1	3.5-3.7	4/18	62/2" **(62/2)**	Well Graded **GRAVEL** w/ 20% brown sand and trace silt, angular-vesicular-basalt gravel, 1/4 to 1.5-inch diameter, very dense, gray and brown, dry **(GP-GM)**		GP-GM	
6						Change to soft/fine grained drilling conditions at 6 ft bgs - Cuttings gravelly clay w/sand.		
8.5	SPT-2	8.5-9.5	12/10	41 30/4" **(30/4)**	**SILT** w/ 10% sub-rounded gravel & trace fine sand, clay nodules, slightly moist, hard, light brown to tan w/dark streaks. Gravel in silt matrix **(ML)**	CUTTINGS: 8.5 ft: Dusty-not saturated	ML	
10								Bentonite-Grout Annular Seal (from 10 ft); 2" Schedule 40 PVC
11								WL
12						Driller indicates potential saturation at 12 ft based on dril action/less dust		
13.5	SPT-3	13.5-14.2	10/9	26 50/3" **(50/3)**	Silty **GRAVEL** w/ 10% brown sand, wet, very dense, 20-30% silt, angular basalt gravels 1/4 to 2-inch dia. Trace ML & CL zones **(GM)**		GM	
15						CUTTINGS: Moist, gray basalt, 1/2 to 1-inch gravel w/silt and clay nodules		
18.5	SPT-4	18.5-18.8	3/3	50/3" **(50/3)**	Poor Recovery: Silty/clayey **GRAVEL**, w/ 5% sand, wet, very dense, angular basalt gravels in clay/silt matrix. 50-60% Gravel **(GM-GC)**		GM-GC	
20						Softer drilling		
23.5	SPT-5	23.5-	18/18	20	Gravelly **CLAY** w/trace silt. (cont. on next page)	Sample cohesive-not wet.	CL	

BORING NO: **MW-14D**

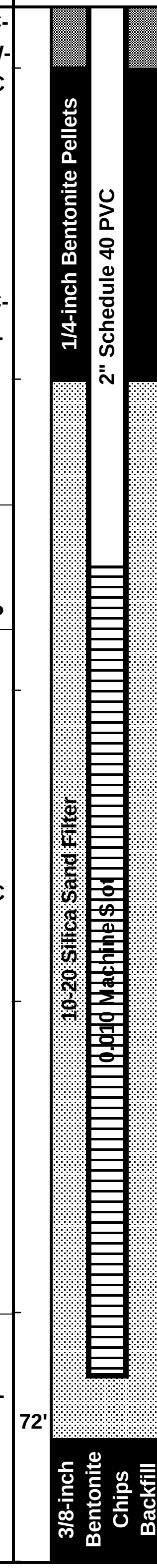
Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
24	SPT-5 (cont.)	23.5-25	18/18	30 43 **(n=73)**	Gravelly **CLAY** w/ trace silt, light brown to tan w/iron streaks, hard, dry to slightly moist, 20-30% sub-rounded gravel, 1/2 to 1-inch diameter **(CL)**	Sample cohesive and doesn't appear to be water-bearing. Sample crumbled and smeared to smooth surface=CLAY	CL	Bentonite-Grout Annular Seal; 2" Schedule 40 PVC
25								
26								
27								
28								
29	SPT-6	28.5-29.9	18/15	19 41 35/3" **(n=76)**	Gravelly **CLAY** w/ trace silt, light brown to tan w/iron streaks, hard, dry to slightly moist, 10% rounded gravel, 10% fine sand to silt, trace iron streaks **(CL)**	Sample crumbles and smears to smooth surface, doesn't appear to be water-bearing or saturated	CL	
30								
31								
32								
33						Dusty-no water observed in cuttings below 20 ft		
34	SPT-7	33.5-34.5	14/10	22 50/4" **(50/4)**	**CLAY** w/ wet sandy gravel zone at 34 to 34.3 ft., very hard, wet lense, tan. Clay w/ 20% gravel and 10% sand, iron staining, 1/2 to 1-inch gravels **(CL)**	Change in drilling action and less dust at 33 ft Rough gravel zone @ 32-33 ft Drill rods wet at bottom 15-20 ft FINISH 3-19-09 at 34 ft RESUME 3-20-09	CL	
35								
36								
37								
38								
39	SPT-8	38.5-40	18/18	12 30 32 **(n=62)**	**CLAY** w/ 5-10% weathered gravel & trace fine sand, tan-gray w/ iron staining/streaks, hard, dry to slightly moist, doesn't appear saturated or transmissive of GW flow, trace fine sand lense <2mm thick **(CL)**		CL	
40								
41								
42								
43								
44	SPT-9	43-5 44.5	12/11	18 50/5" **(50/5)**	**CLAY** w/ 10-20% sub-rounded gravels and trace fine sand, gray/green, iron nodules, hard, dry to slightly moist, doesn't appear saturated or transmissive of GW flow **(CL)**	Sample cohesive and doesn't appear to be water-bearing. Sample crumbled and smeared to smooth surface=CLAY Soft/clay-like drilling action at 44 ft	CL	
45								
46								
47								
48								
	SPT-10	48.5-	8/11	16	Clayey **GRAVEL** w/ sand. (Cont. on next page)	No evidence of saturation	GC	

SOIL BORING / WELL LOG

BORING NO: **MW-14D**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile
49	SPT-10	48.5-49.3	8/11	50/5" **(50/5)**	Clayey gray basalt **GRAVEL** (1/4 to 3-inch dia.) w/ 10% sand, 10-15% brown-tan fines, cohesive clay matrix, dry, very dense **(GC, GW-GC)**	Gravel zone within clay unit Inferred to be a gravelly zone a SPT-10, predominantly fine-soft, drill action	**GC-GW-GC**
50							
51							
52							
53							
54	SPT-11	53.5-54.5	12/10	21 32/4" **(32/4)**	Clayey **GRAVEL** to gravelly CLAY, w/ tan-brown san and 20% fines, very dense/hard, dry, no evidence of saturation, rounded basalt gravels (3/4 to 1.5-inch dia.) **(GC-CL)**	Fines smear smooth to surface Gravel clasts occasionally touching	**GC-CL**
55							
56							
57						Encounter water-bearing zone at ~57 ft bgs; formation water produced, <10 gpm via air circulation.	
58							
59	SPT-12	58.5	0/0	Heave	**NO RECOVERY**. Sample washed out; heave. **GRAB**: Poorly graded fine to med **SAND**, wet, w/ heave, <5% fines, 80% silica/quartz, mica and 15% basalt grains, trace silt. Clean **(SP)**	DTW: 12.7 ft bgs w/casing at 58.5 ft bgs FINISH 3-20-09 at 57.5 ft RESUME: 3-24-09 Driller observes transition to gravels at 59 ft	**SP**
60							
61							
62							
63	SPT-13	63-63.5	2/5	50/5" **(R)**	Basalt **GRAVEL**/cuttings, w/ clay and trace fine sand w/ cobble, iron staining. Gravel angular, pulverized t 2-inch dia. **(GC)**		**GC**
64							
65							
66							
67							
68					Drill action infers same material as above	Unable to verify cuttings due to containment setup	
69							
70						Observe possible decrease in water production, decrease dril chatter. Driller observes tan clay cuttings at ~70.5 - 71 ft	
71	SPT-14	71-72	14/11.5	25 50/5.5" **(50/5.5)**	Tan **SILT** with clay, w/ trace mica, moist, very stiff, non-plastic. No evidence of saturation **(ML)**		**ML**
72							
73							

Well Construction



BORING NO: **MW-14D**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	**Soil Description** soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	**Soil Profile**	**Well Construction**
74	SPT-15	74-75.5	14/18	21 58 97 **(155)**	Tan **SILT** w/ increasing clay w/ trace mica, very stiff, moist. 2-inch silica med. sand lense at 75 ft. Immediate transition to tan CLAY, hard, becoming light tan, not saturated or evidence of GW transmissivity **(ML, SP, CL)**	FINISH drilling at 74 ft. Begin continuous sampling due to subsurface conditions and driller concerns of getting casing stuck	**ML** **SP** **CL**	3/8-inch Bentonite Chips Backfill
75.5	SPT-16	**75.5 76.5**	10/12	79 95 **(95)**	Tan-yellow **CLAY** w/ decreasing silt, some iron staining, hard, moist, not saturated, increasing iron staining with depth **(CL)**		**CL**	
76.5	SPT-17 (2" SPT)	**76.5 77.5**	9/12	33 103 **(103)**	SAME AS ABOVE **(CL)**		**CL**	
77.5	SPT-18 (2" SPT)	**77.5 78.5**	8/12	87 115 **(115)**	SAME AS ABOVE **(CL)**		**CL**	
78.5	SPT-19 (2" SPT)	**78.5 79**	7/8	127 82/2" **(82/2)**	SAME AS ABOVE **(CL)**	TD by SPT at 79 ft bgs (3-24-09)	**CL**	6 5/8"

Depth scale: 74, 74.5, 75, 75.5, 76, 76.5, 77, 77.5, 78, 78.5, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93

MW-15

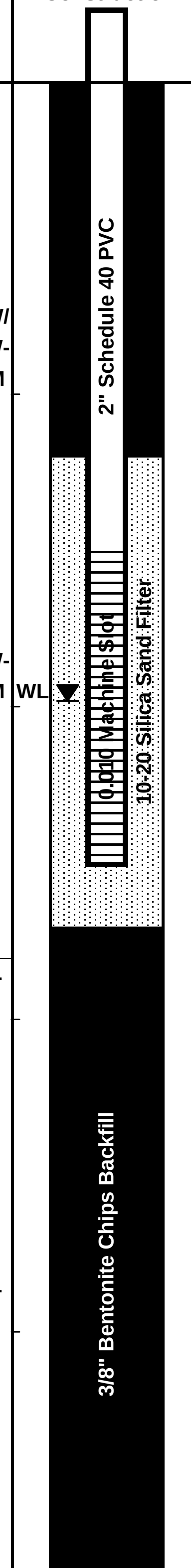
CH2MHILL

SOIL BORING / WELL LOG

BORING NO: **MW-15**
PROJECT NO: **331908.08.A2.03**
PROJECT NAME: Asotin County Regional Landfill Remedial Investigation
LOCATION: Near Dry Creek, west of Evans Road
DRILLING CONTRACTOR: Budinger
TOC ELEVATION: 1102.71
GROUND ELEVATION: 1100.48
START DATE: 3/26/2009
END DATE: 3/27/2009
LOGGER: R. Greer
DRILLING EQUIPMENT: Mobile B-57 Air rotary w/downhole hammer
BORING DIAMETER: 6 5/8
TOTAL DEPTH: 40.5
SWL: 12.19 ft btc
SWL DATE: 5/27/2009

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description: soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments: drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile
0						START: 14:15 3-26-09	
4						Rough gravel drilling action	
4	SPT-1	4 4.9	10/10	34 50/4" **(50/4)**	Sandy gray **GRAVEL** (1/4 to 1/2-inch dia.) w/ 5% silt and brown fines, dry, very dense, 10-15% sand **(GW/GW-GM)**		GW/ GW- GM
6						Change to soft/fine grained drilling conditions at 6 ft. Cuttings gravelly clay w/sand.	
8.5						CUTTINGS: 8.5 ft: Dusty-not saturated	
9	SPT-2	9 9.5	4/6	87/6" **(R)**	Poor Recover: Well graded **sandy GRAVEL** to **silty GRAVEL** (1/4 to 3-inch dia.), w/ 5% silt and brown fines, wet, very dense, 10-15% sand **(GW-GM)**	Tip of SPT wet. WL= 9.0 ft.	GW- GM
12						Driller indicates potential saturation at 12 ft. based on drill action/less dust	
14	SPT-3	14 15.5	--	28 39 50/3" **(50/3)**	Gravelly **CLAY** w/ trace fine sand, 20-40% gravel, sub-rounded, clasts typically not touching, tan-gray, dry, iron-stained **(CL)**		CL
16						Clay matrix w/ significant gravel, not saturated	
19						FINISH: 3-26-09	
19	SPT-4	19 20.5	15/17	15 30 50/5" **(50/5)**	Brown **CLAY** w/ 5% sub-rounded, slightly vesiculed, slightly weathered gravel with trace silt, moderate density, dry. Increasing gravel/cobbles at 20 ft **(CL)**	RESUME: 3-27-09 Cobble/gravel at 20 ft.	CL

Well Construction



SOIL BORING / WELL LOG

CH2MHILL

BORING NO: **MW-15**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
24	SPT-5	24-25	10/9	34 50/3" **(50/3)**	Brown **CLAY** w/ silt, low plasticity, w/ 10% coarse, sub-rounded gravel, moist, stiff, increasing gravel at 24.8 ft. **(CL)**		**CL**	3/8" Bentonite Chips Backfill
25								
26						Driller observes increasing sand and gravel Faster drill advancement		
27								
28								
29	SPT-6	29-29.5	3/6	50/6" **(R)**	Brown **CLAY** w/ trace fine sand and 30% sub-angula gravel, moist, stiff, potential increase in moisture **(CL)**	Moist air cuttings 6 inches of water at 29.5 ft. Probable saturated lense abov clay at 29 ft.	**CL**	
30								
31								
32								
33						Probable large cobble		
34	SPT-7	34-36	20/24	20 21 26 29 **(n= 76)**	Angular coarse **GRAVEL** with clay, moist, for first 2 inches. Abrupt transition to brown CLAY w/ silt and trace fine sand, trace iron staining and trace sub-rounded gravel, stiff, moist **(GP-GC/CL)**		**GP-GC** **CL**	
35								
36								
37								
38								
39	SPT-8	39-40.5	16/18	19 38 45 **(n=83)**	Brown **CLAY** w/ 20% coarse sub-rounded gravel (1/2 to 2-inch dia.), w/ trace iron staining, trace silt with fine sand, moist, stiff **(CL)**	Auto-hammer gear drive malfunction. Drilling manually controls hammer TD: 40.5 ft on 3-27-09	**CL**	6 5/8"
40								
41								
42								
43								
44								
45								
46								
47								
48								

SOIL BORING / MONITORING WELL LOG

CH2MHILL

WELL NO: **MW-16**
PROJECT NUMBER: 436782
PROJECT NAME: ACRL Future Cell D Expansion
LOCATION: SE of Cell D, 5 1/2 feet from N-S Fence, 8' N of Bollards
DRILLING CONTRACTOR: Environmental West Exploration
TOC ELEVATION: 1,242.82
GROUND ELEVATION: 1,240.50
START DATE/TIME: 9-19-12 / 12:37
END DATE/TIME: 9-20-12 / 8:46
LOGGER: J. Freed
DRILLING EQUIPMENT: Air Rotary - Mobile B-90
BORING DIAMETER: 6"
TOTAL DEPTH: 125
SWL: 1128.14 ft / 112.36 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	Soil Description soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other
5						
	Grab	7.5'	-	-	**Cuttings:** SILT **(ML)**, light brown, micaceous, dry, trace very fine sand.	
10	Grab	9.5'	-	-	**Cuttings:** As above **(ML)**, medium brown, slightly moist.	12:43 12:48
15	Grab	14.5'	-	-	**Cuttings:** WELL GRADED GRAVEL with SILT and SAND **(GW-GM)**. Light brown, dry. Gravel is sub-rounded to sub-angular, fine to 3/4". Contains 30% sand, well graded, ~ 15% silt.	
20	Grab	20'	-	-	**Cuttings:** SILTY SAND **(SM)**, light brown, very fine, poorly graded, contains 20% silt, slightly moist.	12:52 12:57
25						

Graphic Log

Monitoring Well
Above Ground

Concrete

2" Schedule 40 Blank PVC Casing

3/8" Bentonite Chips

SOIL BORING / MONITORING WELL LOG

CH2MHILL

WELL NO:	MW-16		
PROJECT NUMBER:	436782	START DATE/TIME:	9-19-12 / 12:37
PROJECT NAME:	ACRL Future Cell D Expansion	END DATE/TIME:	9-20-12 / 8:46
LOCATION:	SE of Cell D, 5 1/2 feet from N-S Fence, 8' N of Bollards	LOGGER:	J. Freed
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Air Rotary - Mobile B-90
TOC ELEVATION:	1,242.82	BORING DIAMETER:	6"
GROUND ELEVATION:	1,240.50	TOTAL DEPTH:	125 SWL: 1128.14 ft / 112.36 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	Soil Description soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other
25	Grab	25'	-	-	**Cuttings:** As above **(SM)**.	
30	Grab	29.5'	-	-	**Cuttings:** SAND SILT **(ML)**, dark brown, slightly moist, contains very fine sand 15%, micaceous.	13:05 13:10
35	Grab	34.5'	-	-	**Cuttings:** SILT **(ML)**, contains clay, brown, slightly moist, becoming slightly cohesive, crumbles when rolled, no visible sand.	
40	Grab	39'	-	-	**Cuttings:** LEAN CLAY **(CL)**, tan-brown, medium dense, supports a 4mm roll, medium plasticity, moist.	13:17 13:24 Clay
	Grab	41'	-	-	**Cuttings:** WELL GRADED SAND with SILT **(SM)**, trace gravel, medium brown, moist, gravel is rounded, fine, 5%. Contains 30% silt, clay clumps, likely from above interval.	Increasing dust @ 43 1/2
45	Grab	44'	-	-	**Cuttings:** BASALT, angular, fine 1/16" to 1" clasts, blue-grey, dry.	Transition to basalt Slowed drilling rate, very hard. Very dusty cuttings.
						Transition to silt/sand Very easy drilling.
50						13:38

Monitoring Well Construction: 2" Schedule 40 Blank PVC Casing; 3/8" Bentonite Chips

SOIL BORING / MONITORING WELL LOG

CH2MHILL

WELL NO: **MW-16**

PROJECT NUMBER:	436782	START DATE/TIME:	9-19-12 / 12:37
PROJECT NAME:	ACRL Future Cell D Expansion	END DATE/TIME:	9-20-12 / 8:46
LOCATION:	SE of Cell D, 5 1/2 feet from N-S Fence, 8' N of Bollards	LOGGER:	J. Freed
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Air Rotary - Mobile B-90
TOC ELEVATION:	1,242.82	BORING DIAMETER:	6"
GROUND ELEVATION:	1,240.50	TOTAL DEPTH:	125 SWL: 1128.14 ft / 112.36 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	Soil Description soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Graphic Log	Monitoring Well Construction
50	Grab	50'	-	-	**Cuttings:** SILT **(ML)**, pale yellow, some cementation, easily cut with fingernail, dry, no sand/gravel within, up to 1/2" rounded "cemented pellets".	13:45		2" Schedule 40 Blank PVC Casing; 3/8" Bentonite Chips
55	Grab	54.5'	-	-	**Cuttings:** Same as above **(ML)**.			
60	Grab	59.5'	-	-	**Cuttings:** Same as above, **(ML)** yellowish-white color.			
65	Grab	65'	-	-	**Cuttings:** Same as above **(ML)**.	Transition to sand with silt.		
	Grab	67.5'	-	-	**Cuttings:** POORLY GRADED SAND with SILT **(SP-SM)**, yellow - brown, very fine sand with fine gravel, contains ~15% silt, dry.			
70						14:05 14:11		
	Grab	71.5'	-	-	**Cuttings:** SILTY SAND **(SM)** very light yellow, increasing silt content (~30%), dry.			
75								

CH2MHILL

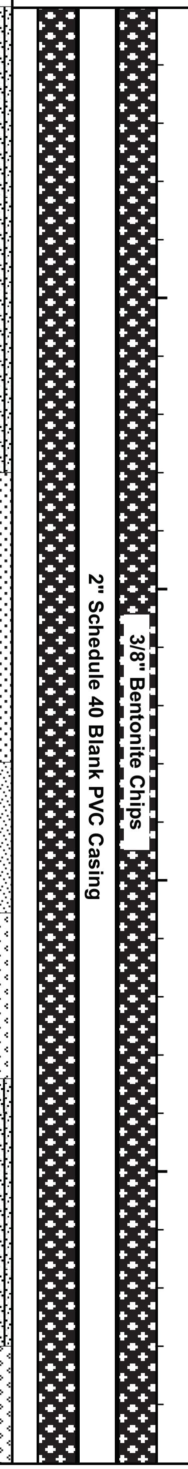
SOIL BORING / MONITORING WELL LOG

WELL NO: **MW-16**

PROJECT NUMBER:	436782	START DATE/TIME:	9-19-12 / 12:37
PROJECT NAME:	ACRL Future Cell D Expansion	END DATE/TIME:	9-20-12 / 8:46
LOCATION:	SE of Cell D, 5 1/2 feet from N-S Fence, 8' N of Bollards	LOGGER:	J. Freed
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Air Rotary - Mobile B-90
TOC ELEVATION:	1,242.82	BORING DIAMETER:	6"
GROUND ELEVATION:	1,240.50	TOTAL DEPTH:	125 SWL: 1128.14 ft / 112.36 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	**Soil Description** soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other
75						
80	Grab	79.5'	-	-	**Cuttings:** Same as above, **(SM)**.	14:15 14:21
						Transition to sand
	Grab	82.5'	-	-	**Cuttings:** POORLY GRADED SAND **(SP)**, medium, sub-angular, trace silt content, light tan to smoky quartz color.	
85	Grab	85.5'	-	-	**Cuttings:** Same as above, **(SP)** increasing grain size.	
						Transition to gravel
	Grab	88.5'	-	-	**Cuttings:** WELL GRADED SAND with GRAVEL **(SW)**. Gravel is fine to 1/2" sub-rounded, numerous angles, fractured clasts, up to 1/2", 15%	14:27 14:32
90	Grab	90.5'	-	-	**Cuttings:** BASALT, vesicular, medium purple-brown to dark gray, fine to 3/4" angular, fractured clasts.	Very hard drilling Dry/very dusty cuttings.
	Grab	93.5'	-	-	**Cuttings:** SILTY SAND with GRAVEL **(SM),** Gravel is fine, poorly graded. Contains 20% fractured, vesicular basalt rubble, ~20% brown silt.	14:39 14:42
95						Increasing dust. Transition to Basalt
	Grab	98'	-	-	**Cuttings:** BASALT, cuttings up to 1", angular, blue-gray, dry.	
100						14:51

Monitoring Well Construction



SOIL BORING / MONITORING WELL LOG

CH2MHILL

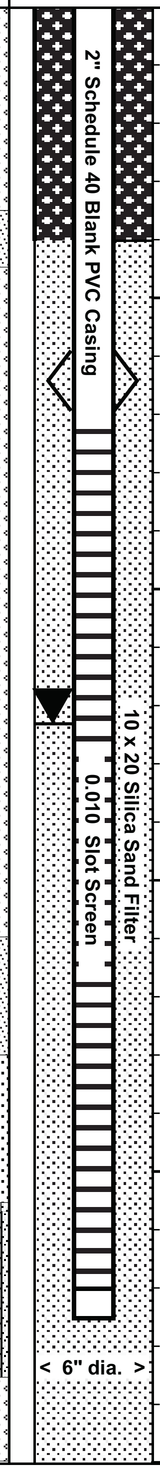
WELL NO: **MW-16**

PROJECT NUMBER:	436782	START DATE/TIME:	9-19-12 / 12:37
PROJECT NAME:	ACRL Future Cell D Expansion	END DATE/TIME:	9-20-12 / 8:46
LOCATION:	SE of Cell D, 5 1/2 feet from N-S Fence, 8' N of Bollards	LOGGER:	J. Freed
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Air Rotary - Mobile B-90
TOC ELEVATION:	1,242.82	BORING DIAMETER:	6"
GROUND ELEVATION:	1,240.50	TOTAL DEPTH:	125
		SWL:	1128.14 ft / 112.36 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	Soil Description soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other
100						14:59
	Grab	101.5'	-	-	**Cuttings:** Same as above, (BASALT)	
						Transition out of hard Basalt
	Grab	103.5'	-	-	**Cuttings:** Well graded sand (SW), mixed with fractured basalt, angular to sub-angular, up to 1".	Sharp transition to very soft drilling
105	SPT 1 (3" dia.)	105	35 50/1" **(50/1")**	7"/7"	BASALT, black, fractured. Fine to 2 3/4" clasts with cream/olive-orange mottling in vesicles. Minor moisture noted 5" from shoe. No visible water.	15:06 DTW measurement taken, no 16:07 recordable water present - minor moisture on tip of probe.
						Dry/dusty cuttings
						Decrease in dust @ 108 ft bgs.
					Cuttings: Brown fractured basalt, moist, light grey color, no visible water, up to 1/2", angular,	16:14 DTW - Dry
110	SPT 2 (3" dia.)	110	50/0" **(50/0")**	0"/0"	NO RECOVERY	16:55
						Driller notes easier drilling conditions.
	Grab	112 '	-	-	**Cuttings:** Same as above (BASALT)	
						DTW (at 115') = 114 ft bgs, 112 ft bgs after SPT
						17:05 Finish for day at 115' (9-19-12)
115	SPT 3 (3" dia.)	115 I 116.5	24 15 33 **(48)**	14"/18"	BASALT clasts, angular, vesicular, up to 2" dia. Transition near 116 ft to unconsolidated, small clusters of quartz, well graded sand, and clay, wet, yellow-brown color, sand is well graded, angular. WELL GRADED SAND with GRAVEL **(SW)**	7:42 Resume at 115 (9-20-12) DTW - 112 ft bgs 7:00 (9-20-12)
					Cuttings: POORLY GRADED SAND **(SP)**, coarse, angular, contains 40% angular basalt, fractured, vesicular, no rounding, wet, up to 1".	Becomes harder @ 119 ft bgs.
						7:48 DTW - 113.44 bgs
120	SPT 4 (3" dia.)	120 I 121.5	19 15 14 **(29)**	12"/18"	POORLY GRADED SAND **(SP)**, with unconsolidated chert, angular, top 4" of sample. Bottom 8" is SILTY SAND **(SM)**, sand is well graded, angular, contains 40% silt, yellow-tan, soft, wet. Large 2 1/2" chert rock in shoe.	8:41
	Grab	123.5'	-	-	**Cuttings**: Black vesicular basalt with slough from above, 1/8" - 1/4" angular clasts, wet.	Becomes hard @ 124'
125						8:46

Graphic Log

Monitoring Well Construction



SOIL BORING / MONITORING WELL LOG

CH2MHILL

WELL NO: **MW-17**

PROJECT NUMBER:	436782	START DATE/TIME:	9-17-12/ 9:15
PROJECT NAME:	ACRL Future Cell D Expansion	END DATE/TIME:	9-18-12/15:30
LOCATION:	North of ACRL, 20 ft North of 6th Ave, North of Cell D	LOGGER:	RSG
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Air Rotary - Mobile B90
TOC ELEVATION:	1,196.11	BORING DIAMETER:	6" OD
GROUND ELEVATION:	1,193.66	TOTAL DEPTH:	145.5' SWL: 1081.90 ft / 111.76 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	Soil Description soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other
0						9:15
5	Grab	5.5'	-	-	**Cuttings:** Brown SILTY SAND **(SM)**, with fine sand	
10	Grab	10'	-	-	**Cuttings:** Brown SANDY SILT **(ML)**, with fine basaltic gravel. Sand is very fine.	9:18 9:27
15	Grab	16.5'	-	-	**Cuttings:** Brown SANDY SILT with GRAVEL **(ML)**, with increasing gravel with depth, fine, sub-rounded to sub-angular gravel.	Harder drilling.
20						9:34 9:40
	Grab	23'	-	-	**Cuttings:** Brown SILTY SAND with GRAVEL **(SM)**. Gravel continues to increase with depth, mostly fine, becoming more coarse, moist.	
25						

Graphic Log

Monitoring Well
Above Ground

Concrete

2" Schedule 40 Blank PVC Casing

3/8" Bentonite Chips

CH2MHILL

SOIL BORING / MONITORING WELL LOG

WELL NO: **MW-17**

PROJECT NUMBER: 436782
START DATE/TIME: 9-17-12/ 9:15
PROJECT NAME: ACRL Future Cell D Expansion
END DATE/TIME: 9-18-12/15:30
LOCATION: North of ACRL, 20 ft North of 6th Ave, North of Cell D
LOGGER: RSG
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING EQUIPMENT: Air Rotary - Mobile B90
TOC ELEVATION: 1,196.11
BORING DIAMETER: 6" OD
GROUND ELEVATION: 1,193.66
TOTAL DEPTH: 145.5'
SWL: 1081.90 ft / 111.76 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	**Soil Description** soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Graphic Log	Monitoring Well Construction
25	Grab	25'	-	-	**Cuttings:** BASALT, appears mostly competent, angular to sub-angular cuttings, up to 1" diameter, dry, dusty.	Hard basaltic drilling - dusty cuttings.		2" Schedule 40 Blank PVC Casing; 3/8" Bentonite Chips
	Grab	29'	-	-	**Cuttings:** FRACTURED BASALT with fine brown sand and fine angular to sub-rounded gravel.	9:49		
30						9:54		
	Grab	31'	-	-	**Cuttings:** WELL GRADED GRAVEL **(GW)** well rounded to sub-rounded, with fine sand, with 1" basalt clasts.			
35								
	Grab	38.5'	-	-	**Cuttings:** WELL GRADED GRAVEL **(GW)** well rounded to sub-rounded, with fine sand, with 1" basalt clasts.	10:03		
40						10:17		
45								
	Grab	46.5'	-	-	**Cuttings:** Increasing basalt clasts/gravel with round fine gravel. Increasing medium sand, transitioning to POORLY GRADED GRAVEL with SAND **(GP)**.			
50						10:28		

CH2MHILL

SOIL BORING / MONITORING WELL LOG

WELL NO: **MW-17**

PROJECT NUMBER:	436782	START DATE/TIME:	9-17-12/ 9:15
PROJECT NAME:	ACRL Future Cell D Expansion	END DATE/TIME:	9-18-12/15:30
LOCATION:	North of ACRL, 20 ft North of 6th Ave, North of Cell D	LOGGER:	RSG
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Air Rotary - Mobile B90
TOC ELEVATION:	1,196.11	BORING DIAMETER:	6" OD
GROUND ELEVATION:	1,193.66	TOTAL DEPTH:	145.5'
		SWL:	1081.90 ft / 111.76 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	Soil Description soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other
50						
	Grab	53'	-	-	**Cuttings:** Brown SILT **(ML)**, with trace fine gravel, moist.	
55						
	Grab	56.5'	-	-	**Cuttings:** Brown SILT **(ML)**, with trace fine gravel, moist, no plasticity.	
	Grab	58.5'	-	-	**Cuttings:** POORLY GRADED GRAVEL with SILT **(GP-GM)**, and basalt - possible fractured basalt, sub-angular basalt cuttings with silt, moist.	11:12 11:18
60						
						Change in drill chatter/action.
65	Grab	64.5'	-	-	**Cuttings:** Gray SILT with GRAVEL/BASALT **(ML)**, increasing silt (GM), moist	
	Grab	68'	-	-	**Cuttings:** SILTY SAND **(SM)**, fine, poorly graded, with 20% tan and brown silt, moist.	
70	Grab	70'	-	-	**Cuttings:** BASALT, competent, angular cuttings up to 5/8" diameter.	11:37 11:42 Very hard drilling at 70' bgs.
						Easier drilling.
	Grab	72'	-	-	**Cuttings:** Brown SILTY SAND **(SM)**, up to 20% silt, decreasing gravel.	
75						

Graphic Log

Monitoring Well Construction

2" Schedule 40 Blank PVC Casing

3/8" Bentonite Chips

SOIL BORING / MONITORING WELL LOG

CH2MHILL

WELL NO: **MW-17**

PROJECT NUMBER:	436782	START DATE/TIME:	9-17-12/ 9:15
PROJECT NAME:	ACRL Future Cell D Expansion	END DATE/TIME:	9-18-12/15:30
LOCATION:	North of ACRL, 20 ft North of 6th Ave, North of Cell D	LOGGER:	RSG
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Air Rotary - Mobile B90
TOC ELEVATION:	1,196.11	BORING DIAMETER:	6" OD
GROUND ELEVATION:	1,193.66	TOTAL DEPTH:	145.5' SWL: 1081.90 ft / 111.76 ft bgs

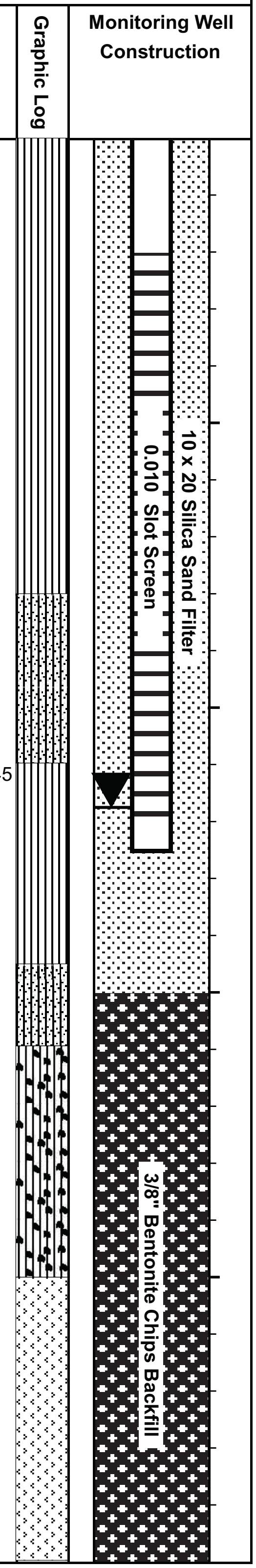
Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	Soil Description soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Graphic Log	Monitoring Well Construction
75						Very dusty cuttings, hard drilling.		2" Schedule 40 Blank PVC Casing; 3/8" Bentonite Chips
	Grab	77'	-	-	**Cuttings:** BASALT and gravel. Basalt is angular, competent and fractured, up to 2.5" diameter. Gravel is round, up to 3/4" diameter			
80						11:56 12:02		
85								
	Grab	88.5'	-	-	**Cuttings:** BASALT and gravel. Basalt is angular, competent and fractured, up to 2.5" diameter. Gravel is round, up to 3/4" diameter	Dusty cuttings. 12:17 12:24		
90								
95	SPT 1	95	75/2" **(75/2")**	0"/2"	BASALT clasts/gravel, up to 1", angular, some moisture at tip of shoe.	12:29 13:09 Collect DTW - None - faint moist sand on tip of probe.		
	Grab	99'	-	-	**Cuttings:** Same as Above (BASALT) with increase in brown silt.	Slight decrease in dust. 13:13		
100								

SOIL BORING / MONITORING WELL LOG

WELL NO: **MW-17**

PROJECT NUMBER:	436782	START DATE/TIME:	9-17-12/ 9:15
PROJECT NAME:	ACRL Future Cell D Expansion	END DATE/TIME:	9-18-12/15:30
LOCATION:	North of ACRL, 20 ft North of 6th Ave, North of Cell D	LOGGER:	RSG
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Air Rotary - Mobile B90
TOC ELEVATION:	1,196.11	BORING DIAMETER:	6" OD
GROUND ELEVATION:	1,193.66	TOTAL DEPTH:	145.5'
		SWL:	1081.90 ft / 111.76 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	Soil Description soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other
100	SPT 2	100.0 100.5	50/6" **(50/6")**	3"/6"	Brown <u>SILT</u> **(ML)**, with trace fine sand, moist, stiff.	13:41 Collect DTW - Probe beeps at bottom but no water observed at probe.
105	SPT 3 (3" dia.)	100.0 106.0	50/6 138/6 **(138/6")**	12"/12"	Brown <u>SILT</u> **(ML)**, with trace fine sand, moist, stiff, possible slight increase in moisture.	13:50 14:17 Collect DTW - no water/mud.
	Grab	108.5'	-	-	**<u>Cuttings:</u>** Very fine <u>SILTY SAND</u> (**SM**), grayish-brown moist, "sticky", possible increase in water.	
110	SPT 4 (3" dia.)	110.0 | 111.5	22 38 22 **(70)**	18"/18"	<u>SILTY SAND</u> **(SM),** Brown, very fine, moist, with increasing silt with depth, very dense. Becoming gray <u>SILT</u> **(ML)** @ 110.0 ft, decreasing moisture, hard.	14:23 15:52 No water when air applied. Collect DTW @ 110': ~2.5" muddy water. Pull back casing 4 ft and let boring stand 45 minutes. 2.5" water/mud observed with no measurable increase.
115	SPT 5 (3" dia.)	115.0 115.5	50 50/1" **(50/1")**	6"/7"	Brown <u>SILTY SAND</u> **(SM)**, 35% silt, sand is fine, becomes gray <u>SILTY GRAVEL</u> **(GM)** at 116 ft, with basalt clasts/gravel, coarse, up to 2.5" diameter, moist, very dense.	16:01 Water not detected 16:46 No water generated when air applied Dusty gravel/basalt drilling.
120	SPT 6 (3" dia.)	120.0 120.5	90/5" **(90/5")**	5"/5"	<u>BASALT</u> fragments/clasts up to 2 1/2" diameter with brown silt @ 120.3' bgs.	Water not detected. 17:40 Dry, dusty cuttings, slow drilling.
125						17:45 End for day (9-17-12)



SOIL BORING / MONITORING WELL LOG

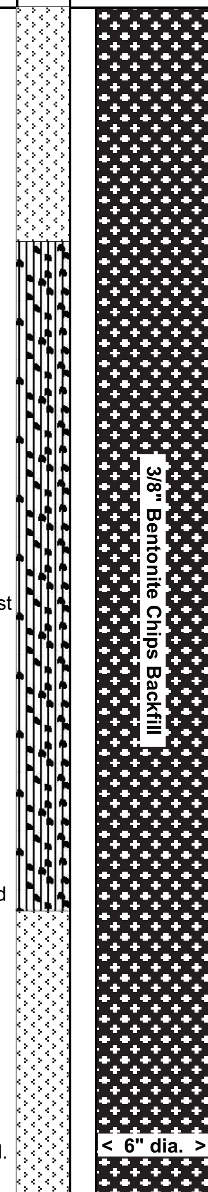
CH2MHILL

WELL NO: **MW-17**

PROJECT NUMBER: 436782
START DATE/TIME: 9-17-12/ 9:15
PROJECT NAME: ACRL Future Cell D Expansion
END DATE/TIME: 9-18-12/15:30
LOCATION: North of ACRL, 20 ft North of 6th Ave, North of Cell D
LOGGER: RSG
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING EQUIPMENT: Air Rotary - Mobile B90
TOC ELEVATION: 1,196.11
BORING DIAMETER: 6" OD
GROUND ELEVATION: 1,193.66
TOTAL DEPTH: 145.5'
SWL:

Depth (ft)	Sample ID/ TYPE	Sample Interval	SPT blows per 6"	Recovery (in/in)	**Soil Description** soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other
125	SPT 7 (3" dia.)	125.0	50/5" **(50/5")**	0"/5"	BASALT clast in shoe - no recovery, no moisture	8:45 Resume drilling (9-18-12)
						Decrease in dust.
						Resume dusty cuttings.
						9:00 No moisture observed on bit
130	SPT 8 (3" dia.)	130.0 130.5	75/5" **(75/5")**	0"/5"	SILTY GRAVEL **(GM)**, gray, coarse, up to 2.5" dia., sub-rounded, moist, very dense, moist.	9:45 No water observed after letting boring sit for 30 minutes
						Dusty cuttings.
						11:42
135	SPT (3") 9	135.0	75/4" **(75/4")**	0"/4"	NO RECOVERY. Tip of shoe moist/muddy (1/8" deep).	12:45 Collect DTW: Tip of probe is moist with silty sand and mud
	Grab	136'	-	-	**Cuttings:** SILTY GRAVEL **(GM)**, with gray silt, gravel is coarse, fractured, sub-angular to sub-rounded, moist.	
						Dusty cuttings
	Grab	139'	-	-	**Cuttings:** SAME AS ABOVE, with increasing BASALT clasts/gravel.	Drill bit very moist. 13:01 DTW: 139 ft (1.5 ft thick)
140	SPT (3") 10	140.0	50/2" **(50/2")**	0"/2"	NO RECOVERY. SPT wet.	14:17 Water generated when air applied No dust.
	Grab	141'	-	-	**Cuttings:** BASALT, fractured, angular cuttings up to 1" dia.	Hard drilling.
	Grab	142'	-	-	**Cuttings:** BASALT, mostly competent, wet, but decreasing water with advancement.	Very hard drilling. (14:45)
	Grab	143'	-	-	**Cuttings:** BASALT, possibly fractured, with possible increase in gray silt/clay.	Increase in dust. (15:13)
	Grab	144'	-	-	**Cuttings:** BASALT, fractured/weathered, very moist, with silt and sand.	Fracture zone - easier advancement. Muffled drill chatter. Loss of dust observed.
145						15:25 **TD at 145.5 ft bgs on 9-18-12**
150						

Graphic Log / **Monitoring Well Construction**



SOIL BORING LOG

Boring ID: **MW-22**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek at Section 36 property boundary
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: SONIC
ELEVATION: *975.0 ground surface; 977.50 top-of-casing*

START DATE: 12/7/2020
END DATE: 12/8/2020
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance SONIC
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 78 ft bgs
SWL: Moist/wet 58 ft

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	Soil Description Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	Comments	Graphic Log
0	R-1	0-5'	NA	NA	0-1 ft: Silty **SAND** with gravel (SM), topsoil, dry, brown, loose, rounded 1" gravel.	Sample Type "R-#" is sample run/interval from SONIC continous sample core.	SAND (SM) 1'
5	R-2	5-8'	NA	NA	1-28 ft: Poorly graded **GRAVEL** with silt and sand (GP-GM), grey, dry, dense, sub-rounded gravels, estimated 5-10% fines and 20% sand.		
	R-3	8-18'	NA	NA			
10							
15							GRAVEL (GP-GM)
	R-4	18-25'	NA	NA			
20							
25	R-5	25-28'	NA	NA			
	R-6	28-38'	NA	NA	28-30 ft: Silty **SAND** with gravel (SM-SM), moist, brown, loose, 10% fines.		28' SAND (SP-SM) 30'
30					30-48 ft: Poorly graded **GRAVEL** with silt and sand (GP-GM), grey, dry, dense, sub-rounded gravels to 3" diameter, estimated 5-810% fines and 20% sand.	Trace fine cobbles starting at 30 ft and increasing with depth, sub-rounded alluvial gravels.	
35							
	R-7	38-48'	NA	NA			GRAVEL (GP-GM)
40							
45							
	R-8	48-58'	NA	NA	48-49 ft: Silty **SAND** with gravel (SM-SM), moist, brown, loose, 5-10% fines.		48' SAND (SP-SM) 49'
50							

(continued....

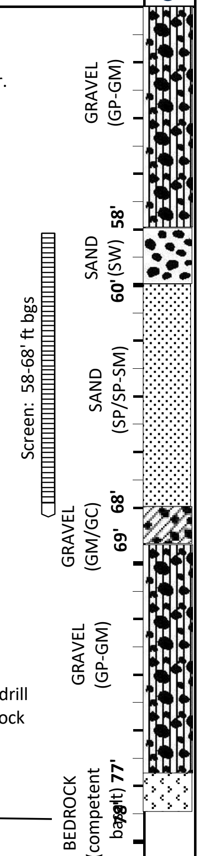
SOIL BORING LOG

Boring ID: **MW-22**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek at Section 36 property boundary
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: SONIC
ELEVATION: *975.0 ground surface; 977.50 top-of-casing*

START DATE: 12/7/2020
END DATE: 12/8/2020
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance SONIC
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 78 ft bgs
SWL: Moist at 58 ft

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	**Soil Description** Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	**Comments**
50	R-8	48-58'	NA	NA	49-58 ft: Poorly graded **GRAVEL** with silt and sand (GP-GM), grey, dry, dense, sub-rounded gravels, estimated 10% fines and 20% sand.	Note: driller adding water to faciliate advancement, some samples logged as 'wet' may be from water added by driller.
55					58-60 ft: Well graded **SAND** with fine gravel (SW), wet, brown, loose, 5% fines, clean.	
	R-9	58-68'	NA	NA		Note: sonic recovery sample material at 58 to 66 ft zone logged as 'wet' or uppermost groundwater; however, moisture on sampled could have been from water added to faciliate SONIC drill method.
60					60-68 ft: Poorly graded fine-medium **SAND (SP)**, wet, brown, loose, mostly SP with some SP-SM zones.	
					68-69 ft: Silty to clayey **GRAVEL** (GM/GC), grey-geen, moist, compacted-cohesive, 30-40% fines, rounded gravels.	
65						
	R-10	68-78'	NA	NA		
70					69-77 ft: Poorly graded **GRAVEL** with sand (GP-GM), grey, dry, loose, estimated 10-15% fines, 10-15% sand.	
					77-78 ft: **BASALT**, vescicular, glassy, fresh, obsidian-like, black to dark grey, dry.	
75						Note: very slow/rough drilling ~refusal drill action at 77 ft correlates to top of bedrock (inferred basalt).
80					Total Depth = 78 ft bgs 12/7/20	End of Log
85						
90						
95						
100						

Graphic Log



SOIL BORING LOG

Boring ID: **MW-23**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek; at intersection of Evans Road and Turning Point Lane
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: Air Rotary
ELEVATION: *1076.6 ground surface; 1079.11 top-of-casing*

START DATE: 6/4/2021
END DATE: 6/4/2021
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance ODEX Air-Rotary
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 45 ft bgs
SWL: 27 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	**Soil Description** Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	**Comments**	**Graphic Log**
0							
	G-1 (grab)	0-5'	NA	NA	0-7 ft: Poorly graded **SAND** with silt **(SP-SM)** with cobbles and gravel, dark brown, dry, loose [inferred fill due to nearby	Relatively fast/easy advancement. Dry dusty discharge. Inferred fill soils 0-14 ft due to color of material and Dry Creek culvert nearby.	SAND (SP-SM)
5							7'
10	G-2 (grab)	5-10'	NA	NA	7-30 ft: Poorly graded **GRAVEL (GP-GM)** with estimated 20% sand, 10% fines, trace cobbles, dark brown, dry loose. [inferred fill to 14 ft bgs due to nearby culvert and color change to light brown]	FILL 0-14 ft bgs (dark brown)	GRAVEL (GP-GM)
15	G-3 (grab)	10-15'	NA	NA		NATIVE soils start at 14 ft bgs (light tan/brown)	14'
20	G-4 (grab)	15-20'	NA	NA			
25	G-5 (grab)	20-25'	NA	NA		Screen: 22-37 ft bgs	GRAVEL (GP-GM)
30	G-6 (grab)	25-30'	NA	NA	30-37 ft: Predominantly well graded **GRAVEL** with silt and sand (GW-GM), light brown-tan, wet at 30 ft bgs, 10% sand and 5% fines.	Uppermost saturated conditions observed at 30 ft bgs from soil cuttings and when applying air-discharge.	30' GRAVEL (GW-GM)
35	G-7 (grab)	30-35'	NA	NA			
40	G-8 (grab)	35-40'	NA	NA	37-45 ft: **CLAY** with very fine sand (CL), lean, distinct light tan to off white color, cohesive rolls to thread, moist.	Transition to fine-grained CLAY layer at 37 ft bgs; soft drilling clay cuttings from 37 to 45 ft bgs.	37' CLAY (CL)
45	G-9	40-44'	NA	NA	**Total Depth 45 ft bgs** **06/04/21**	**(END OF LOG)**	45'
50							

SOIL BORING LOG

Boring ID: **MW-24**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek; approx.
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: Air Rotary
ELEVATION: *1044.10 ground surface; 1046.85 top-of-casing*
START DATE: 6/1/2021
END DATE: 6/3/2021
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance ODEX Air-Rotary
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 125 ft bgs
SWL: ~115'

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	Soil Description Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	Comments	Graphic Log
0							
	G-1 (grab)	3-5'	NA	NA	G-1: **Poorly graded GRAVEL with silt and sand (GP-GM)**, grey, dry, loose. Estimated 20% fine-medium sand.	Relatively fast/easy advancement. Dry dusty discharge.	GRAVEL (GP-GM)
5							
							8'
10	G-2 (grab)	5-10'	NA	NA	G-2: **Well graded GRAVEL with ~5-8% fines (GW/GW-GM),** estimated 20% sand, rounded to sub-rounded gravels, dry, grey and multi-color gravels, dusty discharge.		
15	G-3 (grab)	10-15'	NA	NA	G-3: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
20	G-4 (grab)	15-20'	NA	NA	G-4: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
25	G-5 (grab)	20-25'	NA	NA	G-5: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
30	G-6 (grab)	25-30'	NA	NA	G-6: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		GRAVEL (GW/GW-GM)
35	G-7 (grab)	30-35'	NA	NA	G-7: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
40	G-8 (grab)	35-40'	NA	NA	G-8: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
45	G-9 (grab)	40-45'	NA	NA	G-9: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
50					(continued.........)		

SOIL BORING LOG

Boring ID: **MW-24**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek; approx.
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: Air Rotary
ELEVATION: *1044.10 ground surface; 1046.85 top-of-casing*

START DATE: 6/1/2021
END DATE: 6/3/2021
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance ODEX Air-Rotary
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 125 ft bgs
SWL: ~115'

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	Soil Description Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	Comments	Graphic Log
50	G-10 (grab)	50-55'	NA	NA	(Cont.): **Well graded GRAVEL with ~5-8% fines (GW/GW-GM),** estimated 20% sand, rounded to sub-rounded gravels, dry, grey and multi-color gravels, dusty discharge.	Relatively fast/easy advancement. Dry dusty discharge.	GRAVEL (GW/GW-GM)
55	G-11 (grab)	55-60'	NA	NA	G-10 and 11: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
60	G-12 (grab)	60-65'	NA	NA	G-12: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
65	G-13 (grab)	65-70'	NA	NA	G-13: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
70	G-14 (grab)	70-75'	NA	NA	G-14: Same-as-above. Dry dusty discharge. **(GW/GW-GM).** Lense of poorly graded SAND (SP/SP-SM) with silt from 69 to	Increase in grain size cobbles and boulders at depths below 70 ft bgs.	69' SAND 72'
75	G-15 (grab)	75-80'	NA	NA	G-15: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
80	G-16 (grab)	80-85'	NA	NA	G-16: Same-as-above. Dry dusty discharge. **(GW/GW-GM).** Lense of poorly graded SAND (SP/SP-SM) with silt from 69 to 72 ft bgs.		82' SAND 84'
85	G-17 (grab)	85-90'	NA	NA	G-17: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		GRAVEL (GW/GW-GM)
90	G-18 (grab)	90-95'	NA	NA	G-18: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
95	G-19 (grab)	95-100'	NA	NA	G-19: Same-as-above. Dry dusty discharge. **(GW/GW-GM).** Poorly graded SAND (SP/SP-SM) with silt starting at 97 ft bgs.	No indication of moisture or saturated conditions to 100 ft bgs.	97' SAND (SP-SM)
100					(continued.........)		

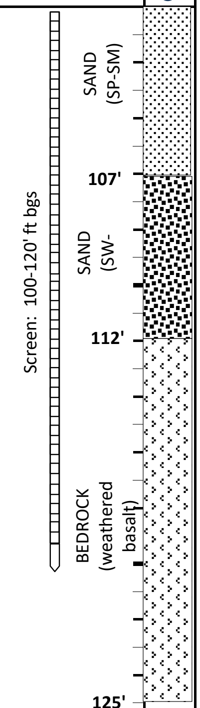
SOIL BORING LOG

Boring ID: **MW-24**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek; approx.
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: Air Rotary
ELEVATION: *1044.10 ground surface; 1046.85 top-of-casing*

START DATE: 6/1/2021
END DATE: 6/3/2021
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance ODEX Air-Rotary
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 125 ft bgs
SWL: ~115'

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	Soil Description Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	Comments
100	G-20 (grab)	100-105'	NA	NA	GRAB 100-107: Poorly graded **SAND** with silt (SP-SM), moist, tan, loose, 5% fine gravel.	Dry dusty discharge.
105	G-21 (grab)	105-110'	NA	NA	GRAB 107-112: Well graded **SAND** with silt (SW-SM), dark brown, moist, loose, 10% fine gravel.	
110	G-22 (grab)	110-115'	NA	NA	GRAB 112-125: CUTTINGS weathered angular vescicular rock fragments, fresh, dark brown, fine-grained, wet/saturated cuttings (inferred **BASALT**).	
115	G-23 (grab)	115-120'	NA	NA		Wet/water discharge at 115 ft when applying air discharge; all cuttings below 115 ft were fully saturated.
120	G-24 (grab)	120-125'	NA	NA		
125					**Total Depth 125 ft bgs** **06/03/21**	
130						
135						
140						
145						
150						

Graphic Log



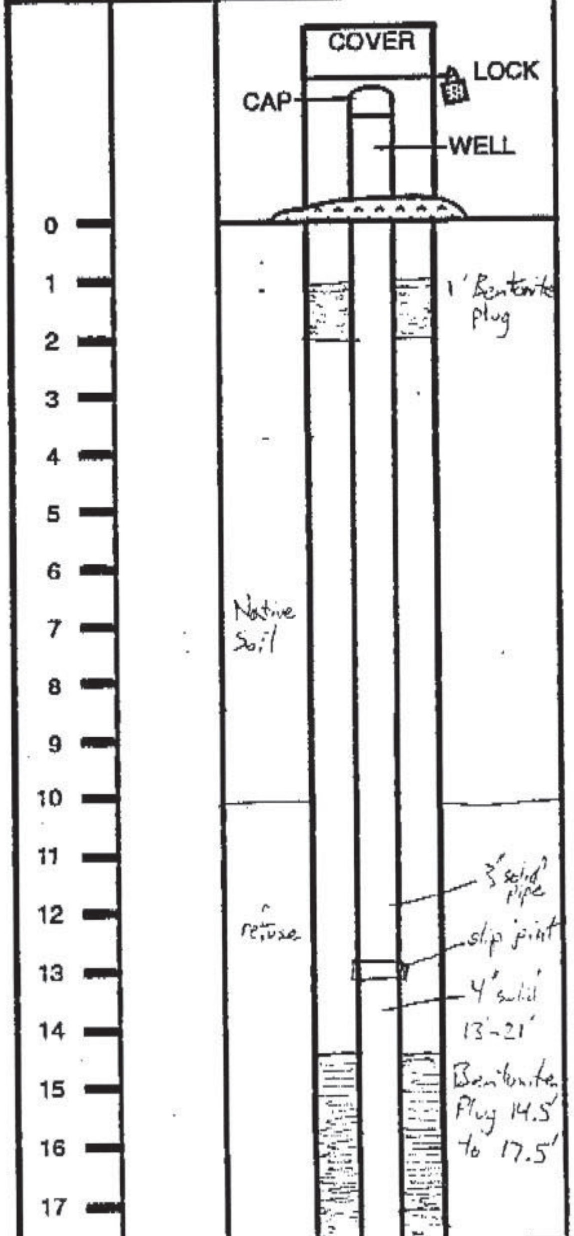
A.3 Landfill Gas Completion Logs

BORING LOG

SCS ENGINEERS
Environmental Consultants
2405 140th Ave NE
Suite 107
Bellevue, WA 98005
800-727-6393
FAX (206) 746-6747

PROJECT: Asotin County LFG
LOCATION:
JOB NUMBER: 0494008
GEOLOGIST/ENGINEER: B. Dorn
DRILLER: DBM
DRILL RIG:
DRILLING METHOD: 26" bucket auger

HOLE/WELL #: LGW-1
DIAMETER: 26"
TOTAL DEPTH: 46' (53' of pipe)
DATE STARTED: Oct. 31, 1995 0910
DATE COMPLETED: Nov. 1, 1995 0900
SAMPLING DEVICE:
PAGE: 1 OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
						Began drilling at 9:10 ≃7' of 3" casing above grade Native soil w/ ~~[illegible]~~ gravel + cobbles dry. med. brown
0–10						
10–17						10' refuse dry, grey, 50-75% soil includes tire, wire, plastic small quantity of yard waste house hold refuse (Paper dating from 1981)

BORING LOG

PROJECT: Asotin County Landfill | HOLE/WELL #: LCW-1

JOB NUMBER: CH94008 | PAGE: 2 | OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
		6" ¢ +				household waste same yard waste dry
15						
20						
22						
24						
26						Darker grey household refuse
28		24' slotted pipe				
30						
32		joint @ 33'				
34						
36						36' wood, log? and native soil, evergreen branches
38						38' yard waste grass clippings. (still green) Plastic + soil
40						
42						42' paper, wood, plastic
44						44' hitting cobbles + native soil
46'		hole bottom				46' native soil w/ gravel and cobbles. Stopped work at 2:00PM 10/31
						Casing caved in @ 3:00PM 11/1

BORING LOG

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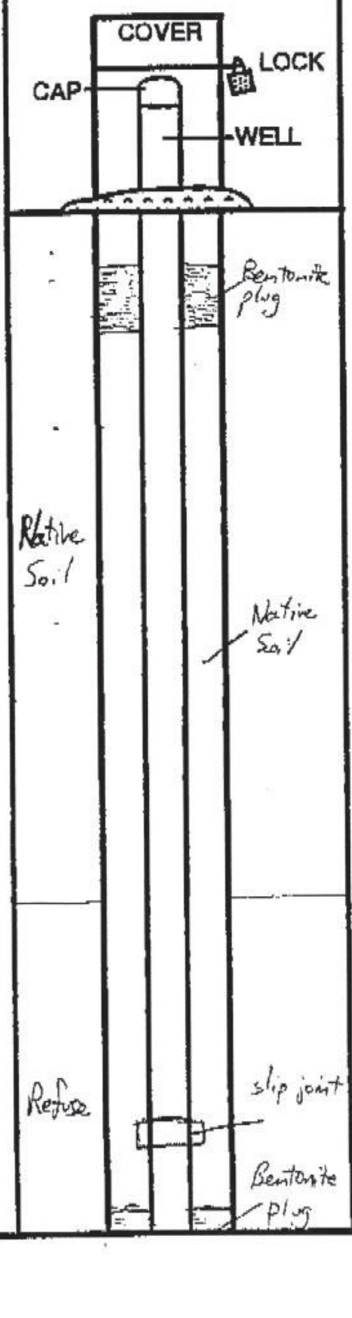
PROJECT: Asotin County Landfill	HOLE/WELL #: LGW-2
LOCATION:	DIAMETER: 24"
JOB NUMBER: C494008	TOTAL DEPTH: 37' (45' of pipe)
GEOLOGIST/ENGINEER: B. Doan	DATE STARTED: Nov. 7, 1995 1150
DRILLER: DBM	DATE COMPLETED: Nov. 7, 1995 1450
DRILL RIG:	SAMPLING DEVICE:
DRILLING METHOD: Bucket Auger	PAGE: 1 OF: 2

COMPLETION DETAIL

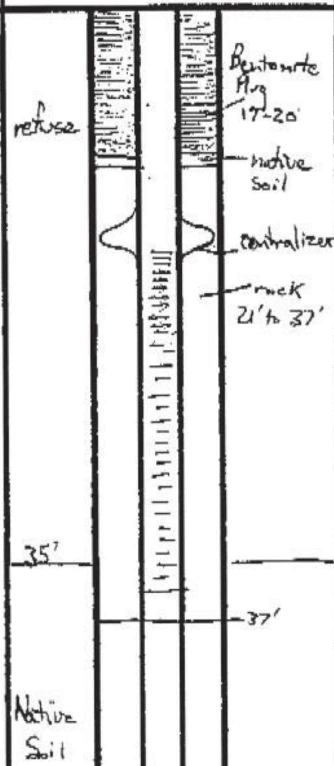


DEPTH (FEET)	SAMPLE	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
(above grade)					Well casing extends approx. 4' above grade Extended 5' 11-8-95 45' total
0					0-12' Native Soil
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					Slightly grey material & soil paper, tire, textiles, plastic
14					
15					greyish-brown soil, grey paper & clothes
16					
17					Moist yard waste, paper, plastic, household refuse

BORING LOG

PROJECT: Asotin County Landfill HOLE/WELL #: LGW-2

JOB NUMBER: 0494008 PAGE: 2 OF: 2



DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
18						Dry, grey, soil and paper debris; plastic, household refuse.
20						
22						Wire, grey wood debris, paper plastic Dry to slightly moist
24						
26						Grey, moist paper, plastic, and yard waste (cedar boughs)
28						
30						DK grey, moist paper debris, yard waste, plastic, tires.
32						
34						
36						
38						
						Predictions, Rock to 21 ~~Bentonite~~ Soil to 20½ Bentonite to 17

BORING LOG

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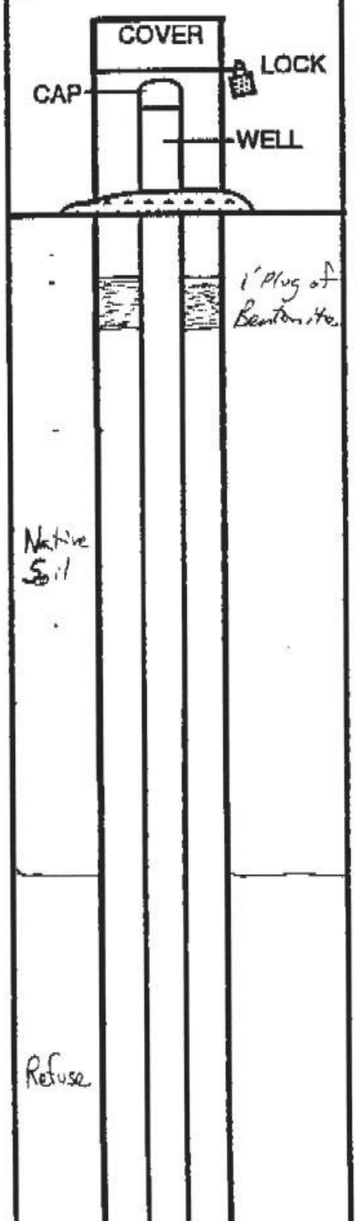
PROJECT: Asotin County Landfill
LOCATION:
JOB NUMBER: 0494008
GEOLOGIST/ENGINEER: B. Doan
DRILLER: DBM
DRILL RIG:
DRILLING METHOD:

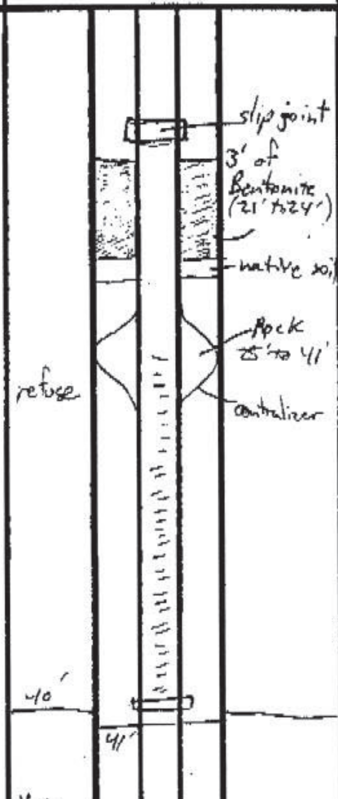
HOLE/WELL #: LGW-3
DIAMETER: ~~26~~ 24"
TOTAL DEPTH: 41' (50' of pipe)
DATE STARTED: Nov. 7, 1995 0830 hrs
DATE COMPLETED: Nov. 7 1995 1145
SAMPLING DEVICE:
PAGE: 1 OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
						Casing extends approx. 5½' above grade Extended 5' 11-8-95 to 50' total
0						0 - 11½' Native soil
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						Clothes, paper, grey material moist
13						
14						
15						
16						Paper, moist putrid material plastic
17						ND methane w/ Gastech meter

BORING LOG

PROJECT: Asotin County Landfill HOLE/WELL #: LGW-3

JOB NUMBER: 0494008 PAGE: 2 OF: 2



DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
						Tire, grey soil (50%), foam rubber, paper, plastic
18						
20						Grey, moist, leaves, paper, wood debris
22						
24						
26						
28						
30						Tire, wood debris (dk grey), Paper, plastic
32						
34						Dk grey material, yard waste, paper, slightly moist
36						wood debris, grey soil, paper
38						
40						40'. native soil
42						drilled to 41' - refused
						5% methane in bore hole when 35' was reached

BORING LOG

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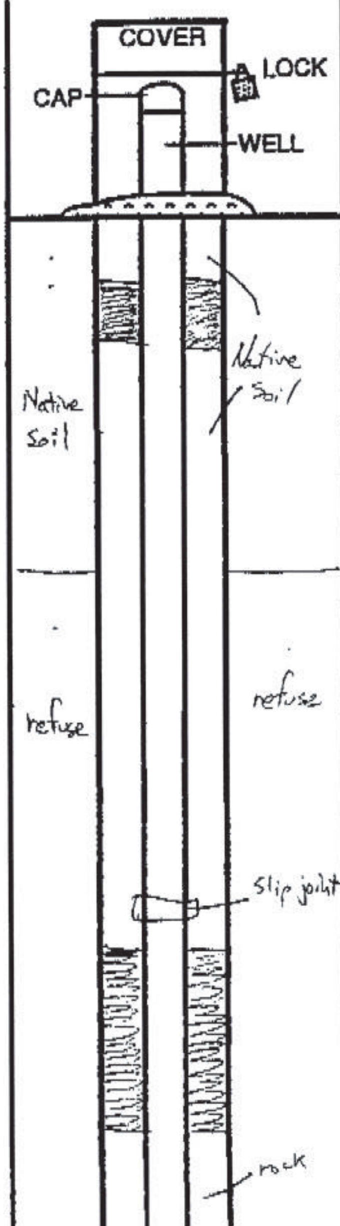
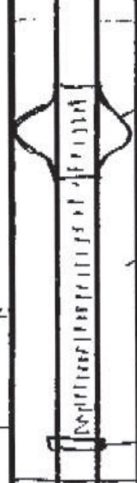
PROJECT: Asotin County Landfill	HOLE/WELL #: LGW-4
LOCATION:	DIAMETER: 26"
JOB NUMBER: 0494008	TOTAL DEPTH: 33'
GEOLOGIST/ENGINEER: B. Doan	DATE STARTED: Nov. 6, 1995 1520 hrs
DRILLER: DBM	DATE COMPLETED: Nov. 7, 1995 0820 hrs
DRILL RIG:	SAMPLING DEVICE: 40' pipe
DRILLING METHOD:	PAGE: 1 OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
						Well Casing extends approx. 8' above grade
0						0-6' native soil
1						
2						
3						
4						
5						
6						Soil, wood debris, paper
7						Paper and plastic.
8						
9						
10						greyish-brown soil, paper and plastic, clothing
11						moist paper, grass clippings
12						tire
13						
14						Grey/green slightly moist yard waste (grass, branches)
15						paper, plastic
16						Paper, wood debris, slightly moist
17						

BORING LOG

PROJECT: Asotin County Landfill HOLE/WELL #: LGW-4

JOB NUMBER: 0484008 PAGE: 2 OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
18						Grey, paper, plastic
20		Centralizer				
22						Dk grey, moist to slightly moist material
24		rock				Books
26						Tire
28		Refuse				
30		31'				
32		4" cap				31' native soil 1645hrs
34		33'				drilled to 33'
		Native Soil				

Nov. 7: drillers arrived at 0720

I Installed caps on LGW-7 and LGW-9 at 0740

Finished LGW-4 at 0820

BORING LOG

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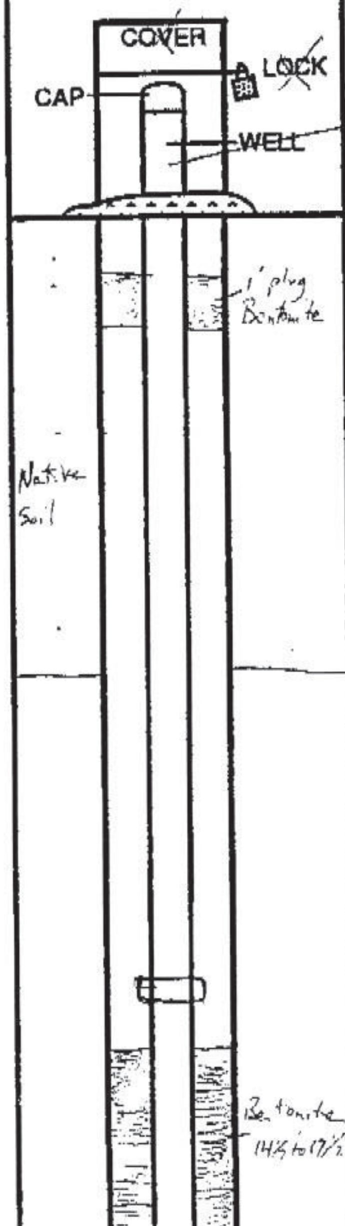
PROJECT: Asotin County Landfill
LOCATION: LGW-5
JOB NUMBER: 0495008
GEOLOGIST/ENGINEER: B. Dean
DRILLER: DBM
DRILL RIG:
DRILLING METHOD: Bucket Auger

HOLE/WELL #: LGW-5
DIAMETER: 26"
TOTAL DEPTH: 33'
DATE STARTED: Nov. 6, 1995 1055
DATE COMPLETED: Nov. 6, 1995 1515
SAMPLING DEVICE: 40' of pipe
PAGE: 1 OF: 2

COMPLETION DETAIL

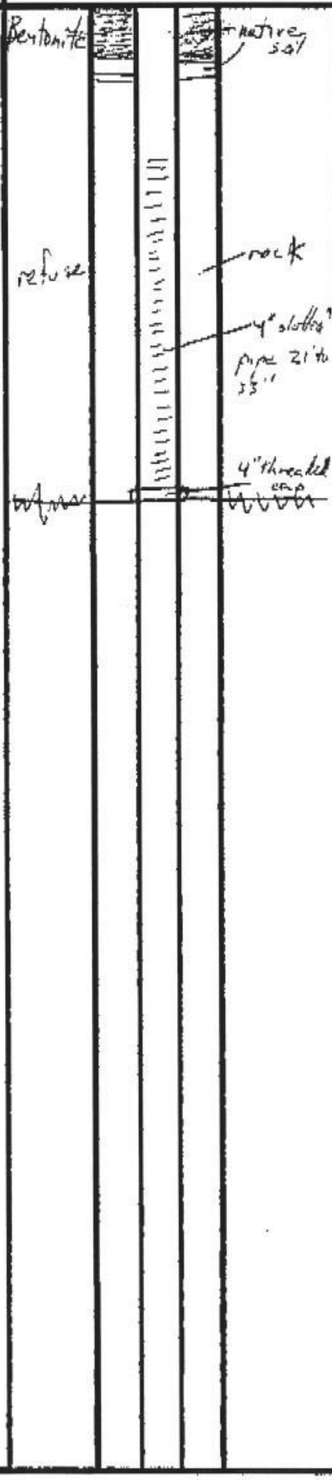


DEPTH (FEET)	SAMPLE	SAMPLE #	BLOW COUNTS/FOOT	USCS SYMBOL	DESCRIPTION
(above grade)		7½' of casing above grade			Well casing extends approx. 7½' above grade
0					0-8' Native Soil, dry
1					
2					
3					
4					
5					
6					
7					
8					Grey soil, textiles, dry
9					tire, paper wood debris
10					
11					11' cable hose, paper, green grass plastic, dk. grey paper dry
12					
13					wood Debris, grey paper dry
14					
15					brown/grey soil w/ wood debris and paper, dry
16					wire
17					brown wood debris, paper

BORING LOG

PROJECT: Asotin County Landfill HOLE/WELL #: LGW-5

JOB NUMBER: 0494008 PAGE: 2 OF: 2



DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/FOOT	USCS SYMBOL	DESCRIPTION
						brown wood debris, tires wire, dry
18						several semi-truck tires wood debris, paper,
20						
22						Dk. gray soil, moist, plastic, paper (waste oil?)
24						
26						
28						Brownish ~~gray~~ soil and wood debris
30						
32						
34						stopped drilling 1400 hrs. hole was collapsing at bottom and progress was not being made. 41' of well casing (fully extended) resting on bottom of ~~[illegible]~~ bore hole.
36						

Steve woodbury

BORING LOG

SCS ENGINEERS
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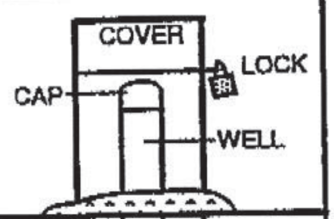
Suite 107
Bellevue, WA 98005

800-727-6393
FAX (206) 746-6747

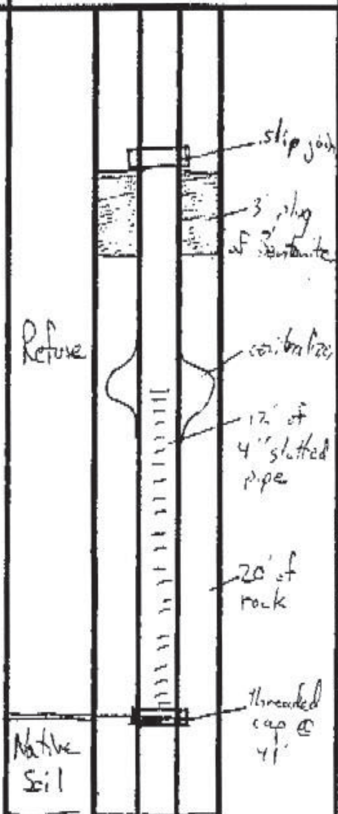
PROJECT: Asotin County Landfill Gas Wells
HOLE/WELL #: LGW-6
LOCATION:
DIAMETER: 26"
JOB NUMBER: 0494008
TOTAL DEPTH: 44.0' (50' of pipe)
GEOLOGIST/ENGINEER: B. Doan
DATE STARTED: Nov. 2, 1995 1020 hrs
DRILLER: DBM
DATE COMPLETED: Nov. 2, 1995 1515 hrs 40' of pipe
Nov. 8, 1995 0930 hrs Extended 10' to 8' above grade
DRILL RIG:
SAMPLING DEVICE:
DRILLING METHOD:
PAGE: 1 OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/FOOT	USCS SYMBOL	DESCRIPTION
						Well casing capped 1' below grade. Extended 10' (to 8' above grade) 11-8-95
0						0-10' Dry, brown, native soil
1		threaded cap	Extended 11-8-95			
2						
3						
4		native soil				
5						
6						
7						
8		3' solid pipe				
9		Native soil				
10						
11						Med. brown-grey soil and refuse (plastic + paper)
12						
13		refuse				Green grass clippings, wood-debris, branches, plastic, paper
14						
15						
16						Grey-brown soil, wood debris plastic, paper alum. cans diaper
17						

BORING LOG

PROJECT: Asotin County Landfill Gas Wells HOLE/WELL #: LGW-6

JOB NUMBER: 0494008 PAGE: 2 OF: 2



DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
18						Household refuse - textiles, paper plastic inner tube.
20						Tire small debris, grey, dry. paper, plastic (not much soil)
22						Mostly paper w/ occasional plastic ~ wire 1979)
24						
26						
28						slightly grey paper, plastic + green grass clippings.
30						30' - same material but greyer.
32						32' - green grass, dk. grey material carpet.
34						wire and upholstery
36						Plastic, paper, dk grey material green grass clippings
38						
40						~~40.5'~~ 41' native soil
42						
44						
						Total depth 44.0
						~~Rep~~ Well casing deployed to 41'
						Repaired drill rig 1200 to 1335 Nov. 2 (approx. 24' below grade)

BORING LOG

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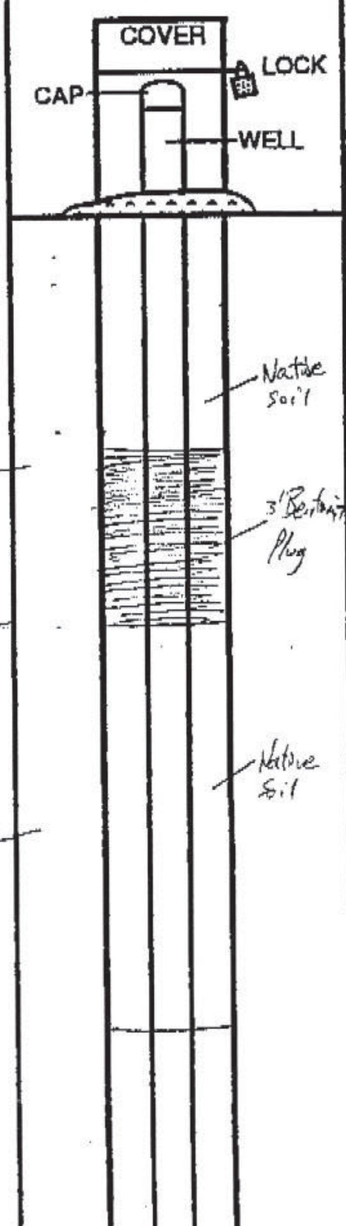
PROJECT: Asotin County Landfill Gas Wells	HOLE/WELL #: LGW-7(A)
LOCATION:	DIAMETER: 36"
JOB NUMBER: 0494008	TOTAL DEPTH: 14'
GEOLOGIST/ENGINEER: B. Dean	DATE STARTED: Nov. 1, 1995 1525 hrs
DRILLER: DBM	DATE COMPLETED: Nov. 2, 1995 1000 hrs abandoned
DRILL RIG:	SAMPLING DEVICE:
DRILLING METHOD: Bucket Auger	PAGE: 1 OF: 1



DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
						No casing installed. This well was abandoned and drill crew moved 5' east.
0						Dry, med. brown, native soil w/ small amount of gravel.
1						
2						
3						
4	Native Soil					
5						
6						
7						7'-9' Household refuse; paper, textile, wire. Tire, yard waste (green grass)
8						
9						
10	refuse					
11						
12						
13						
14						14' wire + cable decided to move to 5' East of hole. Would begin drilling 11-2-95
15						
16						
17						

BORING LOG

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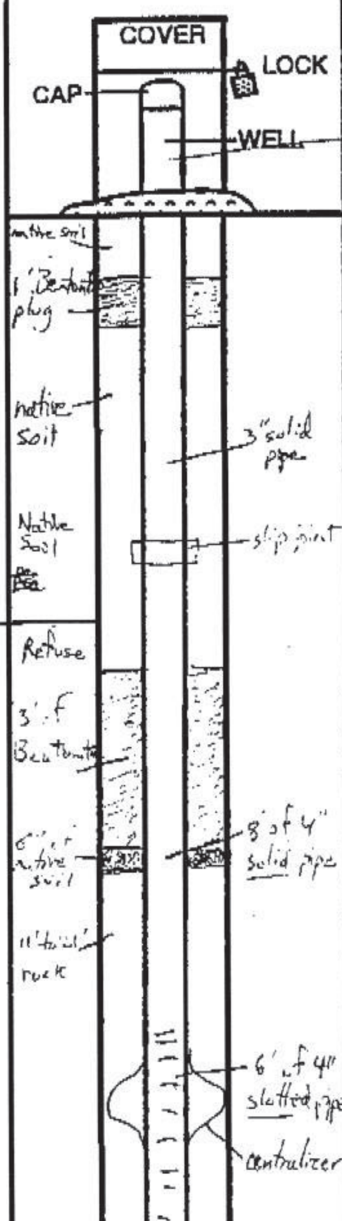
PROJECT: Asotin County Landfill Gas wells	HOLE/WELL #: LGW-7 (B)
LOCATION: on hub (not 5' west)	DIAMETER: 26"
JOB NUMBER: 0194003	TOTAL DEPTH: 21' 28' of pipe
GEOLOGIST/ENGINEER: B. Dorn	DATE STARTED: Nov 2, 1995 0700
DRILLER: D Bill	DATE COMPLETED: Nov. 2, 1995 0930 (move lateral 5' to the east)
DRILL RIG:	SAMPLING DEVICE:
DRILLING METHOD: Bucket Auger	PAGE: 1 OF: 2



DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
(above grade)			7' 4" of 3" pipe above grade			Arrived 0730. Driller had begun drilling 5' east of previous (on hub) not 5' East of hub. Contractor will have to move lateral 5' east
0						
1						0-7' Native soil
2						
3						
4						
5						
6						
7						
8						7'-10'
9						75% soil, grey w/ paper and plastic
10						Grey soil, paul waste textiles plastic paper
11						
12						
13						
14						Wire and cable
15						Paper + plastic
16						
17						grey, gravelly soil

BORING LOG

PROJECT: Asotin County Landfill Gas Wells HOLE/WELL #: LGW-7

JOB NUMBER: 0194008 PAGE: 2 OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
	refuse	4" slotted pipe				Dry, grey soil, w/gravel 17'-19' Cans, small bits of refuse (plastic, paper)
18		coupler				
20	soil	threaded cap				19-21' Dry, brown native soil w/ gravel + cobbles 0815
22						
24						
26						
28						
30						Water pump was frozen and took about 15 min to clear

BORING LOG

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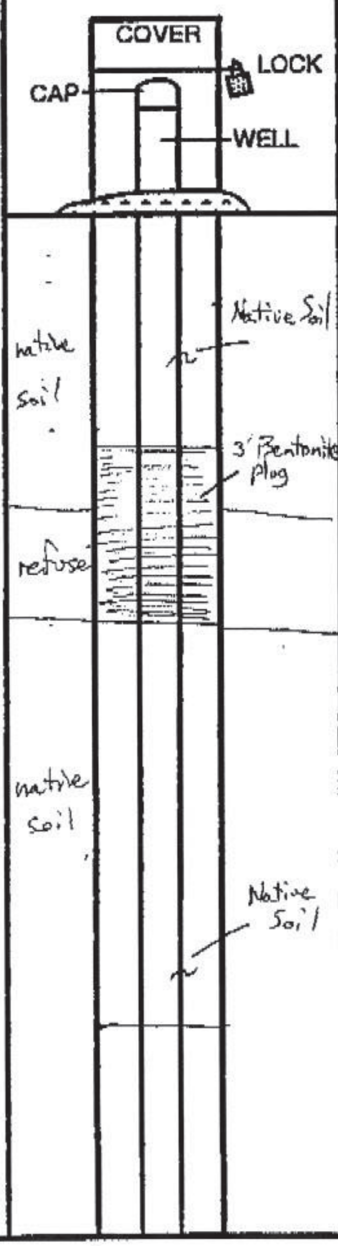
FAX (206) 746-6747

PROJECT:	Asotin County Landfill Gas Wells	HOLE/WELL #:	LGW-8-A
LOCATION:		DIAMETER:	26"
JOB NUMBER:	0494008	TOTAL DEPTH:	
GEOLOGIST/ENGINEER:	B. Doan	DATE STARTED:	Nov. 1, 1995 1330
DRILLER:	DBM	DATE COMPLETED:	Nov. 8, 1995 0930
DRILL RIG:		SAMPLING DEVICE:	
DRILLING METHOD:		PAGE:	1 OF: 1

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
0						
1						0-5' dry, med. brown native soil
2						
3						
4						
5						
6						5-7' plastic, paper, household refuse. Grey, dry.
7						
8						Soil, native, dry w/ gravel + cobbles
9						
10						
11						
12						Hole stopped at 14' at 1430 hrs.
13						Upon receiving instructions, moved to LGW-7 @ 1515 hrs.
14						
15						
16						
17						

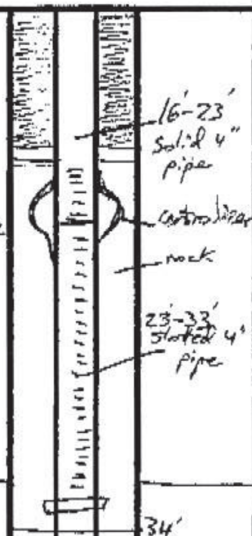


BORING LOG

PROJECT: Asotin County Landfill HOLE/WELL #: LGW-8

JOB NUMBER: 0494008 PAGE: 2 OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
18						Wood debris, paper
20						Dk. grey small bits of wood debris, paper, some plastic
22		Refuse				
24						moist, dk grey paper bits, plastic, household refuse
26						
28						
30						Grey soil, slightly moist
32		32'				
34						
36						Hit native soil at 32' Drilled to 34'. 1640hrs
		Native Soil				



Predictions

rock soil Bentonite
34'-20½ ½' 20'-17'

casing
33'-23' slotted 4" (2x5')
23'-16' solid 4" (1x7')
16'-up solid 5" (5x5')
42' of casing

Tee will be 4'4" below grade

upper Bentonite seal from 6½' to 5½'

42' of pipe including above grade

BORING LOG

SCS ENGINEERS
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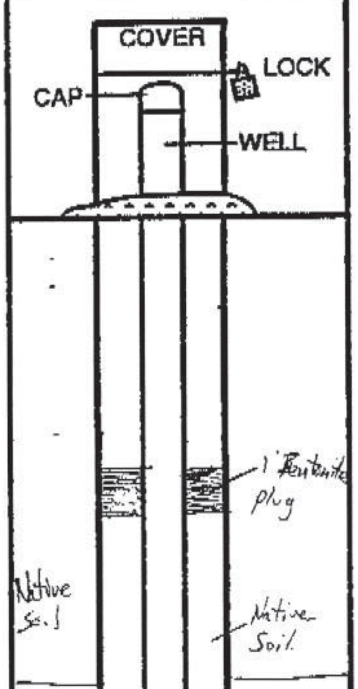
FAX (206) 746-6747

PROJECT:
LOCATION: Asotin County Landfill
JOB NUMBER: 0494008
GEOLOGIST/ENGINEER: B. Dean
DRILLER: DBM
DRILL RIG:
DRILLING METHOD: 26" bucket auger

HOLE/WELL #: LGW-9
DIAMETER: 26"
TOTAL DEPTH: 40' (46' of pipe)
DATE STARTED: Nov. 1, 1995 0830
DATE COMPLETED: Nov. 1, 1995 1315
SAMPLING DEVICE:
PAGE: 1 OF: 2

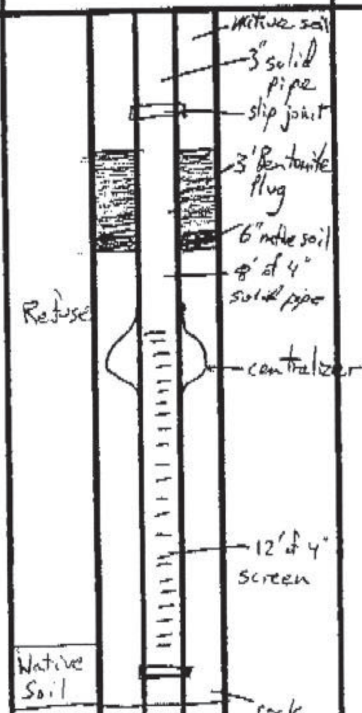
DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
						Extended 5' 11-8-95 to 7' above grade. 46' total 2' of 3" riser extending above grade. See note bottom of pg. 2.
0						0 - 8' Med brown, dry native soil w/ a small amount of gravel.
1						
2						
3						
4						
5						
6						
7						
8						
9						Med Dark grey material and household refuse: paper, plastic and wood Dry.
10						
11						
12						Dry, dk. grey wood debris
13						
14						(Paper dating from early 1970's)
15						
16						Grey, dry wood debris and plastic paper.
17						All small debris

BORING LOG

PROJECT: Asotin Landfill Gas Wells HOLE/WELL #: LGW-9

JOB NUMBER: C494008 PAGE: 2 OF: 2

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ FOOT	USCS SYMBOL	DESCRIPTION
18						Grey, dry material approx. 50% soil. Wood debris + small refuse.
20						DK. Grey soil 18'-24'
22						
24						
26						Dry grey soil (25%) and unrecognizable household refuse
28						
30						
32						Tire, paper, green grass clippings plastic, soil
34						32'-37'±
36						Dk grey soil and unrecognizable household refuse.
38						38' native soil and gravel
40						40' bottom of hole 1200
						Install well casing 1200-13
						Total installed height = 41' (two feet are above grade)
						Height above grade is deficient and will have to be adjusted for when Tee fitting is installed; more riser pipe will need to be added.



CH2MHILL

SOIL BORING / WELL LOG

BORING NO: **GP-LGW-10**
PROJECT NO: **331908.08.A2.03**
PROJECT NAME: Asotin County Regional Landfill Remedial Investigation
LOCATION: NE end of interior closed landfill
DRILLING CONTRACTOR: Budinger
TOC ELEVATION: N/A
GROUND ELEVATION: 1271.63
START DATE: 3/30/2009
END DATE: 4/3/2009
LOGGER: R. Greer
DRILLING EQUIPMENT: Mobile B-57 6 1/2" H.S.A., 3x18" SPT
BORING DIAMETER: 6.5-inches
TOTAL DEPTH: 75 ft
SWL: N/A

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description: soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments: drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
0					AUGER CUTTINGS: Sandy **SILT** w/glay and gravel, dry. Hard/rough drilling **(ML)**	START: 08:30 -Moderate/easy advancement	ML	3/8" Bentonite Chips; 1" Schedule 80 PVC
1–2						AIR: NDs, O2: 20.9%		
2.5–3						Slow/rough drilling at 2.5 ft. bgs. Sandy silt w/ rounded gravels		
6						AIR: NDs, O2: 20.9%		
9						Transition to easier/ smoother drilling at 8.9 ft.		
10	SPT-1 (3" dia.)	9.5-11'	18/18	15 30 30 **(n=60)**	Gray sandy **SILT/CLAY** w/ 10-30% gravels, dry, 9.5-10 ft. Transition to borderline brown **sandy SILT/silty fine SAND**, micaceous, slightly moist to dry, very dense to hard, 20-50% fines **(ML, ML-SM)**		ML ML-SM	
11						Iron-stained w/ black nodules		
12						Transition to CLAY w/ trace fine sand and gravel		
16						AIR: NDs, O2: 20.9%		
20	SPT-2	19.5-20.3'	6/9	20 60/3" **(60/3")**	Silty **SAND** w/ trace gravel, brown, dry, very dense, angular basalt gravels **(SM)**		SM	
21						AIR: NDs, O2: 20.9%		
22					AUGER CUTTINGS: Transition to **CLAY** w/ trace sand & fine gravel, dark green/gray, slightly moist, hard (fill cover soil) **(CL)**		CL	
24						Slow advancement		

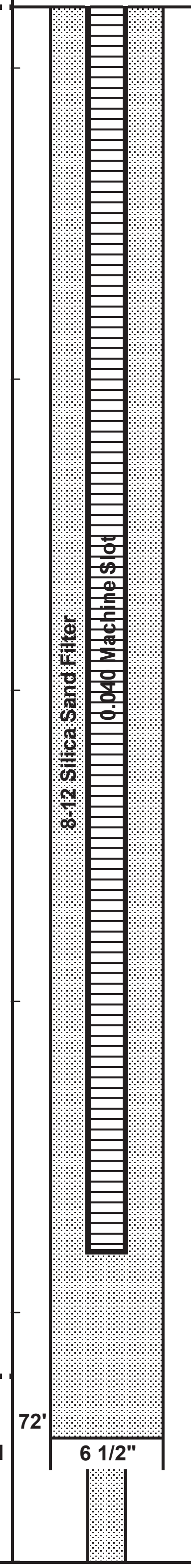
BORING NO: **GP-LGW-10**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description: soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments: drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
24								1" Schedule 40 PVC
25						AIR: NDs, O2: 20.9%		
26								
27								
28								
29	**FILL COVER SOIL** / **REFUSE MATERIAL**				**FILL COVER SOIL** / AUGER CUTTINGS: Transition at 29 ft. to **REFUSE**: Intermixed MSW refuse w/ clay soil, dry. MSW cuttings consist of plastic, paper, metal scraps, & wood	Change in drill action; auger cuttings show MSW refuse		
30								
31								
32								
33						Hard drilling at 32.5 ft. Drillers trip out to clean off auger flights		
34						AIR: LEL: 2, CO: 1, O2: 20.6		
35					AUGER CUTTINGS: **REFUSE** w/ gray clay and sand.	AIR (over boring): LEL: Alarm (high %), O2: Alarm (low %), VOCs: 4.6 ppm, CO: 10ppm		
36								
37						AIR (12" over boring): LEL: 2, CO: 3, O2: 20.6%		
38								8-12 Silica Sand Filter; 0.040 Machine Slot
39							REFUSE	
40					AUGER CUTTINGS: **REFUSE** w/ dark gray clay and sand w/ trace gravel			
41								
42						AIR (breathing area): LEL:2, CO: 3, O2: 20.7%		
43								
44								
45					AUGER CUTTINGS: **REFUSE** w/ dark gray clay and sand w/ trace gravel	AIR: (breathing area): CO: 7 (probable rig exhaust), O2: 20.7%		
46								
47								
48						Advancement slows, drill chatter, hard material		

BORING NO: **GP-LGW-10**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile
49					AUGER CUTTINGS: **REFUSE** w/dark gray Clay and fine sand w/fine gravel	Very hard material	
50						AIR (over boring-partially covered): LEL ALarm (high), O2: ALarm (low), CO: 14 ppm, VOCs: 2.4 ppm	
51							
52	SPT-3	52-53	10/14	20 50 50/2" **(100)**	**REFUSE**: Wood, plastic, other material w/ gray clay and sand, dense	No advancement or cuttings at 51.5 ft. Augers clogged; trip out. Drive SPT to investigate conditions	
53							
54					AUGER CUTTINGS: **REFUSE** w/ gray clay w/ sand		
55							
56							
57							
58						AIR (Beathing area): NDs, O2: 20.8%	
59					AUGER CUTTINGS: **REFUSE** Materials w/ gray clay w/ sand	Driller observes change in drilling action: Conditions slightly softer	**REFUSE**
60							
61							
62							
63							
64					AUGER CUTTINGS: Metal and **REFUSE** in cuttings	AIR: LEL: 4, CO: 2, VOCs: 0.1, O2: 20.9%	
65							
66							
67						AIR: NDs, O2: 20.9%	
68							
69					AUGER CUTTINGS: **REFUSE** material with Gray clay and increasing sand	Slight change in drilling action	
70							
71	**REFUSE MATERIAL** / **NATIVE MATERIAL TRANSITION**					Hard drilling action	
72	SPT-4	72-73.5	4/10	15 20 50/5" **(70)**	Tan & brown poorly graded fine **SAND** w/ silt (20%), moist, dense **(SM)**	TD (drilling): 72 ft at 19:00, 3-30-09	**SM**
73							
73.5							

Well Construction



SOIL BORING / WELL LOG

CH2MHILL

BORING NO: **GP-LGW-10**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	**Soil Description** soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
73.5							SM	
74	SPT-5	73.5-75	18/18	36 50 84 **(134)**	Tan and brown poorly graded fine **SAND** w/ thin silt bedding (1/16 to 1/4-inch), moist, dense. Increasing **SILT** and clay at 74.5 ft. **(SM, ML)**		ML	
75						TD (3-inch SPT Sampling) to 75 ft		3"
76								
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								
87								
88								
89								
90								
91								
92								
93								
94								
95								
96								
97								

SOIL BORING / WELL LOG

CH2MHILL

BORING NO: **GP-LGW-11**
PROJECT NO: **331908.08.A2.03**
PROJECT NAME: Asotin County Regional Landfill Remedial Investigation
LOCATION: North, central in Interior closed landfill
DRILLING CONTRACTOR: Budinger
TOC ELEVATION: N/A
GROUND ELEVATION: 1276.10
START DATE: 4/3/2009
END DATE: 4/8/2009
LOGGER: R. Greer
DRILLING EQUIPMENT: Mobile B-57 6 1/2" H.S.A., 3x18" SPT
BORING DIAMETER: 6.5-inches
TOTAL DEPTH: 78 ft
SWL: N/A

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	**Soil Description** soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	**Soil Profile**	**Well Construction**
0						START: 12:00		3/8" Bentonite Chips; 1" Schedule 80 PVC
2–3					AUGER CUTTINGS: Moist, tan **SILT** with 30% gravel, round to sub-rounded, 1/2 - 1.5 in. dia.**(ML)**		**ML**	
7						Slow, steady drill advancement		
9–10	SPT-1 (3" dia.)	9-10.5	18/18	30 26 24 **(50)**	Brown **CLAY** w/ silt and trace rounded to sub-rounded gravel, moist, moderate density**(CL)**	AIR: NDs, O2: 20.9%	**CL**	
12						Less drill chatter		
13						Transitions between clayey and coarse material throughout		
14						AIR: NDs, O2: 20.9%		
19–20	SPT-2	19-20	12/12	27 32 **(32)**	Brown **CLAY** with silt and trace, sub-rounded gravel with sand, moist, medium density. **(CL)** Transitions to brown **SILT** with clay and increasing sand @ 19.5 ft. **(ML)**		**CL** **ML**	
21						Drilling becomes rough		
22						Drilling steady		
23						AIR: NDs, O2: 20.9%		

BORING NO: **GP-LGW-11**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
24	**FILL COVER SOIL**				AUGER CUTTINGS: Inceasing gray **CLAY** with trace fine gravel **(CL)**	Driller observes "sticky" conditions.	**CL**	**1" Sch 80 PVC**
25	**REFUSE MATERIAL**				AUGER CUTTINGS: Transition to **REFUSE**, some plastic, wood/debris observed in cuttings.			
26						AIR: NDs, O2: 20.9%		
27								
28								
29						FINISH: 4-3-09 RESUME: 4-6-09		
30						AIR (Headspace): CO ALARM, O2: 20.9%, NDs		
31						Slow, steady drilling		
32						AIR (Breathing Area): CO: 2, O2 20.9%, NDs		
33					AUGER CUTTINGS: **REFUSE** (plastic, wood, metal) with gray clay and sand	Rough, slow drilling		
34						Trip out augers due to clogging		
35								
36								
37							**REFUSE**	**1/2 to 1-inch clean rounded gravel filter** **0.040 Machine Slot**
38					Collect SPT: **REFUSE** MATERIALS with clay and coarse sand some hard wood, very stiff			
39						AIR (Headspace): LEL: 7, VOCs: 9.7, O2: 20.8%		
40						AIR (Breathing Area): VOCs: 0.2, O2: 20.9%, NDs		
41								
42								
43					AUGER CUTTINGS: **REFUSE** w/ dark gray clay and sand w/ trace gravel	AIR (breathing area): NDs, O2: 20.9%		
44						Trip out augers due to clogging		
45					AUGER CUTTINGS: **REFUSE** w/ dark gray clay and sand w/ trace gravel			
46						Steady drill action		
47								
48								

BORING NO: **GP-LGW-11**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
49					AUGER CUTTINGS: **REFUSE** w/dark gray clay and sand - Not a lot of cuttings conveying to the surface		REFUSE	1/2 - 1-inch clean rounded gravel filter; 0.040 Machine Slot
50						Rough drilling		
51								
52								
53								
54					AUGER CUTTINGS: **REFUSE** w/ dark gray clay and sand w/ fine gravel - Not a lot of cuttings conveying to the surface	AIR: CO: 3, O2: 20.9%, NDs		
55								
56						Slow steady drilling		
57								
58						AIR: CO: 2, O2: 20.9%, NDs		
59					Collect SPT: **REFUSE** MATERIALS with clay and coarse sand and fine gravel	FINISH: 4-6-09 RESUME 4-7-09		
60								
61					AUGER CUTTINGS: **REFUSE** w/ gray clay, sand and gravel	AIR: CO: 2, O2: 20.9%, NDs		
62						Steady, easier advancement		
63								
64					AUGER CUTTINGS: Observe possible increase in sand and decrease in refuse. Collect SPT: **REFUSE** w/ gray clay and sand			
65								
66						AIR: O2: 20.9%, NDs		
67						Driller observes possible change in conditions at 67 ft.		
68					Collect SPT: **REFUSE** w/ gray clay and sand. Transition to gray clay and sand, trace refuse at 69 ft.			
69						Driller observes hard gravelly drilling action		
70					Collect SPT: **REFUSE** (newspaper, plastic and glass) w/ gray clay and sand			
71								
72								
73						Slow steady advancement		

SOIL BORING / WELL LOG

BORING NO: **GP-LGW-11**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
74					Collect SPT: **REFUSE**: Paper and metal with gray clay and sand w/ gravel	AIR: O2: 20.9%, NDs	REFUSE	
75								
76								
77								
78					**REFUSAL**: Hard metal at 78 ft. - unable to advance; drag bit ground down 1/2-3/4"	Very hard - unable to advance, probably thick metal **TD: 78 ft. on 4-7-09**		
79								
80								
81								
82								
83								
84								
85								
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91								
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94								
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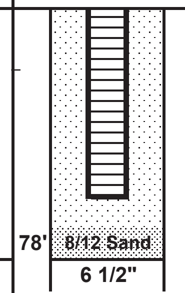
96								
97								
98								



SOIL BORING / WELL LOG

CH2MHILL

BORING NO: **GP-LGW-12**
PROJECT NO: **331908.08.A2.03**
PROJECT NAME: Asotin County Regional Landfill Remedial Investigation
LOCATION: West-center end of interior closed landfill
DRILLING CONTRACTOR: Budinger
TOC ELEVATION: N/A
GROUND ELEVATION: 1279.00
START DATE: 4/8/2009
END DATE: 4/8/2009
LOGGER: R. Greer
DRILLING EQUIPMENT: Mobile B-57 6 1/2" H.S.A., 3x18" SPT
BORING DIAMETER: 6.5-inches
TOTAL DEPTH: 28 ft
SWL: N/A

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	**Soil Description** soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	**Soil Profile**	**Well Construction** (Well Not Installed)
1								3/8-inch Bentonite Chips Backfill
2					AUGER CUTTINGS: Brown **SILT** w/ sub-rounded gravel, up to 2-inch dia. **(ML)**		**ML**	
3					AUGER CUTTINGS: Increasing gravel, sub-angular, 3/4 to 3-inch dia. **(GM)**	Gravelly drilling action	**GM**	
4								
5					AUGER CUTTINGS: Same as above **(GM)**		**GM**	
6						AIR: CO:1, O2: 20.9%, NDs Hard drilling, slow advancement		
7								
8								
9								
10	SPT-1 (3" dia.)	9.5-11	14/18	12 20 21 **(41)**	Brown **SILT** with 20% sub-rounded to sub-angular gravel, some clay, trace sand **(ML)**	AIR: O2: 20.9%, NDs	**ML**	
11						Difficult Drilling - very gravelly		
12								
13								
14								
15					AUGER CUTTINGS: Transition from brown **SILT** to **CLAY**, w/ sand, decreasing gravel **(ML - CL)**	Easier advancement	**ML** **CL**	
16								
17						AIR: NDs, O2: 20.9%		
18								
19								
20	SPT-2	19.5-20.3	13/18	12 25 24 **(49)**	Brown and tan **CLAY** w/ silt, moist, dense **(CL)** Transition to Dark gray **CLAY** & silt with sand. Possible refuse interface **(CL)**	Drilling becomes harder	**CL**	
21						AIR: NDs, O2: 20.9%		
22	**FILL COVER SOIL**				AUGER CUTTINGS: Dark gray **CLAY** with sand and silt, possible increase in moisture **(CL)**	Drilling becoming difficult	**CL**	
23	**REFUSE MATERIAL**				AUGER CUTTINGS: Dark gray CLAY & SAND w/ wood debris - inferred **REFUSE**	Scrap metal observed in cuttings AIR: NDs, O2: 20.9% Large chunk of metal in cuttings		

CH2MHILL

SOIL BORING / WELL LOG

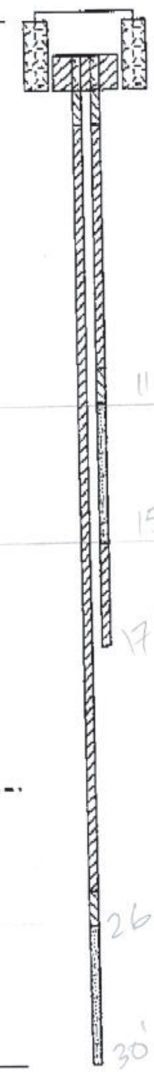
BORING NO: **GP-LGW-12**

Depth (ft)	Sample ID	Interval (ft)	Recovery (in)	SPT blows per 6" (n)	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile	Well Construction
24–25					AUGER CUTTINGS: **REFUSE** with gray clay w/ sand. Refuse: Wood, metal, copper tubing.	Hard Drilling/Very slow advancement	REFUSE	3/8-inch Bentonite Chips Backfill
26–27					AUGER CUTTINGS: **REFUSE**: Large scrap metal pieces in cuttings.	Unable to advance		
28					**REFUSAL** @ 28 ft. BGS	**TD: 28 ft. 4-8-09**		6 1/2"

WELL GP-1 *(Page 1 of 1)*

CLIENT NAME Asotin County Landfill
DATE DRILLED 04/24/95
SURFACE ELEVATION NA
TOTAL DEPTH OF HOLE 30 Feet

DEPTH (ft)	Sample No.	Odor, HNu or OVM?	CHEMICAL CONCENTRATIONS (ppm) 0 10 20 30 40 50	SAMPLES	SYMBOLS	MATERIALS DESCRIPTION
0					SAND	SILTY SAND with <5% clay, brown, moist.
						SANDY SILT with <5% clay, brown, moist.
5						SANDY SILT with <5% clay, brown, moist.
10						SANDY SILT with <5% clay, brown, moist.
15						SILTY SAND, medium to coarse grained, fine gravel, light tan, moist.
20						SILTY SAND with basalt gravel, brown, moist.
					BSLT	BASALT GRAVEL with silty sand, black, moist.
25						BASALT GRAVEL, black, moist.
30						TOTAL DEPTH LOGGED = 30'.
35						
40						



Gasprobe GP-1D installed to a depth of 30' with a boring diameter of 2" to 20' and 1" to 30'.

Gasprobe GP-1S installed to a depth of 15' with a boring diameter of 2".

Gasprobe diagram depicts view facing south.

Nested gasprobes spaced approximately 18" apart.

JOB NUMBER: 0494008.01
LOCATION: Clarkston, Washington

SCS Engineers
Solid and Hazardous Waste Consultants

WELL GP-2 *(Page 1 of 1)*

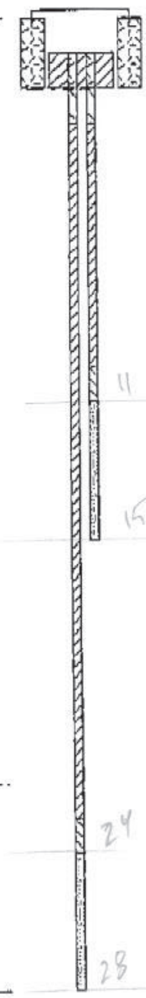
CLIENT NAME Asotin County Landfill

DATE DRILLED 04/25/95

SURFACE ELEVATION NA

TOTAL DEPTH OF HOLE 28 Feet

DEPTH (ft)	Sample No.	Odor, HNu or OVM?	CHEMICAL CONCENTRATIONS (ppm) 0 10 20 30 40 50	SAMPLES	SYMBOLS	MATERIALS DESCRIPTION
0					SAND	SILTY SAND with <5% clay, brown, moist.
						SANDY SILT with <5% clay, brown, moist.
5						SANDY SILT with <5% clay, brown, moist.
10						SANDY SILT with <5% clay, brown, moist.
15						SILTY SAND, medium to coarse grained, fine gravel, light tan, moist.
20						SILTY SAND with basalt gravel, brown, moist.
					BSLT	BASALT GRAVEL with silty sand, black, moist.
25						
30						
35						
40						



TOTAL DEPTH LOGGED = 28'. REFUSAL at 28'

Gasprobe GP-2D installed to a depth of 28' with a boring diameter of 2".

Gasprobe GP-2S installed to a depth of 15' with a boring diameter of 2".

Gasprobe diagram depicts view facing south.

Nested gasprobes spaced approximately 18" apart.

SCS Engineers

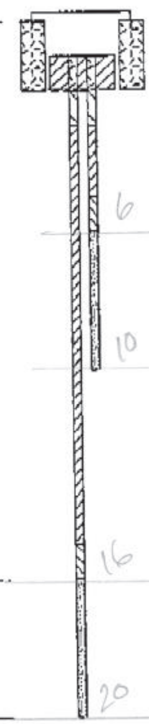
Solid and Hazardous Waste Consultants

JOB NUMBER: 0494008.01
LOCATION: Clarkston, Washington

WELL GP-3 *(Page 1 of 1)*

CLIENT NAME Asotin County Landfill
DATE DRILLED 04/25/95
SURFACE ELEVATION NA
TOTAL DEPTH OF HOLE 20 Feet

DEPTH (ft)	Sample No.	Odor, HNu or OVM?	CHEMICAL CONCENTRATIONS (ppm) 0 10 20 30 40 50	SAMPLES	SYMBOLS	MATERIALS DESCRIPTION
0					SAND	SILTY SAND with <5% clay, fine grained, brown, moist.
						SILTY SAND with <5% clay, brown, moist.
5						SANDY SILT with <5% clay, brown, moist.
10						SANDY SILT with <5% clay, brown, moist.
15					BSLT	SILTY SAND with black basalt gravel, brown, moist.
20						
25						
30						
35						
40						



TOTAL DEPTH LOGGED = 20'. REFUSAL at 20'

Gasprobe GP-3D installed to a depth of 20' with a boring diameter of 2".

Gasprobe GP-3S installed to a depth of 10' with a boring diameter of 1".

Gasprobe diagram depicts view facing south.

Nested gasprobes spaced approximately 18" apart.

SCS Engineers
Solid and Hazardous Waste Consultants

JOB NUMBER: 0494008.01
LOCATION: Clarkston, Washington

WELL GP-4 *(Page 1 of 1)*

CLIENT NAME: Asotin County Landfill
DATE DRILLED: 04/28/95
SURFACE ELEVATION: NA
TOTAL DEPTH OF HOLE: 12 Feet

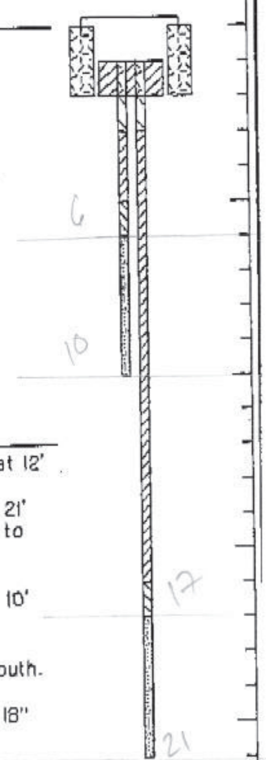
DEPTH (ft)	Sample No.	Odor, HNu or OVM?	CHEMICAL CONCENTRATIONS (ppm) 0 10 20 30 40 50	SAMPLES	SYMBOLS	MATERIALS DESCRIPTION
0					SAND	SILTY SAND with <5% clay, fine grained, brown, moist.
						SILTY SAND with <5% clay, brown, moist.
5						
						SANDY SILT with cobbles and <5% clay, brown, moist.
10						
12						TOTAL DEPTH LOGGED = 12'. REFUSAL at 12'.
15						
20						
25						
30						
35						
40						

Gasprobe GP-4D installed to a depth of 21' with a boring diameter of 2" to 12' and 1' to 21'.

Gasprobe GP-4S installed to a depth of 10' with a boring diameter of 1".

Gasprobe diagram depicts view facing south.

Nested gasprobes space approximately 18" apart.



SCS Engineers
Solid and Hazardous Waste Consultants

JOB NUMBER: 0494008.01
LOCATION: Clarkston, Washington

CH2MHILL

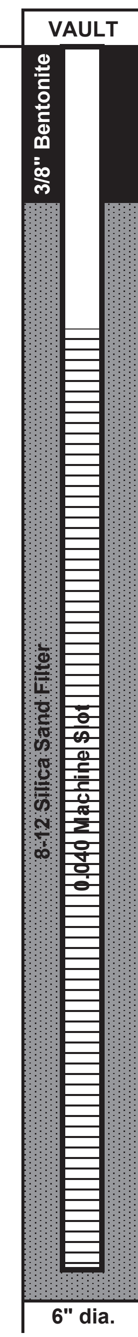
SOIL BORING / WELL LOG

BORING NO: **GP-05**
PROJECT NO: **331908.08.A2.03**
PROJECT NAME: Asotin County Regional Landfill Remedial Investigation
LOCATION: Offsite, north of closed landfill, west of intersection of Evans Rd
DRILLING CONTRACTOR: Budinger
TOC ELEVATION: N/A
GROUND ELEVATION: 1,145.74

START DATE: 3/12/2009
END DATE: 3/12/2009
LOGGER: R. Greer
DRILLING EQUIPMENT: Mobile B-57 6" Air rotary w/downhole hammer
BORING DIAMETER: 6-inch
TOTAL DEPTH: 20 ft
SWL: N/A

Depth (ft)	Sample ID	Interval (ft)	Recovery (%)	SPT blows per 6"	**Soil Description** soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	**Soil Profile**
0						Start flight: 11:35	
5						End flight: 11:38	
5	G-1	5-6	NA	NA	GRAB SAMPLE: CUTTINGS: brown **SILT** w/ fine, poorly graded sand, trace clay, trace sub-rounded gravel and mica **(ML)**	Start flight: 11:43	**ML**
7.5	G-2	7.5-8	NA	NA	GRAB SAMPLE: CUTTINGS: Transition to weathered & fractured basalt/basaltic gravels, 3/8 to 1¼-inch dia. sub-angular fragments, decreasing silt **(inferred basalt)**		**(Inferred Basalt)**
10						End flight: 11:50 Start flight: 11:55	
11	G-3	11-12	NA	NA	GRAB SAMPLE: CUTTINGS: Becoming light gray/blue cobbles with **GRAVEL**, decreasing basalt **(GP)**		**GP**
14	G-4	14-15	NA	NA	GRAB SAMPLE: CUTTINGS: Transition to brown **SILT**, w/ decreasing gravel **(ML)**	End flight: 12:03	**ML**
15	G-5	15-16	NA	NA	GRAB SAMPLE: CUTTINGS: Brown **SILT** with gravel, trace clay and sand, obesrved increasing moisture from cuttings **(ML)**	Start flight: 12:08	
18	G-6	18-19	NA	NA	GRAB SAMPLE: CUTTINGS: Increase **GRAVEL** with brown silt, sub-angular to sub-rounded **(GM)**	Driller obeserves gravel/rock formation drilling action @ 18 ft.	**GM**
20						**TD at 20 ft. on 3-12-09**	

Well Construction



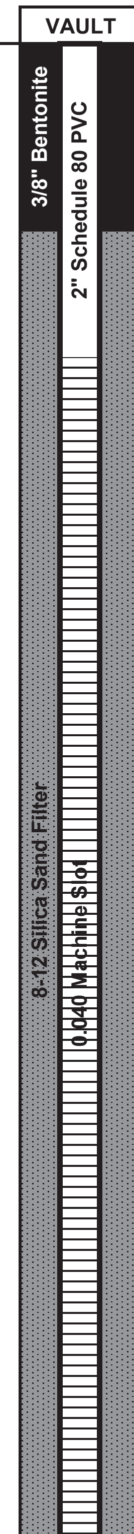
SOIL BORING / WELL LOG

CH2MHILL

BORING NO:	GP-06
PROJECT NO:	331908.08.A2.03
PROJECT NAME:	Asotin County Regional Landfill Remedial Investigation
LOCATION:	Offsite, between north side of closed landfill and Peola Rd.
DRILLING CONTRACTOR:	Budinger
TOC ELEVATION:	N/A
GROUND ELEVATION:	1,160.92
START DATE:	3/11/2009
END DATE:	3/11/2009
LOGGER:	R. Greer
DRILLING EQUIPMENT:	Mobile B-57 6" Air rotary w/downhole hammer
BORING DIAMETER:	6-inch
TOTAL DEPTH:	30.5 ft
SWL:	N/A

Depth (ft)	Sample ID	Interval (ft)	Recovery (%)	SPT blows per 6"	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile
0						Start flight: 11:35	
5	G-1	4.5-5	NA	NA	GRAB SAMPLE: CUTTING: gray **GRAVEL**, angular to sub-angular, w/ trace brown silt, trace sand **(GP)**	End flight: 12:20 Start flight: 12:30	GP
7	G-2	7-8	NA	NA	GRAB SAMPLE: CUTTINGS: **GRAVEL** and cobble fragments w/ brown silt **(GM)**	Drilling becomes difficult	GM
9	G-3	9-10	NA	NA	GRAB SAMPLE: CUTTINGS: Brown **SILT** w/ fine trace gravel w/ trace fine sand **(ML)**	End flight: 12:42 Start flight: 12:54	ML
10.5	G-4	10.5-11	NA	NA	GRAB SAMPLE: CUTTINGS: Increasing **GRAVEL** with cobbles, trace oxidation, possible increase in moisture **(GM)**		GM
13	G-5	13-14	NA	NA	GRAB SAMPLE: CUTTINGS: Increasing rock/cobbles and **GRAVEL** w/ deceasing brown silt **(GP)**	End flight: 13:08 Start flight: 13:13	GP
16	G-6	16-17	NA	NA	GRAB SAMPLE: CUTTINGS: Transition back to brown **SILT** with decreasing gravel **(ML)**		ML
19	G-7	19-20	NA	NA	GRAB SAMPLE: CUTTINGS: Transition to sub-angular to sub-rounded **GRAVEL** and cobbles, decreasing silt, trace sand, some clay **(GP)**	End flight: 13:26 Start flight: 13:34	GP
20.5	G-8	20.5-21	NA	NA	GRAB SAMPLE: CUTTINGS: **GRAVEL** transitioning back to brown **SILT** w/ decreasing sub-angular to sub rounded gravel, trace sand, some clay **(GM-ML)**		GM ML

Well Construction



BORING NO: **GP-06**

Depth (ft)	Sample ID	Interval (ft)	Recovery (%)	SPT blows per 6"	**Soil Description** soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	**Soil Profile**
24						End flight: 13:45	
25	G-9	25-26	NA	NA	GRAB SAMPLE: CUTTINGS: Brown **SILT** w/ sub-angular to sub-rounded gravel, trace sand, some clay **(ML)**	Start flight: 13:52	**ML**
26							
27							
28							
29	G-10	29-30	NA	NA	GRAB SAMPLE: CUTTINGS: Same As Above **(ML)**		**ML**
30						**TD at 30.5 ft. on 3-11-09**	
31							
32							
33							
34							
35							
36							
37							
38							
39							
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47							
48							

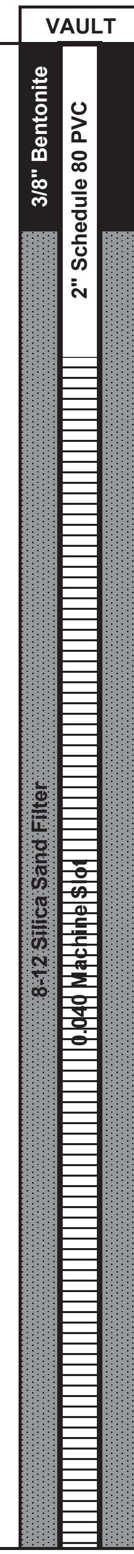
Well Construction

SOIL BORING / WELL LOG

BORING NO: **GP-07**
PROJECT NO: **331908.08.A2.03**
PROJECT NAME: Asotin County Regional Landfill Remedial Investigation
LOCATION: Offsite, between north side of closed landfill and Peola Rd.
DRILLING CONTRACTOR: Budinger
TOC ELEVATION: N/A
GROUND ELEVATION: 1,191.56
START DATE: 3/11/2009
END DATE: 3/11/2009
LOGGER: R. Greer
DRILLING EQUIPMENT: Mobile B-57 6" Air rotary w/downhole hammer
BORING DIAMETER: 6-inch
TOTAL DEPTH: 30.5 ft
SWL: N/A

Depth (ft)	Sample ID	Interval (ft)	Recovery (%)	SPT blows per 6"	Soil Description soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	Comments drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	Soil Profile
0						Start flight: 8:25	
4	G-1	4-5	NA	NA	GRAB SAMPLE: CUTTINGS: Brown **SILT** w/ fine, poorly graded sand, trace gravel, moist **(ML)**		ML
5						End flight: 8:28 Start flight: 8:41	
7						Increasing gravel observed in cuttings	GM
8						Decreasing gravel, possible basalt material	(Inferred Basalt)
10						End flight: 8:45 Start flight: 8:52	
12	G-2	12-13	NA	NA	GRAB SAMPLE: CUTTINGS: Dark gray/black angular to sub-angular, 1/4 to 3/4-inch dia. basalt and basaltic gravel, w/ decreasing brown silt **(Inferred Basalt)**		
14	G-3	14-15	NA	NA	GRAB SAMPLE: CUTTINGS: Transition to Dark gray angular to sub-angular **GRAVEL** (1/2 to 1-inch dia.) and basalt fragments, w/ decreasing brown silt **(GP)**		GP
15						End flight: 8:58 Start flight: 9:06 Drilling becoming harder Driller observes competent material	
16					GRAB SAMPLE: CUTTINGS: Small, angular basalt cuttings - 1/8 to 3/8 ft. dia. w/ trace brown silt **(inferred basalt)**		(Inferred Basalt)
20	G-4	20-21	NA	NA	GRAB SAMPLE: CUTTINGS: Same As Above **(inferred basalt)**		

Well Construction



CH2MHILL

SOIL BORING / WELL LOG

BORING NO: **GP-07**

Depth (ft)	Sample ID	Interval (ft)	Recovery (%)	SPT blows per 6"	**Soil Description** soil name, USCS group symbol, color, moisture, density or consistency, structure, mineralogy, grain size and grading	**Comments** drilling rate, drilling fluid loss, depth of casing, vapor tests, odor, other	**Soil Profile**	**Well Construction**
24								
25	G-5	25-26	NA	NA	GRAB SAMPLE: CUTTINGS: Same As Above **(Inferred basalt)**		**(Inferred Basalt)**	**8-12 Silica Sand Filter** **0.040 Machine Slot**
26								
27								
28								
29	G-6	28.5-29	NA	NA	GRAB SAMPLE: CUTTINGS: Same As Above **(Inferred basalt)**			
30						**TD at 30.5 ft. on 3-11-09**		**6" dia.**
31								
32								
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A.4 Field Investigation Data Report for Asoltin County Regional Landfill (Great West 2021)

TECHNICAL MEMORANDUM

Field Investigation Data Summary Report for the Asotin County Regional Landfill – Closed Landfill Groundwater Remediation Project

Prepared For:	Steve Becker/Asotin County Regional Landfill Marni Solheim/Washington State Department of Ecology Martyn Quinn/Washington State Department of Ecology
Prepared By:	Craig Sauer, PG/Great West Engineering
Reviewed By:	Robert Martin, LHG/Jacobs Engineering Travis Pyle, PE/Great West Engineering
Date:	August 23, 2021
Project Number:	4-17110
Revision No.:	0
Approved By:	Craig Sauer, PG/Great West Engineering

1.0 Introduction

This technical memorandum (TM) summarizes the field investigation activities, subsurface conditions, well installation details, and initial groundwater quality sampling results for the new groundwater wells associated with the Closed Landfill Groundwater Remediation Project at the Asotin County Regional Landfill (ACRL). The Closed Landfill Groundwater Remediation Project is being administered under the Independent Remedial Action of Model Toxics Control Act (MTCA), Chapter 173-304 of the Washington Administrative Code (WAC).

The purpose of this work was to further characterize the downgradient nature and extent of groundwater contamination from the Closed Landfill, as follow on to the (draft) *Remedial Investigation and Feasibility Study Report for Asotin County Regional Landfill* ('RI/FS Report') (CH2M HILL, 2010) and as discussed with Ecology in meetings held in September 2019. This work was conducted in support of, and concurrent with, ongoing operation of vapor extraction system (VES) as the selected remedy for remediation of the groundwater. This work is also a follow-up to the finalization of cleanup levels as presented to Ecology in the technical memorandum titled, *Proposed Cleanup Levels for Groundwater Remediation* (Jacobs, 2020).

1.1 List of Figures, Tables, and Attachments

The following figures, tables, and attachments are included in this Field Investigation Data Summary Report to support the narrative descriptions. The figures and tables are attached as well as the TM attachments at the end of the document:

- Figure 1. Site Map, Well Locations, and Cross-Section Line
- Figure 2. Generalized Hydrogeologic Cross-Section A-A' (South to North)

- Figure 3. Groundwater Elevations and Flow Map
- Table 1. Well Completion Details
- Table 2. Summary of Field Parameters, Detected VOCs, and Comparison to Cleanup Levels
- Attachment A. Photo Log
- Attachment B. Boring Logs
- Attachment C. Physical Properties Soils Testing Results
- Attachment D. Sampling Forms, Chain-of-Custody (COC), and Laboratory Analytical Report

2.0 Project Planning and Approach

In September 2019, representatives from Ecology, Asotin County, Jacobs Engineering, and Great West Engineering met in Spokane to discuss the status of the Closed Landfill Groundwater Remediation Project and results from the most recent year-end VES data summary reports. As an outcome from this meeting, it was determined by Ecology that Asotin County would: (1) Formalize the cleanup levels in groundwater for the primary contaminants-of-concern (COCs); (2) Develop a focused groundwater assessment to evaluate progress in groundwater concentration for COCs towards achievement of cleanup levels; and (3) Characterize the downgradient extent of groundwater contamination for the COCs via installation and monitoring of new (supplemental) groundwater monitoring wells.

These activities are consistent with recommendations and path forward in the *(draft) Remedial Investigation and Feasibility Study Report for Asotin County Regional Landfill* (CH2M HILL, 2010) and support the cleanup process under the Independent Remedial Action of MTCA, Chapter 173-340 of WAC. Details of the Closed Landfill cleanup levels for the COCs were submitted to Ecology in the TM titled, *Proposed Cleanup Levels for Groundwater Remediation* (Jacobs, 2020).

The supplemental drilling and well installation work for the Closed Landfill Groundwater Remediation Project were coordinated with the drilling and well installation for the Cell E permitting and hydrogeologic study. Findings and data for the Cell E permit application package were submitted to Ecology and the Asotin County Health District in July 2021. Drilling and well installation work for the Closed Landfill at the initial well location was completed in December 2020, concurrently with Cell E drilling activities. Well MW-22 was installed and was found to be dry as part of well development activities (refer to Section 3.1).

Additional supplemental drilling locations to support the Closed Landfill Groundwater Remediation Project to target areas within the Dry Creek drainage area are owned by the Port of Clarkston, which required a delay in drilling schedule to secure property access agreements. The property access agreement was secured in April 2021, and the final two groundwater well locations were completed in June 2021 (MW-23 and MW-24). Subsequently, the newly installed wells were sampled in mid-July 2021.

Details of the field investigation, well installation, and initial groundwater monitoring results from the newly installed wells downgradient of Closed Landfill are presented below.

3.0 Field Investigation Summary

Three supplemental wells were installed as part of Closed Landfill Groundwater Remediation Project, over two separate drilling sessions. As previously noted, MW-22 was installed first during the Cell E hydrogeology study work in December 2020 and was found to be dry during well development (refer to

Section 3.1). Two more wells (MW-23 and MW-24) were installed later in June 2021 after securing access agreements with the Port of Clarkston.

Table 1 (attached) summarizes the well construction details. **Attachment A** provides photo logs, and **Attachment B** presents the boring logs.

3.1 Well Development

Following well installation, the drilling contractor developed the new wells to remove formation fines (silt-clay and fine sand) from drilling and finalized the well installation activities. Well development consisted of an initial phase of bailing using a decontaminated, weighted stainless-steel bailer to surge/agitate the saturated screen interval and to purge the groundwater. Following the initial bailing activities, a decontaminated submersible 12-volt pump was lowered into the bottom of screen zone and purged at approximately 2 gallons per minute (gpm) until the water clarity improved based on visual observation. Several phases of sustained purging and then surging with the submersible pump were conducted as the final phase of development. MW-22 had approximately 1.5 feet of water within the bottom of the screen zone immediately following well installation; however, it was bailed dry during development activities and did not recover. For this location, the field observations of 'wet conditions' in the zone from 58 to 66 feet below ground surface (bgs) were believed to be from driller adding potable water to enable SONIC drilling advancement in the dense gravel unit, and not representative of groundwater. Following well installation and development, and from several subsequent water-level checks, MW-22 was considered 'dry' and was not sampled for groundwater quality. This well will continue to be periodically checked for saturated conditions, and if water is observed, will be monitored and sampled.

3.2 Groundwater Levels and Flow Map

Figure 3 is an initial groundwater elevation (flow map) showing the groundwater levels/elevations from measurements collected on July 15, 2021. These static groundwater levels were collected as part of the initial groundwater monitoring activities. The groundwater elevations support a generalized and inferred flow direction to the north, and a relatively steep hydraulic gradient of 0.13 ft/ft between wells MW-23 and MW-24. The relatively steep gradient would be consistent with surface topography sloping to the north, and influenced by the depositional environment whereby the lower confining unit (clay) appears to have been eroded (removed) at locations north of MW-23, with the alluvial sequence overlying basalt at the MW-24 and MW-22 locations to the north. A generalized northward flow direction is consistent with the conceptual site model as presented in the (draft) RI/FS Report, and the uppermost groundwater within Dry Creek drainage is inferred as preferential flow downgradient of the closed landfill.

3.3 Groundwater Quality Monitoring

Prior to collecting groundwater quality samples, MW-23 and MW-24 were equipped with dedicated pumps (low-flow stainless-steel submersible Redi-flow sampling pumps). The l pumps were decontaminated with Alconox solution and potable rinse prior to installation. The discharge lines were connected to well-caps with new ½-inch Polyethylene tubing from the pump manufacturer. These Redi-flow sampling pumps are the same type as used for routine sampling of the Closed Landfill and Active Landfill wells at the ACRL, following the methods and sampling procedures as outlined in the *Groundwater Sampling and Analysis Plan for Asotin County Regional Landfill* (CH2M HILL 2014).

Groundwater quality samples were collected at MW-23 and MW-24 on July 15, 2021, and submitted for analysis of the 'detection monitoring suite', which is the same parameter suite as the quarterly monitoring conducted for the ACRL. **Attachment D** presents copies of the field sampling forms, chain-of-custody (COC), and the laboratory report.

Table 2 summarizes the field measurements and analytical results from the initial sampling event conducted at wells MW-23 and MW-24 on July 15, 2021 and most recent results in wells MW-14s, MW-14d, and MW-15, located along the Dry Creek drainage. See **Attachment D** for a complete summary of water quality results from all parameters under the detection monitoring suite, including general chemistry, major ions, metals, and full suite of volatile organic compounds (VOCs).

PCE and TCE were the only detected VOCs in the new wells, which is consistent with the VOC detections from the Closed Landfill wells. These results show PCE and TCE concentrations downgradient of MW-15 below the cleanup levels. The saturated unit as shown in **Figure 2** shows that these wells delineate the lateral and vertical extent of these contaminants in the saturated zone, downgradient of the Closed Landfill.

4.0 Summary

The following bullets summarize the key points with respect to lithology, groundwater flow direction, and the initial groundwater quality results.

- **Lithology**: Three wells (MW-22, MW-23, MW-24) were installed in downgradient areas within the Dry Creek drainage to further characterize the downgradient nature and extent of contamination from the Closed Landfill, as part of the Independent Remedial Action of MTCA Chapter 173-340 of WAC. The Dry Creek drainage to north of the landfill is the inferred preferential flow zone to assess downgradient contamination from the Closed Landfill, as developed in the (draft) RI/FS Report, which has been submitted and discussed with Ecology. In areas closest to the landfill at MW-23, the lithology is comparable to the sequence observed in wells near the closed landfill with a relatively coarse-grained alluvial flood gravel unit underlain by fine-grained lower confining unit logged as 'lean clay'. For samples collected in the clay unit at MW-23, the lower confining unit has a relatively low permeability, with lab testing demonstrating a permeability value of 2.32×10^{-6} cm/sec. For the wells further north (MW-24 and MW-22, respectively), the lithology consists of the alluvial flood gravel deposited overlying basalt, with apparent erosion (removal) of the clay unit to the north of MW-23.
- **Groundwater Elevations/ Flow**: Groundwater levels/elevations from the new wells within the Dry Creek drainage support a flow direction to the north and a relatively steep hydraulic gradient. A preferential flow and northward flow direction associated with the Dry Creek drainage towards the Snake River is consistent with the expected conditions and the conceptual site model as presented in the (draft) RI/FS Report. In areas north of MW-23, the absence of the lower confining unit results in saturation overlying the basalt. Well MW-22 being dry, may indicate vertical flow into basalt or lateral flow into a larger and higher yield gravel unit. As described in the RI/FS Report, the top of Columbia River Basalt Group (CRBG) sequence contains thick flow interiors and relatively low permeability sedimentary interbeds, which like the clay unit beneath the landfill, would promote lateral groundwater flow, and minimize or limit vertical infiltration into underlying regional aquifer source for the greater Lewiston-Clarkston area.
- **Groundwater Quality**: Groundwater quality results for the two COCs (that is, PCE and TCE) demonstrate the concentration levels are relatively low, comparable between the two wells, and are below the cleanup levels at both MW-23 and MW-24 and confirming previous results in MW-15. Concentrations at the new wells are lower than concentrations observed from existing wells to south (further upgradient) near the Closed Landfill, delineating the lateral and vertical extent of the groundwater concentrations below cleanup levels. Groundwater concentrations of PCE and TCE were detected in the new wells sampled and supports that these new wells are located downgradient and within the flow from the Closed Landfill. These new wells establish a downgradient set of wells demonstrating groundwater concentrations in the uppermost hydrostratigraphic unit are below cleanup levels and effectively characterizing the downgradient nature and extent of contamination.

5.0 References

CH2M HILL, 2010. (Draft) *Remedial Investigation and Feasibility Study Report for Asotin County Regional Landfill*.

CH2M HILL, 2014*. Groundwater Monitoring Plan for Asotin County Reginal Landfill.*

Great West, 2020*. Asotin County Regional Landfill Hydrogeologic Work Plan* for Cell E Permitting.

Jacobs, 2020. *Proposed Cleanup Levels for Groundwater Remediation*.

FIGURES

LEGEND

- CLOSED LANDFILL DETECTION MONITORING WELLS (MONITORED QUARTERLY)
- CLOSED LANDFILL – WELLS INSTALLED IN 2009 FOR MTCA REMEDIAL INVESTIGATION
- ABANDONED BORING
- CLOSED LANDFILL – SUPPLEMENTAL WELLS INSTALLED IN 2020/2021 FOR MTCA REMEDIAL INVESTIGATION
- A A' CROSS–SECTION LINE

0 375 750
SCALE IN FEET

NORTH

GreatWest ENGINEERING

Figure 1.
Site Map, Well Locations, and Cross-Section Line

Asotin County Regional Landfill

Y:\Shared\Boise Projects\4-17110-Asotin County SW Services\CADD 4-17110 Cell E ER\Exhibits\CLF Drilling -- Access Agreement\CLF Wells.dwg

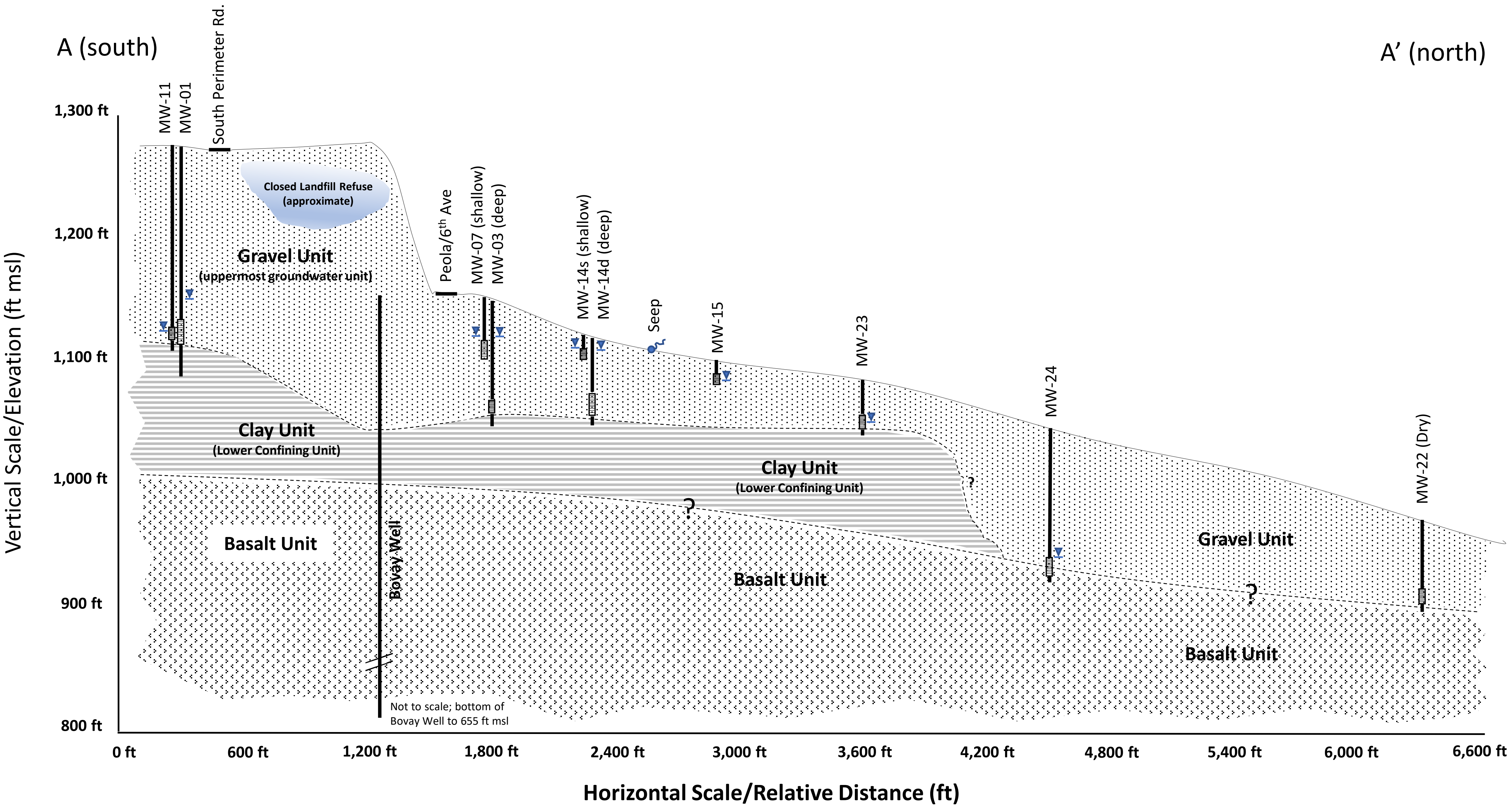


Figure 2. Generalized Hydrogeologic Cross-section A-A' (South to North)
Closed Landfill Groundwater Remediation Project

LEGEND

CLOSED LANDFILL DETECTION MONITORING WELLS (MONITORED QUARTERLY)

CLOSED LANDFILL – WELLS INSTALLED IN 2009 FOR MTCA REMEDIAL INVESTIGATION

CONTOUR INTERVAL

CLOSED LANDFILL – SUPPLEMENTAL WELLS INSTALLED IN 2020/2021 FOR MTCA REMEDIAL INVESTIGATION

A A'

CROSS–SECTION LINE

INFERRED FLOW DIRECTION

0 375 750

SCALE IN FEET

NORTH

GreatWest ENGINEERING

Figure 3.
Groundwater Elevations and Flow Map

Asotin County Regional Landfill

Y:\Shared\Boise Projects\4-17110-Asotin County SW Services\CADD 4-17110 Cell E ER\Exhibits\CLF Drilling – Access Agreement\CLF Wells 2.dwg

TABLES

Table 1. Well Construction Details

Closed Landfill Groundwater Remediation Project - Supplemental Wells in Dry Creek Drainage

Location ID	Coordinates		Ground	Top of Casing	Date of	Total	Well Screen Interval		Well Screen Elevation		Screen Material Type	Comments
	Northing[1]	Easting[1]	Elevation	Elevation[2]	Install	Depth[3]	Top[3]	Bottom[3]	Top	Bottom		
MW-22	406019.81	2497053.05	975.0	977.50	12/7/2020	78	58	68	917.0	907.0	Poorly graded SAND	Top of basalt encountered at bottom of boring
MW-23	403326.17	2495801.70	1078.6	1079.11	6/4/2021	45	22	37	1056.6	1041.6	Poorly to well graded GRAVEL	Clay unit beneath uppermost groundwater
MW-24	404056.36	2496416.97	1044.4	1046.85	6/1/2021	125	100	120	944.4	924.4	SAND and vecsicular BASALT	Top of basalt unit encountered at bottom of boring

Notes:

[1] Washington State Plane Coordinates (NAD83).

[2] Top of casing elevation is the top of PVC casing, if applicable; all elevations in feet above mean sea level (NAVD88).

[3] Total depth and screen interval is feet below ground surface.

Table 2. Groundwater Quality Results and Comparison to Criteria

Closed Landfill Groundwater Remediation Project

Asotin County Regional Landfill

Chemical Group	Analyte	Unit	Downgradient Wells for Closed Landfill Groundwater Remediation under MTCA Program					WAC 173-200 Criteria	MTCA 173-340 Criteria
			MW-14s (shallow)	MW-14d (deep)	MW-15	MW-23	MW-24		
DATE	--	--	3/9/2021	3/9/2021	2/9/2021	7/15/2021	7/15/2021	-	-
Field	Temperature	°C	13.3	15.3	*NM*	14.9	16.7	-	--
Field	pH	units	7.2	7.3	*NM*	7.05	7.3	6.5-8.5	--
Field	Conductivity	uS/cm	1167	1164	*NM*	1,122	1155	-	-
Field	Static Depth to Water	ft btc	10.30	12.80	*NM*	24.39	106.80	-	-
Field	Static Groundwater Elev.	ft msl	1,113.00	1110.53	~1089	1054.72	940.05	-	--
Genchem	Alkalinity, Total (as CaCO3)	mg CaCO3/L	256	260	150	432	134	-	--
Genchem	Ammonia-N	mg/L	<0.02	<0.02	<0.02	0.0245	<0.02	-	--
Genchem	Total Dissolved Solids	mg/L	**664**	**688**	**524**	**715**	**783**	500	--
Genchem	Total Organic Carbon	mg/L	1.42	0.8	1.93	1.28	1.1	-	--
Genchem	Total Suspended Solids	mg/L	1.2	0.438	42	17.2	39	-	--
Major Ion	Calcium	mg/L	133	119	84.9	97	103	-	--
Major Ion	Chloride	mg/L	68.2	47.8	64.8	68.5	85.9	250	--
Major Ion	Iron	mg/L	<0.01	<0.01	<0.01	0.0136	0.0444	0.3	--
Major Ion	Magnesium	mg/L	31.5	41.7	28.7	30.9	33.6	-	--
Major Ion	Nitrate (as N)	mg/L	**20.4**	3.48	**12.3**	<0.4	<0.5	10	--
Major Ion	Potassium	mg/L	1.35	8.81	6.19	6.2	6.99	-	--
Major Ion	Sodium	mg/L	83.1	85.5	67	83.5	78	-	--
Major Ion	Sulfate	mg/L	150	189	125	130	157	250	--
Trace Metals	Antimony	mg/L	<0.001	<0.001	0.00581	<0.001	<0.001	-	--
Trace Metals	Arsenic	mg/L	**0.001**	**0.00209**	**0.00241**	**0.00258**	**0.00257**	0.00005	--
Trace Metals	Barium	mg/L	0.153	0.099	0.0913	0.115	0.118	1	--
Trace Metals	Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	--
Trace Metals	Cadmium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	--
Trace Metals	Chromium	mg/L	0.00358	<0.001	0.00451	0.00344	0.0156	0.05	--
Trace Metals	Cobalt	mg/L	<0.001	<0.001	0.00193	<0.001	0.00133	-	--
Trace Metals	Copper	mg/L	<0.001	<0.001	0.00289	0.0018	0.00302	1	--
Trace Metals	Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	--
Trace Metals	Manganese	mg/L	<0.001	<0.001	<0.001	0.00235	0.00462	0.05	--
Trace Metals	Nickel	mg/L	<0.001	<0.001	0.0047	0.00207	0.00878	-	--
Trace Metals	Selenium	mg/L	0.00286	0.00228	0.00323	0.00366	0.0061	0.01	--
Trace Metals	Thallium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	-	--
Trace Metals	Vanadium	mg/L	0.0374	0.025	0.031	0.0292	0.029	-	--
Trace Metals	Zinc	mg/L	<0.001	<0.001	0.00855	<0.001	0.00455	5	--
VOC	Tetrachloroethene (PCE)	μg/L	1.76	**28.3**	2.87	2.98	3.18	-	5
VOC	Trichloroethene (TCE)	μg/L	<0.5	**8.1**	0.97	0.86	0.64	3	4

Notes:

- = criteria not established

All trace metals results are total concentrations except Manganese, which is reported as a dissovled concentration.

Bold values indicate concentrations at or above established criteria.

Groundwater samples collected in 2021 as noted for each location.

NA = not analyzed

NM = not measured

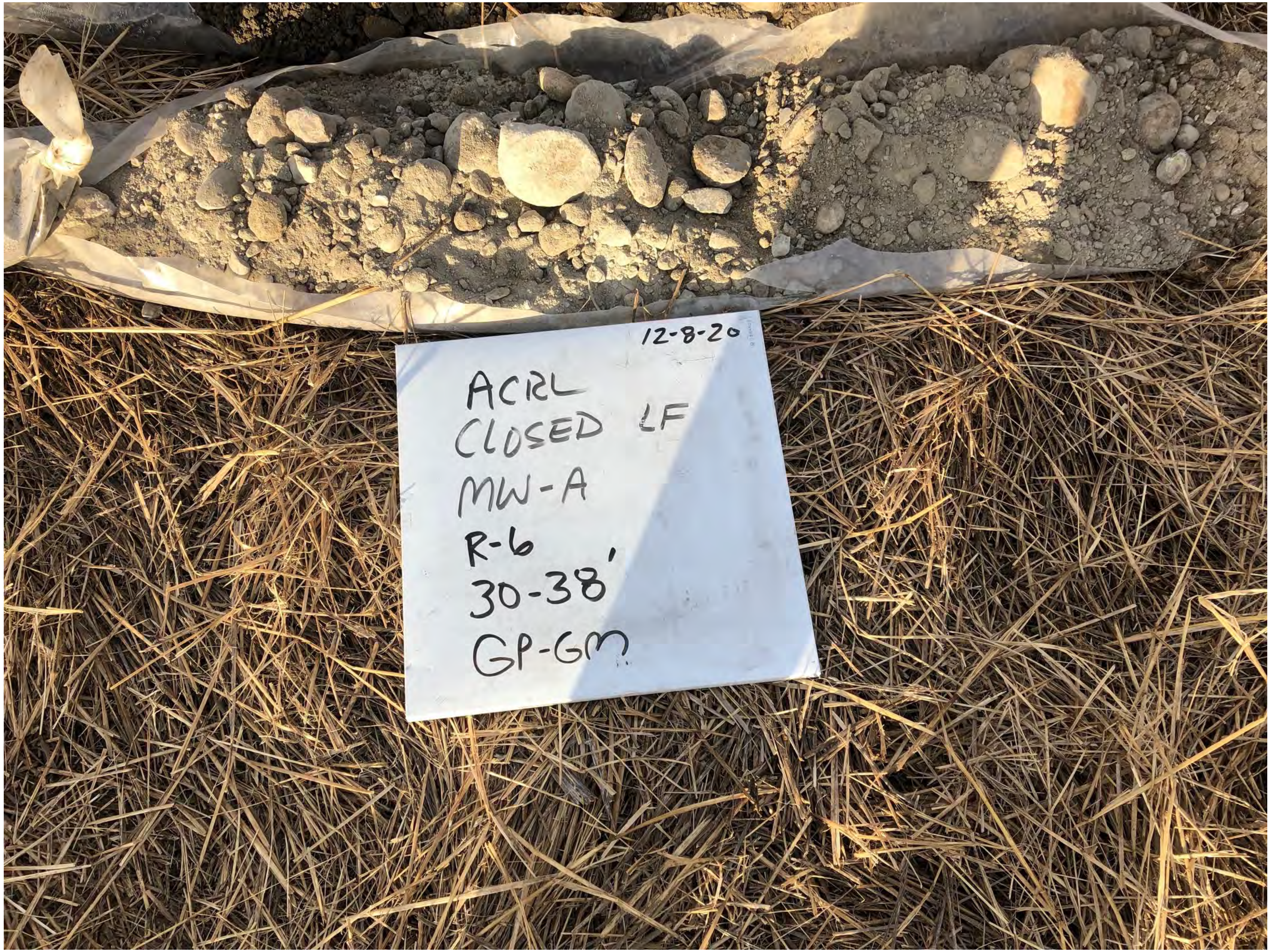
Non-detect values preceded with "<" symbol; non-detect value is laboratory reporting limit.

Volatile organic compound (VOC) results only shown for constituents detected at concentrations above the method reporting limit - refer to lab report for full report.

ATTACHMENT A
Photo Log


Environmental West Exploration


12-8-20
ACRL
CLOSED LF
MW-A
TD= ~78' bgs


12-8-20
ACRL
CLOSED LF
MW-A
R-6
30-38'
GP-GM


R-6 28-30
12-8-20
ACRL
CLOSED LF
MW-A
R-6
28-30'
SP-SM


12-8-20
ACRL
CLOSED LF
MW-A
R-10
~77'
Basalt Fragments
Wet Zone
MARKS-A-LOT
PERMANENT
AVERY

MW-23 6/4/21
SP-SM Fill with cobbles (Fill)
Δ to GP-GM fill ~7'
Similar GP-GM color Δ at 14'
20' SAA; Δ to Moist at ~16-17'
25' SAA, inc. sand 20%, cleaner
30' * SAA, GP-GM → Water out discharge hole @ 30-33'; wet
Cuttings 30-35' GW-GM
GW OR CLAY at 37'
35
40
6/4/2021
MW-23
Ziploc

ATTACHMENT B
Boring Logs

LEGEND

LITHOLOGIC SYMBOL	LITHOLOGIC DESCRIPTION
	GW - Well Graded GRAVEL
	GP - Pooly Graded GRAVEL
	GM - Silty GRAVEL
	GC - Clayey GRAVEL
	GW-GM - Well Graded GRAVEL with Silt and Sand
	GM/GC - Borderline Classification for Silty/Clayey GRAVEL
	SW - Well Graded SAND
	SP - Poorly Graded SAND
	SM - Silty SAND
	SC - Clayey SAND
	ML - SILT, LL <50
	CL - CLAY, LL <50
	OL - ORANIC SILT/CLAY, LL <50
	MH - SILT, LL >50
	CH - CLAY, LL >50
	OH - ORANIC SILT/CLAY, LL >50
	PT - PEAT, HUMUS, SWAMP SOILS
	BR$_x$ - BEDROCK

WELL SYMBOL	WELL SYMBOL DESCRIPTION
	STEEL MONUMENT - Above Ground Surface Stick-Up Completion
	CASING
	SCREEN
	FILTER SAND: No. 8 x 12 or No. 10 x 20
	3/8 BENTONITE HOLE PLUG
	PVC END CAP
	STAINLESS STEEL CENTRALIZERS
	GROUNDWATER LEVEL
	NATIVE FORMATION (i.e., slough)

Abbreviations:
ags = above ground surface
bgs = below ground surface
btc = below top of casing

SOIL BORING LOG

Boring ID:	**MW-22**		
PROJECT NUMBER:	4-17110	START DATE:	12/7/2020
PROJECT NAME:	Asotin County Regional Landfill, Closed Landfill	END DATE:	12/8/2020
LOCATION:	Near Dry Creek at Section 36 property boundary	LOGGER:	C. Sauer
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Casing advance SONIC
DRILLING METHOD:	SONIC	BORING DIAMETER:	6" diameter outer casing
ELEVATION:	*975.0 ground surface; 977.50 top-of-casing*	TOTAL DEPTH:	78 ft bgs
		SWL:	Moist/wet 58 ft

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	Soil Description Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	Comments	Graphic Log
0	R-1	0-5'	NA	NA	0-1 ft: Silty **SAND** with gravel (SM), topsoil, dry, brown, loose, rounded 1" gravel.	Sample Type "R-#" is sample run/interval from SONIC continous sample core.	SAND (SM) 1'
5	R-2	5-8'	NA	NA	1-28 ft: Poorly graded **GRAVEL** with silt and sand (GP-GM), grey, dry, dense, sub-rounded gravels, estimated 5-10% fines and 20% sand.		
	R-3	8-18'	NA	NA			
10							
15							GRAVEL (GP-GM)
	R-4	18-25'	NA	NA			
20							
25	R-5	25-28'	NA	NA			
	R-6	28-38'	NA	NA	28-30 ft: Silty **SAND** with gravel (SM-SM), moist, brown, loose, 10% fines.		28' SAND (SP-SM) 30'
30					30-48 ft: Poorly graded **GRAVEL** with silt and sand (GP-GM), grey, dry, dense, sub-rounded gravels to 3" diameter, estimated 5-810% fines and 20% sand.	Trace fine cobbles starting at 30 ft and increasing with depth, sub-rounded alluvial gravels.	
35							
	R-7	38-48'	NA	NA			GRAVEL (GP-GM)
40							
45							
	R-8	48-58'	NA	NA	48-49 ft: Silty **SAND** with gravel (SM-SM), moist, brown, loose, 5-10% fines.		48' SAND (SP-SM) 49'
50							

(continued....

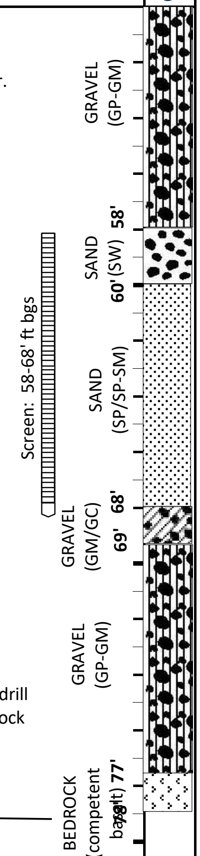
SOIL BORING LOG

Boring ID: **MW-22**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek at Section 36 property boundary
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: SONIC
ELEVATION: *975.0 ground surface; 977.50 top-of-casing*

START DATE: 12/7/2020
END DATE: 12/8/2020
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance SONIC
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 78 ft bgs
SWL: Moist at 58 ft

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	**Soil Description** Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	**Comments**
50	R-8	48-58'	NA	NA	49-58 ft: Poorly graded **GRAVEL** with silt and sand (GP-GM), grey, dry, dense, sub-rounded gravels, estimated 10% fines and 20% sand.	Note: driller adding water to faciliate advancement, some samples logged as 'wet' may be from water added by driller.
55					58-60 ft: Well graded **SAND** with fine gravel (SW), wet, brown, loose, 5% fines, clean.	
	R-9	58-68'	NA	NA		Note: sonic recovery sample material at 58 to 66 ft zone logged as 'wet' or uppermost groundwater; however, moisture on sampled could have been from water added to faciliate SONIC drill method.
60					60-68 ft: Poorly graded fine-medium **SAND (SP)**, wet, brown, loose, mostly SP with some SP-SM zones.	
					68-69 ft: Silty to clayey **GRAVEL** (GM/GC), grey-geen, moist, compacted-cohesive, 30-40% fines, rounded gravels.	
65						
	R-10	68-78'	NA	NA	69-77 ft: Poorly graded **GRAVEL** with sand (GP-GM), grey, dry, loose, estimated 10-15% fines, 10-15% sand.	
70						
					77-78 ft: **BASALT**, vescicular, glassy, fresh, obsidian-like, black to dark grey, dry.	
75						Note: very slow/rough drilling ~refusal drill action at 77 ft correlates to top of bedrock (inferred basalt).
80					Total Depth = 78 ft bgs 12/7/20	End of Log
85						
90						
95						
100						

Graphic Log



SOIL BORING LOG

Boring ID: **MW-23**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek; at intersection of Evans Road and Turning Point Lane
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: Air Rotary
ELEVATION: *1076.6 ground surface; 1079.11 top-of-casing*

START DATE: 6/4/2021
END DATE: 6/4/2021
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance ODEX Air-Rotary
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 45 ft bgs
SWL: 27 ft bgs

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	Soil Description Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	Comments	Graphic Log
0	G-1 (grab)	0-5'	NA	NA	0-7 ft: Poorly graded **SAND** with silt **(SP-SM)** with cobbles and gravel, dark brown, dry, loose [inferred fill due to nearby	Relatively fast/easy advancement. Dry dusty discharge. Inferred fill soils 0-14 ft due to color of material and Dry Creek culvert nearby.	SAND (SP-SM)
5	G-2 (grab)	5-10'	NA	NA	7-30 ft: Poorly graded **GRAVEL (GP-GM)** with estimated 20% sand, 10% fines, trace cobbles, dark brown, dry loose. [inferred fill to 14 ft bgs due to nearby culvert and color change to light brown]	FILL 0-14 ft bgs (dark brown)	7' GRAVEL (GP-GM)
10	G-3 (grab)	10-15'	NA	NA		NATIVE soils start at 14 ft bgs (light tan/brown)	14'
15	G-4 (grab)	15-20'	NA	NA			
20	G-5 (grab)	20-25'	NA	NA		Screen: 22-37 ft bgs	GRAVEL (GP-GM)
25	G-6 (grab)	25-30'	NA	NA			
30	G-7 (grab)	30-35'	NA	NA	30-37 ft: Predominantly well graded **GRAVEL** with silt and sand (GW-GM), light brown-tan, wet at 30 ft bgs, 10% sand and 5% fines.	Uppermost saturated conditions observed at 30 ft bgs from soil cuttings and when applying air-discharge.	30' GRAVEL (GW-GM)
35	G-8 (grab)	35-40'	NA	NA	37-45 ft: **CLAY** with very fine sand (CL), lean, distinct light tan to off white color, cohesive rolls to thread, moist.	Transition to fine-grained CLAY layer at 37 ft bgs; soft drilling clay cuttings from 37 to 45 ft bgs.	37' CLAY (CL)
40	G-9	40-44'	NA	NA			
45					**Total Depth 45 ft bgs** **06/04/21**	**(END OF LOG)**	45'
50							

SOIL BORING LOG

Boring ID: **MW-24**
PROJECT NUMBER: 4-17110
PROJECT NAME: Asotin County Regional Landfill, Closed Landfill
LOCATION: Near Dry Creek; approx.
DRILLING CONTRACTOR: Environmental West Exploration
DRILLING METHOD: Air Rotary
ELEVATION: *1044.10 ground surface; 1046.85 top-of-casing*

START DATE: 6/1/2021
END DATE: 6/3/2021
LOGGER: C. Sauer
DRILLING EQUIPMENT: Casing advance ODEX Air-Rotary
BORING DIAMETER: 6" diameter outer casing
TOTAL DEPTH: 125 ft bgs
SWL: ~115'

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	**Soil Description** Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	**Comments**	**Graphic Log**
0						Relatively fast/easy advancement. Dry dusty discharge.	
5	G-1 (grab)	3-5'	NA	NA	G-1: **Poorly graded GRAVEL with silt and sand (GP-GM)**, grey, dry, loose. Estimated 20% fine-medium sand.		GRAVEL (GP-GM)
							8'
10	G-2 (grab)	5-10'	NA	NA	G-2: **Well graded GRAVEL with ~5-8% fines (GW/GW-GM),** estimated 20% sand, rounded to sub-rounded gravels, dry, grey and multi-color gravels, dusty discharge.		
15	G-3 (grab)	10-15'	NA	NA	G-3: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
20	G-4 (grab)	15-20'	NA	NA	G-4: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
25	G-5 (grab)	20-25'	NA	NA	G-5: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
30	G-6 (grab)	25-30'	NA	NA	G-6: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		GRAVEL (GW/GW-GM)
35	G-7 (grab)	30-35'	NA	NA	G-7: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
40	G-8 (grab)	35-40'	NA	NA	G-8: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
45	G-9 (grab)	40-45'	NA	NA	G-9: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
50					(continued.........)		

SOIL BORING LOG

Boring ID:	**MW-24**		
PROJECT NUMBER:	4-17110	START DATE:	6/1/2021
PROJECT NAME:	Asotin County Regional Landfill, Closed Landfill	END DATE:	6/3/2021
LOCATION:	Near Dry Creek; approx.	LOGGER:	C. Sauer
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Casing advance ODEX Air-Rotary
DRILLING METHOD:	Air Rotary	BORING DIAMETER:	6" diameter outer casing
ELEVATION:	*1044.10 ground surface; 1046.85 top-of-casing*	TOTAL DEPTH:	125 ft bgs SWL: ~115'

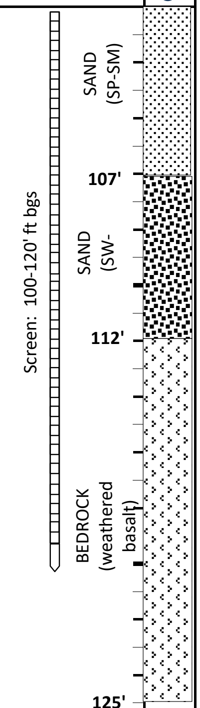
Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	**Soil Description** Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	**Comments**	**Graphic Log**
50	G-10 (grab)	50-55'	NA	NA	(Cont.): **Well graded GRAVEL with ~5-8% fines (GW/GW-GM),** estimated 20% sand, rounded to sub-rounded gravels, dry, grey and multi-color gravels, dusty discharge.	Relatively fast/easy advancement. Dry dusty discharge.	GRAVEL (GW/GW-GM)
55	G-11 (grab)	55-60'	NA	NA	G-10 and 11: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
60	G-12 (grab)	60-65'	NA	NA	G-12: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
65	G-13 (grab)	65-70'	NA	NA	G-13: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**	Increase in grain size cobbles and boulders at depths below 70 ft bgs.	69'
70	G-14 (grab)	70-75'	NA	NA	G-14: Same-as-above. Dry dusty discharge. **(GW/GW-GM).** Lense of poorly graded SAND (SP/SP-SM) with silt from 69 to		SAND 72'
75	G-15 (grab)	75-80'	NA	NA	G-15: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
80	G-16 (grab)	80-85'	NA	NA	G-16: Same-as-above. Dry dusty discharge. **(GW/GW-GM).** Lense of poorly graded SAND (SP/SP-SM) with silt from 69 to 72 ft bgs.		82' SAND 84'
85	G-17 (grab)	85-90'	NA	NA	G-17: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		GRAVEL (GW/GW-GM)
90	G-18 (grab)	90-95'	NA	NA	G-18: Same-as-above. Dry dusty discharge. **(GW/GW-GM).**		
95	G-19 (grab)	95-100'	NA	NA	G-19: Same-as-above. Dry dusty discharge. **(GW/GW-GM).** Poorly graded SAND (SP/SP-SM) with silt starting at 97 ft bgs.	No indication of moisture or saturated conditions to 100 ft bgs.	97' SAND (SP-SM)
100					(continued.........)		

SOIL BORING LOG

Boring ID:	**MW-24**		
PROJECT NUMBER:	4-17110	START DATE:	6/1/2021
PROJECT NAME:	Asotin County Regional Landfill, Closed Landfill	END DATE:	6/3/2021
LOCATION:	Near Dry Creek; approx.	LOGGER:	C. Sauer
DRILLING CONTRACTOR:	Environmental West Exploration	DRILLING EQUIPMENT:	Casing advance ODEX Air-Rotary
DRILLING METHOD:	Air Rotary	BORING DIAMETER:	6" diameter outer casing
ELEVATION:	*1044.10 ground surface; 1046.85 top-of-casing*	TOTAL DEPTH:	125 ft bgs
		SWL:	~115'

Depth (ft)	Sample ID/ TYPE	Sample Interval (ft)	SPT blows per 6"	Recovery (in)	Soil Description Soil name, USCS group symbol, color, density or consistency, structure, mineralogy, grain size, grading, and moisture content. ASTM D-2488	Comments
100	G-20 (grab)	100-105'	NA	NA	GRAB 100-107: Poorly graded **SAND** with silt (SP-SM), moist, tan, loose, 5% fine gravel.	Dry dusty discharge.
105	G-21 (grab)	105-110'	NA	NA	GRAB 107-112: Well graded **SAND** with silt (SW-SM), dark brown, moist, loose, 10% fine gravel.	
110	G-22 (grab)	110-115'	NA	NA	GRAB 112-125: CUTTINGS weathered angular vescicular rock fragments, fresh, dark brown, fine-grained, wet/saturated cuttings (inferred **BASALT**).	Wet/water discharge at 115 ft when applying air discharge; all cuttings below 115 ft were fully saturated.
115	G-23 (grab)	115-120'	NA	NA		
120	G-24 (grab)	120-125'	NA	NA		
125					**Total Depth 125 ft bgs** **06/03/21**	
130						
135						
140						
145						
150						

Graphic Log



ATTACHMENT C

Physical Properties Soils Testing Results

Budinger & Associates

Geotechnical Engineering
Environmental Engineering
Construction Materials Testing
Subsurface Exploration
Special Inspection

Proudly serving the Inland Northwest since 1976

Craig Sauer, PG
Great West Engineering
9221 N Division, Suite F
Spokane, WA 99218

July 21, 2021

Project Number L21734

PROJECT: **Asotin County Regional Landfill**

SUBJECT: **Results of Laboratory Testing**
Report #1

At your request, we provided laboratory testing services for the subject project. Services were limited to the performance of specific laboratory tests, selected at your discretion.

For this period, our involvement was limited to laboratory testing of one sample delivered to our laboratory on July 9, 2021. Laboratory tests were performed in general accordance with methods listed in the attached *Laboratory Summary* sheets.

If you have questions regarding this report, please call.

Respectfully Submitted,
Budinger & Associates, Inc.

Terri Ballard

Terri Ballard
Laboratory Manager

TJB/kdf/Addressee –
Craig Sauer - CSauer@greatwesteng.com

Attachments:
Laboratory Summary – (1 page)
Hydraulic Conductivity Using a Flexible Wall Permeameter Report – (1 page)

SOIL MECHANICS
LABORATORY SUMMARY

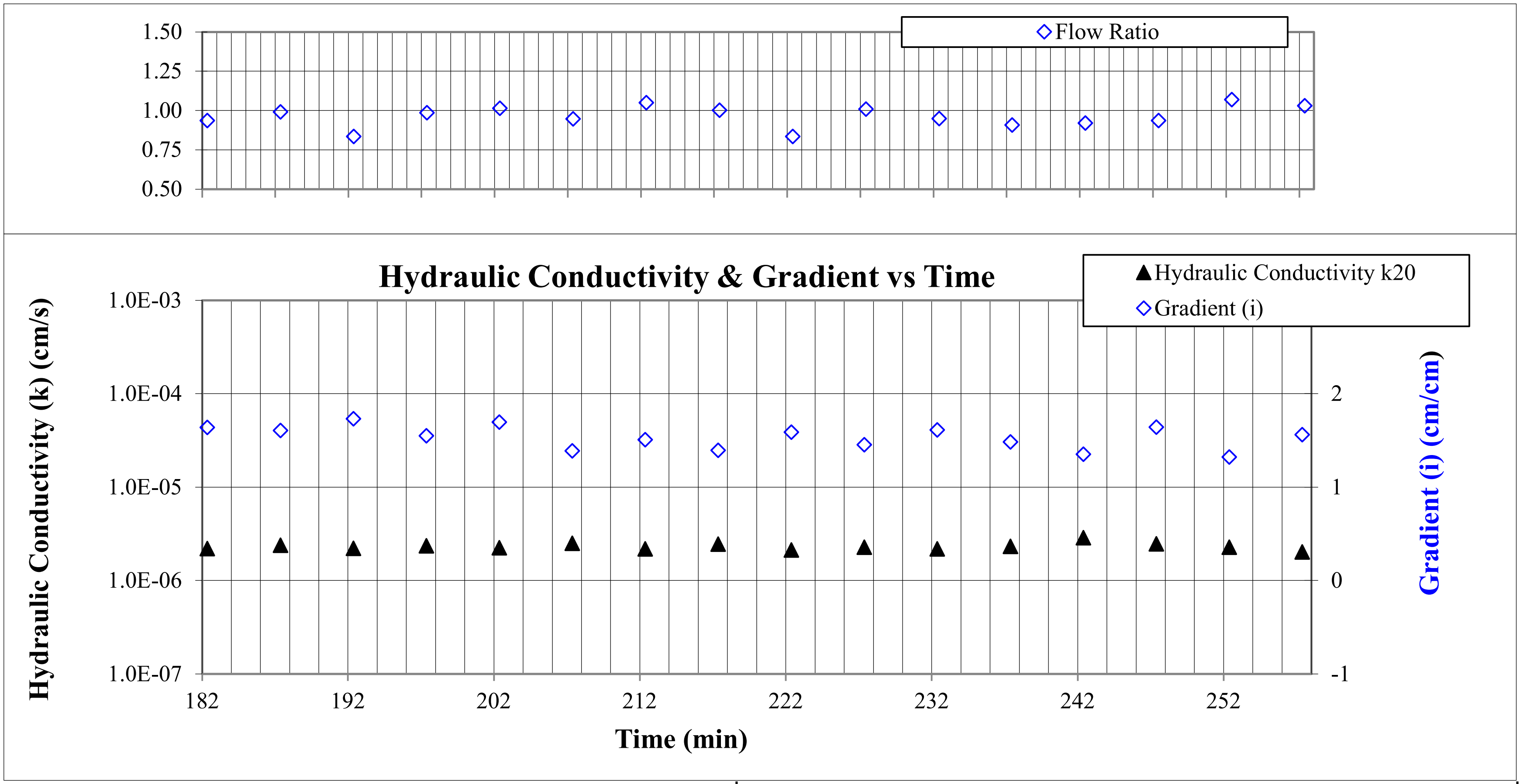
	UNITS	TEST METHOD	
LABORATORY NUMBER			21-0647
SAMPLED BY			Client
SAMPLE TYPE			Bulk
DATE RECEIVED			7/9/2021
SAMPLE DESCRIPTION			Boring Sample
SAMPLE SOURCE			Client Bore MW-23 38'-39' BGS
PERMEABILITY (FLEX WALL)	cm/sec	D5084	$2.32x10^{-6}$

L21689 21-0647

Hydraulic conductivity using a Flexible Wall Permeameter
ASTM D5084

Project Name:	Asotin County Regional Landfill	Sample Description:	Silt with Sand & Clay
Project No.:	L21734	Initial/Final Dry Density:	71.5 / 73.9
Sample ID:	MW-23	Initial/Final Moisture Content:	33.5% / 48.4%
Tested by:	JF	Date Tested:	7/15/2021
Sampled By:	Client	Initial/Final Saturation:	3% / 95%
Sample No.:	21-0647	Consolidation Stress (psi):	5

				Undisturbed:	
				Remolded:	X
Height:	1.96 in	Height:	4.99 cm	Initial Mass:	220.6 g
Diameter:	2.90 in	Diameter:	7.37 cm	Final Mass:	253.1 g
Volume:	13.00 in^3	Volume:	83.89 cm^3		
				Assumed SG:	2.7
				Liquid type:	Water
				Temperature (deg. C):	21.2



Hydraulic Conductivity k_{20}= 2.32E-06 cm/sec

Budinger & Associates, Inc.
Geotechnical & environmental Engineers
Construction Materials Testing & Special Inspection

ATTACHMENT D
Field Forms, COC, and Lab Report

ANATEK LABS

Chain of Custody Record

Anatek Labs, Inc.
1282 Alturas Drive, Moscow ID 83843 (208) 883-2839
504 E Sprague Ste D, Spokane WA 99202 (509) 838-3999

Company Name: Great West
Address: 9221 N. Division St.
City: Spokane State: WA Zip: 99218
Phone: 509.994.9938
Email Address(es): CSauer@greatwesteng.com 509.994.9938

Project Manager: Craig Sauer
Project Name & #: Asotin County
Purchase Order #: Steve Becker
Sampler Name & Phone: Craig Sauer

Turn Around Time & Reporting

Please refer to our normal turn around times at www.anateklabs.com/pricing-lists

✓ Normal
__ Next Day*
__ 2nd Day*
__ Other*

__ Phone
__ Email

*All rush order requests must have prior approval

List Analyses Requested

Lab ID	Sample Identification	Sampling Date/Time	Matrix	# of Containers	Sample Volume	VOC's	TOTAL METALS	Gen. Chem	major IONS
	071521-MW23	07/15 0915	WATER	12		X	X	X	X
	071521-MW24	07/15 1015	WATER	12		X	X	X	X

Preservative:

Note Special Instructions/Comments

* Same analyses as Asotin quarterly sampling
* LAB to filter if needed.

Inspection Checklist

Received Intact?	Y	N
Labels & Chains Agree?	Y	N
Containers Sealed?	Y	N
No VOC Head Space?	Y	N
Cooler?	Y	N
Ice/Ice Packs Present?	Y	N

Temperature (°C): 6.8°C IR#1
Number of Containers: 24
Shipped Via: Hand
Preservative:
Date & Time:
Inspected By:

	Printed Name	Signature	Company	Date	Time
Relinquished by	Craig Sauer	[signature]	Great West	7/15	1600
Received by	Kathy Sattler	Kathy Sattler	Anatek Labs	7-15-21	1600
Relinquished by					
Received by					
Relinquished by					
Received by					

Samples submitted to Anatek Labs may be subcontacted to other accredited labs if necessary. This message serves as notice of this possibility. Subcontracted analyses will be clearly noted on the analytical report.

Groundwater Purging and Sampling Form

Program: ACRL MTCA **Well ID:** MW-23

Field Team: C. Sauer M. Lynch Arrival Time to Well: 0815 Date:

Weather/Temp: 75°F Smoky **Initial DTW (ft btc):** 24.39'

Purge Method: ☐ Bladder ☐ Peristaltic ☐ Grab ☒ Other: Redi-Flow Pump Setting : Low

Field Parameters

Time [1]	DTW [2]	Purge Vol. (gal)	pH	Sp. Cond. (µS/cm)	Temp (°C)	Note color, odor, etc.
	Time Pumping Begins					
0900	~25.5'		7.09	1134	14.98	~sl. turbid, gray, clear.
0906	~26.1		6.98	1122	14.76	DO 8.06 mg/L
0910	~26.1		7.05	1122	14.89	" 7.79 "
Stabilization Criteria [3]	-	-	± 0.1 units	± 3%	-	-

[1] Collect field parameters in consistent 3-5 minute intervals for Low-Flow method

[2] DTW: If possible, drawdown should not exceed 0.33 ft for Low-Flow method

[3] Stabilization achieved once field parameters stabilize for 2 successive readings for Low-Flow method; minimum parameter subset: pH and Sp. Cond.

Sample ID: 071521-MW23 **Sample Time:** 0915

QC SAMPLE : ☐ *FD* ☐ *MS/MSD* ***QC SAMPLE ID*** ***QC Time:***

Analysis **:**

Comments: Installed Redi-Flow Pump Prior to Sampling.

Groundwater Purging and Sampling Form

Program: ACRL MTCA **Well ID:** MW-24

Field Team: C.S. M.L Arrival Time to Well: ~0940 Date: 7/15/21

Weather/Temp: ~85°F Smoky **Initial DTW (ft btc):** 106.80'

Purge Method: ☐ Bladder ☐ Peristaltic ☐ Grab ☒ Other: Redi-Flow Pump Setting: Low Flow

Field Parameters

Time[1]	DTW[2]	Purge Vol. (gal)	pH	Sp. Cond. (µS/cm)	Temp (°C)	Note color, odor, etc.
	Time Pumping Begins					
1002	~107.5'	~2	7.42	1158	16.96	Sl. turbid 8.71 DO
1007	~107.5	~4	7.25	1156	16.78	Clear 8.15 DO
1012	~107.4	~6	7.32	1155	16.73	Clear 8.37 DO mg/L
Stabilization Criteria[3]	-	-	± 0.1 units	± 3%	-	-

[1] Collect field parameters in consistent 3-5 minute intervals for Low-Flow method

[2] DTW: If possible, drawdown should not exceed 0.33 ft for Low-Flow method

[3] Stabilization achieved once field parameters stabilize for 2 successive readings for Low-Flow method; minimum parameter subset: pH and Sp. Cond.

Sample ID: 071521-MW24 **Sample Time:** 1015

QC SAMPLE : ☐ *FD* ☐ *MS/MSD* ***QC SAMPLE ID*** **QC Time:**

Analysis **:**

Comments: Installed new Redi-Flow SS Grundfos Pump prior to sample.

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Client:	Great West Engineering, Inc.	Work Order:	WBG0576
Address:	9221 N. Division St., Suite F	Project:	Asotin County
	Spokane, WA 99218	Reported:	8/1/2021 13:25
Attn:	Craig Sauer		

Analytical Results Report

Sample Location:	071521-MW23		
Lab/Sample Number:	WBG0576-01	Collect Date:	07/15/21 09:15
Date Received:	07/15/21 16:00	Collected By:	Craig Sauer
Matrix:	Groundwater		

Analyte	Result	Units	PQL	Analyzed	Analyst	Method	Qualifier
Inorganics							
Total Organic Carbon (TOC)	1.28	mg/L	0.100	7/27/21 18:58	taz	SM 5310 B	*
Alkalinity-Lab	432	mg CaCO3/L	5.00	7/21/21 10:00	ARS	SM 2320 B	
Ammonia/N	0.0245	mg/L	0.0200	7/19/21 16:00	TLM	SM 4500-NH3 H	
Bicarbonate	432	mg CaCO3/L	5.00	7/21/21 10:00	ARS	SM 2320 B	*
Carbonate	<5	mg CaCO3/L	5.00	7/21/21 10:00	ARS	SM 2320 B	
Chloride	68.5	mg/L	0.400	7/16/21 14:55	BAS	EPA 300.0	
Cyanide	ND	mg/L	0.00500	7/20/21 14:36	TLM	EPA 335.4	
Nitrate-N	ND	mg/L	0.400	7/16/21 14:55	BAS	EPA 300.0	
Sulfate	130	mg/L	0.500	7/19/21 12:17	BAS	EPA 300.0	
TDS	715	mg/L	5.00	7/20/21 10:55	BAS	SM 2540 C	
TSS	17.2	mg/L	0.250	7/20/21 15:00	ARY	SM 2540 D	
Metals by ICP-MS							
Silver	<0.00003	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Arsenic	0.00258	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Barium	0.115	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Beryllium	<0.00005	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Dissolved Calcium	97.0	mg/L	0.100	7/23/21 11:44	TRC	EPA 6020B	
Cadmium	<0.00001	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Cobalt	ND	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Chromium	0.00344	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Copper	0.00180	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Dissolved Iron	0.0136	mg/L	0.0100	7/22/21 13:27	TRC	EPA 6020B	
Dissolved Potassium	6.20	mg/L	0.100	7/23/21 11:44	TRC	EPA 6020B	
Dissolved Magnesium	30.9	mg/L	0.100	7/23/21 11:44	TRC	EPA 6020B	
Dissolved Manganese	0.00235	mg/L	0.00100	7/22/21 13:27	TRC	EPA 6020B	
Dissolved Sodium	83.5	mg/L	0.100	7/23/21 11:44	TRC	EPA 6020B	
Nickel	0.00207	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Lead	ND	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Antimony	ND	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Selenium	0.00366	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Thallium	<0.00005	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Vanadium	0.0292	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Zinc	ND	mg/L	0.00100	7/22/21 14:27	TRC	EPA 6020B	
Volatiles							
1,1,1,2-Tetrachloroethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,1,1-Trichloroethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	

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Analytical Results Report
(Continued)

Sample Location:	071521-MW23		
Lab/Sample Number:	WBG0576-01	Collect Date:	07/15/21 09:15
Date Received:	07/15/21 16:00	Collected By:	Craig Sauer
Matrix:	Groundwater		

Analyte	Result	Units	PQL	Analyzed	Analyst	Method	Qualifier
Volatiles (Continued)							
1,1,2-Trichlorethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,1-Dichloroethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,1-Dichloroethylene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,1-Dichloropropene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,2,3-Trichlorobenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,2,3-Trichloropropane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,2,4-Trichlorobenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,2,4-Trimethylbenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,2-Dichlorobenzene (ortho-Dichlorobenzene)	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,2-Dichloroethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,2-Dichloropropane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,3,5-Trimethylbenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,3-Dichloropropane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
1,4-Dichlorobenzene (para-Dichlorobenzene)	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
2,2-Dichloropropane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
2-hexanone	ND	ug/L	2.50	7/21/21 16:50	ARC	EPA 8260D	
Acetone	ND	ug/L	2.50	7/21/21 16:50	ARC	EPA 8260D	
Acrylonitrile	ND	ug/L	0.200	7/21/21 16:50	ARC	EPA 8260D	
Benzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Bromobenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Bromochloromethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Bromodichloromethane	ND	ug/L	0.200	7/21/21 16:50	ARC	EPA 8260D	
Bromoform	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Bromomethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Carbon disulfide	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Carbon Tetrachloride	ND	ug/L	0.200	7/21/21 16:50	ARC	EPA 8260D	
Chlorobenzene (Monochlorobenzene)	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Chloroethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Chloroform	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Chloromethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
cis-1,2-Dichloroethylene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
cis-1,3-Dichloropropene	ND	ug/L	0.200	7/21/21 16:50	ARC	EPA 8260D	
DBCP (screening)	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Dibromochloromethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Dibromomethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Dichlorodifluoromethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
EDB (screening)	ND	ug/L	0.200	7/21/21 16:50	ARC	EPA 8260D	
Ethylbenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Hexachlorobutadiene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Iodomethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Isopropylbenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
m/p Xylenes (MCL for total)	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
m-Dichlorobenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Methyl ethyl ketone (MEK)	ND	ug/L	2.50	7/21/21 16:50	ARC	EPA 8260D	
Methyl isobutyl ketone (MIBK)	ND	ug/L	2.50	7/21/21 16:50	ARC	EPA 8260D	

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Analytical Results Report

(Continued)

Sample Location:	071521-MW23		
Lab/Sample Number:	WBG0576-01	Collect Date:	07/15/21 09:15
Date Received:	07/15/21 16:00	Collected By:	Craig Sauer
Matrix:	Groundwater		

Analyte	Result	Units	PQL	Analyzed	Analyst	Method	Qualifier
Volatiles (Continued)							
Methylene Chloride (Dichloromethane)	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
methyl-t-butyl ether (MTBE)	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Naphthalene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
n-Butylbenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
n-Propylbenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
o-Chlorotoluene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
o-Xylene (MCL for total)	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
p-Chlorotoluene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
p-isopropyltoluene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
sec-Butylbenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Styrene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
tert-Butylbenzene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Tetrachloroethylene	2.98	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Toluene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Total Xylenes	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
trans-1,2 Dichloroethylene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
trans-1,3-Dichloropropene	ND	ug/L	0.200	7/21/21 16:50	ARC	EPA 8260D	
trans-1-4-Dichloro-2-butene	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Trichloroethene	0.860	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Trichloroflouromethane	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Vinyl acetate	ND	ug/L	0.500	7/21/21 16:50	ARC	EPA 8260D	
Vinyl Chloride	ND	ug/L	0.200	7/21/21 16:50	ARC	EPA 8260D	
Surrogate: 1,2-Dichlorobenzene-d4	*99.4%*		*70-130*	*7/21/21 16:50*	*ARC*	*EPA 8260D*	
Surrogate: 4-Bromofluorobenzene	*99.2%*		*70-130*	*7/21/21 16:50*	*ARC*	*EPA 8260D*	
Surrogate: Toluene-d8	*100%*		*70-130*	*7/21/21 16:50*	*ARC*	*EPA 8260D*	
Volatiles SIM							
Acrylonitrile	ND	ug/L	0.0700	7/22/21 12:52	ARC	EPA 8260D SIM	
EDB (screening)	ND	ug/L	0.0100	7/22/21 12:52	ARC	EPA 8260D SIM	
Vinyl Chloride	ND	ug/L	0.0200	7/22/21 12:52	ARC	EPA 8260D SIM	
Surrogate: 1,2-Dichlorobenzene-d4	*101%*		*70-130*	*7/22/21 12:52*	*ARC*	*EPA 8260D SIM*	
Surrogate: 4-Bromofluorobenzene	*97.0%*		*70-130*	*7/22/21 12:52*	*ARC*	*EPA 8260D SIM*	
Surrogate: Toluene-d8	*102%*		*70-130*	*7/22/21 12:52*	*ARC*	*EPA 8260D SIM*	

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Analytical Results Report

(Continued)

Sample Location:	071521-MW24		
Lab/Sample Number:	WBG0576-02	Collect Date:	07/15/21 10:15
Date Received:	07/15/21 16:00	Collected By:	Craig Sauer
Matrix:	Groundwater		

Analyte	Result	Units	PQL	Analyzed	Analyst	Method	Qualifier
Inorganics							
Total Organic Carbon (TOC)	1.10	mg/L	0.100	7/27/21 19:17	taz	SM 5310 B	*
Alkalinity-Lab	134	mg CaCO3/L	5.00	7/21/21 10:00	ARS	SM 2320 B	
Ammonia/N	<0.02	mg/L	0.0200	7/19/21 16:02	TLM	SM 4500-NH3 H	
Bicarbonate	124	mg CaCO3/L	5.00	7/21/21 10:00	ARS	SM 2320 B	*
Carbonate	10.0	mg CaCO3/L	5.00	7/21/21 10:00	ARS	SM 2320 B	
Chloride	85.9	mg/L	0.500	7/16/21 15:11	BAS	EPA 300.0	
Cyanide	ND	mg/L	0.00500	7/20/21 14:37	TLM	EPA 335.4	
Nitrate-N	ND	mg/L	0.500	7/16/21 15:11	BAS	EPA 300.0	
Sulfate	157	mg/L	1.00	7/19/21 12:33	BAS	EPA 300.0	
TDS	783	mg/L	5.00	7/20/21 10:55	BAS	SM 2540 C	
TSS	39.0	mg/L	0.500	7/20/21 15:00	ARY	SM 2540 D	
Metals by ICP-MS							
Silver	<0.00003	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Arsenic	0.00257	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Barium	0.118	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Beryllium	ND	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Dissolved Calcium	103	mg/L	0.100	7/23/21 11:51	TRC	EPA 6020B	
Cadmium	<0.00001	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Cobalt	0.00133	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Chromium	0.0156	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Copper	0.00302	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Dissolved Iron	0.0444	mg/L	0.0100	7/22/21 13:34	TRC	EPA 6020B	
Dissolved Potassium	6.99	mg/L	0.100	7/23/21 11:51	TRC	EPA 6020B	
Dissolved Magnesium	33.6	mg/L	0.100	7/23/21 11:51	TRC	EPA 6020B	
Dissolved Manganese	0.00462	mg/L	0.00100	7/22/21 13:34	TRC	EPA 6020B	
Dissolved Sodium	78.0	mg/L	0.100	7/23/21 11:51	TRC	EPA 6020B	
Nickel	0.00878	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Lead	ND	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Antimony	ND	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Selenium	0.00610	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Thallium	<0.00005	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Vanadium	0.0290	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Zinc	0.00455	mg/L	0.00100	7/22/21 14:44	TRC	EPA 6020B	
Volatiles							
1,1,1,2-Tetrachloroethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,1,1-Trichloroethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,1,2-Trichlorethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,1-Dichloroethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,1-Dichloroethylene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,1-Dichloropropene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,2,3-Trichlorobenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,2,3-Trichloropropane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,2,4-Trichlorobenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,2,4-Trimethylbenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	

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Analytical Results Report
(Continued)

Sample Location:	071521-MW24		
Lab/Sample Number:	WBG0576-02	Collect Date:	07/15/21 10:15
Date Received:	07/15/21 16:00	Collected By:	Craig Sauer
Matrix:	Groundwater		

Analyte	Result	Units	PQL	Analyzed	Analyst	Method	Qualifier
Volatiles (Continued)							
1,2-Dichlorobenzene (ortho-Dichlorobenzene)	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,2-Dichloroethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,2-Dichloropropane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,3,5-Trimethylbenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,3-Dichloropropane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
1,4-Dichlorobenzene (para-Dichlorobenzene)	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
2,2-Dichloropropane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
2-hexanone	ND	ug/L	2.50	7/21/21 17:23	ARC	EPA 8260D	
Acetone	ND	ug/L	2.50	7/21/21 17:23	ARC	EPA 8260D	
Acrylonitrile	ND	ug/L	0.200	7/21/21 17:23	ARC	EPA 8260D	
Benzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Bromobenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Bromochloromethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Bromodichloromethane	ND	ug/L	0.200	7/21/21 17:23	ARC	EPA 8260D	
Bromoform	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Bromomethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Carbon disulfide	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Carbon Tetrachloride	ND	ug/L	0.200	7/21/21 17:23	ARC	EPA 8260D	
Chlorobenzene (Monochlorobenzene)	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Chloroethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Chloroform	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Chloromethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
cis-1,2-Dichloroethylene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
cis-1,3-Dichloropropene	ND	ug/L	0.200	7/21/21 17:23	ARC	EPA 8260D	
DBCP (screening)	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Dibromochloromethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Dibromomethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Dichlorodifluoromethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
EDB (screening)	ND	ug/L	0.200	7/21/21 17:23	ARC	EPA 8260D	
Ethylbenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Hexachlorobutadiene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Iodomethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Isopropylbenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
m/p Xylenes (MCL for total)	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
m-Dichlorobenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Methyl ethyl ketone (MEK)	ND	ug/L	2.50	7/21/21 17:23	ARC	EPA 8260D	
Methyl isobutyl ketone (MIBK)	ND	ug/L	2.50	7/21/21 17:23	ARC	EPA 8260D	
Methylene Chloride (Dichloromethane)	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
methyl-t-butyl ether (MTBE)	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Naphthalene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
n-Butylbenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
n-Propylbenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
o-Chlorotoluene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
o-Xylene (MCL for total)	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	

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Analytical Results Report
(Continued)

Sample Location:	071521-MW24		
Lab/Sample Number:	WBG0576-02	Collect Date:	07/15/21 10:15
Date Received:	07/15/21 16:00	Collected By:	Craig Sauer
Matrix:	Groundwater		

Analyte	Result	Units	PQL	Analyzed	Analyst	Method	Qualifier
Volatiles (Continued)							
p-Chlorotoluene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
p-isopropyltoluene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
sec-Butylbenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Styrene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
tert-Butylbenzene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Tetrachloroethylene	3.18	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Toluene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Total Xylenes	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
trans-1,2 Dichloroethylene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
trans-1,3-Dichloropropene	ND	ug/L	0.200	7/21/21 17:23	ARC	EPA 8260D	
trans-1-4-Dichloro-2-butene	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Trichloroethene	0.640	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Trichloroflouromethane	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Vinyl acetate	ND	ug/L	0.500	7/21/21 17:23	ARC	EPA 8260D	
Vinyl Chloride	ND	ug/L	0.200	7/21/21 17:23	ARC	EPA 8260D	
Surrogate: 1,2-Dichlorobenzene-d4	*100%*		*70-130*	*7/21/21 17:23*	*ARC*	*EPA 8260D*	
Surrogate: 4-Bromofluorobenzene	*98.6%*		*70-130*	*7/21/21 17:23*	*ARC*	*EPA 8260D*	
Surrogate: Toluene-d8	*101%*		*70-130*	*7/21/21 17:23*	*ARC*	*EPA 8260D*	
Volatiles SIM							
Acrylonitrile	ND	ug/L	0.0700	7/20/21 18:13	ARC	EPA 8260D SIM	
EDB (screening)	ND	ug/L	0.0100	7/20/21 18:13	ARC	EPA 8260D SIM	
Vinyl Chloride	ND	ug/L	0.0200	7/20/21 18:13	ARC	EPA 8260D SIM	
Surrogate: 1,2-Dichlorobenzene-d4	*100%*		*70-130*	*7/20/21 18:13*	*ARC*	*EPA 8260D SIM*	
Surrogate: 4-Bromofluorobenzene	*91.8%*		*70-130*	*7/20/21 18:13*	*ARC*	*EPA 8260D SIM*	
Surrogate: Toluene-d8	*101%*		*70-130*	*7/20/21 18:13*	*ARC*	*EPA 8260D SIM*	

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Analytical Results Report
(Continued)

Sample Location:	Trip Blank		
Lab/Sample Number:	WBG0576-03	Collect Date:	07/08/21 10:44
Date Received:	07/15/21 16:00	Collected By:	Craig Sauer
Matrix:	Groundwater		

Analyte	Result	Units	PQL	Analyzed	Analyst	Method	Qualifier
Volatiles							
1,1,1,2-Tetrachloroethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,1,1-Trichloroethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,1,2,2-Tetrachloroethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,1,2-Trichlorethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,1-Dichloroethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,1-Dichloroethylene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,1-Dichloropropene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,2,3-Trichlorobenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,2,3-Trichloropropane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,2,4-Trichlorobenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,2,4-Trimethylbenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,2-Dichlorobenzene (ortho-Dichlorobenzene)	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,2-Dichloroethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,2-Dichloropropane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,3,5-Trimethylbenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,3-Dichloropropane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
1,4-Dichlorobenzene (para-Dichlorobenzene)	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
2,2-Dichloropropane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
2-hexanone	ND	ug/L	2.50	7/21/21 17:54	ARC	EPA 8260D	
Acetone	ND	ug/L	2.50	7/21/21 17:54	ARC	EPA 8260D	
Acrylonitrile	ND	ug/L	0.200	7/21/21 17:54	ARC	EPA 8260D	
Benzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Bromobenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Bromochloromethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Bromodichloromethane	ND	ug/L	0.200	7/21/21 17:54	ARC	EPA 8260D	
Bromoform	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Bromomethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Carbon disulfide	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Carbon Tetrachloride	ND	ug/L	0.200	7/21/21 17:54	ARC	EPA 8260D	
Chlorobenzene (Monochlorobenzene)	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Chloroethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Chloroform	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Chloromethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
cis-1,2-Dichloroethylene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
cis-1,3-Dichloropropene	ND	ug/L	0.200	7/21/21 17:54	ARC	EPA 8260D	
DBCP (screening)	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Dibromochloromethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Dibromomethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Dichlorodifluoromethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
EDB (screening)	ND	ug/L	0.200	7/21/21 17:54	ARC	EPA 8260D	
Ethylbenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Hexachlorobutadiene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Iodomethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Isopropylbenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
m/p Xylenes (MCL for total)	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	

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Analytical Results Report
(Continued)

Sample Location:	Trip Blank		
Lab/Sample Number:	WBG0576-03	Collect Date:	07/08/21 10:44
Date Received:	07/15/21 16:00	Collected By:	Craig Sauer
Matrix:	Groundwater		

Analyte	Result	Units	PQL	Analyzed	Analyst	Method	Qualifier
Volatiles (Continued)							
m-Dichlorobenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Methyl ethyl ketone (MEK)	ND	ug/L	2.50	7/21/21 17:54	ARC	EPA 8260D	
Methyl isobutyl ketone (MIBK)	ND	ug/L	2.50	7/21/21 17:54	ARC	EPA 8260D	
Methylene Chloride (Dichloromethane)	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
methyl-t-butyl ether (MTBE)	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Naphthalene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
n-Butylbenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
n-Propylbenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
o-Chlorotoluene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
o-Xylene (MCL for total)	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
p-Chlorotoluene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
p-isopropyltoluene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
sec-Butylbenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Styrene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
tert-Butylbenzene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Tetrachloroethylene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Toluene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Total Xylenes	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
trans-1,2 Dichloroethylene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
trans-1,3-Dichloropropene	ND	ug/L	0.200	7/21/21 17:54	ARC	EPA 8260D	
trans-1-4-Dichloro-2-butene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Trichloroethene	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Trichloroflouromethane	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Vinyl acetate	ND	ug/L	0.500	7/21/21 17:54	ARC	EPA 8260D	
Vinyl Chloride	ND	ug/L	0.200	7/21/21 17:54	ARC	EPA 8260D	
Surrogate: 1,2-Dichlorobenzene-d4	*99.6%*		*70-130*	*7/21/21 17:54*	*ARC*	*EPA 8260D*	
Surrogate: 4-Bromofluorobenzene	*97.4%*		*70-130*	*7/21/21 17:54*	*ARC*	*EPA 8260D*	
Surrogate: Toluene-d8	*100%*		*70-130*	*7/21/21 17:54*	*ARC*	*EPA 8260D*	
Volatiles SIM							
Acrylonitrile	ND	ug/L	0.0700	7/20/21 18:42	ARC	EPA 8260D SIM	
EDB (screening)	ND	ug/L	0.0100	7/20/21 18:42	ARC	EPA 8260D SIM	
Vinyl Chloride	ND	ug/L	0.0200	7/20/21 18:42	ARC	EPA 8260D SIM	
Surrogate: 1,2-Dichlorobenzene-d4	*101%*		*70-130*	*7/20/21 18:42*	*ARC*	*EPA 8260D SIM*	
Surrogate: 4-Bromofluorobenzene	*95.8%*		*70-130*	*7/20/21 18:42*	*ARC*	*EPA 8260D SIM*	
Surrogate: Toluene-d8	*103%*		*70-130*	*7/20/21 18:42*	*ARC*	*EPA 8260D SIM*	

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Authorized Signature,

Kathleen Sattler, Laboratory Manager

PQL	Practical Quantitation Limit
ND	Not Detected
MCL	EPA's Maximum Contaminant Level
Dry	Sample results reported on a dry weight basis
*	Not a state-certified analyte

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Certifications

Code	Description	Facility	Number
W WA DOE	Washington Department of Ecology	Anatek-Spokane, WA	C585

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Quality Control Data

Inorganics

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0506 - W Ions										
Blank (BBG0506-BLK1)					Prepared & Analyzed: 7/16/2021					
Chloride	ND		0.100	mg/L						
Nitrate-N	ND		0.100	mg/L						
LCS (BBG0506-BS1)					Prepared & Analyzed: 7/16/2021					
Chloride	3.94			mg/L	4.00		98.6	90-110		
Nitrate-N	3.91			mg/L	4.00		97.8	90-110		
Matrix Spike (BBG0506-MS1)		**Source: WBG0633-02**			Prepared & Analyzed: 7/16/2021					
Chloride	16.8			mg/L	4.00	12.9	97.8	80-120		
Nitrate-N	3.89			mg/L	4.00	0.00	97.2	80-120		
Matrix Spike Dup (BBG0506-MSD1)		**Source: WBG0633-02**			Prepared & Analyzed: 7/16/2021					
Chloride	16.8			mg/L	4.00	12.9	98.5	80-120	0.171	20
Nitrate-N	4.10			mg/L	4.00	0.00	102	80-120	5.30	20
Batch: BBG0564 - W FIA										
Blank (BBG0564-BLK1)					Prepared & Analyzed: 7/19/2021					
Ammonia/N	ND		0.0200	mg/L						
Blank (BBG0564-BLK2)					Prepared & Analyzed: 7/19/2021					
Ammonia/N	ND		0.0200	mg/L						
Blank (BBG0564-BLK3)					Prepared & Analyzed: 7/19/2021					
Ammonia/N	ND		0.0200	mg/L						
Blank (BBG0564-BLK4)					Prepared & Analyzed: 7/19/2021					
Ammonia/N	ND		0.0200	mg/L						

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Quality Control Data

(Continued)

Inorganics (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0564 - W FIA (Continued)										
Blank (BBG0564-BLK5)					Prepared & Analyzed: 7/19/2021					
Ammonia/N	ND		0.0200	mg/L						
LCS (BBG0564-BS1)					Prepared & Analyzed: 7/19/2021					
Ammonia/N	0.198		0.0200	mg/L	0.200		98.9	90-110		
LCS (BBG0564-BS2)					Prepared & Analyzed: 7/19/2021					
Ammonia/N	0.198		0.0200	mg/L	0.200		98.8	90-110		
LCS (BBG0564-BS3)					Prepared & Analyzed: 7/19/2021					
Ammonia/N	0.190		0.0200	mg/L	0.200		94.8	90-110		
Matrix Spike (BBG0564-MS1)		**Source: WBG0137-02**			Prepared & Analyzed: 7/19/2021					
Ammonia/N	0.223		0.0200	mg/L	0.200	0.0260	98.7	80-120		
Matrix Spike (BBG0564-MS2)		**Source: WBG0344-02**			Prepared & Analyzed: 7/19/2021					
Ammonia/N	0.196		0.0200	mg/L	0.200	0.0132	91.3	80-120		
Matrix Spike Dup (BBG0564-MSD1)		**Source: WBG0137-02**			Prepared & Analyzed: 7/19/2021					
Ammonia/N	0.233		0.0200	mg/L	0.200	0.0260	104	80-120	4.34	20
Matrix Spike Dup (BBG0564-MSD2)		**Source: WBG0344-02**			Prepared & Analyzed: 7/19/2021					
Ammonia/N	0.192		0.0200	mg/L	0.200	0.0132	89.6	80-120	1.75	20
Batch: BBG0565 - W Ions										
Blank (BBG0565-BLK1)					Prepared & Analyzed: 7/19/2021					
Sulfate	ND		0.100	mg/L						

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Quality Control Data
(Continued)

Inorganics (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0565 - W Ions (Continued)										
LCS (BBG0565-BS1)					Prepared & Analyzed: 7/19/2021					
Sulfate	3.98			mg/L	4.00		99.6	90-110		
Matrix Spike (BBG0565-MS1)		**Source: WBG0576-01**			Prepared & Analyzed: 7/19/2021					
Sulfate	30.6			mg/L	4.00	26.0	115	80-120		
Matrix Spike Dup (BBG0565-MSD1)		**Source: WBG0576-01**			Prepared & Analyzed: 7/19/2021					
Sulfate	30.2			mg/L	4.00	26.0	104	80-120	1.37	20
Batch: BBG0568 - W Wet Chem										
Blank (BBG0568-BLK1)					Prepared: 7/20/2021 Analyzed: 7/29/2021					
Bicarbonate	ND		5.00	mg CaCO3/L						
Alkalinity-Lab	ND		5.00	mg CaCO3/L						
Carbonate	ND		5.00	mg CaCO3/L						
LCS (BBG0568-BS1)					Prepared: 7/20/2021 Analyzed: 7/29/2021					
Alkalinity-Lab	47.0			mg CaCO3/L	50.0		94.0	85-115		
Bicarbonate	47.0			mg CaCO3/L	50.0		94.0	90-110		
Batch: BBG0569 - W Wet Chem										
Blank (BBG0569-BLK1)					Prepared & Analyzed: 7/20/2021					
TDS	ND		5.00	mg/L						
Blank (BBG0569-BLK2)					Prepared & Analyzed: 7/20/2021					
TDS	ND		5.00	mg/L						

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Quality Control Data
(Continued)

Inorganics (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0569 - W Wet Chem (Continued)										
LCS (BBG0569-BS1)					Prepared & Analyzed: 7/20/2021					
TDS	487			mg/L	500		97.4	80-120		
LCS Dup (BBG0569-BSD1)					Prepared & Analyzed: 7/20/2021					
TDS	490			mg/L	500		98.0	80-120	0.614	20
Duplicate (BBG0569-DUP1)		**Source: WBG0576-02**			Prepared & Analyzed: 7/20/2021					
TDS	775		5.00	mg/L		783			1.03	20
Matrix Spike (BBG0569-MS1)		**Source: WBG0507-01**			Prepared & Analyzed: 7/20/2021					
TDS	790		5.00	mg/L	500	281	102	80-120		
Matrix Spike Dup (BBG0569-MSD1)		**Source: WBG0507-01**			Prepared & Analyzed: 7/20/2021					
TDS	784		5.00	mg/L	500	281	101	80-120	0.762	20
Batch: BBG0590 - W FIA										
Blank (BBG0590-BLK1)					Prepared & Analyzed: 7/20/2021					
Cyanide	ND		0.00500	mg/L						
LCS (BBG0590-BS1)					Prepared & Analyzed: 7/20/2021					
Cyanide	0.0986		0.00500	mg/L	0.100		98.6	90-110		
Matrix Spike (BBG0590-MS1)		**Source: WBG0507-01**			Prepared & Analyzed: 7/20/2021					
Cyanide	0.0940		0.00500	mg/L	0.100	ND	94.0	90-110		
Matrix Spike Dup (BBG0590-MSD1)		**Source: WBG0507-01**			Prepared & Analyzed: 7/20/2021					
Cyanide	0.0916		0.00500	mg/L	0.100	ND	91.6	90-110	2.59	20

Quality Control Data
(Continued)

Inorganics (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0653 - W Filtration										
Blank (BBG0653-BLK1)					Prepared & Analyzed: 7/20/2021					
TSS	ND		1.00	mg/L						
LCS (BBG0653-BS1)					Prepared & Analyzed: 7/20/2021					
TSS	97.0			mg/L	100		97.0	90-110		
LCS Dup (BBG0653-BSD1)					Prepared & Analyzed: 7/20/2021					
TSS	97.0			mg/L	100		97.0	90-110	0.00	10
Duplicate (BBG0653-DUP1)		**Source: WBG0600-01**			Prepared & Analyzed: 7/20/2021					
TSS	68.0		2.00	mg/L		58.0			15.9	20
Matrix Spike (BBG0653-MS1)		**Source: WBG0603-01**			Prepared & Analyzed: 7/20/2021					
TSS	186		2.00	mg/L	100	78.0	108	80-120		
Matrix Spike Dup (BBG0653-MSD1)		**Source: WBG0603-01**			Prepared & Analyzed: 7/20/2021					
TSS	190		2.00	mg/L	100	78.0	112	80-120	2.13	20
Batch: BBG0831 - TOC										
Blank (BBG0831-BLK1)					Prepared & Analyzed: 7/27/2021					
Total Organic Carbon (TOC)	ND		0.100	mg/L						
LCS (BBG0831-BS1)					Prepared: 7/27/2021 Analyzed: 7/28/2021					
Total Organic Carbon (TOC)	10.6		0.100	mg/L	10.0		106	80-120		
LCS Dup (BBG0831-BSD1)					Prepared & Analyzed: 7/27/2021					
Total Organic Carbon (TOC)	10.6		0.100	mg/L	10.0		106	80-120	0.378	20

Quality Control Data
(Continued)

Metals by ICP-MS

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0607 - W 3010 Digest										
Blank (BBG0607-BLK1)					Prepared: 7/21/2021 Analyzed: 7/23/2021					
Dissolved Magnesium	ND		0.100	mg/L						
Dissolved Iron	ND		0.0100	mg/L						
Dissolved Sodium	ND		0.100	mg/L						
Dissolved Potassium	ND		0.100	mg/L						
Dissolved Manganese	ND		0.00100	mg/L						
Dissolved Calcium	ND		0.100	mg/L						
LCS (BBG0607-BS1)					Prepared: 7/21/2021 Analyzed: 7/23/2021					
Dissolved Potassium	10.1		0.100	mg/L	10.0		101	80-120		
Dissolved Manganese	0.0545		0.00100	mg/L	0.0500		109	80-120		
Dissolved Magnesium	10.3		0.100	mg/L	10.0		103	80-120		
Dissolved Sodium	10.1		0.100	mg/L	10.0		101	80-120		
Dissolved Calcium	10.1		0.100	mg/L	10.0		101	80-120		
Dissolved Iron	0.103		0.0100	mg/L	0.100		103	80-120		
Matrix Spike (BBG0607-MS1)		**Source: WBG0576-01**			Prepared: 7/21/2021 Analyzed: 7/22/2021					

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Quality Control Data

(Continued)

Metals by ICP-MS (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0607 - W 3010 Digest (Continued)										
Matrix Spike (BBG0607-MS1)		**Source: WBG0576-01**			Prepared: 7/21/2021 Analyzed: 7/22/2021					
Dissolved Manganese	0.264		0.00500	mg/L	0.250	0.00235	105	75-125		
Dissolved Magnesium	81.3		0.500	mg/L	50.0	30.9	101	75-125		
Dissolved Sodium	136		0.500	mg/L	50.0	83.5	105	75-125		
Dissolved Potassium	55.9		0.500	mg/L	50.0	6.20	99.4	75-125		
Dissolved Iron	0.497		0.0100	mg/L	0.500	0.0136	96.7	75-125		
Dissolved Calcium	149		0.500	mg/L	50.0	97.0	104	75-125		
Matrix Spike Dup (BBG0607-MSD1)		**Source: WBG0576-01**			Prepared: 7/21/2021 Analyzed: 7/23/2021					
Dissolved Calcium	150		0.500	mg/L	50.0	97.0	106	75-125	0.449	20
Dissolved Sodium	135		0.500	mg/L	50.0	83.5	103	75-125	0.845	20
Dissolved Manganese	0.257		0.00500	mg/L	0.250	0.00235	102	75-125	2.66	20
Dissolved Iron	0.494		0.0100	mg/L	0.500	0.0136	96.0	75-125	0.722	20
Dissolved Magnesium	82.8		0.500	mg/L	50.0	30.9	104	75-125	1.88	20
Dissolved Potassium	56.5		0.500	mg/L	50.0	6.20	101	75-125	1.13	20
Batch: BBG0608 - W 3010 Digest										
Blank (BBG0608-BLK1)					Prepared: 7/21/2021 Analyzed: 7/22/2021					
Cadmium	ND		0.00100	mg/L						
Selenium	ND		0.00100	mg/L						
Zinc	ND		0.00100	mg/L						
Chromium	ND		0.00100	mg/L						
Copper	ND		0.00100	mg/L						
Vanadium	ND		0.00100	mg/L						
Silver	ND		0.00100	mg/L						
Arsenic	ND		0.00100	mg/L						
Cobalt	ND		0.00100	mg/L						
Nickel	ND		0.00100	mg/L						
Thallium	ND		0.00100	mg/L						
Beryllium	ND		0.00100	mg/L						
Antimony	ND		0.00100	mg/L						
Lead	ND		0.00100	mg/L						
Barium	ND		0.00100	mg/L						

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Quality Control Data
(Continued)

Metals by ICP-MS (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0608 - W 3010 Digest (Continued)										
LCS (BBG0608-BS1)					Prepared: 7/21/2021 Analyzed: 7/22/2021					
Beryllium	0.0511		0.00100	mg/L	0.0500		102	85-115		
Cadmium	0.0539		0.00100	mg/L	0.0500		108	85-115		
Cobalt	0.0497		0.00100	mg/L	0.0500		99.5	85-115		
Chromium	0.0522		0.00100	mg/L	0.0500		104	85-115		
Zinc	0.0510		0.00100	mg/L	0.0500		102	85-115		
Barium	0.0516		0.00100	mg/L	0.0500		103	85-115		
Lead	0.0526		0.00100	mg/L	0.0500		105	85-115		
Copper	0.0527		0.00100	mg/L	0.0500		105	85-115		
Silver	0.0516		0.00100	mg/L	0.0500		103	80-120		
Arsenic	0.0521		0.00100	mg/L	0.0500		104	85-115		
Antimony	0.0529		0.00100	mg/L	0.0500		106	85-115		
Selenium	0.0531		0.00100	mg/L	0.0500		106	85-115		
Nickel	0.0500		0.00100	mg/L	0.0500		100	85-115		
Vanadium	0.0531		0.00100	mg/L	0.0500		106	85-115		
Thallium	0.0522		0.00100	mg/L	0.0500		104	85-115		
Matrix Spike (BBG0608-MS1)		**Source: WBG0479-02**			Prepared: 7/21/2021 Analyzed: 7/22/2021					
Silver	0.254		0.00500	mg/L	0.250	ND	101	75-125		
Copper	0.253		0.00500	mg/L	0.250	0.00203	100	70-130		
Beryllium	0.255		0.00500	mg/L	0.250	ND	102	70-130		
Barium	0.334		0.00500	mg/L	0.250	0.0769	103	70-130		
Chromium	0.258		0.00500	mg/L	0.250	ND	103	70-130		
Arsenic	0.261		0.00500	mg/L	0.250	0.00141	104	70-130		
Cadmium	0.265		0.00500	mg/L	0.250	ND	106	70-130		
Nickel	0.248		0.00500	mg/L	0.250	0.00135	98.7	70-130		
Cobalt	0.246		0.00500	mg/L	0.250	0.000195	98.2	70-130		
Lead	0.259		0.00500	mg/L	0.250	ND	104	70-130		
Antimony	0.263		0.00500	mg/L	0.250	0.000584	105	70-130		
Selenium	0.261		0.00500	mg/L	0.250	ND	104	70-130		
Thallium	0.259		0.00500	mg/L	0.250	ND	104	70-130		
Vanadium	0.264		0.00500	mg/L	0.250	ND	106	70-130		
Zinc	0.252		0.00500	mg/L	0.250	0.00321	99.7	70-130		

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Quality Control Data
(Continued)

Metals by ICP-MS (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0608 - W 3010 Digest (Continued)										
Matrix Spike (BBG0608-MS2)		**Source: WBG0574-03**			Prepared: 7/21/2021 Analyzed: 7/22/2021					
Thallium	0.0513		0.00100	mg/L	0.0500	ND	103	70-130		
Beryllium	0.0506		0.00100	mg/L	0.0500	ND	101	70-130		
Arsenic	0.0540		0.00100	mg/L	0.0500	0.00296	102	70-130		
Silver	0.0513		0.00100	mg/L	0.0500	ND	103	75-125		
Zinc	0.177		0.00100	mg/L	0.0500	0.130	94.7	70-130		
Cobalt	0.0480		0.00100	mg/L	0.0500	0.0000350	95.9	70-130		
Nickel	0.0488		0.00100	mg/L	0.0500	0.000495	96.6	70-130		
Lead	0.0539		0.00100	mg/L	0.0500	0.00104	106	70-130		
Antimony	0.0519		0.00100	mg/L	0.0500	0.000448	103	70-130		
Chromium	0.0512		0.00100	mg/L	0.0500	0.000398	102	70-130		
Copper	0.0905		0.00100	mg/L	0.0500	0.0420	96.9	70-130		
Selenium	0.0518		0.00100	mg/L	0.0500	0.000233	103	70-130		
Vanadium	0.0524		0.00100	mg/L	0.0500	0.000910	103	70-130		
Cadmium	0.0535		0.00100	mg/L	0.0500	0.000136	107	70-130		
Barium	0.0759		0.00100	mg/L	0.0500	0.0253	101	70-130		
Matrix Spike Dup (BBG0608-MSD1)		**Source: WBG0479-02**			Prepared: 7/21/2021 Analyzed: 7/22/2021					
Vanadium	0.267		0.00500	mg/L	0.250	ND	107	70-130	0.899	20
Barium	0.339		0.00500	mg/L	0.250	0.0769	105	70-130	1.51	20
Chromium	0.259		0.00500	mg/L	0.250	ND	104	70-130	0.486	20
Nickel	0.250		0.00500	mg/L	0.250	0.00135	99.4	70-130	0.721	20
Arsenic	0.262		0.00500	mg/L	0.250	0.00141	104	70-130	0.308	20
Cobalt	0.247		0.00500	mg/L	0.250	0.000195	98.6	70-130	0.347	20
Lead	0.264		0.00500	mg/L	0.250	ND	106	70-130	2.04	20
Silver	0.263		0.00500	mg/L	0.250	ND	105	75-125	3.71	20
Thallium	0.260		0.00500	mg/L	0.250	ND	104	70-130	0.306	20
Antimony	0.260		0.00500	mg/L	0.250	0.000584	104	70-130	1.15	20
Zinc	0.258		0.00500	mg/L	0.250	0.00321	102	70-130	2.18	20
Selenium	0.256		0.00500	mg/L	0.250	ND	103	70-130	1.81	20
Copper	0.258		0.00500	mg/L	0.250	0.00203	103	70-130	2.24	20
Cadmium	0.268		0.00500	mg/L	0.250	ND	107	70-130	1.05	20
Beryllium	0.257		0.00500	mg/L	0.250	ND	103	70-130	1.06	20

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Quality Control Data
(Continued)

Metals by ICP-MS (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0608 - W 3010 Digest (Continued)										
Matrix Spike Dup (BBG0608-MSD2)		**Source: WBG0574-03**		Prepared: 7/21/2021 Analyzed: 7/22/2021						
Barium	0.0769		0.00100	mg/L	0.0500	0.0253	103	70-130	1.28	20
Arsenic	0.0551		0.00100	mg/L	0.0500	0.00296	104	70-130	1.99	20
Thallium	0.0524		0.00100	mg/L	0.0500	ND	105	70-130	2.16	20
Beryllium	0.0511		0.00100	mg/L	0.0500	ND	102	70-130	0.851	20
Copper	0.0910		0.00100	mg/L	0.0500	0.0420	97.9	70-130	0.540	20
Selenium	0.0524		0.00100	mg/L	0.0500	0.000233	104	70-130	1.07	20
Zinc	0.181		0.00100	mg/L	0.0500	0.130	102	70-130	2.03	20
Cadmium	0.0543		0.00100	mg/L	0.0500	0.000136	108	70-130	1.50	20
Antimony	0.0527		0.00100	mg/L	0.0500	0.000448	105	70-130	1.70	20
Silver	0.0522		0.00100	mg/L	0.0500	ND	104	75-125	1.74	20
Vanadium	0.0535		0.00100	mg/L	0.0500	0.000910	105	70-130	1.99	20
Chromium	0.0523		0.00100	mg/L	0.0500	0.000398	104	70-130	2.08	20
Lead	0.0538		0.00100	mg/L	0.0500	0.00104	106	70-130	0.156	20
Nickel	0.0496		0.00100	mg/L	0.0500	0.000495	98.2	70-130	1.67	20
Cobalt	0.0489		0.00100	mg/L	0.0500	0.0000350	97.7	70-130	1.81	20

Quality Control Data
(Continued)

Volatiles

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0645 - W VOC										
Blank (BBG0645-BLK1)					Prepared & Analyzed: 7/21/2021					
1,1,1,2-Tetrachloroethane	ND		0.500	ug/L						
1,1,1-Trichloroethane	ND		0.500	ug/L						
1,1,2,2-Tetrachloroethane	ND		0.500	ug/L						
1,1,2-Trichlorethane	ND		0.500	ug/L						
1,1-Dichloroethane	ND		0.500	ug/L						
1,1-Dichloroethylene	ND		0.500	ug/L						
1,1-Dichloropropene	ND		0.500	ug/L						
1,2,3-Trichlorobenzene	ND		0.500	ug/L						
1,2,3-Trichloropropane	ND		0.500	ug/L						
1,2,4-Trichlorobenzene	ND		0.500	ug/L						
1,2,4-Trimethylbenzene	ND		0.500	ug/L						
DBCP (screening)	ND		0.500	ug/L						
EDB (screening)	ND		0.200	ug/L						
1,2-Dichlorobenzene (ortho-Dichlorobenzene)	ND		0.500	ug/L						
1,2-Dichloroethane	ND		0.500	ug/L						
1,2-Dichloropropane	ND		0.500	ug/L						
1,3,5-Trimethylbenzene	ND		0.500	ug/L						
m-Dichlorobenzene	ND		0.500	ug/L						
1,3-Dichloropropane	ND		0.500	ug/L						
1,4-Dichlorobenzene (para-Dichlorobenzene)	ND		0.500	ug/L						
2,2-Dichloropropane	ND		0.500	ug/L						
o-Chlorotoluene	ND		0.500	ug/L						
2-hexanone	ND		2.50	ug/L						
p-Chlorotoluene	ND		0.500	ug/L						
Acetone	ND		2.50	ug/L						

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Quality Control Data
(Continued)

Volatiles (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0645 - W VOC (Continued)										
Blank (BBG0645-BLK1)					Prepared & Analyzed: 7/21/2021					
Acrylonitrile	ND		0.200	ug/L						
Benzene	ND		0.500	ug/L						
Bromobenzene	ND		0.500	ug/L						
Bromochloromethane	ND		0.500	ug/L						
Bromodichloromethane	ND		0.200	ug/L						
Bromoform	ND		0.500	ug/L						
Bromomethane	ND		0.500	ug/L						
Carbon disulfide	ND		0.500	ug/L						
Carbon Tetrachloride	ND		0.200	ug/L						
Chlorobenzene (Monochlorobenzene)	ND		0.500	ug/L						
Chloroethane	ND		0.500	ug/L						
Chloroform	ND		0.500	ug/L						
Chloromethane	ND		0.500	ug/L						
cis-1,2-Dichloroethylene	ND		0.500	ug/L						
cis-1,3-Dichloropropene	ND		0.200	ug/L						
Dibromochloromethane	ND		0.500	ug/L						
Dibromomethane	ND		0.500	ug/L						
Dichlorodifluoromethane	ND		0.500	ug/L						
Ethylbenzene	ND		0.500	ug/L						
Hexachlorobutadiene	ND		0.500	ug/L						
Iodomethane	ND		0.500	ug/L						
Isopropylbenzene	ND		0.500	ug/L						
m/p Xylenes (MCL for total)	ND		0.500	ug/L						
Methyl ethyl ketone (MEK)	ND		2.50	ug/L						
Methyl isobutyl ketone (MIBK)	ND		2.50	ug/L						
Methylene Chloride (Dichloromethane)	ND		0.500	ug/L						
methyl-t-butyl ether (MTBE)	ND		0.500	ug/L						
Naphthalene	ND		0.500	ug/L						
n-Butylbenzene	ND		0.500	ug/L						
n-Propylbenzene	ND		0.500	ug/L						
o-Xylene (MCL for total)	ND		0.500	ug/L						
p-isopropyltoluene	ND		0.500	ug/L						
sec-Butylbenzene	ND		0.500	ug/L						
Styrene	ND		0.500	ug/L						
tert-Butylbenzene	ND		0.500	ug/L						
Tetrachloroethylene	ND		0.500	ug/L						
Toluene	ND		0.500	ug/L						
Total Xylenes	ND		0.500	ug/L						
trans-1,2 Dichloroethylene	ND		0.500	ug/L						
trans-1,3-Dichloropropene	ND		0.200	ug/L						
trans-1-4-Dichloro-2-butene	ND		0.500	ug/L						
Trichloroethene	ND		0.500	ug/L						
Trichloroflouromethane	ND		0.500	ug/L						
Vinyl acetate	ND		0.500	ug/L						
Vinyl Chloride	ND		0.200	ug/L						
Surrogate: Toluene-d8			*5.01*	*ug/L*	*5.00*		*100*	*70-130*		
Surrogate: 1,2-Dichlorobenzene-d4			*5.01*	*ug/L*	*5.00*		*100*	*70-130*		
Surrogate: 4-Bromofluorobenzene			*4.99*	*ug/L*	*5.00*		*99.8*	*70-130*		

Anatek Labs, Inc.

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504 E Sprague Ste. D - Spokane, WA 99202 - (509) 838-3999 - fax (509) 838-4433 - email spokane@anateklabs.com

Quality Control Data
(Continued)

Volatiles (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0645 - W VOC (Continued)										
LCS (BBG0645-BS1)					Prepared & Analyzed: 7/21/2021					
1,1-Dichloroethylene	4.43		0.500	ug/L	5.00		88.6	70-130		
Benzene	4.38		0.500	ug/L	5.00		87.6	70-130		
Chlorobenzene (Monochlorobenzene)	4.37		0.500	ug/L	5.00		87.4	70-130		
Ethylbenzene	4.41		0.500	ug/L	5.00		88.2	70-130		
o-Xylene (MCL for total)	4.57		0.500	ug/L	5.00		91.4	70-130		
Tetrachloroethylene	3.68		0.500	ug/L	5.00		73.6	70-130		
Toluene	4.30		0.500	ug/L	5.00		86.0	70-130		
Trichloroethene	4.17		0.500	ug/L	5.00		83.4	70-130		
Surrogate: Toluene-d8			*5.00*	*ug/L*	*5.00*		*100*	*70-130*		
Surrogate: 1,2-Dichlorobenzene-d4			*5.08*	*ug/L*	*5.00*		*102*	*70-130*		
Surrogate: 4-Bromofluorobenzene			*5.03*	*ug/L*	*5.00*		*101*	*70-130*		

Quality Control Data
(Continued)

Volatiles SIM

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0624 - W VOC										
Blank (BBG0624-BLK1)					Prepared & Analyzed: 7/20/2021					
Vinyl Chloride	ND		0.0200	ug/L						
Acrylonitrile	ND		0.0700	ug/L						
EDB (screening)	ND		0.0100	ug/L						
Surrogate: Toluene-d8			*5.01*	*ug/L*	*5.00*		*100*	*70-130*		
Surrogate: 4-Bromofluorobenzene			*4.91*	*ug/L*	*5.00*		*98.2*	*70-130*		
Surrogate: 1,2-Dichlorobenzene-d4			*5.08*	*ug/L*	*5.00*		*102*	*70-130*		
LCS (BBG0624-BS1)					Prepared & Analyzed: 7/20/2021					
Vinyl Chloride	1.90		0.0200	ug/L	2.00		95.0	70-130		
Acrylonitrile	1.98		0.0700	ug/L	2.00		99.0	70-130		
EDB (screening)	2.13		0.0100	ug/L	2.00		106	70-130		
Surrogate: Toluene-d8			*5.02*	*ug/L*	*5.00*		*100*	*70-130*		
Surrogate: 4-Bromofluorobenzene			*5.07*	*ug/L*	*5.00*		*101*	*70-130*		
Surrogate: 1,2-Dichlorobenzene-d4			*5.04*	*ug/L*	*5.00*		*101*	*70-130*		
Batch: BBG0686 - W VOC										
Blank (BBG0686-BLK1)					Prepared & Analyzed: 7/22/2021					
Vinyl Chloride	ND		0.0200	ug/L						
Acrylonitrile	ND		0.0700	ug/L						
EDB (screening)	ND		0.0100	ug/L						
Surrogate: Toluene-d8			*5.05*	*ug/L*	*5.00*		*101*	*70-130*		
Surrogate: 4-Bromofluorobenzene			*4.73*	*ug/L*	*5.00*		*94.6*	*70-130*		
Surrogate: 1,2-Dichlorobenzene-d4			*4.99*	*ug/L*	*5.00*		*99.8*	*70-130*		
LCS (BBG0686-BS1)					Prepared & Analyzed: 7/22/2021					
Vinyl Chloride	1.64		0.0200	ug/L	2.00		82.0	70-130		
Acrylonitrile	2.02		0.0700	ug/L	2.00		101	70-130		
EDB (screening)	2.07		0.0100	ug/L	2.00		104	70-130		
Surrogate: Toluene-d8			*5.02*	*ug/L*	*5.00*		*100*	*70-130*		

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Quality Control Data
(Continued)

Volatiles SIM (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: BBG0686 - W VOC (Continued)										
LCS (BBG0686-BS1)					Prepared & Analyzed: 7/22/2021					
Surrogate: 4-Bromofluorobenzene			*4.86*	*ug/L*	*5.00*		*97.2*	*70-130*		
Surrogate: 1,2-Dichlorobenzene-d4			*4.92*	*ug/L*	*5.00*		*98.4*	*70-130*		

WBG0576

Due: 07/30/21

ANATEK LABS

Chain of Custody Record

Anatek L
1282 Alturas Drive, Mosco
504 E Sprague Ste D, Spoka

Turn A

Company Name: Great West	Project Manager: Craig Sauer
Address: 9221 N. Division St	Project Name & #: Asotin County
City: Spokane State: WA Zip: 99218	Purchase Order #: Steve Becker
Phone: 509.994.9938	Sampler Name & Phone: Craig Sauer
Email Address(es): Csauer@greatwesteng.com	509.994.9938

Please refer to our normal turn around times at www.anateklabs.com/pricing-lists

✓ Normal
_Next Day*
_2nd Day*
_Other*_____

_Phone
_Email

*All rush order requests must have prior approval

List Analyses Requested

Lab ID	Sample Identification	Sampling Date/Time	Matrix	# of Containers	Sample Volume	VOC's	TOTAL METALS	Gen. Chem	major ions					
	071521-MW23	07/15 0915	WATER	12		X	X	X	X					
	071521-MW24	07/15 1015	WATER	12		X	X	X	X					

Preservative:

Note Special Instructions/Comments

* Same analyses as Asotin quarterly sampling
* LAB to filter if needed.

Inspection Checklist

Received Intact?	Y	N
Labels & Chains Agree?	Y	N
Containers Sealed?	Y	N
~~No~~ VOC Head Space?	Y	N
Cooler?	Y	N
Ice/Ice Packs Present?	Y	N

Temperature (°C): 6.8°C IR#1
Number of Containers: 24
Shipped Via: Hand
Preservative: NaOH 2000405 pH>10
HCl 59072 pH<2 H_2SO_4 2004162 pH paper 2001015
Date & Time: 7-15-21 / 1600
Inspected By: KAS

	Printed Name	Signature	Company	Date	Time
Relinquished by	Craig Sauer	[signature]	Great West	7/15	1600
Received by	Kathy Sattler	Kathy Sattler	Anatek Labs	7-15-21	1600
Relinquished by					
Received by					
Relinquished by					
Received by					

Samples submitted to Anatek Labs may be subcontacted to other accredited labs if necessary. This message serves as notice of this possibility. Subcontracted analyses will be clearly noted on the analytical report.

APPENDIX B

Future Proposed Work to Expand VE System

B.1 Concept Design to Expand VE System

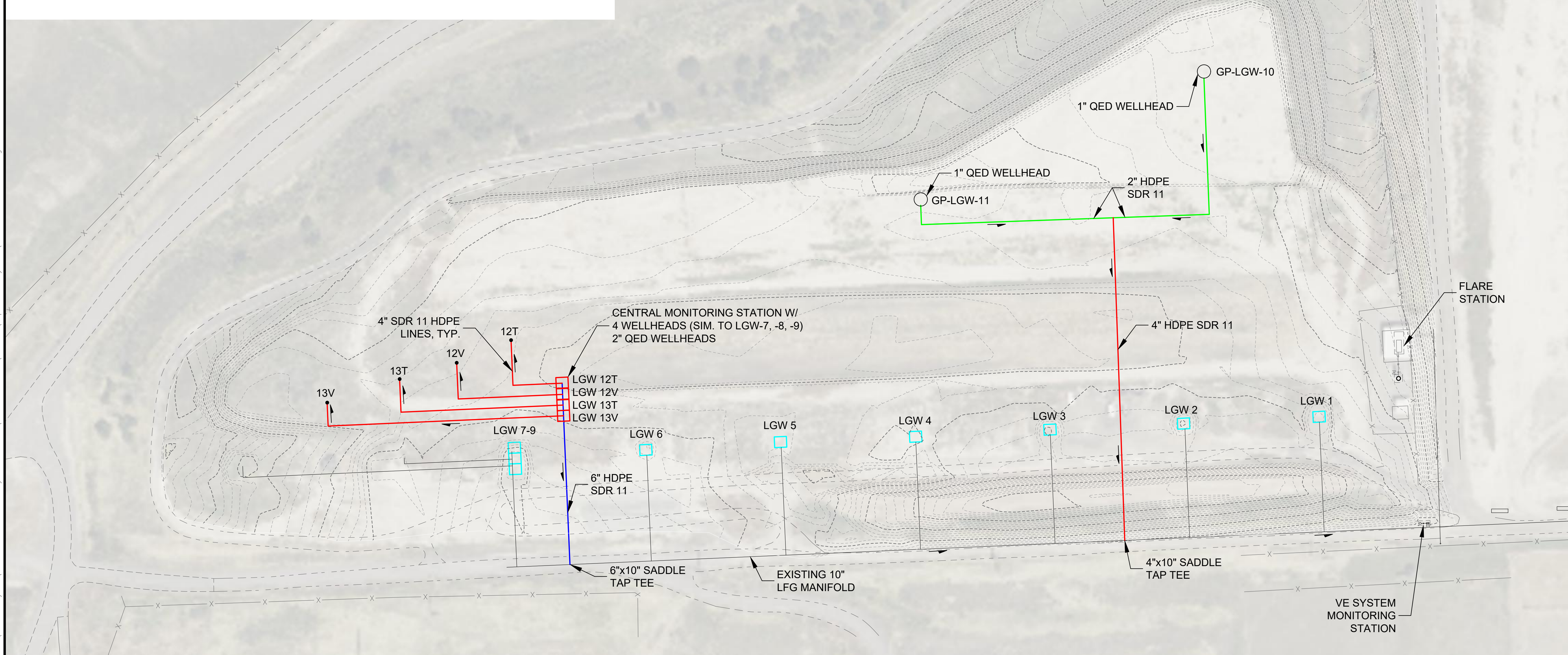
EXPLANATION OF PLAN TO EXPAND THE VAPOR EXTRACTION SYSTEM:

GENERAL: THE PLAN CONSISTS OF ADDING 6 MORE VAPOR EXTRACTION LOCATIONS TO THE EXISTING ACTIVE VAPOR EXTRACTION SYSTEM; CONSISTING OF PLUMING IN TWO EXISTING LOCATIONS (GP-LGW-10, GP-LGW-11) FOR ACTIVE VAPOR EXTRACTION, PLUS THE DRILLING AND CONSTRUCTION OF FOUR (4) NEW GAS EXTRACTION WELLS LOCATED IN THE WEST END OF THE CLOSED LANDFILL IN THE PRIMARY SOURCE AREA AS DESCRIBED IN THE *DRAFT REMEDIAL INVESTIGATION AND FEASIBILITY STUDY REPORT FOR CLOSED LANDFILL AT THE ASOTIN COUNTY REGIONAL LANDFILL* (CH2M HILL, 2010). DETAILS OF THESE PLANS ARE EXPLAINED BELOW.

TWO EXISTING PASSIVE GAS MONITORING PROBES (GP-LGW-10, AND GP-LGW-11) WILL BE TRANSITIONED TO ACTIVE GAS EXTRACTION WELLS BY INSTALLATION OF SURFACE MONITORING ASSEMBLIES TO QUANTIFY FLOW, COLLECT CONTAMINANT VAPOR SAMPLES, AND CONNECTED TO THE ACTIVE GAS EXTRACTION SYSTEM, VIA 2” HDPE AND 4” HDPE, PLUMED INTO THE MAIN-LINE EXTRACTION SYSTEM, AND ROUTED THROUGH THE COMBINED MONITORING STATION, AND THEN ULTIMATELY TO THE FLARE STATION FOR THERMAL DESTRUCTION.

FOUR NEW EXTRACTION LOCATIONS WILL BE DRILLED AND CONSTRUCTED AS NEW GAS EXTRACTION WELLS, LOCATED IN THE SOURCE AREAS IN THE WESTERN END OF THE CLOSED LANDFILL, SHOWN AS BLACK DOTS AND LABELED LGW-12T, LGW-12V, LGW-13T, AND LGW-13V. THE **BLACK DOTS** REPRESENT THE PLAN-VIEW LOCATION OF THE VERTICAL GAS EXTRACTION PROBES; THE LOCATIONS LGW-12T AND LGW-13T (TRENCH) REFER TO A TRENCH INSTALLATION WHEREBY THE GOAL OF THE EXTRACTION WELL IS TO EXTRACT VAPOR FROM FORMER WASTE TRENCH (REFUSE) ESTIMATED TO BE APPROXIMATELY 50 FT DEEP; WHEREAS THE LOCATIONS OF LGW-12V AND LGW-13V (VADOSE) REFER TO A DEEPER PROBE INSTALLATION TO DEPTHS OF UP TO 80 FT BGS WHEREBY THE GOAL OF THE EXTRACTION WELL IS TO SCREEN ADJACENT TO NATIVE SOILS BENEATH THE WASTE TRENCH. THE **RED LINES** AND RED BOXES REPRESENT THE CONFIGURATION OF THE EXTRACTION LINES AND ASSOCIATED SURFACE MONITORING ASSEMBLIES, WHICH WILL BE CONSTRUCTED WITH QED STYLE MONITORING ASSEMBLIES TO FACILITATE COLLECTION OF FIELD READINGS FOR FLOW AND LANDFILL GAS, PLUS THE COLLECTION OF CONTAMINANT VAPOR CONCENTRATIONS. THE CENTRALIZED SURFACE MONITOR ASSEMBLIES (RED BOXES) WILL BE SIMILAR TO THE CENTRALIZED MONITORING ASSEMBLIES ON-SITE FOR EXISTING LGW-7, LGW-8, AND LGW-9. A DRILLING CONTRACTOR WILL BE REQUIRED TO INSTALL THE NEW VERTICAL PROBES; A GENERAL CONSTRUCTION CONTRACTOR WILL BE NEEDED FOR THE PLUMBING OF THE LATERAL LINES AND CONSTRUCTION OF THE MONITORING ASSEMBLIES.

THE NEW GAS EXTRACTION WELLS AS DESCRIBED ABOVE WILL BE MONITORED FOR A MINIMUM OF 1 YEAR TO DETERMINE IF A GIVEN LOCATION SUPPORTS CONTINUED LONG-TERM EXTRACTION AND RELATED MONITORING OF THE SYSTEM.



LEGEND

□	EXISTING LANDFILL GAS WELLS (LGWs)	green line	2" HDPE SDR 11
•	PROPOSED VERTICAL GAS EXTRACTION WELLS (SEE INSET DESCRIPTIONS OF TRENCH VERSUS VADOSE ZONE)	red line	4" HDPE SDR 11
○	EXISTING, UNCONNECTED LANDFILL GAS WELLS (LGWs)	blue line	6" HDPE SDR 11
□ (red)	PROPOSED CENTRALIZED SURFACE MONITORING STATION/WELLHEADS (SEE INSET DESCRIPTION OF CENTRALIZED MONITORING STATION)	arrow	CONDENSATE DRAINAGE DIRECTION

0 75 150
SCALE IN FEET

GreatWest ENGINEERING

Appendix B.1 Concept Design to Expand the VE System
Closed Landfill Cleanup Action Plan and Compliance Monitoring

\EgnyteDrive\greatwesteng\Shared\Boise Projects\4-17110-Asotin County SW Services\CADD 4-17110\Exhibits\Expand VE System\4-17110-EM-FIG01.dwg

B.2 Opinion of Cost

GreatWest ENGINEERING

ENGINEER'S OPINION OF COST

PROJECT **Asotin County Vapor Extraction System Expansion**	PROJECT NO. **4-17110**	DATE 1/17/2024	
	ESTIMATOR **D. Breedlove/PE**	REVIEWER(S) **T.Pyle/C.Sauer**	

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
General Conditions					
	GC Mobilization and Demobilization / General Conditions	1	LS	$55,000	$55,000
	State of Washington Drilling Permits	4	EA	$200	$800
New LGWs					
	Specialty Driller Mobilization (Bucket Auger Rig)	1	LS	$50,000	$50,000
	3-ft Diam Well Boring (4 Locations)	360	LF	$75	$27,000
	6" Well Screen	170	LF	$85	$14,450
	6" Well Casing (Blank)	190	LF	$70	$13,300
	Annular Gravel	90	CY	$55	$4,950
	Bentonite Annular Seal	10	CY	$700	$7,000
	Well Surface Completion	4	EA	$3,000	$12,000
	2" QED Wellheads	4	EA	$3,500	$14,000
	Monitoring Station Pad	1	LS	$12,000	$12,000
	Buried gas line (4" HDPE SDR 11)	1020	LF	$45.00	$45,900
	Buried gas line (6" HDPE SDR 11)	250	LF	$65.00	$16,250
	6"x10" Saddle Tap Tee Connection	1	LS	$1,500	$1,500
Existing 1" Wells					
	1" QED Wellheads	2	EA	$2,800	$5,600
	Buried gas line (2" HDPE SDR 11)	660	LF	$38.00	$25,080
	Buried gas line (4" HDPE SDR 11)	480	LF	$45.00	$21,600
	4"x10" Saddle Tap Tee Connection	1	LS	$1,300	$1,300
		Construction Subtotal 1			**$327,730**
		Contingency		30%	$98,319
		Construction Subtotal 2			**$426,049**
		Sales and Use Tax		8%	$34,084
		TOTAL CONSTRUCTION			**$460,133**
		Engineering Services		20%	$92,027
		PROJECT TOTAL (rounded)			**$553,000**

Notes:

This Opinion of Probable Cost is the opinion of the engineer of the probable construction cost based on conceptual layouts as provided by the Architect, and is supplied as a guide only. Since the engineer has no control over the costs of labor and materials or over competitive bidding and market conditions, the engineer does not guarantee the accuracy of such opinion as compared to contractor's bids or actual costs to the owner.

B.3 CAP Reserve Account Financials

Appendix B.3
Closed Landfill – CAP Reserve Account

Asotin County Regional Landfill
Closed Landfill CAP Reserve Account Contribution Summary
February 2025

Period	Year	Forecasted In-Coming MSW Tonnage	Annual CAP Costs	Design & Const. Costs	Total CAP Costs	CAP Reserve Acct. Contribution	End-Year Fund Balance	$/ton	Notes/Comments/Inputs
1	2024	63,217	$49,000	$0	$49,000	---	$58,887	---	"LF Old Post-Closure Monitoring" Fund (per C. Kemp)
2	2025	63,993	$50,259	$0	$50,259	$161,263	$171,983	$2.52	<setpoint #1 >$50K for D&C in 2028/2029>
3	2026	64,782	$51,551	$0	$51,551	$163,249	$287,486	$2.52	<Set min fund balance of ~$50k>
4	2027	65,583	$52,876	$0	$52,876	$165,268	$405,430	$2.52	Rates:
5	2028	66,396	$54,235	$101,858	$156,093	$180,553	$437,326	$2.72	Rate of Inflation = 2.57% (estimate)
6	2029	67,223	$55,629	$522,378	$578,007	$182,802	$50,052	$2.72	Interest Rate Earned = 1.50% (estimate)
7	2030	68,063	$57,058	$34,934	$91,992	$185,086	$145,285	$2.72	
8	2031	68,917	$58,525	$0	$58,525	$68,917	$158,373	$1.00	
9	2032	69,784	$60,029	$0	$60,029	$69,784	$171,027	$1.00	Post-Closure Annual Costs:
10	2033	70,666	$61,571	$0	$61,571	$70,666	$183,217	$1.00	$49,000 Total closure cost (2025$)
11	2034	71,561	$63,154	$0	$63,154	$93,030	$216,539	$1.30	<setpoint #2 >$50k for second D&C in 2048/2049>
12	2035	72,472	$64,777	$39,659	$104,436	$94,213	$210,271	$1.30	
13	2036	73,397	$66,442	$0	$66,442	$95,416	$243,115	$1.30	Capital Costs
14	2037	74,338	$68,149	$0	$68,149	$104,283	$283,678	$1.40	Recovery System Upgrade / Plan Updates:
15	2038	75,294	$69,901	$0	$69,901	$105,624	$324,449	$1.40	<see D&C Schedule Tab>
16	2039	76,266	$71,697	$0	$71,697	$106,987	$365,408	$1.40	
17	2040	77,253	$73,540	$45,024	$118,564	$116,945	$370,148	$1.51	
18	2041	78,258	$75,430	$0	$75,430	$118,466	$419,625	$1.51	
19	2042	79,279	$77,368	$0	$77,368	$120,011	$469,462	$1.51	
20	2043	80,317	$79,357	$0	$79,357	$131,200	$529,331	$1.63	
21	2044	81,372	$81,396	$0	$81,396	$132,924	$589,796	$1.63	
22	2045	82,445	$83,488	$51,115	$134,603	$134,677	$599,727	$1.63	
23	2046	83,537	$85,634	$0	$85,634	$147,253	$671,446	$1.76	
24	2047	84,646	$87,834	$0	$87,834	$149,209	$744,012	$1.76	
25	2048	85,775	$90,092	$137,895	$227,987	$151,198	$679,517	$1.76	
26	2049	86,922	$92,407	$707,197	$799,604	$165,340	$56,686	$1.90	
27	2050	88,089	$94,782	$58,030	$152,812	$167,560	$73,542	$1.90	
28	2051	89,276	$97,218	$0	$97,218	$169,818	$148,518	$1.90	
29	2052	90,483	$99,716	$0	$99,716	$93,198	$144,927	$1.03	
30	2053	91,711	$102,279	$0	$102,279	$94,462	$139,992	$1.03	
31	2054	92,960	$104,908	$0	$104,908	$95,748	$133,651	$1.03	
32	2055	94,230	$107,604	$65,880	$173,483	$103,653	$66,603	$1.10	
33	2056	95,522	$110,369	$0	$110,369	$105,074	$63,095	$1.10	<setpoint #3 - >$50k for final balance in 2058>
34	2057	96,837	$113,206	$0	$113,206	$106,520	$58,155	$1.10	
35	2058	98,174	$116,115	$0	$116,115	$107,991	$51,714	$1.10	<Keep fund contribution the same for the last year>

APPENDIX C

Groundwater Monitoring Sampling and Analysis Plan (SAP)

Presented by:

Appendix C

Groundwater Monitoring Sampling and Analysis Plan for Closed Landfill

ASOTIN COUNTY REGIONAL LANDFILL

December 2024

Client Commitment Empowered Employees Quality Solutions

APPENDIX C

ASOTIN COUNTY REGIONAL LANDFILL

Groundwater Monitoring Sampling and Analysis Plan for Closed Landfill

December 2024

FORWARD

Appendix C is part of the Closed Landfill Cleanup Action Plan (CAP) and supports the objectives of the compliance monitoring plan (CMP) for groundwater media. It is intended to be both part of the CAP and CMP via appendix, but also effectively a stand-alone guidance document for the groundwater monitoring Sampling & Analysis Plan (SAP). This SAP includes appropriate levels of quality assurance and quality control (QA/QC) to be considered a combined SAP/quality assurance project plan (QAPP). The functional and procedural elements of this SAP/QAPP may be used as a stand-alone document via field staff to perform the necessary groundwater monitoring activities; in addition, this procedural document may be updated or optimized without the need to amend or modify the CAP and CMP objectives.

TABLE OF CONTENTS

List of Exhibits (tables)

List of Figures

List of Attachments

*****Denotes items established CAP also carried forward in the SAP to be a stand-alone document.***

C.1.0 Groundwater Monitoring Program

Exhibit C.1 summarizes the groundwater monitoring network and well construction details, along with the sampling frequency for the two groups of wells (either semi-annual, or annual). **Figure C.1** shows the monitoring well locations, and each well has been annotated to show gradient designation (upgradient, or downgradient), and whether it's in the "perimeter group" sampling frequency of semi-annual, or if it's in the "downgradient group" frequency of annual monitoring.

Exhibit C.2 summarizes the groundwater parameters, test methods, reporting limits, and applicable groundwater quality criteria. **Exhibit C.3** summarizes the groundwater field-measured performance criteria. **Exhibit C.4** summarizes the groundwater sample containers, preservatives, and hold times.

The subsequent sections provide functional details for groundwater monitoring at each well, and assumes the well network, parameters, and frequency as described above.

C.2.0 Groundwater Monitoring Methods

C.2.1 Sampling Method and Standard Operating Procedures

The goal of groundwater sampling is to collect samples that are representative of in situ groundwater conditions and to minimize changes in groundwater chemistry during sample collection and handling. The general approach for routine groundwater sampling will rely on using dedicated purge pumps and discharge tubing, to support with the 'low flow' or low stress groundwater sampling method as described by *US EPA Low Stress (low flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EPA, 2017), and as cited in *Guidance for Monitoring at Landfills and Other Facilities Regulated Under Chapters 173-304, 173-306, 173-350, and 173-351* (Ecology 2018). ACRL has equipped all wells with dedicated submersible low-flow pumps to support with low-flow sampling; details on purge pump depth are included in **Exhibit C.1**.

Attachment C.1 includes a blank form to document sample activities and field parameters for each well; and also includes EPA guidance on the low-flow sample method. The standard procedures for collection of groundwater samples following the low-flow sampling technique are described below.

Well Inspection

Prior to sampling, each well will be visually inspected each quarter upon arrival for any signs of damage or tampering of the outer protective monuments, well casing, and the well cap or seal. Visual evidence of damage or tampering will be recorded on the field sampling forms. The field sampling forms will also be used at each well to record the purging and sampling data (described in steps that follow). If a well seal or well casing is found to be damaged or broken, the field sampling leader will notify ACRL's Solid Waste Manager. In coordination with Ecology, any suspect or damaged wells included in the monitoring program will be repaired or replaced.

Static Depth to Water (DTW)

The static depth to water is measured in each well prior to the well purging activities. The static depth to water is converted to groundwater elevation and used for reporting requirements as described in Section 4. Procedures for static measurement are provided in the following text.

The well cap (or protective cap) will be removed and static depth to water (DTW) measured before purging. Measurements will be read to the nearest 0.01 foot, using an electronic water level indicator probe. The DTW will be measured from known datum (top of polyvinyl chloride [PVC] casing) and compared to the expected DTW range. If the two measurements vary considerably (greater than 5 feet), the water level will be measured again for verification. The verified level will be recorded as “static” on the dedicated field sampling forms.

Water level indicator probes will be decontaminated before and after measuring each monitoring well by spraying them with a solution of Alconox and deionized water, rinsing with deionized water, and then wiping with paper towels. To prevent potential cross-contamination from the water-level indicator, the typical sampling sequence will start at the upgradient well locations and progress to downgradient wells.

Well Purging and Field Methods

The low-flow sampling (purging) procedures consist of purging a well with a variable-flow pump at a low rate (typically less than 0.15 liter per minute). The groundwater level will be monitored during the purging cycle, and the pumping rate will be adjusted (reduced) to a point where the flow rate matches the well recharge rate (as indicated by a stabilized groundwater level during the active purge process). Once the purge cycle begins, field measured parameters consisting of temperature, pH, and specific conductance (SC) will be measured at approximately 3- to 5-minute intervals using a multi-parameter monitoring probethat provides in-situ readings of temperature, pH, and specific conductance. **Exhibit C.3** presents the field parameters and groundwater stabilization criteria. Field measurements and water levels will be recorded on a dedicated field sampling form and retained for the permanent sampling record.

Following the third consecutive set of field readings, and when pH and SC indicator parameters have stabilized to within ± 0.1 for pH and ± 3 percent for SC, the groundwater quality sample collection process will begin (details of collecting groundwater samples provided in following text). If purge time reaches 1 hour and the field criteria have not been met, a sample may be collected and details of the purge process will be retained on the field sampling sheets.

Sample Collection

Exhibit C.2 summarizes the detection monitoring analytical parameters and methods. Groundwater samples will be collected in laboratory-supplied sampling containers after the low-flow purge criteria have been satisfied (described above).

Exhibit C.4 summarizes the monitoring sample containers, preservatives, and hold times; Samples will be collected directly from the dedicated discharge tubing into the laboratory supplied containers being filled using a low-flow rate of approximately 0.1 liter per minute. To the extent possible, samples will be collected to limit the atmospheric contact between the discharge water and the sampling container. Disposable latex (or nitrile) gloves will be worn while handling sampling containers and while collecting the water-quality sample. Sampling gloves will be discarded after each sampling location. New gloves will be used at each new sampling location.

The unique sample identification and time will be recorded on the sampling bottles, field forms, and transferred onto the chain-of-custody (COC) forms. Details regarding sample documentation, handling, and quality control are provided in **Section C.3**.

C.3.0 Field Procedures and Quality Control

C.3.1 Sample ID and Field Documentation

Sample labels will be affixed to containers prior to collection of the groundwater sample. Labels will use the following system for unique sample identification during each event:

“XXXX-DDMMYY” for groundwater samples

Where:

XXXX = unique well ID (typically 4 digits; well MW-01 would be “MW01”)

DDMMYY = unique sampling date where YY is last 2 digits of year; MM is 2-digit month; and DD is 2-digit date.

For example, the unique sample identification for well sampling on March 22, 2015, at Well MW01 would be “MW01-150322.” The FD sample will be labeled as “FD” with the unique date—for example, “FD-DDMMYY.” The sample location for the FD will be recorded on the field forms and retained for permanent record to distinguish the location in which the sample was collected. All sample labels will have additional information such as date and sample time to complete the singularity of each sample.

Specific information and observations will be recorded on dedicated groundwater sampling field sampling forms during sampling. The most important information to be documented is as follows:

- Sampling team personnel
- Monitoring well purging data (including purge method, rate, total volume removed during evacuation, water levels at the beginning, during, and end of the purging process)
- Field parameters (temperature, pH, and SC) collected during monitoring well purging, including field meter used to collect parameters
- Sample identification and time on each bottle
- Management of purge water (discharge onto ground)
- Miscellaneous observations regarding well integrity, other nearby field activities and equipment problems/troubleshooting measures

Dedicated field sampling forms provide a convenient format for recording the information listed above for groundwater sampling.

C.3.2 Sample Handling

Specific procedures for sample packaging and shipping will be followed to ensure sample quality and minimize breakage during transport to the analytical testing laboratory. Sample handling includes sample preservation, sample custody, sample packaging, and sample shipment procedures as described in the following text.

Sample Preservation:

Some sample types require preservation to retard biological action, slow hydrolysis, and reduce sorption effects. Preservation methods generally consist of pH control through chemical addition (for example, sulfuric acid or nitric acid), refrigeration (chill to 4°C), and protection from light.

Samples will be placed in a cooler containing ice immediately after collection and held under COC until samples are ready for transport or shipment to the testing laboratory. When a chemical preservative is needed for selected parameters, the laboratory will provide bottles with appropriate preservatives (for example, sulfuric acid or nitric acid). Bottles prepared with preservation will be pre-labeled and identified as ”preserved” in order to distinguish them from unpreserved bottles.

Exhibit C.4 summarizes the sample containers, preservatives (if needed), and hold times for the groundwater monitoring parameters.

Sample Custody (COC Record)

Field personnel will maintain custody records on-site for all samples collected as part of the monitoring program. A COC record will be completed for each container (cooler) or batch of samples relinquished to the testing laboratory and include the following information at a minimum:

- Date and time of sample collection
- Place of collection
- Type of sample
- Sample identification number
- Type of container(s)
- Analytical test methods (in accordance with the methods listed in Appendix A and/or B as appropriate)
- Signature of sampler
- Signature of receiver

Sample containers will be labeled at the time of collection with the unique sample number, date, and time collected. Sample numbers will be recorded on the COC form along with the time the sample was collected. COC forms will be signed and filled out for each cooler or batch of samples to be relinquished to the laboratory. If coolers are shipped, the COC form will be sealed in a clear plastic bag and placed in the cooler (typically taped to the inside lid of the cooler). The COC forms will be kept onsite (or on file) as part of the permanent sampling record.

Sample Packaging

Because the testing laboratory (Anatek) provides courier services to the testing facility (in Moscow, Idaho), the samples are maintained in full custody by the sampling lead from the time of sampling until they are delivered and relinquished to the laboratory. During sampling, the samples are placed in coolers containing ice to maintain target temperature of 4° ± 2°C and to protect bottles from breaking.

If shipping is necessary, samples will be handled and packaged appropriately to maintain complete COC records and prevent damage during transit or shipment. Coolers, provided by the contract laboratory, will be used for shipping sample containers. Bubble wrap will be used to pack and cushion the sample containers in the cooler (if shipped or mailed by a third-party courier such as Fed-Ex). The COC form will be placed in a sealed (zip-lock) plastic bag and attached to inside of the cooler lid. COC seals will be attached at both the front and back of container. The name and address of the receiving laboratory will be placed in a position clearly visible on the outside of the cooler, and the lid will be secured with strapping tape.

Sample Transport or Shipment

ACRL's contracted laboratory is Anatek with testing facilities in Moscow (Idaho) and Spokane (Washington). Samples will be packaged as described previously and transported by the courier same-day of collection from the site directly to the testing facility.

If shipment of samples is necessary, samples will be shipped in accordance with U.S. Department of Transportation approved procedures for hazardous substances. Samples will be shipped to the contracted laboratory for analysis via a courier that can deliver the samples to meet the shortest holding time requirement (for example, Fed-Ex).

The following will be followed when shipping the cooler:

- Coolers will be shipped to the appropriate laboratory by courier. All samples will be shipped as soon as possible after collection and conform to applicable hold times.
- Groundwater quality samples will be shipped directly to a certified laboratory.

After the samples have been shipped, the field sampler will verify samples were received by the laboratory and troubleshoot if necessary.

C.3.3 Calibration of Field Equipment

The following field equipment will be used to support the groundwater sampling activities:

- Electronic water level indicator (graduated to 0.01-foot increments and capable of recording measurements to the bottom of each well)
- pH meter with temperature display
- Conductivity meter with temperature compensation

Exhibit C.4 lists the field meter accuracy and range for each parameter. Calibration will be performed prior to each sampling event or in accordance with the manufacturer's specifications. The field meter will be recalibrated if inconsistent or suspect readings are obtained. If the meter fails to calibrate to within the manufacturer's guidelines, the unit will be evaluated for probe replacement and/or shipped to a certified vendor for repair.

C.3.4 Decontamination

To the extent practicable and possible, the sampling equipment used for water sampling is either dedicated (for example, dedicated polyethylene tubing connected to the purge pumps) or is used new and consumed during each sampling event. Sample containers with preservative (when needed) are provided by the contract laboratory for each sampling event and are discarded after use. All field meters and their probes are cleaned and rinsed with water between sample locations and at the end of each sampling event.

All nondedicated field equipment used during sampling activities will be decontaminated using the following procedure:

- Wash with nonphosphate detergent

- Rinse with deionized water
- Air dry (or dried with clean paper towel)

The decontamination procedure will be performed prior to sampling at each location to avoid cross-contamination. Excess decontamination water is expected to be minimal and will be managed as described in the next section.

C.3.5 Management of IDW

Investigation-derived waste developed from the sampling activities may consist of minor quantities of decontamination water (as described above), excess purge water during groundwater sampling, and consumable sampling supplies. Protocol for handling these wastes is described in the following text.

Decontamination water and excess purge water from groundwater sampling will be temporarily containerized at each location and discharged into the on-site sanitary sewer system (same as leachate collection system, etc). The excess purge volume from low-flow sampling is typically less than 0.5 gallon per well for a given sampling event.

Consumable sampling supplies (for example, paper towels, nitrile gloves, sample tubing, and packaging supplies) will be containerized in plastic trash bags and disposed of within the active cell area.

C.4.0 Laboratory Procedures and Quality Control

C.4.1 Quality Control Samples

QC samples will be collected during each quarterly sampling event to assist in determining data quality and reliability. QC samples include field duplicates (FDs), blank samples, and laboratory QC samples (for matrix spike [MS] and matrix spike duplicate [MSD] analyses). QC samples are normally collected from locations that are suspected to be of moderate concentrations (for example, downgradient well locations). QC samples will be collected using the same procedures and immediately following collection of the target or “normal” sample. The assessment of QC samples is described in Section 4 of the CAP/CMP.

FD samples will be collected at a minimum frequency of one FD per sampling event. A FD is an independent sample collected as close as possible to the original sample from the same source and is used to assess sampling precision. FDs will be labeled and packaged in the same manner as normal samples so that the laboratory cannot distinguish between normal samples and duplicates. Each FD will be taken using the same sampling and preservation method as other samples.

Laboratory QC samples will be collected to perform MS and MSD analyses and will be collected at a frequency of one MS/MSD per sample event. An MS is an aliquot of a sample spiked with a known concentration of target analyte(s). An MS analysis provides a measure of the method accuracy. The MSD is a laboratory split sample of the MS and is used to determine the precision of the method. Twice the normal sample volume will be collected for laboratory QC samples. Laboratory QC samples will be labeled as such on sample bottles and field sampling forms.

C.4.2 Quality Control Methods and Procedures

The contracted testing laboratory is Anatek with offices in Moscow (Idaho) and Spokane (Washington). Anatek is an accredited laboratory approved by Ecology and is certified per NELAP. The laboratory provides drop-off service of the quarterly bottle orders to the laboratory, to include pre-labeled sample sets and preservatives to meet the parameter/data needs of this SAP. The laboratory also provides same-day courier service to pick up samples from the landfill and deliver them same-day of sampling directly to their testing laboratory under their custody by the courier.

Samples will be transported in coolers packed with ice to preserve them at the target temperature of 4° ± 2°C. Upon receipt of the samples, the laboratory uses an infrared temperature probe to determine the internal temperature of the cooler. If the temperature of samples upon receipt exceeds temperature requirements, the exceedance will be documented in the laboratory report and communicated to the sample coordinator. Given the short time interval between sample collection and delivery to the laboratory, it is common to have the 'as-received' temperature above the target transport temperature, which is not considered a deviation in protocol or outside the quality control guidelines.

Once samples reach the laboratory, they will be checked against information on the COC form for anomalies. The condition, temperature, and appropriate preservation of samples will be checked and documented on the COC form. The occurrence of any anomalies in the received samples and their resolution will be documented in laboratory records. All sample information will then be entered into a tracking system, and unique analytical sample identifiers will be assigned. A copy of this information will be reviewed by the laboratory chemist for accuracy. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Procedures ensuring internal laboratory COC will also be implemented and documented by the laboratory. Specific instructions concerning the analysis specified for each sample will be communicated to the analysts. Analytical batches will be created, and laboratory QC samples will be introduced into each batch.

Once at the laboratory, samples will be stored in limited-access, temperature-controlled areas. Refrigerators and coolers will be monitored for temperature 7 days per week. Acceptance criterion for refrigerators and coolers temperatures is 4° ± 2°C. All cold storage areas will be monitored by thermometers that have been calibrated with a National Institute of Standards and Technology-traceable thermometer. As indicated by the findings of calibration, correction factors will be applied to each thermometer. Records that include acceptance criteria will be maintained. Samples will be stored after analysis until disposed of as applicable under local, state and federal regulations. Disposal records will be maintained by the laboratory.

- Laboratory QC procedures and documentation will include the following:
- Methodology and QC according to the analyte-specific methods listed in Appendix A.
- Instrument calibration and standards as defined in the analyte-specific methods listed in Appendix A
- Laboratory blank measurements at a minimum frequency of 5 percent or one per batch
- Accuracy and precision measurements at a minimum of 1 in 20, 1 per set
- Laboratory documentation

EXHIBITS

Exhibit C.1. Groundwater Monitoring Well Network
Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill
Asotin County Regional Landfill, near Clarkston, Washington

Well	Positional Coordinates		Date Completed	Boring Depth (ft bgs)	Ground Elevation (ft msl)	Elevation, Top-of-Casing (ft toc)	Screen Length (ft)	Screen Top (ft bgs)	Screen Bott. (ft bgs)	Screen Top (ft Elev.)	Screen Bott. (ft Elev.)	Gradient	Comments:
	X Coordinate	Y Coordinate											
Perimeter Well Group: Semi-Annual Monitoring Frequency.													
MW-1	400526.702	2494111.487	1190	170	1275.60	1276.63	18	149	167	1128	1110	Upgradient	
MW-11	400519.340	2493887.844	1993	170	1279.20	1280.47	10	155	165	1124	1114	Upgradient	
MW-03	401885.208	2494646.139	1990	99	1154.90	1156.35	10	88	98	1067	1057	Downgradient	Screened at base of uppermost groundwater, companion to MW-07
MW-04	401764.227	2494171.056	1990	65	1154.00	1155.07	20	44	64	1110	1090	Downgradient	Mainly sample for nitrate; typically ND or low for volatiles.
MW-05	401509.649	2493442.613	1990	91	1189.40	1191.16	20	70	90	1119	1099	Downgradient	
MW-06	401923.775	2495086.868	1990	87	1175.40	1176.82	20	65	85	1110	1090	Downgradient	Between closed and active landfill, observed contamination from CLF
MW-07	401896.654	2494655.653	1990	50	1154.60	1155.95	15	33	48	1121	1106	Downgradient	Shallow screen interval, companion to MW-03
MW-09	401680.747	2493772.709	1993	99	1192.30	1193.65	10	85	95	1107	1097	Downgradient	
MW-10	401252.185	2493136.543	1993	88	1191.80	1193.22	10	75	85	1117	1107	Downgradient	
MW-14S	402377.328	2494792.510	3/26/2009	20	1121.10	1123.30	10	10	20	1111	1101	Downgradient	Shallow screen interval, companion to MW-14d
MW-14D	402382.584	2494793.584	3/25/2009	79	1121.10	1123.33	13	58	71	1063	1050	Downgradient	Screened at base of uppermost groundwater, companion to MW-14s
MW-15	402903.413	2495247.487	3/27/2009	39	1100.50	1102.71	5	7.5	12.5	1093	1088	Downgradient	Often dry, sample if enough water (greater than 1 ft).
Downgradient Well Group: Annual Monitoring Frequency													
MW-23	403327.4486	2495802.932	6/4/2021	45	1076.6	1079.11	15	22	37	1055	1040	Downgradient	Sample to verify concentrations remain below cleanup levels; annual frequency.
MW-24	404057.1859	2496417.690	6/3/2021	125	1044.1	1046.85	20	100	120	944	924	Downgradient	Sample to verify concentrations remain below cleanup levels; annual frequency.
MW-22	406020.8094	2497054.419	12/8/2020	78	975.0	977.5	10	56	68	919	907	Downgradient	Dry; check for water, if present collect sample

Notes:
"--" Not available and/or not measured.
"ft" = feet
ft bgs = feet below ground surface
ft TOC = feet below top of casing (surveyed reference point)
ft Elev. = feet Elevation

Exhibit C.2. Groundwater Parameters, Reporting Limits, Water Quality Criteria, and Cleanup Levels
Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill
Asotin County Regional Landfill, near Clarkston, Washington

Ref. No.	Constituent	Test Method	Reporting Limit	Units	Water Quality Standard (WAC 173-200)
Field Parameters					
--	Temperature*	Field, Hand-held meter	0.1	Celcius	--
--	pH*	Field, Hand-held meter	0.01 Unitless	NA	6.5 - 8.5
--	Specific Conductance*	Field, Hand-held meter	1	umhos/cm	--
--	Static depth to groundwater	Field, Hand-held meter	0.01	ft	--
WAC 173-304 Parameters and Secondary COC					
1	Chloride*	EPA 300.0	1.5	mg/L	250
2	**Nitrate* (Secondary COC)**	EPA 300.0	0.1	mg/L	10
3	Nitrite*	EPA 300.0	0.1	mg/L	1
4	Ammonia*	SM 4500-NH3	0.0200	mg/L	NA
5	Sulfate*	EPA 300.0	1.5	mg/L	250
6	Iron (dissolved phase)*	EPA 6020B	0.01	mg/L	0.3
7	Manganese (dissolved phase)*	EPA 6020B	0.001	mg/L	0.05
8	Zinc (dissolved phase)*	EPA 6020B	0.001	mg/L	5
9	Total Organic Carbon*	SM 5310 B	0.1	mg/L	NA
10	Total Dissolved Solids (TDS)	SM 2540C	NA	mg/L	500
Primay COCs - Volatile Organic Constituents required per WAC 173-351. Method SW8260C/D					
17	Acetone	EPA 8260 D	2.5	ug/L	-
18	Acrylonitrile	EPA 8260 D	0.07	ug/L	0.07
19	Benzene	EPA 8260 D	0.5	ug/L	1
20	Bromochloromethane	EPA 8260 D	0.5	ug/L	-
21	Bromodichloromethane	EPA 8260 D	0.2	ug/L	0.3
22	Bromoform; Tribromomethane	EPA 8260 D	0.5	ug/L	5
23	Carbon Disulfide	EPA 8260 D	0.5	ug/L	-
24	Carbon Tetrachloride	EPA 8260 D	0.2	ug/L	0.3
25	Chlorobenzene	EPA 8260 D	0.5	ug/L	-
26	Chloroethane; Ethyl Chloride	EPA 8260 D	0.5	ug/L	-
27	Chloroform; Trichloromethane	EPA 8260 D	0.5	ug/L	7
28	Dibromochloromethane; Chlorodibromomethane	EPA 8260 D	0.5	ug/L	-
29	1,2-Dibromo-3-chloropropane; DBCP	EPA 8260 D	0.5	ug/L	-
30	1,2-Dibromoethane; Ethylene Dibromide; EDB	EPA 8260 D	0.01	ug/L	0.001
31	o-Dichlorobenzene; 1,2-Dichlorobenzene	EPA 8260 D	0.5	ug/L	-
32	p-Dichlorobenzene; 1,4-Dichlorobenzene	EPA 8260 D	0.5	ug/L	-
33	trans-1,4-Dichloro-2-butene	EPA 8260 D	0.5	ug/L	-
34	1,1-Dichloroethane; Ethylidene Chloride	EPA 8260 D	0.5	ug/L	1
35	1,2-Dichloroethane; Ethylene Dichloride	EPA 8260 D	0.5	ug/L	0.5
36	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene	EPA 8260 D	0.5	ug/L	-
37	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	EPA 8260 D	0.5	ug/L	-
38	trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	EPA 8260 D	0.5	ug/L	-
39	1,2-Dichloropropane; Propylene dichloride	EPA 8260 D	0.2	ug/L	-
40	cis-1,3-Dichloropropene	EPA 8260 D	0.5	ug/L	-
41	trans-1,3-Dichloropropene	EPA 8260 D	0.5	ug/L	-
42	Ethylbenzene	EPA 8260 D	0.5	ug/L	-
43	2-Hexanone; Methyl butyl ketone	EPA 8260 D	2.5	ug/L	-
44	Methyl bromide; Bromomethane	EPA 8260 D	0.5	ug/L	-
45	Methyl chloride; Chloromethane	EPA 8260 D	0.5	ug/L	-
46	Methylene bromide; Dibromomethane	EPA 8260 D	0.5	ug/L	-
47	Methylene chloride; Dichloromethane	EPA 8260 D	0.5	ug/L	5
48	Methyl ethyl ketone; MEK; 2-Butanone	EPA 8260 D	2.5	ug/L	-
49	Methyl iodide; Idomethane	EPA 8260 D	0.5	ug/L	-
50	4-Methyl-2-pentanone; Methyl isobutyl ketone	EPA 8260 D	0.5	ug/L	-
51	Styrene	EPA 8260 D	0.5	ug/L	-
52	1,1,1,2-Tetrachloroethane	EPA 8260 D	0.5	ug/L	-
53	1,1,2,2-Tetrachloroethane	EPA 8260 D	0.5	ug/L	-
54	**Tetrachloroethene (PCE) (Primary COC)**	EPA 8260 D	0.5	ug/L	0.8
55	Toluene	EPA 8260 D	0.5	ug/L	-
56	1,1,1-Trichloroethane; Methylchloroform	EPA 8260 D	0.5	ug/L	-
57	1,1,2-Trichloroethane	EPA 8260 D	0.5	ug/L	-

Exhibit C.2. Groundwater Parameters, Reporting Limits, Water Quality Criteria, and Cleanup Levels

Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill

Asotin County Regional Landfill, near Clarkston, Washington

Ref. No.	Constituent	Test Method	Reporting Limit	Units	Water Quality Standard (WAC 173-200)
58	**Trichloroethene (TCE) (Primary COC)**	EPA 8260 D	0.5	ug/L	3
59	Trichlorofluoromethane; CFC-11	EPA 8260 D	0.5	ug/L	-
60	1,2,3-Trichloropropane	EPA 8260 D	0.5	ug/L	-
61	Vinyl acetate	EPA 8260 D	0.5	ug/L	-
62	Vinyl chloride	EPA 8260 D	0.02	ug/L	0.02
63	Xylenes	EPA 8260 D	0.5	ug/L	-

Exhibit C.3. Groundwater Measurement Performance Criteria for Field Measured Parameters

Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill

Asotin County Regional Landfill, near Clarkston, Washington

Matrix	Field Measured Parameter	Method	Units	Stabilization Criteria[1]	Accuracy	Detection Limits
Groundwater (Water Quality)	pH	Hand-held multi-parameter probe	Unitless	+/- 0.1	+/- 0.1	0 to 14
Groundwater (Water Quality)	Temperature	Hand-held multi-parameter probe	Deg. Celcius	NA	+/- 1.0	0 to 55
Groundwater (Water Quality)	Specific Conductance	Hand-held multi-parameter probe	uS/cm	+/-3%	+/-3%	0 to 9,999uS/cm

Notes:

1. Stabilization criteria only applicable to groundwater sampling via 'low-flow' method as described in Section 4 (details provided in Appendix C).

Exhibit C.4. Groundwater Sample Containers, Preservatives, and Hold Times

Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill

Asotin County Regional Landfill, near Clarkston, Washington

Matrix	Parameter	Method	Container	Preservation	Analytical Holding Time
Water	Anions	E300.0	1x 500 mL Plastic	Unpreserved, 4°C	28 days
Water	pH	A4500-H B			0.25 hours (see notes)
Water	Conductivity	A2510 B			28 days
Water	Dissolved Metals	E 6020B	1 x 250 mL Plastic	HNO_3, 4°C	180 days
Water	TDS	SM 2540D	1L HDPE	Unpreserved, 4°C	7 days
Water	TOC	SM 5310 B	250 mL Glass	H_2SO_4, 4°C	28 days
Water	VOCs	SW8260D	3 x 40 mL Clear Glass VOA	HCL, 4°C	14 days
Water	VOCs (Trip Blank)	SW8260D	1 x 40 mL Clear Glass VOA	HCL, 4°C	14 days

FIGURES

LEGEND

PERIMETER GROUP OF WELLS – SEMI–ANNUAL MONITORING FREQUENCY

DOWNGRADIENT GROUP OF WELLS – ANNUAL MONITORING FREQUENCY (SPRING). NOTE, CHECK FOR WATER IN MW–22.

CLOSED LANDFILL BOUNDARY

ACTIVE LANDFILL BOUNDARY

CROSS–SECTION LINE

0 375 750

SCALE IN FEET

NORTH

GreatWest ENGINEERING

Figure C.1. Site Map, Monitoring Well Locations, and Cross-Section Line
Cleanup Action Plan and Compliance Monitoring for Closed Landfill
Asotin County Regional Landfill

\\EgnyteDrive\greatwesteng\Shared\Boise Projects\4-17110-Asotin County SW Services\CADD 4-17110 Cell E ER\Exhibits\CLF Drilling - Access Agreement\CLF Wells.dwg

ATTACHMENT C.1

Field Forms

Groundwater Purging and Sampling Form

Well ID: ______________

Field Team: ______________________ Arrival Time to Well: ________ Date: ________

Weather/Temp: ______________________ **Initial DTW (ft btc):** ________

Purge Method: ☐ Bladder ☐ Peristaltic ☐ Grab ☐ Other: __________ Pump Setting : ________

Field Parameters						
Time [1]	**DTW [2]**	**Purge Vol. (gal)**	**pH**	**Sp. Cond. (mS/cm)**	**Temp (°C)**	**Note color, odor, etc.**
	Time Pumping Begins					
Stabilization Criteria [3]	**-**	**-**	**± 0.1 units**	**± 3%**	**-**	**-**

[1] Collect field parameters in consistent 3-5 minute intervals for Low-Flow method
[2] DTW: If possible, drawdown should not exceed 0.33 ft for Low-Flow method
[3] Stabilization achieved once field parameters stabilize for 3 successive readings for Low-Flow method; minimum parameter subset: pH and Sp. Cond.

Sample ID: ______________________ **Sample Time:** ________

QC SAMPLE : ☐ *FD* ☐ *MS/MSD* ***QC SAMPLE ID*** ____________ ***QC Time:*** ________

Comments:

ATTACHMENT C.2

EPA Guidance for Low-Flow Groundwater Sampling Method

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
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Prepared by: ROBERT REINHART Digitally signed by ROBERT REINHART Date: 2017.09.19 16:15:38 -04'00' ______________

(Robert Reinhart, Quality Assurance Unit) Date

Approved by: JOHN SMALDONE Digitally signed by JOHN SMALDONE Date: 2017.09.20 15:11:00 -04'00' ______________

(John Smaldone, Quality Assurance Unit) Date

Revision Page

Date	**Rev #**	**Summary of changes**	**Sections**
7/30/96	1	Finalized	
01/19/10	2	Updated	All sections
3/23/17	3	Updated	All sections
9/20/17	4	Updated	Section 7.0

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1.0 USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the "Monitoring Indicator Field Parameters" section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

2.0 SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

3.0 BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

4.0 HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

5.0 CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

6.0 PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

7.0 EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®) are preferred. PTFE, however, should not be used when sampling for per- and polyfluoroalkyl substances (PFAS) as it is likely to contain these substances.

Note: If extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

PTFE (Teflon®) or PTFE-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. As discussed in the previous section, PTFE tubing should not be used when sampling for PFAS. In this case, a suitable alternative such as high-density polyethylene tubing should be used.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

Note: If tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic ”tape”, pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A “T” connector coupled with a valve is connected between the pump’s tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

8.0 EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

9.0 PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed, lay out a sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

10.0 PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. <u>Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:</u>

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). Throughout the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods (e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 µm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

11.0 DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well, and then following sampling of each subsequent well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

<u>Procedure 1</u>

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

<u>Procedure 2</u>

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

12.0 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

13.0 FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

14.0 DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

15.0 REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

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U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017 or latest version.

U.S Environmental Protection Agency, EPA SW-846.

U.S Environmental Protection Agency, 40 CFR 136.

U.S Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

APPENDIX A

PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases, (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could affect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or discolored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or discolored water is usually from the well-being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take a while (pump may be removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note:

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note: at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

Turbidity (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

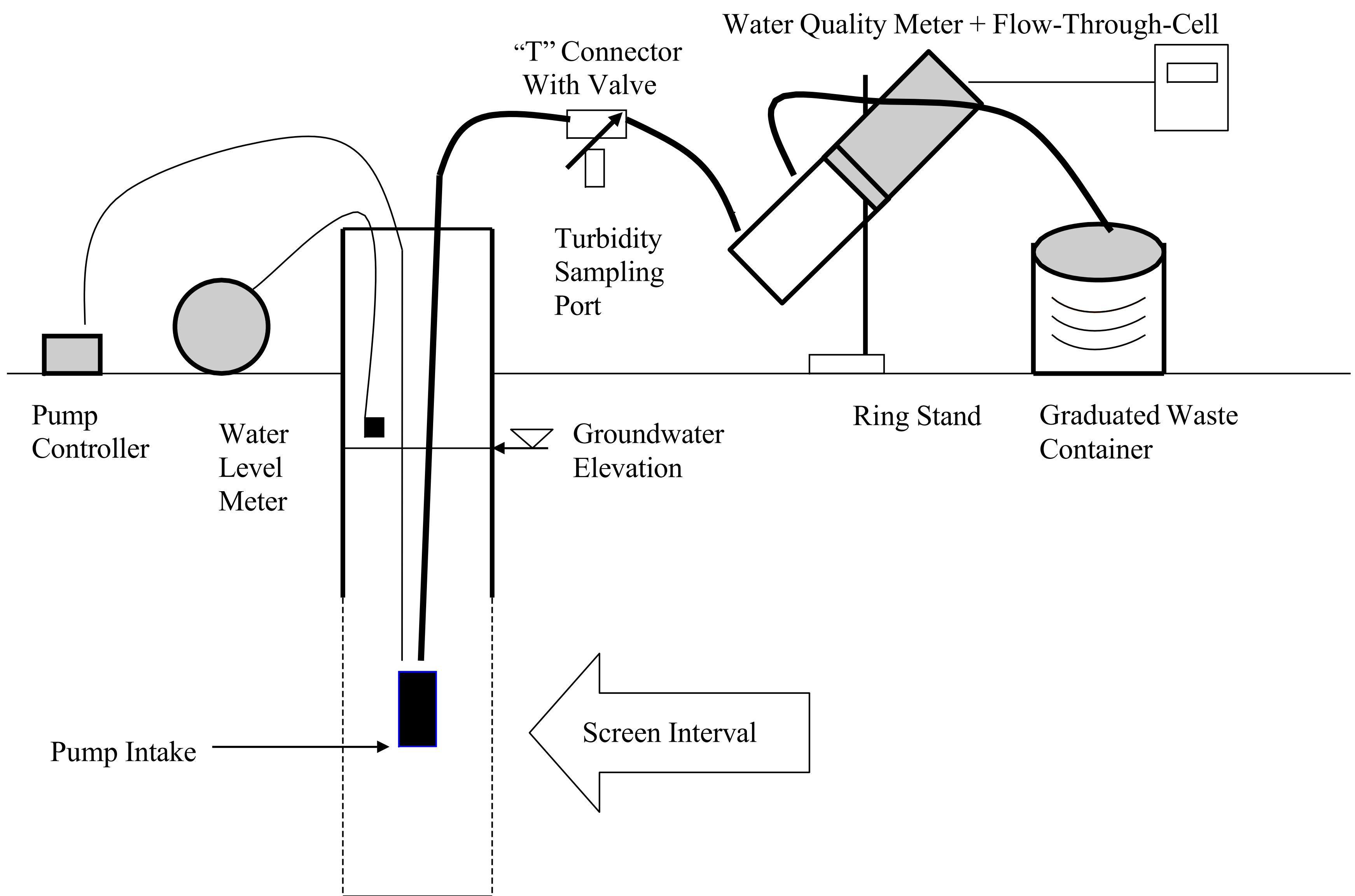
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C

EXAMPLE (Minimum Requirements)

WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)______________________________

Well Number________________ Date_______________________

Field Personnel____

Sampling Organization____________________________________

Identify MP____

Depth to _________/________ of screen
(below MP) top bottom

Pump Intake at (ft. below MP)_________

Purging Device; (pump type)_________

Total Volume Purged _______________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. "C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Tur-bidity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	±10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

APPENDIX D

Landfill Gas Monitoring Sampling and Analysis Plan (SAP)

Presented by:

GreatWest ENGINEERING

Appendix D

Landfill Gas Sampling and Analysis Plan for Closed Landfill

ASOTIN COUNTY REGIONAL LANDFILL

December 2024

Client Commitment *Empowered Employees* *Quality Solutions*

APPENDIX D

ASOTIN COUNTY REGIONAL LANDFILL

Landfill Gas Sampling and Analysis Plan for Closed Landfill

December 2024

FORWARD

Appendix D is part of the Closed Landfill Cleanup Action Plan (CAP) and supports the objectives of the compliance monitoring plan (CMP) for landfill gas media. It is intended to be both part of the CAP and CMP via appendix, but also effectively a stand-alone guidance document for the landfill gas Sampling & Analysis Plan (SAP). This SAP includes appropriate levels of quality assurance and quality control (QA/QC) to be considered a combined SAP/quality assurance project plan (QAPP). The functional and procedural elements of this SAP/QAPP may be used as a stand-alone document via field staff to perform the necessary groundwater monitoring activities; in addition, this procedural document may be updated or optimized without the need to amend or modify the CAP and CMP objectives.

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D.1.0 Landfill Gas Monitoring Program

Exhibit D.1 summarizes the landfill gas monitoring design, along with the sampling frequency for the respective data types. **Figure D.1** shows the landfill gas monitoring design with respect to the combined flare station, the closed landfill monitoring station, location of individual LGW's (extraction wells), and perimeter gas probes (passive monitoring points around perimeter of landfill). The perimeter probes are shown for reference and monitored under WAC 173-351-200 to check for methane concentrations (explosive gases) and reported to Ecology, but are not active monitoring points for evaluating the MTCA groundwater remedy.

Exhibit D.2 summarizes the landfill gas parameters, test methods, and reporting limits. The parameters primarily consist of landfill gas flow rates, landfill gas temperature, fixed gases (such as methane, oxygen, and CO2), and contaminant vapors namely PCE, TCE, VC, and two refrigerants Freon 11 and 12. **Exhibit D.3** summarizes the field-measured performance criteria. **Exhibit D.4** summarizes the landfill gas sampling container and hold times.

The subsequent sections provide functional details for landfill gas monitoring with respect to the flare station, closed landfill station, and individual LFG extraction wells.

D.2.0 Landfill Gas Monitoring Methods

D.2.1 Sample Method and Standard Operating Procedures

The general sampling method consists of monthly monitoring via GEM field meter to obtain gas flow rates (at active wells) and fixed gases to monitor temperature, methane, O2 and CO2; coupled with quarterly monitoring to include systems operation data (such as system flow rates from flare and closed landfill), and collection of landfill gas samples via Summa Canisters submitted to a testing laboratory to quantify concentrations of fixed gases (methane, O2, and CO2) and full toxics suite (volatile organic compounds, via TO-15). Each of the LFWs is equipped with a QED wellhead, which includes manual flow valve/regulator (0 to 100% open), quick-connect ports to utilize the GEM meter, as well as to obtain Summa Canister samples.

Standard operating procedures for monthly field readings obtained via GEM meter, and also the quarterly monitoring to collect grab Summa Samples, is provided below.

GEM Meter Field Readings – Monthly Frequency

ACRL owns and maintains a hand-held landfill gas analyzer meter (such as a GEM) for routine monitoring of explosive gases (methane) as required per WAC, and can be utilized to check for landfill gas extraction flow rates, vacuum, temperature, and fixes gases such as methane, oxygen, and CO2. At present, the facility has a GEM 2000 unit; and may upgrade to another landfill gas meter in the future. Landfill gas meters are needed to provide data as outlined in this SAP. For routine operations and maintenance, the meter will be sent into the manufacturer for calibration or repair (if needed), and prior to use will be recharged. Field readings will be collected per the manufacturer's instructions; the standard process for LGW extraction well includes the following.

LGW Extraction Points:

- Field zero the meter with ambient air concentrations away from any known fumes or exhaust (or away from any landfill gas features); the fresh air calibration should read 0 for methane and CO2, and oxygen in the range of 20-21%. If the fresh air calibration does not provide these readings, troubleshoot per manufacturer recommendations and potentially send in to manufacturer for repair or evaluations.

- Toggle the GEM to the appropriate sample location, the meter requires the user to pre-program the sample locations and configuration. Select ‘landfill gas analyzer’ to measure gas composition; connect the static port (intake) to the quick-connect on the LGW QED wellhead; start the vacuum flow of meter and allow gas concentrations to stabilize, if possible. Once stabilized or near the end of the 180 second purge process/cycle, record the landfill gas readings in the dedicated field forms (See Appendix Z).
- After gas composition data are recorded, toggle GEM to ‘measure flow’ option; connect the static (intake) and dynamic tubes to the QED quick-connect ports, and follow the prompts to obtain vacuum (pressure) and landfill gas flow. Once stable, record these readings of vacuum in inches, and flow in CFS on the field form.
- Field check/compare readings of gas composition and flow to prior data, if erroneous or inconsistent, repeat the process again to verify field readings are accurate at the time of sampling.

In addition to the above data each month via GEM, the following field data are collected at additional monitoring stations:

- Flare Station: obtain flow and flare temperature from visual readouts of the new flare station panel (digital real-time values from the panel); and then use the quick-connect ports on the exhaust line and connect to GEM to measure gas composition for methane, oxygen, and CO2.

- Closed Landfill Monitoring Station: real-time digital readout flow reading; and then use GEM via quick-connect ports to obtain fixed gas composition for methane, oxygen, and CO2.

Summa Canister Sampling – Quarterly Frequency

Exhibit D.1 shows the locations for collection of landfill gas samples via Summa Canisters, submitted to ALS Environmental testing laboratory (contact information in the Distribution list). Each quarter, a primary and replicate sample (2 full samples) are collected from the closed landfill station, which represents the flow and gas composition from the combined effects of active LGWs. A replicate sample is collected as a conservative means to get the required data from the CLF monitoring station; if results from the primary sample are erroneous or vacuum failure should occur from the primary sample, then the results from the replicate sample may be used to complete the data requirements. The replicate is not required but considered best practice. In addition to two samples at the CLF, typically, samples are also collected from two of the source areas LGWs, which from historical sampling have been from the west end of the closed landfill, via LGW-8 and LGW-9.

ALS Environmental is the contracted laboratory and the point of contact is listed on the Distribution List. At least 2 weeks prior to a given sample event, the field sampler shall notify the laboratory of the planned sample event, and place the Summa Order. The laboratory ships the Summa Order to either the landfill or to the consultants office, and provides a return shipping next-day Fed-Ex label for return of the collected samples.

Attachment D.1 provides landfill gas field forms used to record sample ID and sample time for Summa samples, as described in the section below.

Attachment D.2 are standard procedures to collect a ‘grab’ landfill gas sample via 6L Summa Canister from the designated monitoring stations, such as Closed Landfill Station, and designated LGWs; refer to Section 3.1 “Grab Sample Using Canisters”.

D.3.0 Field Procedures and Quality Control

D.3.1 Sample ID and Documentation

Sample tags provided by the laboratory will be affixed to each Summa sample, and will include key sampling information that will be identical to the chain-of-custody. Sample IDs will be unique for each event to distinguish sample location and date of sampling, and use the following scheme:

"MMDDYY – XXXX" whereby:

MMDDYY = unique sampling date where YY is last two digits of year; MM is two digit month; and DD is two digit date.

For example, the unique ID for sampling performed in March 12, 2027, at LGW8, would be "031227 – LGW8". For the CLF station the primary and replicate sample IDs would use "CLF1" and "CLF2". The sample tag and COC will also include the following:

- Project Site Name, such as "Asotin County Regional Landfill, Closed Landfill"
- Sample ID, date, and sample time (time of sampling)
- Analytical test methods (see **Exhibit D.2**)
- Pre-sample canister pressure (vacuum), recorded in inches of water-column via pressure gauge (see **SOP in Attachment D.2**)
- Sampler name and initials

D.3.2 Sample Handling

Once the samples are collected, each sample tag affixed to sample containers and COC are double-checked to make sure the tag information matches the COC, to include the project information and required testing. Samples are placed in the box provided by the laboratory, and the return address is used to ship the samples back via Fed-Ex to the ALS Environmental testing laboratory.

D.3.3 Calibration of Field Equipment

No field meters are needed for collection of Summa samples; for field readings see calibration of GEM meter in Section above.

D.3.4 Decontamination

No decontamination of equipment is needed given the VE system is closed and vapors are thermally destroyed at the flare station, and considering samples are collected into enclosed Summa containers and using dedicated tubing and canisters sent to lab. Sampling should be performed using disposable nitrile or latex gloves and can be discarded after each event as 'IDW' and treated as 'municipal solid waste' (MSW).

D.3.5 Management of Investigative Derived Waste (IDW)

As noted above, the VE system is a closed system and landfill gas (vapors) are routed to flare station and thermally destroyed. The only IDW generated from sampling may be used nitrile or latex gloves, or consumable supplies (such as paper towels, or poly tubing), and may be disposed of into the active permitted landfill as MSW.

D.4.0 Laboratory Procedures and Quality Control

D.4.1 Quality Control Samples

A “replicate” (extra) sample will be collected at the CLF station during each quarterly sampling event. For this project, a replicate sample is an extra sample collected immediately after the primary sample, following the same sample handling, sample methods, and same laboratory test methods. As noted earlier, the sample ID will be for primary sample to be “CLF1” and the replicate sample will be “CLF2”.

D.4.2 Quality Control Methods and Procedures

As shown on the Distribution List, the contracted laboratory is ALS Environmental and their facility is located in Simi Valley, California; project manager contact is Sue Anderson. ALS Environmental is NELAP and DoD-ELAP-approved and follows their established quality assurance program and related protocol and quality control per the analytical test methods. The fixed gases analysis (oxygen, methane, CO_2) is performed with a gas chromatograph equipped with thermal conductivity detector; and following laboratory SOP VOA-EPA3C. The VOC analysis are performed following EPA Method TO-15 from the *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition* (EPA/625/R-96/010b, 1999); per this method the analytical system was comprised of a gas chromatograph / mass spectrometer (GC/MS) interfaced to a whole-air preconcentrator. Per WA DOE, ALS Environmental is certified per C946.

EXHIBITS

Exhibit D.1. Landfill Gas Monitoring Design
Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill
Asotin County Regional Landfill, near Clarkston, Washington

	Data Needs / Data Types							
Monitoring Staion	Air Flow Rate CFM	Pressure/ Vaccum PSI (inches)	Gas Temprature (Degrees F)	Field Gas Concentration Methane, O2, CO2 (via GEM meter) percentage (%)	Laboratory Landfill Gas Concentration Fixed Gases (ASTM 1946) percentage (%)	Laboratory Landfill Gas Concentration Toxics Suite (TO-15) ug/m^3	Valve Position (typical) (% open)	Comments
Flare Station	Yes, digitial readout	Yes, digital readout	Yes, digital readout	Yes, GEM meter	--	--	NA	Combined gas from active and closed landfill
Closed Landfill Station	Yes, digitial readout	NA	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	NA	Landfill gas from Closed Landfill; active LGWs.
LGW-1	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	100	
LGW-2	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	20-50	Valve back, minimal toxic vapors.
LGW-3	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	100	
LGW-4	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	50	Valve back, minimal toxic vapors.
LGW-5 (closed/inactive)	--	--	--	--	--	--	0	High oxygen, typically closed valve.
LGW-6	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	100	
LGW-7	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	--	--	20	Elevated oxygen, target lower flow rates
LGW-8	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	40	Target source extraction area
LGW-9	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, GEM meter	Yes, 6L Summa Canister	Yes, 6L Summa Canister	20	Cyclic operation, elevated oxygen, high conc.

Notes:
See Figure 2 for monitoring locations; and Exhibit D.2 for parameters and test methods for laboratory-analyzed parameters.

Exhibit D.2. Landfill Gas Sampling Parameters and Reporting Limits
Cleanup Action Plan and Compliance Monitoring for Closed Landfill
Asotin County Regional Landfill, near Clarkston, Washington

Analyte	Units	Method	PQL	MDL	LCS (LCSD) Limits		
					LCL	UCL	RPD
Methane (CH_4)	percent	ASTM D-1946	0.4	0.042	80	120	20
Oxygen (O_2)	percent	ASTM D-1946	0.5	0.05	80	120	20
Carbon Dioxide (CO_2)	percent	ASTM D-1946	0.5	0.044	80	120	20
TETRACHLOROETHENE (PCE)	**ppbv**	**TO-15**	**2**	**0.58**	**75**	**125**	**25**
TRICHLOROETHENE (TCE)	**ppbv**	**TO-15**	**5**	**0.48**	**75**	**125**	**25**
TRANS-1,2-DICHLOROETHENE	**ppbv**	**TO-15**	**2**	**0.54**	**75**	**125**	**25**
TRICHLOROFLUOROMETHANE	**ppbv**	**TO-15**	**2**	**0.36**	**75**	**125**	**25**
VINYL CHLORIDE	**ppbv**	**TO-15**	**2**	**0.71**	**75**	**125**	**25**
CIS-1,2-DICHLOROETHENE	**ppbv**	**TO-15**	**5**	**1.6**	**75**	**125**	**25**
CARBON TETRACHLORIDE	**ppbv**	**TO-15**	**2**	**0.32**	**75**	**125**	**25**
DICHLORODIFLUOROMETHANE	**ppbv**	**TO-15**	**2**	**0.74**	**75**	**125**	**25**
1,1,1-TRICHLOROETHANE	ppbv	TO-15	2	0.3	75	125	25
1,1,2,2-TETRACHLOROETHANE	ppbv	TO-15	2	0.61	75	125	25
1,1,2-TRICHLOROETHANE	ppbv	TO-15	2	0.31	75	125	25
1,1-DICHLOROETHANE	ppbv	TO-15	2	0.54	75	125	25
1,1-DICHLOROETHENE	ppbv	TO-15	2	0.26	75	125	25
1,2,4-TRICHLOROBENZENE	ppbv	TO-15	2	0.32	75	125	25
1,2,4-TRIMETHYLBENZENE	ppbv	TO-15	10	0.98	75	125	25
1,2-DIBROMOETHANE	ppbv	TO-15	2	0.63	75	125	25
1,2-DICHLORO-1,1,2,2-TETRAFLUOROETHANE	ppbv	TO-15	2	0.44	75	125	25
1,2-DICHLOROBENZENE	ppbv	TO-15	2	0.32	75	125	25
1,2-DICHLOROETHANE	ppbv	TO-15	2	0.7	75	125	25
1,2-DICHLOROPROPANE	ppbv	TO-15	2	0.47	75	125	25
1,3,5-TRIMETHYLBENZENE	ppbv	TO-15	2	0.52	75	125	25
1,3-DICHLOROBENZENE	ppbv	TO-15	2	0.65	75	125	25
1,4-DICHLOROBENZENE	ppbv	TO-15	2	0.65	75	125	25
BENZENE	ppbv	TO-15	2	0.64	75	125	25
BROMODICHLOROMETHANE	ppbv	TO-15	2	0.56	75	125	25
BROMOMETHANE	ppbv	TO-15	2	0.44	75	125	25

Exhibit D.2. Landfill Gas Sampling Parameters and Reporting Limits
Cleanup Action Plan and Compliance Monitoring for Closed Landfill
Asotin County Regional Landfill, near Clarkston, Washington

					LCS (LCSD) Limits		
Analyte	**Units**	**Method**	**PQL**	**MDL**	**LCL**	**UCL**	**RPD**
CHLOROBENZENE	ppbv	TO-15	2	0.38	75	125	25
CHLOROETHANE	ppbv	TO-15	2	0.49	75	125	25
CHLOROFORM	ppbv	TO-15	2	0.35	75	125	25
CHLOROMETHANE	ppbv	TO-15	2	0.38	75	125	25
CIS-1,3-DICHLOROPROPENE	ppbv	TO-15	3	0.6	75	125	25
ETHYLBENZENE	ppbv	TO-15	2	0.68	75	125	25
HEXACHLOROBUTADIENE	ppbv	TO-15	2	0.68	75	125	25
M,P-XYLENES	ppbv	TO-15	10	0.78	75	125	25
METHYLENE CHLORIDE	ppbv	TO-15	5	0.45	75	125	25
O-XYLENE	ppbv	TO-15	2	1.2	75	125	25
STYRENE	ppbv	TO-15	2	0.61	75	125	25
TOLUENE	ppbv	TO-15	2	0.4	75	125	25
TRANS-1,3-DICHLOROPROPENE	ppbv	TO-15	3	0.5	75	125	25
TRICHLOROTRIFLUOROETHANE	ppbv	TO-15	2	0.24	75	125	25

Notes:

Performance Criteria Assume Analytical Method EPA TO-15.
Bold font indicates primary (landfill gas) contaminants of concern.
PQL is Practical Quantitation Limit (or Reporting Limit).
MDL is the Method Detection Limit (or lowest detectable level).
LCL is lower control limit
UCL is upper control limit
RPD is relative percent difference (for laboratory sample)
Laboratory duplicates for TO-14A/TO-15 have RPD of less than 25%.
Laboratory duplicates for Fixed Gases (ASTM D-1946/ SM2720C) have RPD of less than 20%.

Exhibit D.3 Landfill Gas Measurement Performance Criteria for Field Measured Parameters
Cleanup Action Plan and Compliance Monitoring for Closed Landfill
Asotin County Regional Landfill, near Clarkston, Washington

Field Measurements	Meter	Units	Accuracy	Detection Limits/Resolution
Methane (CH_4)	GEM	%	+/-3% @ 70% max level)	0-70%/0.1%
Oxygen (O_2)	GEM	%	+/-3% @ 40% max level	0-40%/0.1%
Carbon Dioxide (CO_2)	GEM	%	+/-1% @ 25% max level	0-25%/0.1%
Static Pressure	GEM	Inches WC	0.1” WC	0-100” WC/0.1” WC
Temperature	GEM	Degrees Fahrenheit(F)	+/-1 F	+/-0.01 F

Notes:

WC = water column
NA – Not applicable

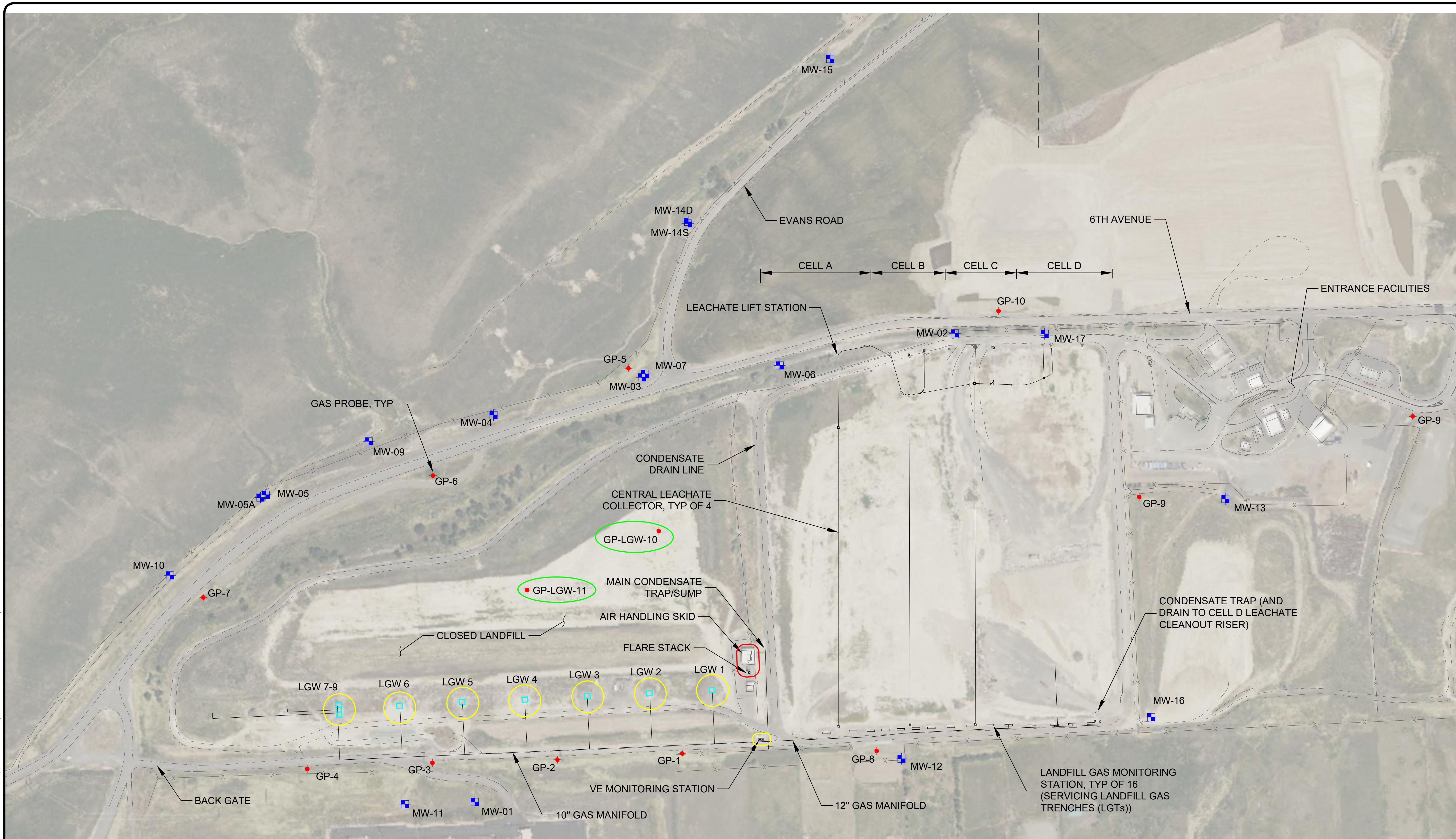
Exhibit D.4. Lanfill Gas Sample Containers, Method, and Hold Times

Cleanup Action Plan and Compliance Monitoring Plan for Closed Landfill

Asotin County Regional Landfill, near Clarkston, Washington

Matrix	Parameter	Method	Container	Preservation	Analytical Holding Time
Landfil Gas	Oxygen	ASTM D1946	6 Liter Silinite Summa Can	Vacuum Sealed/Backfilled with Helium	30 days
Landfil Gas	Methane	ASTM D1946			30 days
Landfil Gas	Carbon Dioxide	ASTM D1946			30 days
Landfil Gas	VOCs (full list in Exhibit D.2)	TO-15			30 days

FIGURES



LEGEND

- GROUNDWATER MONITORING WELL
- GAS PROBE
- LANDFILL GAS (VERTICAL) WELL (LGWs)
- ACTIVE LANDFILL GAS EXTRACTION WELLS (LGW–1 THRU 9), QED STYLE.
- CLOSED LANDFILL COMBINED MONITORING STATION; FLOW FROM ALL ACTIVE LGWs.
- FLARE STATION, COMBINED FLOW FROM ACTIVE AND CLOSED LANDFILL, THERMAL DESTRUCTION.
- INTERIOR GAS MONITORING PROBES.

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Figure D.1. Site Map, VE System Layout, and Monitoring Stations
Cleanup Action Plan and Compliance Monitoring for Closed Landfill
Asotin County Regional Landfill

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ATTACHMENT D.1

Field Form

Asotin VE Pilot System Operations Form System: Tech: Date:

On Arrival: **Hour Meter:** ____ **Time:** ____ **VE System Flow:** ____

System On? Yes No **Vacuum:** ____ in. H2O **Pressure Knockout**

Dilution On Off **Stack Temp:** ____ **Pre:** ____ **Post:** ____

Influent Measurements

	CH4	O2	CO2	Vac	Flow	Valve	Temp	
Influent								A or P
LGW-01								A or P
LGW-02								A or P
LGW-03								A or P
LGW-04								A or P
LGW-05								A or P
LGW-06								A or P
LGW-07								A or P
LGW-08								A or P
LGW-09								A or P
Flare								A or P

Notes:
Ambient Temp:
Weather:

Perimeter Monitoring

Time	Location	Vac	Time	Location	Vac	Time	Location	Vac
	GP-01			GP-05			IGP-11	
	GP-02			GP-06			MW-11	
	GP-03			GP-07			MW-05	
	GP-04			IGP-10			MW-07	

Units ____

On Departure: **Hour Meter:** ____ **Time:** ____ **VE System Flow:** ____

System On? Yes No **Vacuum:** ____ in. H2O **Pressure Knockout**

Dilution On Off ____ % **Stack Temp:** ____ **Pre:** ____ **Post:** ____

Influent Measurements

	CH4	O2	CO2	Vac	Flow	Valve	Temp	
Influent								A or P
LGW-01								A or P
LGW-02								A or P
LGW-03								A or P
LGW-04								A or P
LGW-05								A or P
LGW-06								A or P
LGW-07								A or P
LGW-08								A or P
LGW-09								A or P
Flare								A or P

Notes:

ATTACHMENT D.2

Landfill Gas SOP

Sampling Instructions

Canister Sampling

Required Equipment

QTY.	ITEM
(1)	**Summa or Silco canister** Cleaned, certified, leak checked.
(1)	**Flow Controller/ Regulator** Calibrated by laboratory. Do not disassemble or adjust.
(1)	**Analog Gauge** Gauge used to monitor pressure during sampling.
(1)	**9/16" Wrench** Adjustable crescent wrench required, not provided.

How to Perform a Flow Controller Shut-In Test

Use this short video as a guide to help you assemble and properly conduct a shut-in test to ensure your canister and flow controller are leak-tight prior to sampling.

▶ Play Tutorial

Sample Collection Procedure

Important Information

1	Check initial canister vacuum
A	Ensure canister valve is fully closed—should be turned completely clockwise.
B	Use a 9/16" wrench to remove the brass cap from the valve on the top of the summa canister.
C	Attach the analog gauge on a Swagelok Tee to the valve on the top of the canister. Finger-tighten first, then tighten gently with 9/16" wrench. Stabilize the valve with an adjustable crescent wrench.
D	Reattach the brass cap to the top of the analog gauge. Finger-tighten first, then tighten gently with 9/16" wrench.
E	Open the can approximately 1¼ turns. If the gauge does not equilibrate within 30 seconds or appears to be losing vacuum, the canister is leaking due to a loose fitting. In this case, close the canister valve immediately and tighten the fittings.
2	Grab Sample (Instantaneous—No Flow Controller)
A	Disconnect the brass cap from the top of the canister and open the canister valve, turning the valve counterclockwise until there is no resistance.
B	Turn back clockwise slightly until resistance is detected. Note: you may hear a hissing noise as the vacuum dissipates and draws air in.
3	Time-Integrated Sample (With a Flow Controller)
A1	Disconnect the brass cap and attach the analog vacuum gauge and flow regulator. Finger-tighten first, then tighten gently using 9/16" wrench.
A2	Recommended: Perform a flow regulator **SHUT-IN test** to ensure that all connections are tight and that there are no leaks.
B	To begin sampling, turn the valve counterclockwise until there is no resistance. Then turn back clockwise slightly until resistance is detected.
4	Sampling Completed
A	At the end of the sampling period, close the canister valve by turning the knob clockwise. Do not tighten with a wrench.
B	Remove all attached equipment from the canister and wrap in bubble wrap.
C	Replace the brass cap on the canister valve. Tighten using a 9/16" wrench.
D	Label the sample with the tag provided, and attach the tag to the canister with the provided plastic ties. Do not affix any labels directly onto the canisters. Do not affix labels on bubble wrap or any other packaging material.
E	Complete a chain of custody (CoC) form. Indicate the canister barcode ID number on the CoC. For time-integrated sampling, please also note the flow controller ID number with the corresponding canister.
F	Place the chain of custody form, the bubble-wrapped flow controller, and the canister back into the original boxes in which they were shipped to you.

Canister Sampling

Sampling Information

Important Information

Proper use of wrenches to tighten fittings. Gauges may vary by location, contact your local laboratory for specific inquiry.

Grab Sampling
During grab sampling, the canister valve is simply opened and the vacuum inside the canister draws in a sample within a matter of seconds. This method is most often used for discrete odor events or for static concentration sample streams.

Time-Integrated Sampling
Time-integrated sampling utilizes a flow controller to collect the sample over a particular time frame or at a given flow rate. Flow controllers are equipped with particulate filters and are calibrated by the laboratory for a specified duration or flow rate.

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Guide to Air Sampling

Canisters and Bags

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Always Air. Always Accurate.

Eurofins Air Toxics, Inc.
Guide to Whole Air Sampling – Canisters and Bags

Revision 6/27/14

Contents

Section 1.0 Introduction

Eurofins Air Toxics Inc. presents this guide as a resource for individuals engaged in air sampling. Air sampling can be more involved than water or soil sampling due to the reactivity of chemical compounds in the gas matrix and sample interaction with the equipment and media used. Ensuring that air samples are collected properly is an important step in acquiring meaningful analytical results. This guide is not a substitute for experience and cannot sufficiently address the multitude of field conditions. Note that this guide is intended for projects involving whole air sampling of volatile organic compounds (VOCs) in canisters and Tedlar® bags. Eurofins Air Toxics provides the "Guide to Sorbent-Based Sampling - Volatiles and Semi-Volatiles" for other types of sampling.

1.1 Whole Air Sampling of VOCs

There are three general ways to collect compounds in a gas phase sample. A sampler may collect the gas sample in a container, actively pump the vapor through a sorbent tube, solution or filter, or rely on passive sample collection onto a sorbent bed. This guide focuses on collecting a sample in the most common air sampling containers, Summa canisters and bags. The sample may be collected in the container either passively, relying on an evacuated canister to drive the sample collection, or actively using a pump to fill the container. The container is subsequently sealed and transported to the laboratory for analysis. The sample is referred to as a "whole air sample" and the compounds remain in the gas matrix inside the container.

As a general rule, whole air sampling is appropriate when target compounds are chemically stable and have vapor pressures greater than 0.1 torr at 25°C and 760mm Hg (EPA standard ambient conditions). Performance of a given compound in a whole air sample is dependent upon its chemical properties, the matrix of the sample, and the degree of inertness of the sample container.

1.2 Choosing Between Canisters and Bags

Table 1.2 compares the features and performance of Summa canisters and bags. Summa canisters or similarly treated canisters are rugged containers designed to provide superior inertness and extended sample storage times. Evacuated canisters also do not require a sampling pump for sample collection. By contrast, bags require a sample pump, but can be purchased inexpensively in bulk, require little preparation or cleaning, and take up little space prior to use. Unlike canisters, bags are typically not appropriate for ppbv-level VOC measurements due to their background artifacts and short hold-times. Over time, low molecular weight gases can diffuse through the bag material while chemicals with lower vapor pressures can condense on the bag surface thereby compromising analyte recoveries. Call your Project Manager at 800-985-5955 if you have questions regarding the appropriate sampling media.

Table 1.2 Comparison of Canisters to Bags

	Canisters	Bags
Type of Sampling	Passive (vacuum)	Active (pump required)
Media Hold Time	Up to 30 days recommended	Indefinite
Hold Time to Analysis	Up to 30 days	Up to 3 days
Surface Inertness	Excellent	Fair
Cleanliness	Batch or 100% certified to ppbv/pptv levels	Some VOCs present in the ppbv range
Sampling Application	Ambient air, soil/landfill gas	Soil/landfill gas, stationary sources, SVE systems
Rule of Thumb	"ppbv device"	"ppmv device"
Advantages	Inertness, hold time, ruggedness, no pump	Purchase/shipping cost, availability, convenience

Section 2.0 Canisters and Associated Media

This section provides a description of air sampling canisters, practical considerations for sampling, and step-by-step instructions for collecting grab and integrated samples. Photographs illustrate the correct way to assemble the various sampling components. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister sample.

2.1 Introduction to Canisters

An air sampling canister is a container for collecting a whole air sample. A canister may be spherical or cylindrical and is constructed of specially treated stainless steel. The canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of Mercury (in Hg). Opening the stainless steel bellows valve allows the air sample to enter the canister. Flow controllers can be utilized to restrict the flow and allow for collection at a desired flow rate or over a desired range. When the sample has been collected, the valve is closed and the canister is returned to the laboratory. Canisters range in volume from less than 1 liter (L) to 6 L. In general, 6 L canisters are used to collect ambient air samples and samples requiring time integration greater than 2 hours. One liter canisters are typically used for taking high concentration (i.e., greater than 5 ppbv) samples not requiring time integration such as soil vapor.

2.1.1 Summa Canister

A Summa canister is a stainless steel container that has had the internal surfaces specially passivated using a "Summa" process. This process combines an electropolishing step with a chemical deactivation step to produce a surface that is nearly chemically inert. A Summa surface has the appearance of a mirror: bright, shiny and smooth. The degree of chemical inertness of a whole air sample container is crucial to minimizing reactions with the sample and maximizing recovery of target compounds from the container. Eurofins Air Toxics maintains a large inventory of Summa canisters in 1 and 6 L volumes.

2.1.2 Canister Certification

Eurofins Air Toxics provides two types of canister cleaning certification, batch and 100%, depending upon the requirements of the project. The batch certification process is most appropriate for routine ambient air applications and high concentration applications such as soil vapor and landfill gas monitoring. The batch certification process begins by cleaning a set of canisters using a combination of dilution, heat and high vacuum. The cleaning batch is certified by analyzing a percentage of canisters for approximately 60 VOCs using GC/MS. The batch meets cleaning requirements if the target compound concentrations are below 0.2 ppbv. Alternatively, the 100% certification (i.e., individual certification) process is typically required for ambient and indoor air applications driven by risk assessment or litigation requiring pptv (parts per trillion by volume) sensitivity. If 100% certification is required, canisters are individually certified for a client-specific list of target compounds using GC/MS. When the 100% certified canisters are shipped, the analytical documentation demonstrating that they are free of the target compounds down to the project reporting limits is emailed to the client. When sampling with certified media, it is important to note that all media is certified as a train and must be sampled as such (i.e., a particular flow controller goes with a particular canister and is labeled as such).

Specify whether your project requires batch or 100% canister certification.

2.1.3 Canister Hold Time

Media Hold Time: Unlike water and soil environmental samples, which are collected in single-use, disposable vials and jars, air samples are collected in reusable summa canisters. Eurofins Air Toxics requires that canisters be returned within 15 days of receipt to effectively manage our inventory and to insure canisters meet performance requirements in the field. Evacuated canisters have a finite timeframe before the canisters naturally lose vacuum during storage. Using canisters beyond 15 days increases the risk of having unacceptable initial vacuum at the start of sampling.

Sample Hold Time: EPA Method TO-15 cites a sample hold time of up to 30 days for most VOCs. Several non-routine compounds, such as bis(chloromethyl)ether, degrade quickly and demonstrate low recovery even after 7 days. Reactive sulfur compounds such as hydrogen disulfide and methyl, ethyl, and butyl mercaptan are not amenable to storage in stainless steel summa canister, and either fused silica lined (FSL) canisters or Tedlar bags are required for sample collection.

2.2 Associated Canister Hardware

Associated hardware used with the canister includes the valve, brass cap, particulate filter and vacuum gauge. (Flow controllers are covered in detail in section 3.2.)

2.2.1 Valve

An industry standard 1/4" stainless steel bellows valve is mounted at the top of the canister. The valve maintains the vacuum in the canister prior to sampling and seals the canister once the sample has been collected. No more than a half turn by hand is required to open the valve. Do not over-tighten the valve after sampling or it may become damaged. A damaged valve can leak, possibly compromising the sample. Some canisters have a metal cage near the top to protect the valve.

To protect the valve and provide secure connections in the field, a replaceable fitting is attached to all canisters. As threads wear and require replacement, new fittings can be installed at the laboratory prior to shipping to the field. You will need a 1/2" wrench to secure the fitting while connecting or removing the required equipment to the canister.

2.2.2 Brass Cap

Each canister comes with a brass cap (i.e., Swagelok 1/4" plug) secured to the inlet of the valve assembly. The cap serves two purposes. First, it ensures that there is no loss of vacuum due to a leaky valve or a valve that is accidentally opened during handling. Second, it prevents dust and other particulate matter from damaging the valve. The cap is removed prior to sampling and replaced following sample collection.

Always replace the brass cap following canister sampling.

2.2.3 Particulate Filter

Particulate filters should always be used when sampling with a canister. Separate filters are provided to clients taking a grab sample, and filters are built into the flow controllers for clients taking integrated samples. The 2 micron filter is a fritted stainless steel disk that has been pressed into a conventional Swagelok adapter. This device has a relatively high pressure drop across the fritted disk and restricts the flow into the canister even when sampling without a flow controller. Table 2.2.3 lists the typical fill time for a grab sample using a 2 micron particulate filter.

Table 2.2.3 Grab Sample Fill Times for Canisters

CANISTER VOLUME	2 micron filter
6 L	<5 minutes
1 L	<1 minute

2.2.4 Fittings

All fittings on the sampling hardware are 1/4" Swagelok, and a 9/16" wrench is used to assemble the hardware. A 1/2" wrench is also required to tighten fittings onto a union connector. Compression fittings should be used for all connections. Never use tube-in-tube connections. It is critical to avoid leaks in the sampling train. Leaks of ambient air through fittings between pieces of the sampling train will dilute the sample and cause the canister to fill at a faster rate than desired. Eurofins Air Toxics can provide the necessary fittings and ferrules if requested.

2.2.5 Vacuum Gauge

A vacuum gauge is used to measure the initial vacuum of the canister before sampling, and the final vacuum upon completion. A gauge can also be used to monitor the fill rate of the canister when collecting an integrated sample. Eurofins Air Toxics provides 2 types of gauges. For grab sampling, a test gauge checks initial and final vacuums only and is not to be sampled through. For integrated sampling a gauge is built into the flow controller and may be used for monitoring initial and final vacuums, as well as monitoring the fill rate of the canister. Both gauges are considered to be rough gauges, intended to obtain a relative measure of vacuum change. Accuracy of these field gauges are generally on the order of +/-5 in Hg. Individuals with work plans that outline specific gauge reading requirements are strongly encouraged to purchase and maintain their own gauges in the field. In special cases, a laboratory-grade, NIST-traceable vacuum gauge can be provided upon request.

> The vacuum gauges that are routinely provided are intended as a rough gauge measurement device (+/-5 in Hg accuracy).

Section 3.0 Sampling with Canisters

There are two basic modes of canister sampling: grab and integrated. A grab sample is taken over a short interval (i.e., 1-5 minutes) to provide a point-in-time sample concentration, while an integrated sample is taken over a specified duration or utilizing a specified flow rate. In both modes the canister vacuum is used to draw the sample into the canister. This is commonly referred to as passive canister sampling. Sections 3.1 and 3.2 detail procedures for grab and integrated sampling, and section 3.3 provides procedures specific to soil vapor collection.

Regardless of the type of canister samples collected, the following rules apply:

- DO NOT use canister to collect explosive substances, radiological or biological agents, corrosives, extremely toxic substances or other hazardous materials. It is illegal to ship such substances and you will be liable for damages.
- ALWAYS use a filter when sampling. NEVER allow liquids (including water) or corrosive vapors to enter canister.
- DO NOT attach labels to the surface of the canister or write on the canister; you will be liable for cleaning charges.
- DO NOT over tighten the valve, and remember to replace the brass cap.
- IF the canister is returned in unsatisfactory condition, you will be liable for damages.
- DO NOT make modifications to the equipment connections and/or use Teflon tape unless approved by the laboratory.
- AND, if you have any questions or need any support, our experienced project management team is just a phone call away at 800-985-5955.

Use a 9/16" and 1/2" wrench to tighten Swagelok connections on the canister sampling train.

3.1 Grab Sampling Using Canisters

The most common hardware configuration used to take a grab sample is to simply attach a particulate filter to the canister inlet. A particulate filter is shown in section 2.2.3 and is used to prevent particulate matter from fouling the valve and entering the canister.

3.1.1 Step-By-Step Procedures for Canister Grab Sampling

These procedures are for a typical ambient air sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and gauge – if requested).
2. Make sure you include a 9/16" and 1/2" wrench in your field tool kit.
3. Verify the gauge is working properly.
4. Verify the initial vacuum of canister as described in the following section:

- **Verify Initial Vacuum of the Canister**: Prior to shipment, each canister is checked for mechanical integrity. However, it is still important to check the vacuum of the canister prior to use. Eurofins Air Toxics recommends doing this before going to the field if possible. The initial vacuum of the canister should be greater than 25 in Hg. If the canister vacuum is less than 25 in Hg, ambient air may have leaked into the canister during storage or transport and the sample may be compromised. Contact your Project Manager if you have any questions on whether to proceed with sample collection. If sampling at altitude, there are special considerations for gauge readings and sampling (see Section 5.2). The procedure to verify the initial vacuum of a canister is simple but unforgiving.

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove the brass cap.
3. Attach gauge.
4. Attach brass cap to side of gauge tee fitting to ensure a closed train.
5. Open and close valve quickly (a few seconds).
6. Read vacuum on the gauge.
7. Record gauge reading on "Initial Vacuum" column of chain-of-custody.
8. Verify that canister valve is closed and remove gauge.
9. Replace the brass cap.

When ready to sample:

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap.
3. Attach particulate filter to canister.
4. Open valve 1/2 turn (6 L canister normally takes less than 5 minutes to fill).
5. Close valve by hand tightening knob clockwise.
6. Verify and record final vacuum of canister (repeat steps used to verify initial vacuum). For grab samples, the ending vacuum is typically close to ambient pressure (0 in Hg).
7. Replace brass cap.
8. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
9. Return canister in box provided.
10. Return sample media in packaging provided.
11. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
12. Place chain-of-custody in box and retain pink copy.
13. Tape box shut and affix custody seal (if applicable) across flap.
14. Ship accordingly to meet method holding times.

Return all equipment used or unused to the laboratory. Unreturned canisters and associated hardware will result in additional charges as outlined in the media agreement.

3.2 Integrated Sampling with Canisters and Flow Controllers

As an alternative to an "instantaneous" grab sample, an air sample collected at a controlled rate is referred to as an integrated sample. Flow controllers or flow restrictors are devices which provide sample collection at a desired flow rate and/or sampling interval. By using a flow controller at a specified flow rate, air samples can provide information on average compound concentrations over a defined period. For example, an 8- or 10-hour integrated sample can be used to determine indoor air quality in the workplace. Similarly, a 24-hour integrated sample may be collected to determine residential exposure to indoor or outdoor air sources. In addition to using a flow controller for time-integrated sample collection, a flow controller may be required for soil gas collection to restrict the vacuum applied to the soil and pore water and to collect a representative sample with minimal intrusion of ambient air.

Eurofins Air Toxics provides two general types of flow controllers: mass flow controllers and critical orifice devices. Both devices are driven by differential pressure between ambient conditions and vacuum in the canister.

3.2.1 *Mass Flow Controller*

A mass flow controller employs a diaphragm that actively compensates to maintain a constant mass flow rate over the desired time period. As the differential pressure decreases, the flow rate decreases and the diaphragm responds by opening up to allow more air to pass through to maintain a stable flow rate. Mass flow controllers are calibrated in the laboratory to provide flow rates suitable for durations up to 24 hours. Durations greater than 24 hours are possible, however, performance of the flow controller is less reliable due to the low flow rates required.

3.2.2 *Critical Orifice Devices*

Eurofins Air Toxics has two types of critical orifice controllers – “capillary column” and “frit pressed”. Both types restrict the flow rate and the canister fill rate decreases as the canister fills to ambient pressure. These controllers are suitable for applications not requiring constant flow rate over the sampling period such as soil vapor collection or at sites in which temporal variability of VOCs is not expected. Critical orifice devices can cover intervals from 0.5 to 12 hours and flow rate from 10 to 250 ml/min. The “capillary column” device (also known as the Blue Body Flow Controller) restricts air flow by forcing the sample to enter a capillary column of minute radius. The flow rate is a function of the length of inert capillary column. The frit pressed device has a critical orifice machined to meet a set flow rate.

3.2.3 *Sampling Interval and Flow Controller Setting*

When you request canisters and flow controllers from Eurofins Air Toxics, you will be asked for the flow rate (soil vapor) or sampling interval (ambient air), and the flow controllers will be pre-set prior to shipment. The flow rate is set at standard atmospheric conditions (approximately sea level and 25°C). If samples will be collected at elevation or at ambient temperatures significantly different than 25°C, the canister will fill faster or slower depending on sample conditions. If you specify unusual sample conditions at the time of project set-up, we can set the flow controller accordingly. (See Section 5.2 for a discussion of collecting a sample at elevation.) Mass flow controllers should not be utilized for source or process samples in which the collection point is under vacuum or pressure. Please discuss these specific non-standard field conditions with your Project Manager at the time of project set-up.

Table 3.2.3 Flow Rates for Selected Sampling Intervals (mL/min)

Sampling Interval (hrs)	**4 min.**	**0.5**	**1**	**2**	**4**	**8**	**12**	**24**
6 L Canister	NA	167	83.3	41.7	20.8	11.5	7.6	3.8
1 L Canister	167	26.6	13.3	6.7	-	-	-	-

Note: Target fill volumes for 6 L and 1 L canisters are 5,000 mL and 800 mL, respectively.

3.2.4 *Final Canister Vacuum and Flow Controller Performance*

For time-integrated sample collection using a mass flow controller, the final vacuum of a canister should ideally be approximately 5 in Hg or greater. The flow rate will remain constant as the canister fills and will start to decrease as the canister vacuum approaches

5 in Hg. At this point, the differential pressure between the canister and ambient air is not sufficient to maintain the set flow rate. Because of normal fluctuations in the flow rate due to changes in field temperature and pressure, the final vacuum typically ranges between 3 and 10 in Hg.

- **If the residual canister vacuum is greater than 10 in Hg** (i.e., more vacuum), the actual flow rate is lower than the set point and less sample volume is collected. When the canister is pressurized prior to analysis, the pressurization dilution will be greater than normal. This will result in elevated reporting limits.
- **If the residual canister vacuum is near ambient pressure** for a time-integrated sample, the canister filled faster than calibrated. Once the vacuum decreases below 5 in Hg, the flow rate begins to decrease from its set point. This scenario indicates that the sample is weighted toward the first portion of the sampling interval. The sampler cannot be certain the desired sampling interval was achieved before the canister arrived at ambient conditions. Although the actual sampling interval is uncertain, the canister still contains a sample from the site.

Table 3.2.4 Relationship between Final Canister Vacuum, Volume Sampled, and Dilution Factor (6 L Canister)

Final Vacuum (in Hg)	**0**	**2.5**	**5**	**7.5**	**10**	**12.5**	**15**	**17.5**	**20**
Volume Sampled (L)	6	5.5	5.4	5	4	3.5	3	2.5	2
Dilution Factor*	1.34	1.46	1.61	1.79	2.01	2.30	2.68	3.22	4.02

*Canister pressurized to 5 psig for analysis

$$\textbf{Final Reporting Limit} = \text{Method Reporting Limit} \times \text{Dilution Factor (Canister Pressurization)} \times \text{Dilution Factor (Sample Analysis)}$$

$$\textbf{Dilution Factor (Canister Pressurization)} = \frac{\text{Final Pressure}}{\text{Receipt Pressure}} = \frac{14.7\text{ psig} + \text{Final Pressure (psig)}}{14.7\text{ psig}\left[\dfrac{1\text{-Receipt Vacuum (in Hg)}}{29.9\text{ in Hg}}\right]}$$

3.2.5 Considerations for Integrated Sampling with Canisters

Collecting an integrated air sample is more involved than collecting a grab sample. Sampling considerations include verifying that the sampling train is properly configured, monitoring the integrated sampling progress, and avoiding contamination.

- **Avoid Leaks in the Sampling Train**: A leak in any one of these connections means that some air will be pulled in through the leak and not through the flow controller. (Follow the leak check step #4 in 3.2.6).
- **Verify Initial Vacuum of Canister:** See Section 3.1.1 for instructions on verifying initial canister vacuum. A separate gauge is not necessary as both the mass flow controllers and critical orifice flow controllers have built-in rough gauges.
- **Monitor Integrated Sampling Progress**: When feasible, it is a good practice to monitor the progress of the integrated sampling during the sampling interval. The volume of air sampled is a linear function of the canister vacuum. For example, when using a 24-hour mass flow controller, at a quarter of the way (6 hours) into a 24-hour sampling interval, the canister should be a quarter filled (1.25 L) and the gauge should read approximately 6 in Hg lower than

the starting vacuum (~22 in Hg). More vacuum indicates that the canister is filling too slowly; less vacuum means the canister is filling too quickly. If the canister is filling too slowly, a valid sample can still be collected (see Section 3.2.4). If the canister is filling too quickly because of a leak or incorrect flow controller setting, corrective action can be taken. Ensuring all connections are tight may eliminate a leak. It is possible to take an intermittent sample; the time interval need not be continuous.

- **Avoid Contamination**: Flow controllers should be cleaned between uses. This is done by returning them to the laboratory.
- **Caution When Sampling in Extreme Temperatures**: Field temperatures can affect the performance of the mass flow controllers. Laboratory studies have shown that flow rates can increase slightly with decreasing temperatures. A flow rate increase of approximately 10% is expected when sampling at field temperatures of 5 to 10°C.

3.2.6 Step-by-Step Procedures for Integrated Sampling

These procedures are for a typical ambient air sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, and flow controller)
2. Make sure you include a 9/16" and 1/2" wrench in your field tool kit.
3. Verify the gauge is working properly
4. Verify the initial vacuum of canister (section 3.1.1)

When ready to sample:

1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap from canister.
3. Attach flow controller to canister. The flow controller is securely attached if the flow controller body does not rotate.
4. Place the brass cap at the end of the flow controller creating an air tight train, and quickly open and close the canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.
5. Once the sample train is airtight remove the brass cap from the flow controller and open the canister valve a ½ turn.
6. Monitor integrated sampling progress periodically.
7. Verify and record final vacuum of canister (simply read built-in gauge).
8. When sampling is complete, close valve by hand tightening knob clockwise.
9. Detach flow controller and replace brass cap on canister.
10. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
11. Return canisters and associated media in boxes provided. **Failure to return all of the provided equipment will result in a replacement charge as outlined in the media agreement.**
12. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
13. Place chain-of-custody in box and retain pink copy.
14. Tape box shut and affix custody seal at each opening (if applicable).
15. Ship accordingly to meet method holding times.

3.3 Soil Gas Sample Collection

Canisters can be used for the collection of soil vapor by attaching the sampling train to the soil gas probe. Typically, a critical orifice flow controller is used to minimize the applied vacuum in order to minimize partitioning of VOCs from the soil or pore water to the soil vapor. Additionally, lower flow rates help to minimize the intrusion of ambient air into the soil vapor probe. In general, time-integration is not required for soil gas samples; however, there may be exceptions to this rule of thumb. For example, some regulatory guidance documents recommend concurrent indoor air and sub-slab soil vapor collection over a

24-hour period. This means that a mass flow controller calibrated for a 24-hour sample would be required for the sub-slab as well as the indoor air sample.

3.3.1 Canister to probe connection – Tubing

Collection of a soil gas sample requires the use of tubing to connect the soil gas probe to the sample train. Teflon FEP tubing is recommended based on its low background and its inertness. Alternative tubing can be used if shown to meet data quality objectives. Please note that Low Density Polyethylene or flexible Tygon tubing is not recommended due to VOC adsorption during sample collection. Teflon tubing is provided by the laboratory upon request at the time of order. A charge based on the length will be assessed. It is important to store the tubing away from VOC sources during storage and transport to the site to minimize contamination.

3.3.2 Canister to probe connection –Fittings

To connect the tubing to the canister sampling train, a Swagelok fitting and a pink ferrule are used. The position of the ferrule is key to ensure the fitting is securely connected to the canister. See the figure below for the correct positioning and connection. The pink ferrule is flexible and cannot be over-tightened.

3.3.3 Leak Check Compounds Considerations

To determine whether ambient air is introduced into soil gas sample, a leak check may be used. Leak check compounds may be liquid or gaseous tracers. Liquid compounds are challenging to use effectively in the field and can be introduced into the sample due to improper handling in the field, erroneously indicating a leak in the sampling train. Liquid tracers such as isopropanol should never be directly applied to connections in the sampling train. Rather, the liquid is carefully applied to a cloth and placed near the connection or on the ground next to the probe. Great care must be used in the field to insure the liquid tracer is not handled during sampling train assembly or disassembly. Even a trace amount of a liquid tracer on a glove used to replace a canister brass cap can contaminate the sample. Liquid leak check compounds can interfere with the analytical runs, and even small leaks may result in analytical dilution and raised reporting limits when measuring ppbv target compound levels.

Gaseous tracers such as helium are typically used with shroud placed over the sampling equipment and/or borehole. To quantify the leak, the concentration of the tracer gas in the shroud should be measured.

> Specify the leak check compound planned for your soil gas sampling event and record on the COC.

3.3.4 Step-by-Step Procedures for Soil Vapor Sampling

These procedures are for a typical soil vapor sampling application; actual field conditions and procedures may vary. Please consult your specific regulatory guidance for details.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, tubing, fittings, and flow controller).
2. Make sure you include a 9/16” and 1/2” wrench in your field tool kit.
3. Verify the gauge is working properly.
4. Verify the initial vacuum of canister.

Prior to vapor collection:

- **Purge tubing adequately**. A long length of tubing has significant volume of “dead air” inside. Without purging, this air will enter the canister and dilute the sample. Consider using a handheld PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing. A standard rule of thumb is to utilize 3 purge volumes prior to sample collection. However, under certain circumstances, purge volumes of 1 to 10 may be appropriate. Please review your regulatory guidance and your site specific conditions in determining the appropriate purge volumes.
- **Don’t sample water**. If moisture is visible in the sample tubing, the soil gas sample may be compromised. Soil gas probes should be at an appropriate depth to avoid reaching the water table. Additionally, subsurface vapor should not be collected immediately after measurable precipitation.

When ready to sample:

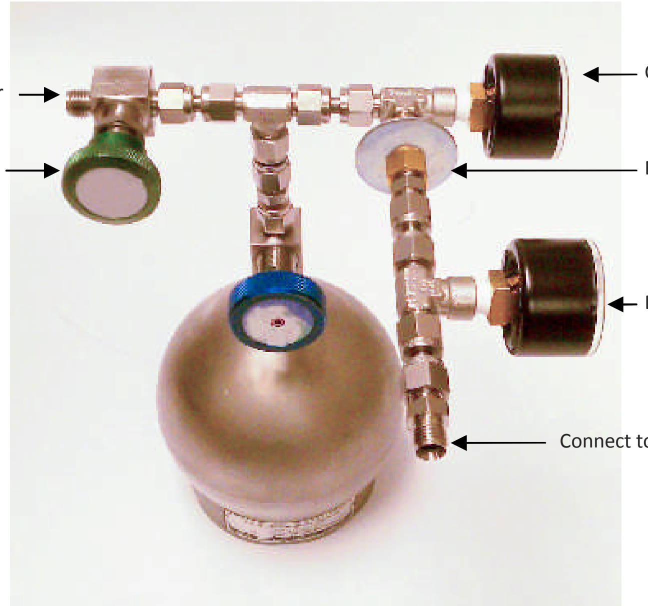
1. Confirm that valve is closed (knob should already be tightened clockwise).
2. Remove brass cap from canister.
3. Attach flow controller to canister if needed. The flow controller is securely attached if the flow controller body does not rotate. (Note: The frit-press flow controller and 1 L canister may be pre-assembled by the laboratory.)
4. Place the brass cap at the end of the flow controller creating an air tight train, and quickly open and close the canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.
5. Once the sample train is airtight remove the brass cap from the flow controller and attach the probe tubing to the flow controller using the pink ferrule and Swagelok nut. (See 3.3.2 for proper positioning of the ferrule.)
6. Once the probe line has been purged and appropriate leak check measures have been implemented, open the canister valve a ½ turn.
7. Verify and record final vacuum of canister (simply read built-in gauge).
8. When canister fills to the desired end vacuum, close valve by hand tightening knob clockwise.

   Please note: Some projects require residual vacuum of approximately 5 in Hg at the end of sample collection even if time-integrated samples are not required. The residual vacuum serves to provide a check of the integrity of the canister during transport to the laboratory to insure no leaks occurred during shipment. A field vacuum reading similar to the lab receipt vacuum reading demonstrated that no leak occurred.

9. Detach tubing and flow controller and replace brass cap on the canister.
10. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).
11. Return canisters and associated media in boxes provided. **Failure to return all of the provided equipment will result in a replacement charge as outlined in the media agreement.**
12. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).
13. Place chain-of-custody in box and retain pink copy
14. Tape box shut and affix custody seal at each opening (if applicable)
15. Ship accordingly to meet method holding times

3.4.4 Collecting Soil Gas Samples with Sampling Manifolds

If required, Eurofins Air Toxics can provide a sampling manifold to assist with leak checking the sampling train, purging the sampling line, and monitoring the vacuum applied to the soil gas bore hole during sample collection. The manifold is shown below:



The 'Down Hole Gauge', located prior to the flow restrictor, is a vacuum gauge that monitors the vacuum applied to the soil gas probe. Because this is not a flow meter but a measure of pressure/vacuum, the gauge should read at zero if there is sufficient flow from the soil. If the gauge begins to read a vacuum, then the flow is being restricted. Low flow, high vacuum conditions can be encountered when sampling in low permeability soil. The 'Canister Gauge', in line after the flow controller and prior to the purge canister, is a vacuum gauge that indicates to the sampler whether or not the canister is filling properly at the expected rate. This setup enables the sampler to evaluate the lithologic conditions at the site and determine if a valid soil gas sample is being taken. Finally, when duplicate samples are required, the manifold can be used as a duplicate sampling "T" by simply replacing the purge canister with another sample canister.

There are several options to use as a purge vacuum source to attach to the purge valve connection – a Summa canister, sampling pump or sampling syringe. The below instructions assume a Summa canister will be used as a purge volume source since other sources are generally provided by the client.

When ready to sample:

Leak Check Test

1. Confirm that canister valves are closed (knob should already be tightened clockwise).

2. Remove brass caps from both the sample canister and the purge canister. (Unless using certified media, there is no difference between the two).

3. Attach manifold center fitting to sample canister.

4. Attach purge canister to the Purge Valve end of the manifold by attaching provided Teflon tubing and compression fittings.

5. Confirm that there is a brass cap secured at the inlet of the manifold creating an air tight train, make sure the manifold valve above the purge canister is open, and quickly open and close the purge canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady.

Purging

6. Once the sample train is airtight remove the brass cap from the manifold inlet, connect the tubing from the sample port using a compression fitting and open the purge canister valve, 1/2 turn.

7. Monitor integrated sampling progress periodically. *Please note, because the purge canister is inline after the flow restrictor the line will not purge faster than at a rate of 167 ml/min.

8. Once the desired purge volume is met close both the manifold valve and the purge canister valve by hand tightening the knobs clockwise.

9. If sampling at multiple locations, the purge canister can be disconnected from the manifold and used to begin purging the next sample location without compromising the sample train.

Sampling

10. The line is now ready to be sampled. Open the sample canister valve and monitor sampling progress periodically.

11. When the sampling is complete close the valve and replace the brass cap on the canister; record final vacuum of canister (simply read built-in gauge).

12. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly).

13. Return canisters in boxes provided and all parts of the soil gas manifold. **Unreturned media will result in a replacement charged assessed as described in the media agreement**.

14. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody).

15. Place chain-of-custody in box and retain pink copy.

16. Ship accordingly to meet method holding times.

Section 4.0 Sampling with Bags

This section provides a description of the types of air sampling bags, selecting the right bag for your application, practical considerations for sampling, and step-by-step instructions for collecting a grab sample. Photographs illustrate the correct way to assemble the various sampling components.

4.1 Introduction to Bags

Air sampling bags are containers used to collect whole air samples for landfill gas, soil gas and stationary source applications. Bags can be constructed from various materials which can differ in terms of stability characteristics and cleanliness. In general, air sampling bags are best suited for projects involving analysis of compounds in the ppmv range. They can be used to collect sulfur compounds, but only if the fittings are non-metallic (e.g., polypropylene, Teflon®, or Nylon).

Air sampling bags are equipped with a valve that allows for filling. Sample collection requires a pressurized sampling port, a low flow rate pump or a lung sampler. The bag expands as the vapor sample is pulled in. When the target volume of the sample is collected, the valve is closed and the bag is returned to the laboratory. Bag materials should be selected based on the specific application. Common air sampling bags include Tedlar film and FlexFoil. Eurofins Air Toxics maintains a limited inventory of air sampling bags in 1 L, 3 L and 5 L volumes.

4.1.1 Tedlar® Film

Tedlar® is a trade name for a polyvinyl fluoride film developed by DuPont Corporation in the 1960's. This patented fluoropolymer has been used in a wide variety of applications including protective surfacing for signs, exterior wall panels and aircraft interiors. Tedlar® film is tough yet flexible and retains its impressive mechanical properties over a wide range of temperatures (from well below freezing to over 200°F). Tedlar® exhibits low permeability to gases, good chemical inertness, good weathering resistance and low off-gassing.

Tedlar® bags may be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, sulfur compounds, atmospheric and biogenic gases and many other classes of compounds. Compounds with low vapor pressures such as Naphthalene are not appropriate for Tedlar bags as recovery is very low even under short sample storage times. Low molecular compounds such as Helium and Hydrogen can diffuse through the Tedlar bag material resulting in poor storage stability.

4.1.2 Tedlar® Bag Suppliers and Re-use

Compounds commonly detected from analyzing new Tedlar® bags include methylene chloride, toluene, acetone, ethanol, 2-propanol, phenol, and dimethylacetamide. While levels of these common artifacts are typically in the ppbv range, the cleanliness of bags can vary significantly between vendors, and purchasing bags directly from an unknown vendor should be avoided. Once the Tedlar® bag is used for sample collection, the surface has been exposed to moisture and possible VOCs. It may irreversibly adsorb many VOCs at the low ppbv level. A series of purges with certified gas may not remove the VOCs from the surface. Consider your data quality objectives to determine whether re-using Tedlar® bags is appropriate.

4.1.3 Hold Time for a Tedlar® Bag

The media hold time for a Tedlar® bag is indefinite if stored out of sunlight in a cool, dry location.

The sample hold time to analysis varies by method and compound. See Table 4.1.3 for recommended sample storage times for commonly requested parameters.

Table 4.1.3 Recommended Maximum Sample Storage Times for Tedlar® Bags

Analytical Method	Chemical Class	Storage Time
ASTM D5504	Suite of sulfur compounds including Reactive Sulfur compounds (Hydrogen sulfide, Methyl mercaptan)	24 hours
ASTM D1946 ASTM D1945	Atmospheric and natural gases: CO, CO2, CH4, C2-C5 hydrocarbons (He and H_2 not recommended)	Up to 3 days
Modified TO-14A, TO-15, TO-3, TO-12	Volatile Organic Compounds (VOCs)	Up to 3 days

4.1.4 FlexFoil Bags

FlexFoil bags are made from an opaque and flexible material with 4-ply construction resulting in high physical strength to minimize rupture and leakage and low permeability to provide good stability for low molecular weight compounds. FlexFoil bags are ideal for target compounds such as Hydrogen and Helium and can be used for the suite of atmospheric and natural gas components. While the reactive sulfur compounds, Hydrogen Sulfide and Methyl Mercaptan, show good stability over 24 hours in FlexFoil bags, other sulfur compounds demonstrate low recovery. Table 4.1.4 summarizes the compounds and the hold times amenable to FlexFoil bags.

Table 4.1.4 Recommended Maximum Sample Storage Times for FlexFoil Bags

Analytical Method	Chemical Class	Storage Time
ASTM D5504	Hydrogen sulfide, Methyl mercaptan only Not recommended for full sulfur list.	24 hours
ASTM D1946 ASTM D1945	Atmospheric and natural gases Full List	Up to 3 days

4.2 Air Bag Sampling

Using a bag to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. There are two methods commonly used to fill a bag: a pump or a lung sampler.

- **Sampling with a Pump**: The most common method for filling a bag is to use a small pump with low flow rates (50-200 mL/min) and tubing to fill the bag. Eurofins Air Toxics, Inc. does not provide pumps but pumps may be rented from equipment providers or purchased from manufacturers such as SKC or Gilian.
- **Sampling with a Lung Sampler**: A "lung sampler" may be used to fill a bag. Although a little more complicated than simply using a pump, the main advantage to using a lung sampler to fill a bag is that it avoids potential pump contamination.

A bag with attached tubing is placed in a small airtight chamber (even a 5-gallon bucket can work) with the tubing protruding from the chamber. The sealed chamber is then evacuated via a pump, causing the bag to expand and draw the sample into the bag through the protruding tube. The sample air never touches the wetted surfaces of the pump. Eurofins Air Toxics does not provide lung samplers, but they can be rented from equipment suppliers or purchased by manufacturers such as SKC Inc.

4.2.1 Considerations for Bag Sampling

Some considerations for collecting a bag sample:

- **Fill the bag no more than 2/3 full**: Allow for possible expansion due to an increase in temperature or decrease in atmospheric pressure (e.g., the cargo hold of a plane)
- **Keep the Tedlar® bag out of sunlight**: Tedlar® film is transparent to ultraviolet light (although opaque versions are available) and the sample should be kept out of sunlight to avoid any photochemical reactions
- **Protect the bag**: Store and ship the bag samples in a protective box at room temperature. An ice chest may be used, but DO NOT CHILL
- **Fill out the bag label**: It is much easier to write the sample information on the label before the bag is inflated. Make sure to use a ball-point pen, never a Sharpee or other marker which can emit VOCs.
- **Provide a "back-up" bag**: Consider filling two bags per location in the rare occasion that a defective bag deflates before analysis. The "hold" sample does not need to be documented on the Chain-of-Custody and should have an identical sample ID to the original sample indicating that it is the "hold" sample
- **Avoid Contamination**: Care should be taken to avoid contamination introduced by the pump or tubing. Begin sampling at locations with the lowest compound concentrations (e.g., sample the SVE effluent before the influent). Decontaminate the pump between uses by purging with certified air for an extended period; better yet, use a lung sampler. Use the shortest length possible of Teflon® tubing or other inert tubing. DO NOT REUSE TUBING. If long lengths of tubing are used, consider purging the tubing with several volumes worth before sampling. If you are concerned about sampling for trace compounds, you shouldn't be using a Tedlar® bag (see Section 1.2)
- **Don't Sample Dangerous Compounds in a Bag**: Do not ship any explosive substances, radiological or biological agents, corrosives or extremely hazardous materials to Eurofins Air Toxics. Bag rupture during transit to the laboratory is possible and the sampler assumes full liability.

4.2.2 Step-by-Step Procedures for Bag Sampling (Pump)

Note: These procedures are for a typical stationary source (e.g., SVE system) sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, bag, and tubing/fittings – if requested).
2. Verify pump cleanliness and operation (Eurofins Air Toxics does not provide pumps).

When ready to sample:

3. Purge sample port.
4. Attach new Teflon® tubing from sample port or probe to low flow rate pump.
5. Purge tubing.
6. Fill out bag sample tag.
7. Attach additional new Teflon® tubing from the pump outlet to the bag valve.
8. Open bag valve.
9. Collect sample (FILL NO MORE THAN 2/3 FULL).
10. Close bag valve by hand tightening valve clockwise.
11. Return filled bags in a rigid shipping container (DO NOT CHILL).
12. Fill out chain-of-custody and relinquish samples properly.
13. Place chain-of-custody in box and retain pink copy.

14. Tape box shut and affix custody seal (if applicable) across flap.
15. Ship first overnight or priority overnight to meet method holding times.

Expedite delivery of air sampling bags to the laboratory for analysis.

Section 5.0 Special Sampling Considerations

This section provides recommendations for the collection of field QC samples such as field duplicates. Considerations for sampling at altitude, sampling SVE ports and using sample cylinders are presented.

5.1 Field QC

To measure accuracy and precision of the field activities, project plans often include field duplicates, field blanks, ambient blanks, trip blanks and/or equipment blanks.

5.1.1 Field Duplicate

A field duplicate is a second sample collected in the field simultaneously with the primary sample at one sampling location. The results of the duplicate sample may be compared (e.g., calculate relative percent difference) with the primary sample to provide information on consistency and reproducibility of field sampling procedures. Due to the nature of the gas phase, duplicate samples should be collected from a common inlet. The configuration for collecting a field duplicate includes stainless steel or Teflon® tubing connected to a Swagelok "T". If integrated samples are being collected and the sample duration is to be maintained, the sample train should be assembled as follows: each canister should have a flow controller attached, then the duplicate sampling T should be attached to the flow controllers. If the collection flow rate from the sample port is to be maintained then the duplicate sampling T should be connected to the canisters; then the flow controller is connected to the inlet of the sampling T.

Alternatively, if the project objective is to assess spatial or temporal variability, then field duplicates may be deployed in close proximity (ambient air sampling) or samples may be collected in succession (soil vapor).

5.1.2 Field Blank

A field blank is a sample collected in the field from a certified air source. Analysis of the field blank can provide information on the decontamination procedures used in the field. Clean stainless steel or Teflon® tubing and a certified regulator should be used. It is imperative that individually certified canisters (the sample canister and the source canister/cylinder, if applicable) be used to collect a field blank.

5.1.3 Ambient Blank

An ambient blank is an ambient air sample collected in the field. It is usually used in conjunction with soil gas or stationary source (e.g., SVE system) sampling. Analysis of the ambient blank can provide information on the ambient levels of site contaminants. It is recommended that an individually certified canister be used to collect an ambient blank.

5.1.4 Trip Blank

When sampling for contaminants in water, the laboratory prepares a trip blank by filling a VOA vial with clean, de-ionized water. The trip blank is sent to the field in a cooler with new sample vials. After sampling, the filled sample vials are placed back in the cooler next to the trip blank and returned to the laboratory. Analysis of the trip blank provides information on decontamination and sample handling procedures in the field as well as the cleanliness of the cooler and packaging.

When sampling for compounds in air, a trip blank provides little, if any, of the information above. A trip blank canister can be individually certified, evacuated, and sent to the field in a box with the sample canisters. Since the valve is closed and the brass cap tightened, it is questionable if the trip blank canister contents are ever "exposed" to sampling conditions. The trip blank VOC concentrations essentially provide information regarding the cleanliness and performance of the trip blank canister. Results cannot necessarily be applied to the associated field sample canisters accompanying the trip blank. **Eurofins Air Toxics does not recommend collecting a trip blank for air sampling.**

5.2 Considerations for Sampling at Altitude

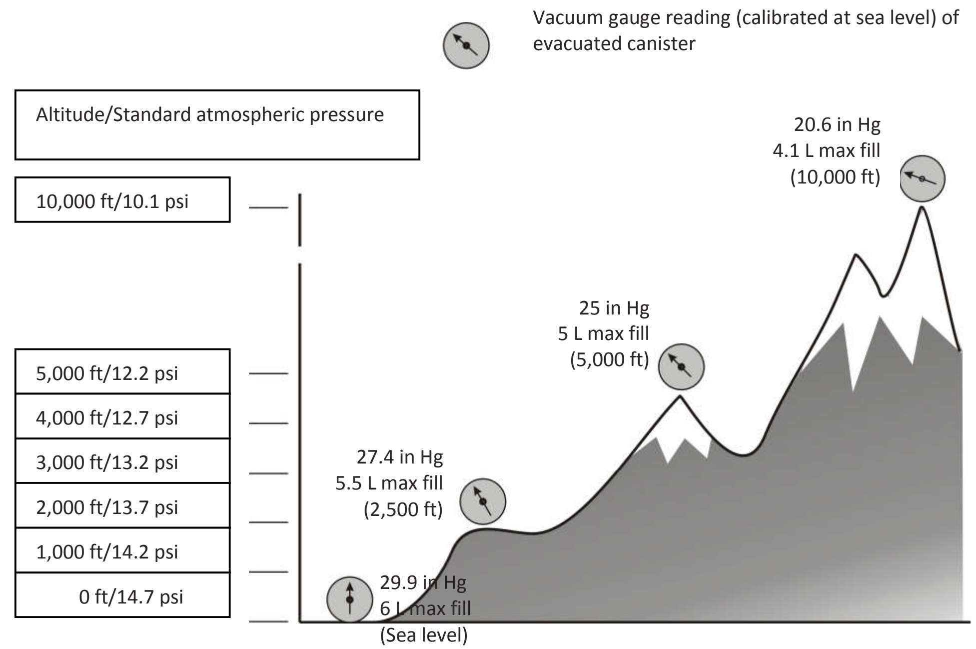
Sampling at altitudes significantly above sea level is similar to sampling a stationary source under vacuum in that target fill volumes may be difficult to achieve. The figure to the right illustrates the relationship between increasing altitude and decreasing atmospheric pressure. Ambient conditions in Denver at 5,000 ft altitude are quite different from ambient conditions at sea level. Canister sampling is driven by the differential pressure between ambient conditions and the vacuum in the canister.

There is less atmospheric pressure in Denver and 5 L is the maximum fill volume of standard air assuming the canister is allowed to reach ambient conditions (i.e., final gauge reading of 0 in Hg). Theoretically, if you sample high enough (e.g., in space), no sample would enter the canister because there is no pressure difference between the evacuated canister and ambient conditions. To fill a canister to 6 L in Denver, you would need to use an air pump.

Sampling at altitude also affects gauge readings. The gauges supplied by Eurofins Air Toxics, Inc. (see Section 2.2.4) measure canister vacuum relative to atmospheric pressure and are calibrated at approximately sea level. Before sampling at altitude, the gauges should be equilibrated (see Section 3.1). But even after equilibrating the gauge, verifying the initial vacuum of a canister at altitude is misleading. In Denver at 5,000 ft, expect the gauge to read 25, not 29.9 in Hg. You do not have a bad canister (i.e., leaking or not evacuated properly). The canister is ready for sampling and the gauge is working properly.

Rule of Thumb: For every 1,000 ft of elevation, the gauge will be off by 1 in Hg and the fill volume will be reduced by 1/5 L.

If you have questions about sampling at altitude, please call your Project Manager at 800-985-5955.



5.3 Considerations for SVE/LFG Collection System Sampling

There are some additional sampling considerations for collecting grab samples (canister or bag) from a Soil Vapor Extraction (SVE) system or landfill gas (LFG) collection system. The general challenge with these samples arises from the need to employ a length of tubing to direct the landfill gas or process air to the canister or bag. Tubing introduces the potential for contamination and diluting the sample.

- **Use inert tubing**. Teflon® tubing is recommended. Tubing with an outer diameter of ¼" works best with the fittings on the particulate filter. (See Section 3.3.1).
- **Do not reuse tubing**.
- **Purge tubing adequately**. A long length of tubing has significant volume of "dead air" inside. Without purging, this air will enter the canister and dilute the sample. Consider using a handheld PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing.
- **Avoid leaks in the sampling train**. Leaks of ambient air through fittings between pieces of the sampling train (e.g., tubing to particulate filter) will dilute the sample.
- Always use compression fittings for all connections; never use tube in tube connections.
- **Purge the sample port**. A sample port on an SVE system or LFG collection system can accumulate solids or liquids depending upon the location of the port in the process and the orientation of the port. An influent sample port located upstream of a filter or moisture knock-out can be laden with particulates or saturated with water vapor. Heavy particulate matter can clog the particulate filter and foul the canister valve. It is important to prevent liquids from entering the canister. A sample port oriented downward may have liquid standing in the valve. Purge the sample port adequately before connecting the sampling train.
- **Consider the effects of sampling a process under vacuum or pressure**. When collecting a grab sample from a stationary source such as an SVE system or LFG collection system, some sample ports may be under vacuum or pressure relative to ambient conditions. When the sample port is under vacuum, such as the header pipe from the extraction well network, it may be difficult to fill the canister with the desired volume of sample. A vacuum pump may be used to collect a canister grab sample from a sample port under considerable vacuum. See the related discussion on sampling at altitude in Section 5.2. When the sample port is under pressure, such as the effluent stack downstream of the blower and treatment system, you may inadvertently pressurize the canister. Only a DOT-approved sample cylinder should be used to transport pressurized air samples (see Section 5.4). Under no circumstances should a Summa canister be pressurized more than 15 psig. Bleed off excess pressure by opening the valve temporarily while monitoring the canister with a pressure gauge.

5.4 Considerations for Sample Cylinder Sampling

Sample cylinders, also known as "sample bombs", are DOT-approved, high pressure, thick-walled, stainless steel cylinders with a valve at each end. They were intended for collecting a pressurized sample for petroleum gas applications. Sample cylinders differ from sample canisters in that they do not have a Summa-passivated interior surface and are not evacuated prior to shipment. Sample cylinders are not suitable for analysis of hydrocarbons at ppbv levels. Sample cylinders can be used for analysis of natural gas by ASTM D-1945 and calculation of BTU by ASTM D-3588. Eurofins Air Toxics assumes that clients requesting a sample cylinder have a pressurized process and sample port with a built-in gauge and 1/4" Swagelok fitting to attach to the sample cylinder. Eurofins Air Toxics has a limited inventory of 500 mL sample cylinders that are particularly suited for landfill gas collection systems (i.e., LFG to energy applications). This section provides step-by-step procedures for sampling with a sample cylinder.

Inform the lab during project set up if hazardous samples (e.g. high Hydrogen Sulfide concentrations) will be collected to verify the lab can safely handle the samples.

Step-by-Step Procedures for Sample Cylinder Sampling

These procedures are for a typical stationary source sampling application and actual field conditions; procedures may vary. Follow all precautions in the site Health and Safety Plan when dealing with a pressurized sample port and sample cylinder. Follow required DOT guidelines for packaging and shipping.

1. Verify contents of the shipped package (e.g., chain-of-custody, sample cylinder, particulate filter).
2. Verify that gauge on sample port is working properly.
3. Purge sample port.

4. Remove brass caps on either end of cylinder.
5. Attach particulate filter to upstream valve.
6. Attach filter/cylinder assembly directly to the sample port.
7. Open both valves 1/2 turn.
8. Allow sample air to flow through sample cylinder (approximately 10 L for a 500 mL cylinder).
9. Close downstream valve of sample cylinder by hand tightening knob clockwise.
10. Allow sample cylinder to pressurize to process pressure (max 100 psig).
11. Close upstream valve of sample cylinder and sample port.
12. Detach filter/cylinder assembly from sample port and remove particulate filter.
13. Replace brass caps.
14. Fill out sample cylinder sample tag.
15. Fill out chain-of-custody and relinquish samples properly.
16. Include the chain-of-custody with the samples and retain pink copy.
17. Pack, label, and ship according to DOT regulations.

Follow DOT regulations for packaging and shipping hazardous samples.

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