Illinois Tool Works Inc.

Field Sampling Plan for Source Investigation and Vertical Aquifer Profiling (FINAL)

Roto-Finish Co., Inc., Portage, MI

25 October 2023

Project No.: 0603218

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Roto-Finish Co., Inc., Portage, MI

Tom O'Connell, P.E.
Partner-in-Charge

Andrea Brazell
Quality Assurance Manager

Peter U Myrczik, PMP
Project Manager

Environmental Resources Management, Inc.

1701 Golf Road
Suite 1-700
Rolling Meadow, IL
60008-4242

T: +1 (847) 258-8900
F: +1 (847) 258-8901

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Acronyms and Abbreviations

Name	Description
AI	Indoor Air Sample
AO	Outdoor Air Sample
BGS	Below Ground Surface
COC	Constituent of Concern
CSM	Conceptual Site Model
CVOC	Chlorinated Volatile Organic Compound
DQO	Data Quality Objective
DUP	Field Blind Duplicate Sample
EB	Equipment Blank Sample
EGLE	Michigan Department of Environment, Great Lakes, and Energy
ERM	Environmental Resources Management, Inc.
FB	Field Blank Sample
FILTB	Filter Blank Sample
FSP	Field Sampling Plan
GB	Sub-Slab Soil Gas Sample
GS	Exterior Soil Gas Sample
HASP	Health and Safety Plan
HCL	Hydrochloric Acid
IDW	Investigation-Derived Waste
ITW	Illinois Tool Works Inc.
mL	Milliliter
MNA	Monitoring Natural Attenuation
MS	Matrix Spike
MSD	Matrix Spike Duplicate
P	Sampling Port

PCE	Tetrachloroethene
PDF	Portable Document Format
PID	Photoionization Detector
PPE	Personal Protective Equipment
PSG	Passive Soil Gas
PSQ	Principal Study Questions
PVC	Polyvinyl Chloride
PZ	Piezometer
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SOP	Standard Operating Procedure
WPSA+VGP	Work Plan for Source Area Investigation and Vertical Groundwater Profiling
TB	Trip Blank Sample
TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
USEPA	United States Environmental Protection Agency
VI	Vapor Intrusion
VOC	Volatile Organic Compound

1. INTRODUCTION

On behalf of Illinois Tool Works Inc. (ITW), Environmental Resources Management, Inc. (ERM) is pleased to submit this Field Sampling Plan (FSP) for investigation of potential on-Site source areas and for performing vertical groundwater profiling to monitor groundwater quality downgradient of the release of chlorinated volatile organic compounds (CVOCs) associated with the former Roto-Finish Co., Inc. (Roto-Finish) property located at 3700 East Milham Avenue, Portage, Michigan (the "Site"). The location of the Site is shown on **Figure 1**.

This FSP (Rev#01) outlines how the data will be collected with respect to the scope provided in the revised September 27, 2023 *Work Plan (Rev#02) for the Source Area Investigation(WPSA)* , including detailed field methodology descriptions. As agreed with USEPA/EGLE, a separate Work Plan for the Vertical Groundwater Profiling task will be prepared and submitted to USEPA/EGLE for review. This FSP (Rev#01) is applicable to both Work Plans.

The previous FSP (ERM 2022b) addressed continuation of groundwater monitoring activities in accordance with the implemented Performance Monitoring Plan (MACTEC 2007a); performance of sub-slab and indoor air monitoring to evaluate seasonal variability in contaminant concentrations; and implementation of a passive soil gas survey to evaluate exterior portions of the Site for suspected historical source areas.

This FSP (Rev#01) was prepared following a preliminary investigation in response to a request by representatives of the (USEPA) and the Michigan Department of Environment, Great Lakes, and Energy (EGLE) to expeditiously evaluate the vapor intrusion exposure pathway at the Site and to provide a plan to evaluate the Site for potential source areas that may be contributing to groundwater impacts. The results of a preliminary sub-slab vapor investigation (ERM 2021a) and Passive Soil Gas (PSG) Survey (ERM 2022b) form the basis for the work outlined in the revised WPSA. This formalized source investigation FSP accompanies the Site's revised Quality Assurance Project Plan (QAPP, ERM 2023a).

1.0 Site Background and Setting

The Site is approximately 6.5 acres in size and developed with two warehouse buildings, which are approximately 52,000 and 10,500 square feet in size. The Site is owned by 3700 Milham, LLC and operated by Clark Logic, a transportation and logistics business.

The Roto-Finish Company used to manufacture specialized equipment to deburr and polish metal castings, mechanical parts, and similar objects at the Site from the 1940s until 1988 when the business was sold. During operations, wastes from rest rooms and laboratories were routed through a system of septic tanks, dry wells, and a tile field. Wastewater from manufacturing and testing processes was discharged to one of five on-Site lagoons until 1980, when the Site was connected to the City of Portage sanitary sewer network. The lagoons were excavated, the contents disposed of off-Site, and the lagoons backfilled in the early 1980s. After 1980, operational wastes were discharged into the City of Portage sanitary sewer system.

In 1986, the Site was placed on the National Priorities List. The primary constituents of concern (COCs) based on the current data include tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene, cis-1,2-dichloroethene, 1,1,1-trichloroethane (TCA), 1,1-dichloroethane and vinyl chloride. The Remedial Investigation and Feasibility Study (RI/FS) was conducted in three phases from 1989 to 1996 (LTI 1996). The former on-Site wastewater lagoons (north, west and south lagoons) were deemed source areas of COCs to groundwater. Between 1979 and 1983, the north, west and south lagoons were investigated, and based on the results, the sediments and underlying soils of the lagoons were excavated and backfilled with clean fill (LTI 1996). The RI/FS report indicated that, after completion of the source control removal action, the primary remaining risk at the Site was posed by contaminated groundwater. In 1995, ITW installed two groundwater extraction wells to capture contaminated groundwater beneath the Site. The extracted groundwater was discharged to the Kalamazoo wastewater treatment plant. The groundwater extraction system was operated through July 2001.

The Record of Decision (ROD) for the Site signed in 1997 defined that the remedial action objective was "*to eliminate or reduce the risks posed by potential future exposure to contaminated groundwater, and to restore the contaminated aquifer to its potential future use as a supply of municipal, residential and industrial drinking water*." To achieve this objective, the ROD included monitored natural attenuation (MNA), institutional controls that limit groundwater use until the aquifer has been restored to cleanup levels, and groundwater monitoring to track the effectiveness of MNA.

Between 2001 and 2006, Remedial Design/Remedial Action work was performed at the Site. The final Performance Monitoring Plan was approved in 2007 (MACTEC 2007a). USEPA recently agreed to a reduction of the monitoring program frequency from quarterly to semi-annually (USEPA, 2023b).

1.1 Alignment with Work Plans and Data Quality Objectives

The QAPP outlines the data quality objectives (DQOs) for the project that will be used to demonstrate that the data collected during each submitted Work Plan investigation and ongoing groundwater monitoring are of acceptable quality (ERM 2023a). Data from the Work Plan investigations will be used to refine the conceptual Site model (CSM), address principal study questions (PSQs) associated with the DQOs in the QAPP and inform decision making for bringing the Site toward closure.

This FSP outlines how the data will be collected with respect to the scope provided in the WPSA+VGP, including detailed field methodology descriptions. This FSP will be updated with additional investigation methodologies as needed as data from the source area investigation is evaluated.

1.2 Source Area Investigation Field Activities

ERM will perform the field activities described in this FSP. Each of these field activities and their purpose are described in Section 3 of this FSP. The FSP will be revised to include any additional activities proposed as part of the WPSA+VGP.

1.3 Project Organization and Field Team Responsibilities

ERM will function as the primary contractor and has the responsibility for subcontractor coordination, field work, and reporting. Key roles and team members are presented below. The QAPP contains detailed descriptions of the complete roles listed below.

Table 1: Key Roles and Team Members

Key Roles	Team Members
Partner-in-Charge	Thomas O'Connell, P.E.
Project Manager	Peter U Myrczik, PMP
Field Team Leader	Samuel Gaeth
Quality Assurance Manager	Andrea Brazell
Field Safety Officer	Role may be fulfilled by various ERM field team members

Key Roles	Team Members
Geospatial Coordinator	Brett Shaver
Technical Advisor	Joe Fiacco, P.G.

P.E. = Professional Engineer

P.G. = Professional Geologist

PMP = Project Management Professional

1.4 Health and Safety Plan

A Health and Safety Plan (HASP) will be prepared to accompany each phase of investigation. The HASP will provide a summary of personnel responsibilities, protective equipment, health and safety procedures and protocols, personnel training, and type and extent of medical surveillance. The plan will identify problems or hazards that may be encountered during performance of the Site investigations and how these will be addressed. Additionally, procedures for protecting third parties, such as Site visitors, vehicular or pedestrian traffic near drilling locations or sampling crews, and for the surrounding community, in general, will be described in the HASP.

2. SAMPLING PLAN DESIGN AND RATIONALE

ERM will implement the WPSA+VGP using a dynamic investigation approach to collect data and develop a three-dimensional understanding of Site geologic and hydrogeologic conditions and the distribution of the chemicals of concern (COCs) which are presented in the QAPP (ERM 2023a). ERM has developed a preliminary CSM, which has been presented to USEPA and EGLE, and will update it as data are generated. ERM will use the updated CSM to support the design of an efficient monitoring well network that will be installed, gauged, sampled, and tested to refine ERM's CSM.

A vapor intrusion (VI) pathway investigation beneath and within the Site buildings (ERM 2021a) and a PSG survey at exterior locations associated with former wastewater lagoons, storm water basins, sludge deposits, sanitary and storm sewers, monitoring wells, abandoned dry wells, and areas with visual indications of potential impact (ERM 2022c) have indicated potential source locations contributing contaminant mass to groundwater. If appropriate, addenda to the WPSA+VGP will be submitted to USEPA for review and approval to allow for a flexible, iterative, and collaborative approach to the WPSA+VGP. Data collected and evaluated during Site characterization activities will be presented to USEPA on a regular basis and used to inform decisions on how to proceed to adequately answer the PSQs.

2.0 Sampling Rationale and Laboratory Analyses

The media to be sampled and associated laboratory analyses were selected to meet the objectives of the PSQ as outlined in the revised WPSA (repeated in Section 3.1 of this report). and the DQOs outlined in the revised QAPP (ERM 2023a). Groundwater and soil samples will be collected for analysis of the VOCs and 1,4-Dioxane parameters listed in Worksheets (WS) #15A and #15D (for groundwater) and WS #15F, #15G, and #15H (for soil) Information on analytical methods, preservation requirements, and container requirements is presented in Worksheet #19 of the QAPP. A detailed discussion of the analytical test methods and the detection limits are further included in the appropriate sections of the QAPP.

2.1 Sample Handling and Custody

Sample handling field activities include sample collection, preservation of the samples, packing, transportation, and handling of the samples prior to receipt by the laboratory. The following sections outline the sample naming conventions by sample type, and protocols for sample collection documentation, container labeling, and packing and shipping. Field quality assurance (QA)/quality control (QC) procedures are summarized in Section 2.4, and in WS #20 of the QAPP. The Standard Operating Procedures (SOP) for field documentation (SOP 01), chain-of-custody (SOP 02), and shipping procedures (SOP 03) are included in Appendix A.

2.1.0 Sample Naming Conventions

All field measurement locations, sample locations, and samples, including those collected for QA/QC purposes, will be assigned a unique identification number. The unique identification number will be used to track field screening data and laboratory analytical results in the project database, as well as presentation of the data in reports. During field work, the unique identification numbers will be recorded in the field book, on field forms, on the sample containers, and/or on the chain-of-custody. The naming conventions used for each type of sample are described below.

2.1.0.0 Groundwater Samples

- Location: MW and Piezometer (PZ), or Waterloo^{APS} location series

- Sampling Port (P) Number (for multi-level wells): P1, P2, P3, etc.
- Sampling Depth (for Waterloo^{APS} samples)
- Sample Matrix: WG (groundwater)
- Sample Date: YYYYMMDD (year, month, day)
- Example: PZ-111-SD-WG-20210102 (groundwater sample collected from PZ-111-SD on 2 January 2021), MW-500-P1-WG-20210302 (groundwater sample collected from Port 1 of MW-500 on 2 March 2021)
- This sample naming convention that will be used differs slightly from the historical data. However, the key pieces of information (location, matrix, date) are included and connection of new sampling data to the historical data will not be affected.

2.1.0.1 Solid Samples

- Location: Soil Boring Sample (SB) will be numbered sequentially in order of boring (001, 002, 003, etc.)
- Sampling Depth Interval (feet bgs): start and end depths from which the sample was collected, reported as feet below ground surface (0-1, 1-2, 2-3, etc.)
- Sample Matrix: SO (solid - i.e., alluvium)
- Sample Date: YYYYMMDD (year, month, day)
- Example Soil Matrix: SB-001-1-2-SO-20230102 (first soil boring solid sample, collected at a depth of one to two feet below ground level on 2 January 2023)

During the soil investigation, the location of soil sample and depth taken will be noted on the associated field sampling form (e.g., inside or outside buildings, on- or off-Site).

2.1.1 Field QA/QC Sample Naming Convention

Field QA/QC samples will include blind duplicates, equipment blanks, field blanks, trip blanks, and matrix spike (MS) / matrix spike duplicates (MSD), as described in Worksheet #20 of the QAPP. Naming conventions for field QA/QC samples are described below.

2.1.1.0 Blind Field Duplicates

- Sample Type: Blind Field Duplicate (DUP)
- Sample Number: 001, 002, 003, etc.
- Sample Matrix: SO, WG, WL, AI, AO, GB, GS, etc.
- Sample Date: YYYYMMDD (year, month, day)
- Example: DUP-001-SO-20210102 (first solid matrix blind field duplicate of sampling event collected on 2 January 2021)

Blind field duplicate samples will be numbered sequentially in order of collection per sample matrix and per sampling event. Blind field duplicate sample names will be recorded on the associated sampling field form for the parent sample and in the field book.

2.1.1.1 Equipment Blanks

- Sample Type: Equipment Blank (EB)
- Sample Number: 001, 002, 003, etc.
- Sample Matrix: WQ (water quality)
- Sample Date: YYYYMMDD (year, month, day)
- Example: EB-001-WQ-20210102 (first equipment blank of sampling event, collected on 2 January 2021)

Equipment blank samples will be numbered sequentially in order of collection per sampling event. The equipment brand, model, and serial number from which each equipment blank was collected will be noted in the field book.

2.1.1.2 Field Blanks

- Sample Type: Field Blank (FB)
- Field Blank Number: 001, 002, 003, etc.
- Sample Matrix: WQ (water quality)
- Sample Date: YYYYMMDD (year, month, day)
- Example: FB-001-WQ-20210102 (first field blank of sampling event, collected on 2 January 2021)

Field blank samples will be numbered sequentially in order of collection per sampling event.

2.1.1.3 Trip Blanks

- Sample Type: Trip Blank (TB)
- Trip Blank Number: 001, 002, 003, etc.
- Sample Matrix: WQ (water quality)
- Sample Date: YYYYMMDD (year, month, day)
- Example: TB-001-WQ-20210102 (first trip blank of sampling event, submitted with samples collected on 2 January 2021)

Trip blank samples will be numbered sequentially in order of submittal per sampling event.

2.1.1.4 Matrix Spike/Matrix Spike Duplicates

For matrix spike/matrix spike duplicate (MS/MSD) analysis, the same sample nomenclature will be used as regular primary samples. Additional volume will be collected as required by the laboratory, and samples will be indicated as MS/MSD on the laboratory chain-of-custody.

2.1.2 Sample Documentation

During sampling activities, pertinent sampling information will be recorded on the applicable field sampling form and field book, as described in the SOP for Field Documentation (SOP 01) in Appendix A. Copies of field forms for the activities described in this FSP are included in Appendix C. Pertinent sampling information will include sample location, date and time of sample collection, sampler name, requested analysis, and container counts and preservation information for each sample. QA/QC samples such as duplicates, and MS/MSDs will also be noted. QA/QC samples that are not associated with a specific sampling location, such as trip blanks, equipment blanks, and filter blanks, will be noted in the field book.

All samples collected for laboratory analysis will be documented on a chain-of-custody, as described below.

2.1.3 Sample Containers and Labeling

For sample collection, each sample container will be identified with a label. The labels will be pre-printed, where possible, or handwritten using indelible ink. Sample container labels will include sample name, sample depth (solid matrix sampling and PSG survey) date and time of sample collection, sampler name, requested analysis, and preservative.

2.1.4 Sample Preservation, Packaging, and Shipping

The type of sample containers, volumes, and preservatives are listed in WS #19 of the QAPP. The containers will either be new or will be pre-cleaned by the laboratory, depending on sample media. Sample containers requiring preservatives will be provided by the analytical laboratories. Groundwater samples collected by the Waterloo^{APS} system for VOC analysis are not collected in pre-preserved vials due to the system setup. After removing the VOC vials from the Waterloo^{APS} sample collection manifold, the appropriate amount of hydrochloric acid (HCL) will be added to the vial and sealed. This will maintain the method required 14-day holding time. Sample containers will be placed on ice in coolers and picked up at the Site by a laboratory courier or shipped to the laboratory per the details outlined in the SOP for Sample Packing and Shipping (SOP 03) in Appendix A.

2.1.5 Sample Chain-of-Custody Forms and Custody Seals

The chain-of-custody provides documentation to trace samples possession continuously from the time of collection until the time of receipt in the laboratory. Chains-of-custody will be completed and sent with the samples for each cooler (SOP 02 in Appendix A). A copy of the chain-of-custody will be kept in the project files.

When the samples leave the custody of the sampling team, the shipping container/cooler will be sealed with a custody seal to determine if the samples have been disturbed during transportation to the laboratory. The laboratory personnel receiving the coolers will note the condition of the seal and the sample containers within the cooler on the chain-of-custody. The laboratory will notify the ERM Quality Assurance Manager (QAM) of any deficiencies. If samples are transferred directly from sampling personnel to laboratory personnel, custody seals are not required, but chains-of-custody must be completed to document the transfer. In the event of an incomplete chain-of-custody form (with regard to the receipt signature), a signed affidavit will be required from the laboratory documenting that the samples were received. The ERM QAM will be contacted should any uncertainty arise regarding the identification of the samples. In the event sample tampering is indicated, the ERM QAM will be contacted immediately.

2.2 Quality Assurance/Quality Control Samples

The QA/QC objectives provide quantitative and qualitative measures of the ability to produce high quality results through a properly designed sampling and analysis program. The objectives of the overall QA/QC program are to:

- Document procedures, including any changes from the Work Plan, FSP, or QAPP requirements.
- Conduct sampling and analytical procedures according to sound scientific principles.

- Monitor the performance of the field sampling team and laboratory with a systematic audit program and provide corrective action necessary to assure sample quality.
- Evaluate the quality of the analytical data through a system of quantitative and qualitative criteria; and
- Record and archive data and observations, as specified in the QAPP.

A description of the proposed field QC samples and laboratory QC samples is included below.

2.2.0 Field Quality Control Samples

Accuracy in the field will be assessed through the use of trip, equipment, and field blanks and through the adherence to protocols and requirements regarding sample handling, preservation, and holding times. Accuracy for field measurements will be maintained through adherence to the calibration procedures for the field instruments as outlined in Worksheet #22 of the QAPP (ERM 2023a), as well as in Section 4.0.

Trip blanks are collected to identify and measure contamination from transit between the field and the laboratory. Equipment blanks are collected to identify and measure cross contamination between monitoring points from field equipment that is not properly decontaminated. Filter blanks are collected to identify and measure contamination from field filtering equipment. Field blanks are collected to identify and measure contamination from ambient sources. The number/frequency for each QC sample type is summarized in Worksheet #20 of the QAPP.

To minimize the chance of cross contamination, samples expected to have high concentrations of COPCs based on past analytical results or location will be segregated and shipped separately from those samples expected to have lower levels of COPCs.

2.2.1 Laboratory Quality Control Samples

Analytical accuracy is expressed as the percent recovery of a spiked constituent, such as a surrogate standard, laboratory control sample/laboratory control sample duplicate, or MS/MSD. Surrogate percent recoveries measure system performance and efficiency during organic analyses. Comparisons of results from laboratory control sample/laboratory control sample duplicate pairs in conjunction with the MS/MSD pairs can be used to provide evidence that the laboratory methods resulted in data that is within acceptance criteria and, if applicable, the extent of matrix interference. Quality control recovery limits are calculated by the laboratory and are established based on statistical evaluation of previous laboratory analytical results for organic and inorganic analyses. Laboratory QC checks are detailed in WS #28A through WS #28AAC of the QAPP.

3. FIELD METHODS AND PROCEDURES

This section describes the Site characterization rationale and the associated field methods and procedures for sample collection that were developed in accordance with industry standard practices. These procedures are intended to provide for the collection of consistent, comprehensive, and representative samples.

SOPs and field forms are included in Appendices A, B and C, respectively. Subcontractor SOPs and user manuals for specialized equipment are included in the QAPP (ERM 2023a). Calibration procedures for field equipment are outlined in Section 4.0. Decontamination procedures for field equipment are outlined in Section 5.0. Investigation-derived waste (IDW) management, handling, sampling, and documentation are outlined in Section 6.0.

3.0 Site Characterization Rationale

The source area characterization activities have been designed to supplement the existing data set with additional data to answer the principal study questions in the WPSA+VGP:

1. *Are CVOCs in soil contributing to the groundwater plume to a degree that would render the MNA remedy ineffective in achieving ROD Cleanup Objectives within the time period stated in the ROD?*
2. *Is (Are) the source area(s) identified contributing to vapor intrusion on Site or off Site?*

This FSP is focused on addressing only the first principal study question to determine the existence of heretofore unidentified CVOC sources impacting groundwater. Following the receipt and review of results from this preliminary investigation, a joint working session will be scheduled with EPA to discuss appropriate additional investigations of soil gas, soil, and/or groundwater.

The following Site characterization tasks have been planned to meet the objectives outlined in the WPSA+VGP:

Shallow groundwater investigation (Figure 2):

- Conduct utility clearance activities consistent with Subsurface Clearance SOP 04, Appendix A at all four proposed drilling locations.
- Advance 29 soil borings to a depth of about 5 feet below the water table (i.e., about 25 feet below ground surface) with direct push methods.
- Collect four discrete-interval soil samples from each boring for laboratory analysis of VOCs by USEPA Method 8260D, and 1,4-Dioxane by SFAM01.1 in accordance with the Solid Matrix Logging and Sampling SOP 07, Appendix A.
- At each of the 29 soil boring locations a discrete-interval groundwater sampling device (such as Geoprobe's SP16) will be used to 10 feet below the water table. Collect two groundwater samples from each boring using the discrete-interval groundwater sampling device; one from the water table, and one from approximately 10 ft below the water table for laboratory analysis of VOCs by USEPA Method 8260D and 1,4-Dioxane by Method SFAM01.1 in general accordance with the Groundwater Sampling SOP 10, Appendix A. A peristaltic pump will be used to collect groundwater samples after one saturated borehole volume of groundwater has been removed.
- Shipping and analyses of soil and groundwater samples will be conducted in accordance with the Sample Packing and Shipping SOP 03, and the Chain of Custody Procedures SOP 02, Appendix A.

- ERM personnel will provide drilling oversight activities, consistent with the Drilling Oversight SOP 06, Appendix A, including geologic logging of soil cores, collection and field screening of soil samples, and collection and submission of soil and groundwater samples for laboratory analysis.
- Vertical (ground surface) and horizontal control for each boring location will be surveyed by a Michigan-licensed land surveyor. The horizontal and vertical accuracy of the survey will be within 0.01 foot. All sampling equipment with be decontaminated in accordance with the Equipment Decontamination SOP 13, Appendix A.
- Investigation derived waste (IDW) will be containerized and characterized for proper disposal in accordance with the IDW Waste Management SOP 14, Appendix A.

Sentinel Vertical Groundwater Profiling (Figure 3):

- Note: implementation of this task is pending upon approval of the location and depth of the sentinel wells. Figure 3 is a draft figure and is subject to change.
- Conduct utility clearance activities consistent with Subsurface Clearance SOP 04, Appendix A at all four proposed drilling locations.
- Conduct vertical groundwater profiling using the Waterloo^{APS} to an estimated depth of 150 feet below ground surface, including collection of up to 13 discrete-depth groundwater samples at approximately 10-foot vertical intervals per SOP CTS-6.43.8, Appendix B. Rotosonic drilling techniques may be used to assist the Waterloo ^{APS} tooling in achieving the target depth and selecting the sampling depths.
- Groundwater samples will be analyzed for VOCs by USEPA Method 8260D.
- Operation details for the Waterloo ^{APS} are presented in SOP 06, Appendix A, for Drilling Oversight. Vertical (ground surface elevation) and horizontal control for each boring location will be surveyed by a Michigan-licensed land surveyor.
- IDW will be containerized and characterized for proper disposal in accordance with the IDW Waste Management SOP 14, Appendix A.

3.1 Preparatory Activities

Off-Site sampling activities as a part of the vertical aquifer profiling task will require access agreements for private properties and notifications to the USEPA. A description of the procedures for each preparatory activity is included below.

3.1.0 Site Access

Access agreement requests will be prepared for the off-Site activities. Access will be requested from property owners and the Federal Aviation Administration. If a location requires private property access, ERM will use its best efforts to obtain access agreements. If USEPA deems it appropriate, it may assist with obtaining access. The ability to drill will be based not only on access agreements, but also on the presence or absence of subsurface and overhead utilities.

3.1.1 Notifications

Required notifications to the USEPA during implementation of the MNA monitoring program and the WPSA+VGP will be completed as follows:

- Unanticipated Site Changes—the USEPA will be notified within 24 hours of discovery of any unanticipated or changed circumstances at the Site.
- Sample Collection Activity—the USEPA and the EGLE will be notified no less than 14 days prior to any sample collection activity to allow for the coordination of the collection of split duplicate samples.

The following notifications will be made related to emergency response and release reporting:

- Emergency Response—the USEPA will be notified should any event occur during performance of the work that causes or threatens to cause a release of waste material on, at, or from the Site that either constitutes an emergency situation or that may present an immediate threat to public health, welfare, or the environment. ERM will take all appropriate action to prevent, abate, or minimize such release or threat of release. ERM will immediately notify the USEPA's Remedial Project Manager of the incident.
- Release Reporting—the USEPA will be notified of any release requiring reporting pursuant to Section 103 of Comprehensive Environmental Response, Compensation, and Liability Act, 42 United States Code (U.S.C.) 9603, or Section 304 of the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. 11004. ERM will immediately orally notify the USEPA's Remedial Project Manager.
- Written Report—a written report will be submitted to the USEPA within 7 days of any Emergency Response or Release Reporting event describing the event, measures taken to mitigate any release or threat of release, and measures taken to prevent the reoccurrence of a release.

3.1.2 Parameters and Groundwater Sample Collection

Groundwater samples from Waterloo^{APS} borings will be purged and sampled in accordance with Groundwater Sampling SOP 10, Appendix A.

3.1.3 Analytical Procedures

Eurofins will analyze the groundwater samples from Waterloo^{APS} borings. The parameters of interest include:

- VOCs by USEPA Method 8260D.
- 1,4-Dioxane by Method SFAM01.1.

Field parameters will be collected and tested by ERM field technicians. The parameters of interest include:

- Field Water Quality Parameters—temperature, turbidity, pH, ORP, dissolved oxygen, specific conductivity, and depth to water (prior to the start of pumping and during pumping for parameter stabilization in preparation for sampling).

Analytical methods and analytes are specified in detail in the QAPP (ERM 2023a).

3.2 Subsurface Clearance Policy

Prior to the initiation of intrusive activities at the Site, ERM or their subcontractor will contact Michigan's one-call public utility locating service to identify, locate, and mark member-company utilities. A private utility locating subcontractor will also be retained to provide ground penetrating radar and electromagnetic induction services to evaluate and clear each proposed intrusive location prior to the commencement of subsurface intrusive activities.

Proposed sampling locations will be adjusted in the field as necessary based on the results of the subsurface clearance effort to facilitate the health and safety of personnel, prevent property damage, and/or to avoid or minimize interference with property operations. The subsurface clearance policy is further described in SOP 04 (Appendix A).

3.3 Subsurface Soil Sampling

This section pertains to the subsurface soil sampling conducted during the on-Site source investigation; no soil samples will be collected during the vertical groundwater profiling.

Soil samples will be examined and screened continuously from the ground surface to each soil boring's completion depth. Selected depth intervals will be sampled for laboratory analysis to evaluate concentrations of COCs and 1,4-dioxane. Soil analytical methods and analytes are specified in detail in the QAPP Worksheet #12 and Worksheet #15 F, G and H (ERM 2023a).

3.3.0 Soil and Groundwater Sample Collection

The upper five feet of each soil boring will be advanced using a stainless-steel hand auger prior to advancement using mechanized drilling equipment, in accordance with the subsurface clearance procedures. At each of the 29 locations shown on Figure 3 a direct-push technology drill rig (Geoprobe, typ.) will be used to advance a soil boring from the bottom of the subsurface clearance interval to approximately 5 feet below the water table (the estimated typical total boring depth will be 25 feet bgs). Continuous soil cores will be collected during advancement for geologic logging and a sample from each 1-foot interval will be screened with a photoionization detector (PID) with an 11.7 electron volt lamp. Four discrete-interval soil samples (i.e., approximately one sample for every 5 vertical feet of soil boring) will be collected from each boring for laboratory analysis of VOCs by USEPA Method 8260D and 1,4-Dioxane by SFAM01.1. These activities will be conducted in accordance with the Solid Matrix Logging and Sampling SOP #07 (ERM 2022a).

Soil borings will be advanced to the planned total depth or drilling refusal depth using direct push drilling methods. Each borehole will be sampled continuously using dedicated sample liners or equivalent discrete interval sampling methods. Drilling equipment will be decontaminated before and between all intrusive activity as described in SOP 13.

Soil will be screened by an ERM geologist using a calibrated photoionization detector (PID). Soil samples will also be examined for physical properties including color, texture, composition, moisture content, odor, and visual evidence of staining, discoloration, or product/sheen. Soil descriptions and other field data/observations will be documented in soil boring logs.

Four discrete-interval soil samples (i.e., approximately one sample for every 5 vertical feet of soil boring) will be collected from each boring for laboratory analysis. The actual sample depth interval will be determined based on PID readings and visual observations. Ideally, the sample exhibiting the highest PID reading will be submitted from each 5-foot interval. If no significant PID readings are measured from a 5-foot interval, then sample collection will be weighted toward the portion of the core exhibiting the finest grain size (i.e., the zone with the highest potential for sorbed or diffused contaminant mass) in accordance with the Solid Matrix Logging and Sampling SOP #07.

Prior to sampling, field staff will ensure that the amount and type of sample containers selected and the various preservation techniques to be used are in compliance with the requirements established in the QAPP WS #19.

Soil samples will be placed into laboratory-provided sampling containers, which will be labeled and stored in a clean cooler with wet ice. All samples will be managed under chain-of-custody procedures and submitted to the project laboratory for analysis of parameters indicated. Decontamination procedures are presented in Section 5 of this FSP.

The soil sample collection procedure is described in SOP 07, Appendix A.

3.3.1 Quality Control Sample Procedures

Quality control samples will be obtained in accordance with procedures described in the QAPP (ERM 2023a). The QAPP provides the rationale for the various QC samples in WS #20.

3.3.1.0 Field Duplicates

Field duplicates will be collected at the ratio of one per every 10 or fewer samples. QA/QC samples will be submitted for analysis of all parameters for which the associated samples are to be analyzed. Field duplicate samples will be collected from the same depth interval at the same time and with the same sampling procedures as the investigative sample. Samples will be collected in accordance with QAPP WS #20 and SOP 07, Appendix A.

3.3.1.1 Field Blanks

Field blanks confirm that the sample containers are clean, and contaminants have not been introduced to the sample from background air conditions. Field blanks will consist of laboratory-supplied deionized water poured from one set of containers to the sampling containers at a specified sampling location.

Field blanks are to be collected in accordance with QAPP WS #20 and SOP 07, Appendix A.

3.3.1.2 Equipment Blanks

Equipment blanks ensure that sampling equipment is clean and that the potential for cross contamination has been minimized. Equipment blanks will only be collected from non-dedicated sampling equipment that is to be reused during the project. The equipment decontamination process is described in SOP 13, Appendix A.

Equipment blanks will be collected in accordance with QAPP WS #20 and SOP 07, Appendix A.

3.3.1.3 Matrix Spike/Matrix Spike Duplicates

MS/MSD samples will be preserved, handled, and delivered to the laboratory following the same procedures as those used for the investigative samples. One sample volume will be collected for the investigative soil sample and two additional volumes will be collected for the MS/MSD sample.

Field MS/MSD Blanks are to be collected in accordance with QAPP WS #20 and SOP 07, Appendix A.

3.3.2 Analytical Procedures

Eurofins will analyze the soil samples from the soil borings. The parameters of interest include:

- VOCs by USEPA Method 8260D, and;
- 1,4-Dioxane by SFAM01.1.

3.3.3 Sample Transportation

Following collection, samples will be transferred to an iced cooler. Wet ice will be used to maintain a constant temperature of 4±2 degrees Celsius within the cooler. To minimize the possibility of container breakage, void space within the cooler will be filled with suitable packaging material, such as bubble wrap. Samples will be transported to the analyzing laboratory in person or via an overnight courier. Rapid return of the samples to the laboratory will ensure that the maximum holding times for the various parameters are not exceeded. The method of shipment and tracking number will be included on the chain-of-custody form. All current regulations (Department of Transportation, International Air Transport Association, courier-specific, etc.) will be observed during the packaging, labeling, and shipping of the samples.

3.3.4 Chain-of-Custody Procedures

The purpose of the chain-of-custody program is the tracking of possession and handling of individual samples from the time of field collection through laboratory analysis. This program will include sample labels, chain-of-custody records, and laboratory logbook.

3.4 Documentation

Field books and field forms will provide the means of recording the data collection activities. All field books and field forms will be scanned to create portable document format (PDF) files for electronic archiving with the central project file. Field data recorded on field forms will not be duplicated in the field book, and vice versa. Field documentation will be submitted to the Field Team Leader and reviewed by the Project Manager. Original field forms will be stored in the project files.

3.4.0 Field Books

Field books will be used to document field observations and activities. The field notes will be clear, with sufficient detail to reconstruct events reconstructed later, if necessary. Field books will document deviations from the QAPP and/or FSP, as well as the reason for the changes. General requirements for book entries include the following:

- One main field book will be maintained for all activities conducted by ERM at the Site.
- Field books will be bound, with consecutively numbered pages.
- Entries will be made legibly with dark, indelible ink.
- Unbiased, accurate language will be used.
- Entries will be made while activities are in progress, or as soon afterward as possible, with the date and time that the notation is made.
- General weather information will be noted at the beginning of each day (e.g., “cloudy” or “sunny”).
- A single stroke with the field staff’s initials will be used to manage unused space left on a page.
- Each consecutive day’s first entry will begin on a new, blank page.
- The date and time, based on military time, will be recorded on each page.
- When a field activity is complete, the field book will be entered into the permanent project file.
- The person recording the information will print and sign each page of the field book. If more than one individual makes entries on the same page, each recorder will print and sign the entry.

- Field book corrections will be made by drawing a single line through the original entry, initialed, and dated.

3.4.1 Field Forms

Field forms will be used when appropriate to achieve efficient and standardized recording of field measurements and observations. The type of field form and the information recorded on it may vary by activity. At a minimum, field forms will be completed for each sample to document the unique sample identifier assigned, to provide information on whether the sample is representative of a primary sample or a QC sample (e.g., field blank, field duplicate), and to provide information regarding the sample matrix, sample date, sample location, and sampling team members. Information from the field forms will be entered into the project database, as needed. Field forms may also be used to document information such as water level gauging data, field observations and measurements, soil sample characteristics (SOP 07, Appendix A), and well construction details.

To the extent possible, electronic field forms (i.e., EQuIS™ Collect forms) will be used. Following submittal of each EQuIS™ Collect form to the project database, a formatted PDF report document will be generated, saved to the project SharePoint site, and included in the appropriate report. For any data that is collected using a hard copy field form, the completed form will be scanned to PDF and then maintained in the project folder; the PDF version will be saved to the project SharePoint site and included in the appropriate report. Data from electronic and hard copy forms will be transferred to the USEPA-accessible database. Copies of hard copy field forms that may be used during the activities described in this FSP are attached in Appendix C.

3.4.2 Photographic Documentation

Photos may be taken over the course of field activities to augment or verify information recorded in the field book and to document general conditions at the Site. Photos will be taken with a rugged field tablet or mobile phone using geographic information system–enabled software to allow for georeferencing. All photographs will be recorded with the date, time, direction, photographer, subject, and scale, as appropriate.

4. CALIBRATION PROCEDURES

This section describes the calibration procedures and the frequency at which these procedures will be performed for field instruments. The calibration procedures listed in this section are specific to the field instruments currently proposed during completion of the Work Plan. If calibration of any instrument or meter is not described herein, it will follow the manufacturer's specified calibration procedures.

4.0 Field Instruments

An overview of field equipment and instruments that will be used during this project is presented below. Detailed calibration procedures for field equipment are detailed in Worksheet #22 in the QAPP. Calibration information, including the date and time, equipment model and serial number, and name of person performing the calibration, will be recorded on the applicable calibration forms, which are included in Appendix C, or in the field book.

0. Electric water level meter (Solinst 102, or similar)—Prior to first use, the water level probes will be calibrated. Calibration procedures are included in the SOP for Fluid Level Measurements (SOP 09 in Appendix A). The water level meters will be re-calibrated on an annual basis.
1. The multi-gas meter will be calibrated by the supplier in accordance with the manufacturer's recommendations. ERM will obtain and document the calibration records. Additionally, ERM will inspect the multi-gas meter and conduct field verification tests, such as the bump test, which exposes the gas monitor's sensors to a target gas to determine if the alarm triggers, in accordance with the manufacturer's recommendations.
2. PID (MiniRae 2000 with 11.7 eV, or equivalent)—The PID will be calibrated daily prior to use with fresh air and a 100-part-per-million isobutylene standard. Calibration procedures are included in the SOP for Field Screening Using a PID (SOP 05 in Appendix A).
3. Water quality meter (YSI ProDSS, or equivalent)—The water quality meter will be calibrated daily prior to use for dissolved oxygen, specific conductivity, pH, and ORP, at a minimum. A separate turbidity meter will be checked daily, and calibrated as needed (Lamotte 2020we, Hach 2100P or equivalent). Calibration procedures are included in the SOP for Groundwater Sampling (SOP 10 in Appendix A).

5. DECONTAMINATION PROCEDURES

Drilling tools and sampling equipment will be decontaminated between each sampling location or boring, as described in the SOP for Equipment Decontamination (SOP 13 in Appendix A). Disposable equipment intended for one-time use will not be decontaminated prior to use.

Equipment will be decontaminated in predesignated areas within a decontamination pad or on plastic sheeting adjacent to the sampling activities. Clean bulky equipment will be stored on plastic sheeting in uncontaminated areas. Cleaned small equipment (e.g., groundwater sampling pump) will be stored in aluminum foil when not in use. Materials to be stored for more than a few hours will also be covered.

Fluids generated during decontamination will be collected and stored onsite in 55-gallon steel drums or a temporary tank pending analytical data.

Decontamination procedures for equipment will be logged as performed in the field book.

6. INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

In the process of conducting the investigation activities described in this Field Sampling, the sampling team will generate different types of potentially contaminated IDW, including but not limited to:

- Soil cuttings.
- Used personal protective equipment (PPE).
- Disposable sampling equipment.
- Decontamination fluids.
- Materials used during or generated by well installation, repair, and abandonment, including old tubing, old pumps, and well construction materials; and
- Purged groundwater from well development and sampling activities.

IDW will be managed in accordance with SOP 14, Appendix A.

7. DATA MANAGEMENT AND EVALUATION

The WPSA+VGP will generate and compile an extensive amount of information that will require proper management to support both the risk assessment and the remedy selection decisions. Procedures will be followed to facilitate the quality, validity, and security of the data. Additional details, including validation methods are included in the QAPP. Data will also be evaluated and compiled into text, tables, figures, and 3-D visualizations to help evaluate and identify any remaining data gaps.

7.0 Data Management

ERM uses a variety of commercially available data management software packages to handle environmental project requirements. ERM utilizes EQuIS™ as the primary environmental data and decision support system. The data is hosted by EarthSoft on a fully managed Microsoft Azure Cloud Services SQL database that is secure and has built in backups and redundancies to prevent the potential for data loss.

7.0.0 Project Database

The EQuIS™ relational project database is the main data lake that feeds data pertaining to environmental chemistry, biology, geology, geotechnical, hydrology, limnology, air, and associated compliance monitoring activities to other data analytics and visualization software such as ArcGIS, EVS, Power BI, and R Markdown.

In general, the database will include well construction details, well development data, survey information, geochemical data, field data, analytical results and field parameters, fluid levels, laboratory qualifiers, additional qualifiers, and other summary information relevant to the investigation.

ERM will submit deliverables to USEPA in the requested format after appropriate data quality checks have been performed, and the final report is ready for submittal.

7.0.1 Spatial Data

Data will be submitted to the USEPA in an appropriate electronic data deliverable format. Spatial data will be submitted in the ESRI File Geodatabase format in a local state plane coordinate system using North American Datum 1983.

An add-on metadata editor for ESRI software, the USEPA Metadata Editor, will be used, as needed. Each file will include an attribute name for each Site unit or sub-unit. Spatial data that will be submitted does not, and is not, intended to define the boundaries of the Site.

8. FIELD EVENTS SCHEDULE

It is anticipated that the WPSA+VGP will be implemented in the summer of 2023. The schedule will be updated monthly during the project.

9. REFERENCES

ERM (Environmental Resources Management, Inc.). 2021a. *Vapor Intrusion Assessment Work Plan: Former Roto-Finish Superfund Site (MID0055340088)*. ERM: 16 June 2021.

ERM. 2021b. *Source Area Characterization Work Plan: Former Roto-Finish Superfund Site (MID0055340088)*. ERM: 14 October 2021.

ERM. 2022a. *FINAL Quality Assurance Project Plan: Former Roto-Finish Site, Portage, Michigan.* ERM: 31 May 2022.

ERM. 2022b. *Field Sampling Plan (Rev#1): Former Roto-Finish Site, Portage, Michigan.* ERM: 07 July 2022.

ERM. 2022c. *Draft Passive Soil Gas Report: Former Roto-Finish Site, Portage, Michigan.* ERM: 14 November 2022

ERM. 2023a Supplemental Quality Assurance Project Plan: Former Roto-Finish Site, Portage, Michigan. ERM: 06 April 2023.

MACTEC (MACTEC Engineering and Consulting, Inc.). 2007a. *Final Performance Monitoring Plan For Remedial Action: Roto-Finish Co. Portage, Michigan.* Prepared for Illinois Tool Works Inc. 16 November 2007.

MACTEC. 2007b. *Final Field Sampling Plan for Implementation of the Performance Monitoring Plan for Remedial Action: Roto-Finish Site Portage, Michigan*. Prepared for Illinois Tool Works Inc. 16 November 2007.

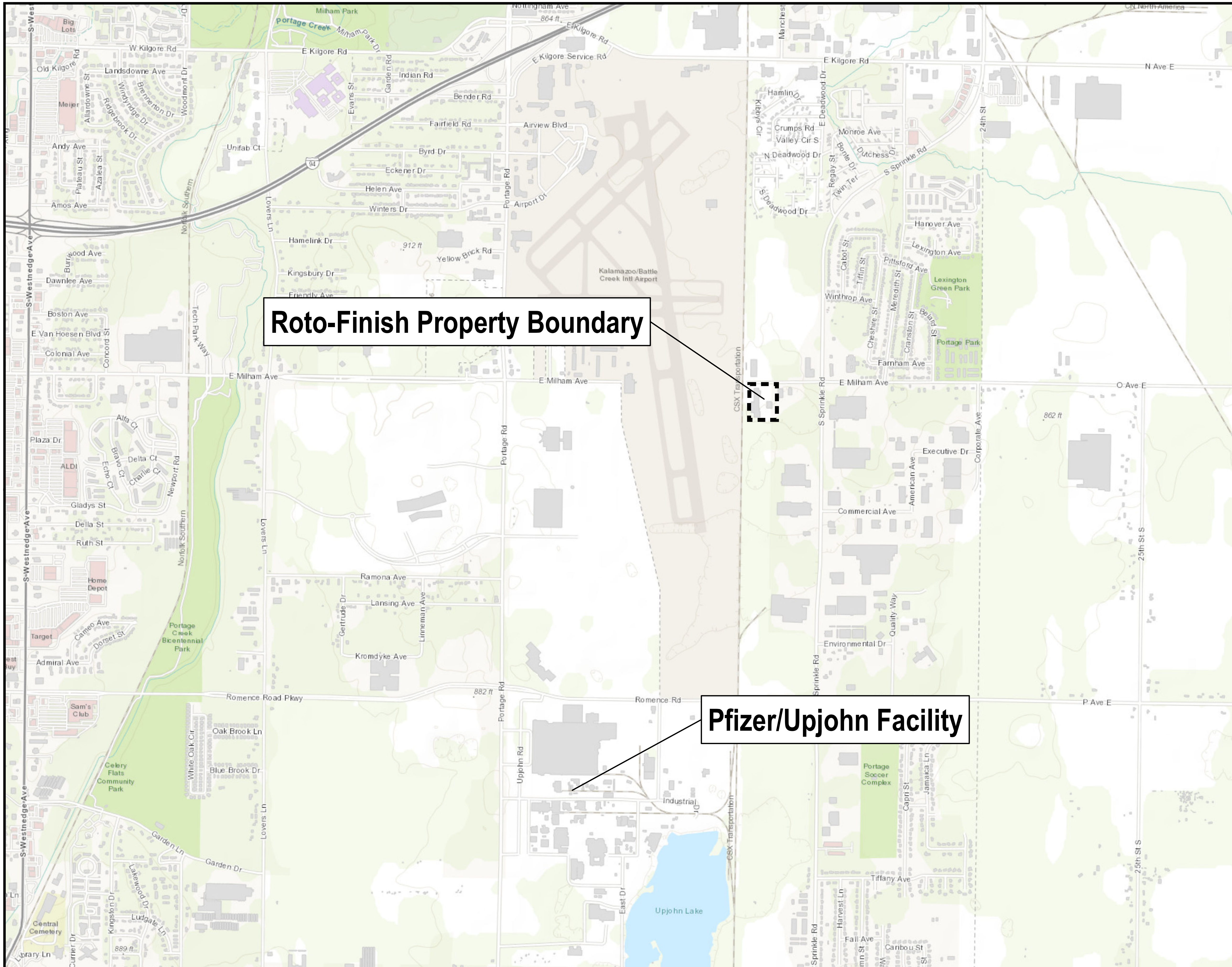
MACTEC. 2010. *Quality Assurance Project Plan: Remedial Action, Roto-Finish Co., Portage, Michigan.* Prepared for Illinois Tool Works Inc. 28 April 2010.

USEPA. 1997. *EPA Superfund Record of Decision: Roto-Finish Co., Inc., Kalamazoo, Michigan*. Chicago, Illinois: USEPA Region 5. 31 March 1997.

USEPA. 2017b. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.* 19 September 2017.

USEPA. 2022a. *Fifth Five-Year Review Report For Roto-Finish Co. Inc. Superfund Site, Kalamazoo County, Michigan*. Chicago, Illinois: USEPA Region 5. 8 April 2022.

FIGURES



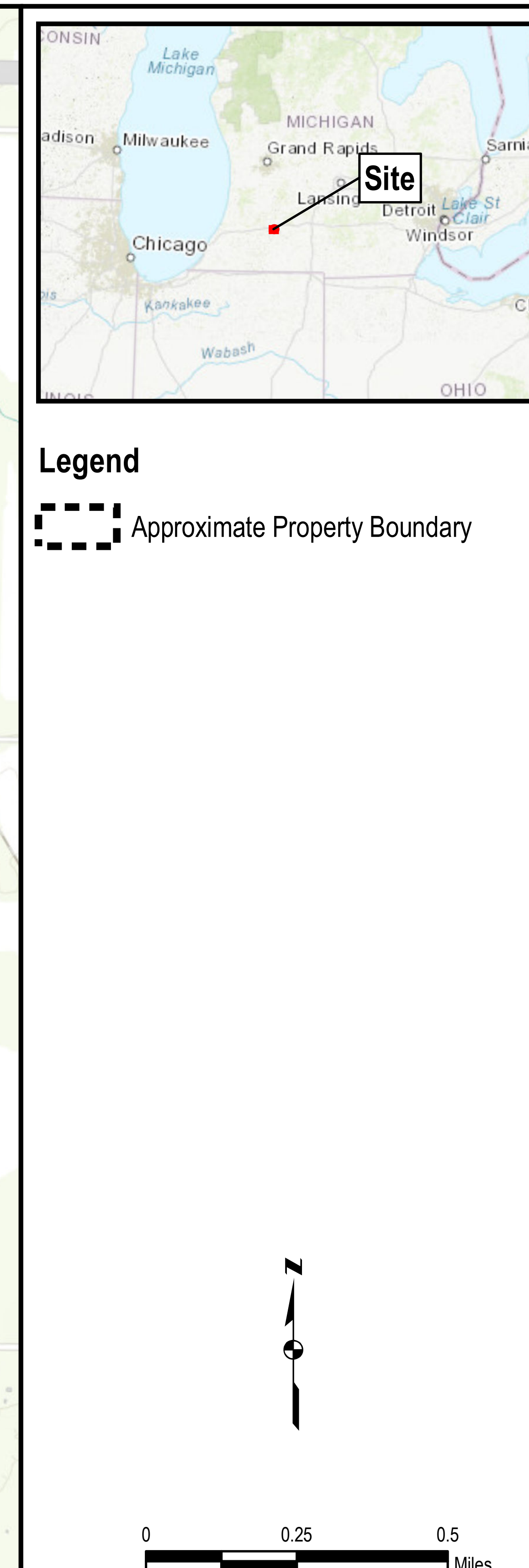
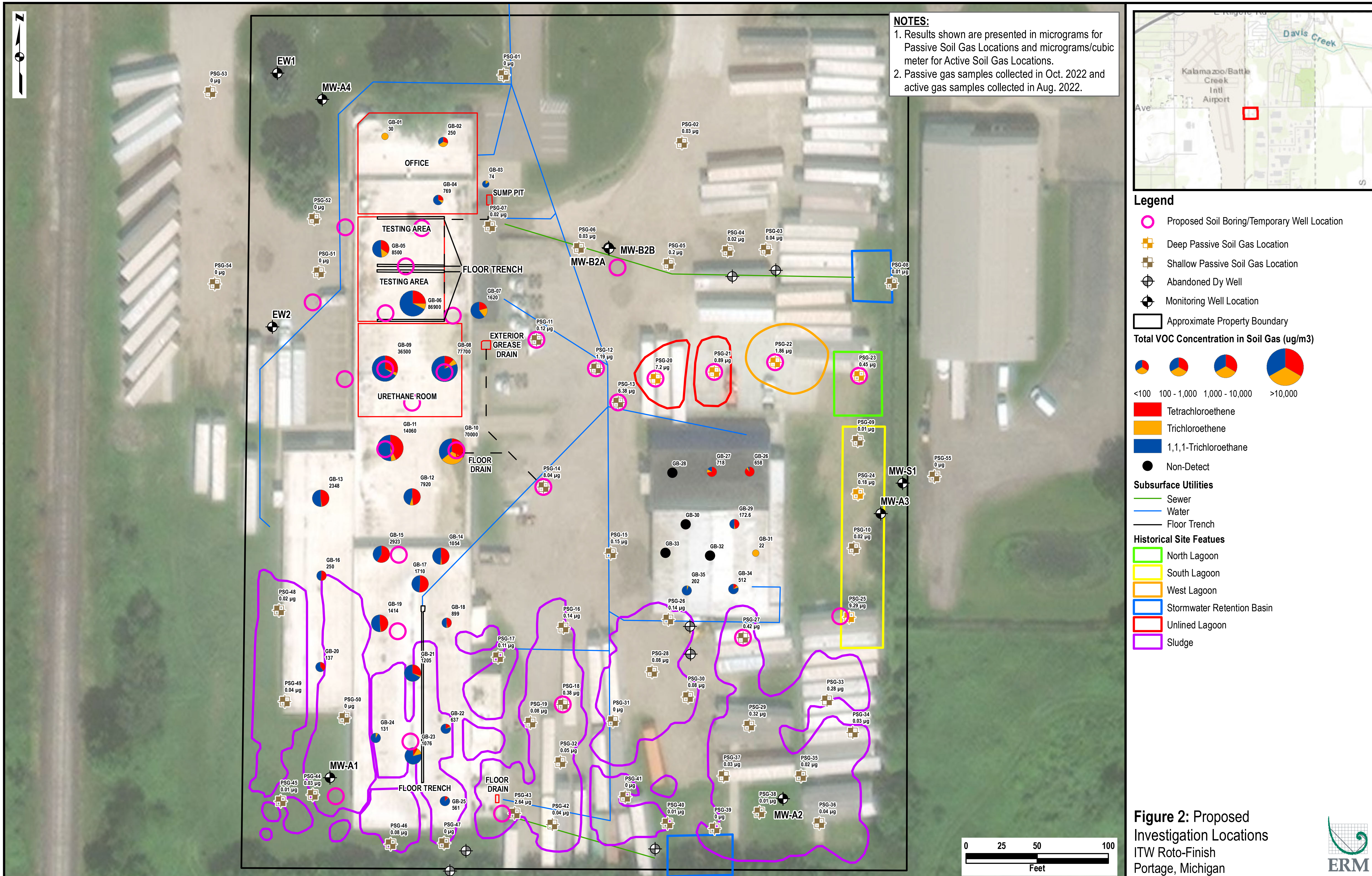
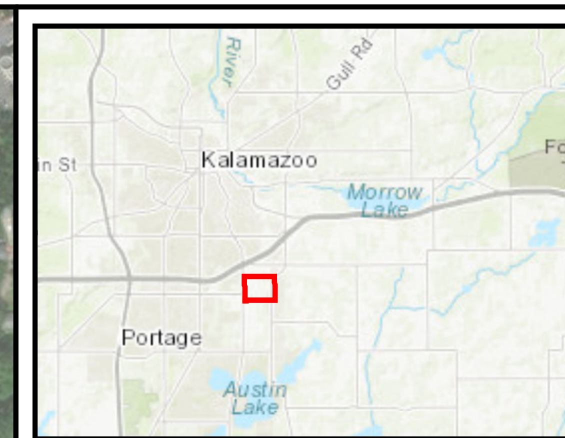


Figure 1: Site Location
ITW Roto-Finish
Portage, Michigan

ERM



NOTES:
1. Results shown are presented in micrograms for Passive Soil Gas Locations and micrograms/cubic meter for Active Soil Gas Locations.
2. Passive gas samples collected in Oct. 2022 and active gas samples collected in Aug. 2022.
Davis Creek
Kalamazoo/Battle Creek Intl Airport
Legend
Proposed Soil Boring/Temporary Well Location
Deep Passive Soil Gas Location
Shallow Passive Soil Gas Location
Abandoned Dy Well
Monitoring Well Location
Approximate Property Boundary
Total VOC Concentration in Soil Gas (ug/m3)
<100
100 - 1,000
1,000 - 10,000
>10,000
Tetrachloroethene
Trichloroethene
1,1,1-Trichloroethane
Non-Detect
Subsurface Utilities
Sewer
Water
Floor Trench
Historical Site Featues
North Lagoon
South Lagoon
West Lagoon
Stormwater Retention Basin
Unlined Lagoon
Sludge
EW1
EW2
MW-A4
MW-B2A
MW-B2B
MW-S1
MW-A3
MW-A1
MW-A2
OFFICE
SUMP PIT
TESTING AREA
TESTING AREA
FLOOR TRENCH
EXTERIOR GREASE DRAIN
URETHANE ROOM
FLOOR DRAIN
FLOOR TRENCH
FLOOR DRAIN
0 25 50 100
Feet
Figure 2: Proposed Investigation Locations
ITW Roto-Finish
Portage, Michigan
ERM



Legend

- Proposed Sentinel Vertical Profiling Location
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Groundwater Flow Direction
- Groundwater Elevation Contour - 1 ft. (Dashed where Inferred)
- Approximate Property Boundary

NOTES:
- Groundwater VOC results are shown in micrograms per liter and concentrations are represented by calculated total COCs.
- * = Identified anomalous head values.
- Groundwater elevations are reported in feet (ft.) above mean sea level.

0 0.05 0.1 0.2 Miles

Draft: Subject to change, pending upon approval of the location and depth of the sentinel wells.

Figure 3: Proposed Sentinel Vertical Profiling Locations
ITW Roto-Finish
Portage, Michigan

ERM

APPENDIX A STANDARD OPERATING PROCEDURES

Standard Operating Procedure #01: Field Documentation

Version #1
November 2021

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to describe documentation requirements during the implementation of Remedial Investigation activities at Roto-Finish Co., Inc. in Portage, Michigan. Field documentation activities include the use of field books and field forms. Procedures regarding chain of custody documentation are provided in a separate SOP (SOP #02, Appendix A of the Quality Assurance Project Plan (QAPP)).

All employees recording field notes must be aware that the field book is a legal document that can be heavily scrutinized. It is therefore the responsibility of the individual to record accurate and legible notes that permit the re-creation of field activities when the field book is reviewed by other parties (e.g., Project Manager, Legal Counsel, etc.). This SOP is applicable to all field staff conducting field activities, and should be used in conjunction with other applicable SOPs for accurate documentation of field activities.

2. PROCEDURE

Field activities vary widely; however, it is the responsibility of the Field Team Lead to properly document activities, observations, conversations and any other event that affects field activities. Field books and field forms are to be completed in a timely basis by the Field Team Lead or other designated responsible party.

General procedures for field documentation are as follows:

- The first page of each field book will contain a sign-in page. All persons assigned the Field Lead role that have documented Site activities in the field book are required to complete this page. The sign-in page shall include printed name, signature, and initials. This page is completed to allow easier identification of signatures and initials within the field book.
- Use permanent black ink. Ultra Fine Point Sharpie® pens work well under most conditions. The use of black ink or marker makes photocopying easier.
- The field book is intended for recording observations and recording data. Do not include opinions or interpretations within the field book.
- There should not be blank pages or blank lines on a page. Use as much of each line and each page as is practical. No lines should be left blank in between field book entries. If you reserve a blank page for later use (such as a listing of photoionization detector [PID] readings, depth-to-water measurements, soil logging) and end up not using it, draw a diagonal line across the page and initial.
- If you make a mistake, draw a line through it such that it is still legible, initial, and write the correct information next to it. The incorrect information must not be erased, made illegible, or otherwise obscured so it cannot be read.
- Write the date and ERM-specific project number on top of each page.
- Number the pages, including the total number of pages (i.e., “Page 1 of 2”, where “1” is the current page and “2” is the total number of pages).

- At the beginning of each field day, at a minimum, the following information must be entered into the field book:
  - Names of field staff on-Site (initials are permissible for ERM field staff), names of contractors on-Site, and time of arrival and departure.
  - A brief summary of the daily Tailgate Health and Safety Meeting, including attendees and any issues or concerns that were raised.
  - A brief summary of anticipated activities for the day including details of any equipment and/or methods to be used.
  - Current atmospheric conditions—temperature, cloudiness, wind, precipitation. Note if there has been substantial precipitation in the last 24 hours or so, or if there is standing snow. If relevant to the project, note whether ground is frozen, mushy, thickly vegetated, etc. Any changes in the atmospheric conditions throughout the day must also be recorded.
  - Observations from Site walk. Note any changes to the Site since previous field book entry and current Site conditions (e.g., damage to wells or equipment, new construction, things added to or removed from work area, appearance of trespassers, etc.).
  - Names of visitors (ERM, contractors, clients, regulators, etc.) entering and leaving the Site, the times of arrival and departure, and purpose of visit.
  - Conversations, teleconferences or meetings with Project Manager, contractors, clients, regulators, etc.; record time, participants in discussion, topics discussed, any decisions made and who made them.
- If instruments are used, document the make, model, and specifications (e.g., PID lamp strength), and calibration activities (i.e., calibration standard used and instrument response), unless otherwise documented on separate calibration or sampling forms.
- Locations of sample collection or measurements if different from established points. Measure out or pace out distances from any new measurement locations to known points. Include a sketch of Site showing permanent structures/utilities and sampling points.
- Document the collection of quality assurance/quality control samples (i.e., field duplicate samples, matrix spike samples, field blank samples, equipment blank samples, trip blank samples).
  - For blind duplicate samples, record the parent location in the field book and on the associated sampling form.
  - For equipment blank samples, record the make, model, and unique serial number for the equipment from which the sample was collected, and note the origin of the water used to collect the sample (i.e., lab provided).
- Beginnings and endings of lunch, breaks, and/or downtime, specifically for subcontractors.
- Management or disposal of investigation-derived wastes.
- If field procedures or methods vary from SOPs or are modified on a project or activity basis (drilling, PID screening, measuring distances, sample procedure), record which method is used each time. However, if you are using only one procedure/method without changing, it may be noted only once.

Standard Operating Procedure #02: Chain of Custody

Version #1
November 2021

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to provide the requirements for completing Chain of Custody (CoC) documentation for Roto-Finish Co., Inc. in Portage, Michigan. A CoC is a standard document for recording important data associated with each individual sample. A CoC is used to record three types of information: field information, laboratory information, and the name of each person who handled the sample.

This SOP is applicable to all field staff collecting environmental media samples for laboratory analysis. It is the responsibility of the individual to accurately and legibly record sample collection information to permit review by other parties (e.g., Project Manager, Field Technician, Sample Custodian, Legal Counsel).

Example CoCs are included in the Field Sampling Plan.

2. DEFINITIONS

Chain of Custody is a legal document designed to track persons who are responsible for the preparation of the sample container, sample collection, sample delivery, sample storage, and sample analysis.

Custody Seal is a label placed on the outside of the cooler to help track sample integrity during handling and transport. Custody seals may be provided by the laboratory, or may be created by the Sample Custodian by placing a piece of duct tape or similar material across the cooler seal.

Field Lead is the person who will conduct oversight of field activities and has overall responsibility for the investigation in the field, including checking the completion of CoC forms.

Sample Number is a unique number given to each sample. This number is provided in the sample label and on the CoC.

Sampler is the person who collects the samples in the field.

Sample Custodian is any person who assumes custody of the samples from the sampler. If the sampler does not relinquish custody after collection, the sampler becomes the Sample Custodian. The sample custodian role may be filled by several people as the samples are collected, consolidated, and shipped.

3. PROCEDURE

3.1 Creating the CoC

A CoC is created for each sampling event. Typically, a CoC has three sections: field information, lab information, and signature information. The CoC should be a carbon-copy document and must be completed legibly with black ballpoint pen.

- **Project Information:** The CoC should contain the project information, including project number, project manager, project contact, billing information, etc.
- **Field Information:** The CoC must contain the following information: sample number, sample date and time, type of sample, type of sample container, requested analysis, and preservative for each sample.
- **Signatures:** The CoC must contain places for all people who handle the sample to sign his/her name. This is a record of persons (i.e., the Sample Custodians) who had custody of the sample

during all steps of the sampling process from sample collection, sample storage, transport, and sample analysis. Signature lines to relinquish custody of the sample and to receive custody of the sample must be completed.

3.2 Filling Out the CoC

The CoC should be completed by the sampler(s), and checked by the Field Lead. At least one of the individuals who collected the samples on the CoC needs to sign the first "relinquished by" line. The "received by" line will be completed by the person receiving custody of the samples from the sample collector. The person who transports the sample to the laboratory or relinquishes the samples to the shipping agency signs last.

After all samples have been recorded on the CoC, the remaining lines must be crossed out and initialed. This indicates that there are no additional CoCs or samples. Similarly, additional unused spaces for requested analyses should be lined out and initialed.

If multiple CoC forms are completed, the CoCs should be numbed "Page X of XX" (where X is the current page, and XX is the total number of pages). If multiple coolers are used to transport samples, the CoC should indicate the total number of coolers. Errors must be lined out and initialed, and the correction written in. A completed copy of the CoC must not be destroyed or discarded and must be retained in the project files.

3.3 Container Preparation

The CoC should be initiated at the time of sampling. The CoC header information, including general project information, may be filled out ahead of time. The sample label should include project number, date and time, requested analysis, preservative, and sampler initials. All information contained on the sample label should be identical to the information on the CoC.

3.4 Sample Collection

The personnel who receives the sample containers, transports them to the field, collects the samples, and places them in to the coolers should sign the first received line along with data and time. Samples should be collected in accordance with other applicable SOPs.

3.5 Sample Storage

If the samples are relinquished to secured storage, the sample custodian should complete the "relinquished by" line on the CoC. The sample custodian should complete a "relinquished by" line on the CoC and print "To Secure Storage" in the "received by" line.

3.6 Sample Shipping

When the samples are prepared for shipping, a CoC should be enclosed in a plastic bag within the sealed cooler. The sample custodian should complete a "relinquished by" line on the CoC and print "To Shipping Company" in the "received by" line.

In addition to filling out the CoC, the Sample Custodian will place custody seals on each sample cooler to document the integrity of the shipping container. A minimum of one custody seal will be placed on each cooler in a manner that the cooler cannot be opened without breaking the seal. Each custody seal will be signed and dated by the person packing the cooler and the seals covered by clear packing tape to prevent accidental loss or damage during shipping.

Standard Operating Procedure #03: Sample Packing and Shipping

Version #1
November 2021

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to describe the procedures that will be used to package and ship samples for laboratory analysis from Roto-Finish Co., Inc. in Portage, Michigan. The procedures described herein are recommended for handling and shipping laboratory samples to minimize the loss of samples associated with breakage and to help make sure that samples are received at laboratory-required temperatures. These procedures are mandatory for laboratory samples being transported by project personnel, laboratory courier, or shipping carrier. Project personnel include ERM employees as well as personnel directly employed by the analytical laboratory (courier). Third-party courier services, regardless of whether contracted internally or by the analytical laboratory, are always considered non-project personnel. Strict adherence to these procedures will protect sample integrity during transport, even if delivery is delayed.

2. EQUIPMENT AND MATERIALS

- Clear packing tape to keep cooler lids sealed during transport;
- Completed chain of custody (CoC) with record of all samples contained in cooler(s);
- Custody seals with sampling personnel signature and date to indicate if sample shipments have been tampered during release and transport;
- Packing material such as bubble wrap to minimize sample breakage during transport; and
- Mailing labels (in addition to any shipping papers), which include either the laboratory or ERM account number and contact number of the sampling personnel. The tracking number will be retained by sampling personnel to minimize delays.

3. PROCEDURE

3.1 Coolers

Coolers are the most common package or containment device used to ship samples. Coolers are also used during sampling efforts to store and transport samples prior to shipping. The samples will be placed in iced coolers immediately after collection to protect integrity of sample concentrations and as a method of preservation. The ice in the cooler used for shipping will be positioned such that melt does not infiltrate sample bottles. The following procedures will be used when packing the cooler for shipment:

1. Secure the drain on the cooler with tape (or alternate seal) to prevent accidental release of ice melt or sample water in the case of breakage.
2. Place each individual sample (soil and/or groundwater) in polypropylene bags to minimize cross-contamination. Vials that are aliquots from the same sample can be placed in the same bag. The vials should be wrapped with bubble wrap or foam to prevent breakage during transportation and shipping.
3. Position the samples in the cooler so there is minimal contact between containers. The positioning and padding of sample containers with bubble wrap, foam, or ice will prevent breakage of glass containers or seal breakage of plastic bottleware (whichever may be required for the analysis).
4. Use bubble wrap, foam, or absorbent pads as packing support to prevent the samples from colliding and breaking during transportation and shipping. A layer of absorbent material/ bubble wrap on the

bottom interior of the cooler may prevent sample breakage. Avoid using shredded paper or Styrofoam™ as packing material. If the paper becomes wet, it will no longer be useful to prevent samples from colliding. A limited amount of packing material should be used as these materials insulate the samples and prevent them from being properly chilled. Plastic sample containers or cardboard can be placed between glass containers. Bags of ice may be also be used as packaging material between samples. Sample containers should be neatly organized in such a way that minimal movement would be anticipated in the cooler during transportation and shipment.

5. Fill the cooler with ice or double-bag the ice in polypropylene bags. Do not use chemical ice packs ("blue ice"). In order to maintain the required sample temperature as stipulated by the laboratory (typically 4 degrees Celsius) 40 to 50 percent of the cooler capacity should contain ice. If a commercial carrier such as Federal Express (FedEx) or United Parcel Service (UPS) is used for sample shipping, additional ice will be packaged in the coolers in case delivery is delayed. Less ice may be used if the samples will be delivered via courier or sampling personnel. As a rule of thumb, an average cooler with a capacity of approximately 48 quarts will require two to three 8-pound bags of ice.

6. Place the CoC with record of all contained samples in a polypropylene bag. If samples are packed in multiple coolers, the number of coolers should be marked on the CoC.

7. Use packing tape to secure the cooler shut to prevent accidental opening or potential leakage. Do not tape down or otherwise restrict access to the cooler handles. Coolers used for shipping should not have broken or missing handles.

8. Custody seals will then be placed on the cooler to document the integrity of the shipping container. A minimum of one custody seal will be placed on each cooler in a manner that the cooler cannot be opened without breaking the seal. Each custody seal will be signed and dated by the person packing the cooler and the seals covered by clear packing tape to prevent accidental loss or damage during shipping.

9. If necessary, affix a mailing label with the laboratory's address on the cooler. Apply clear tape over the address label to prevent accidental loss or damage during shipping. The label should be used in addition to any shipping papers required by carriers and shall include, at a minimum, shipping account numbers and telephone number of personnel knowledgeable on the sample details.

3.2 Boxes

Some samples do not require temperature control and may be shipped in cardboard boxes. The boxes should be sturdy enough to withstand rough handling. No liquids will be shipped in boxes. Materials suitable to be shipped by cardboard box include:

- Air samples in SUMMA® canisters, air-tight gas sampling bags, or other non-pressurized sample containers; and
- Soil samples for geotechnical analyses.

These materials may be packaged and secured in a suitable cardboard box. The box will be sealed with packing tape and affixed with address labels and custody seals as described above.

Standard Operating Procedure #04: Subsurface Clearance

Version #1
November 2021

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to establish the procedures for conducting subsurface clearance (SSC) of utilities and structures prior to any ground disturbance activities for the implementation of Remedial Investigation activities at Roto-Finish Co., Inc. in Portage, Michigan. The SSC Procedure applies to all ERM employees and subcontractors for any ERM-controlled operation, including supervision or oversight, or where ERM is legally or contractually responsible for SSC activities, including at the Roto-Finish Site in Portage, Michigan.

For the purposes of this SOP, ground-disturbance activities are activities that require penetration of the ground surface to any depth, and/or the drilling, coring, or removal of engineered surfaces (pavement, concrete, etc.). Examples of ground-disturbance activities include, but are not limited to: hand digging, hand augering, drilling, direct-push or Geoprobe® borings, well installation, well over-drilling, excavation, trenching, grading, concrete coring, drilling/installation of soil vapor points, and driving of posts, stakes, rods, poles, or sheet piles.

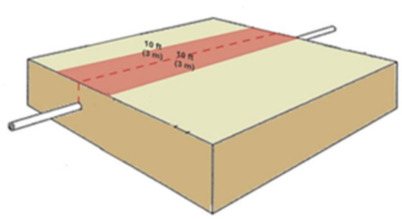
1.1 Definitions

Abandoned/Decommissioned: A subsurface structure that has been confirmed by the owner/operator as inactive and in a state of zero energy. For high value/high hazard subsurface structures (as defined later in this section), confirmation must be made on-Site by qualified personnel (representing the Site and/or owner/operator of the line, unless these entities cannot be identified), witnessed by ERM, and include positive verification of a zero-energy state. Otherwise, these lines must be considered potentially active.

Compressed Air Excavation: The use of compressed air to make a cut, cavity, trench, or depression in the earth's surface. Also known as "Vacuum Extraction," "Vac-Ex," "Air Knifing," and/or "Soft Digging."

Contact Person: A representative of the Site where ground disturbance activities will be conducted who is knowledgeable of the subsurface and/or historical operations at the work location. The contact person may be a client employee or the employee of a third party.

Critical Zone: 10 feet (3 meters) distance in all directions from the surface projection of all known or suspected subsurface structures, taking into account the diameter and spatial extent of the structure (e.g., the outer diameter of a pipe or the outer edges of a tank). Critical Zones do not apply to structures that have been confirmed as abandoned/decommissioned and do not need to be protected.

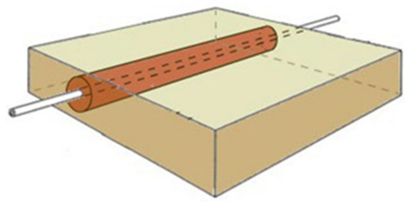


Example Critical Zone illustration, associated with an underground pipe

Detection Equipment: Any equipment used for the detection of subsurface structures, including, but not limited to, devices that utilize electromagnetic detection, magnetic detection, ground-penetrating radar (GPR), acoustic detection, and video surveillance (e.g., sewer cameras).

Excavation: Any man-made cut, cavity, trench, or depression in the earth's surface, NOT including point disturbances as defined later in this section.

Excavation Buffer: A 2-foot (0.6-meter) distance in all directions from the outermost extents of subsurface structures that will be exposed or partially exposed during excavation activities, and within which mechanical digging is prohibited. Excavation Buffers do not apply to structures that have been confirmed as abandoned/decommissioned and do not need to be protected.



Example illustration of Excavation Buffer associated with underground line

Ground Disturbance Activities: Activities which require penetration of the ground surface to any depth, and/or the drilling, coring, or removal of engineered surfaces (pavement, concrete, etc.). Examples of ground-disturbance activities include, but are not limited to: hand digging, hand augering, drilling, direct-push or Geoprobe® borings, well installation, well over-drilling, excavation, trenching, grading, concrete coring, drilling/installation of soil vapor points, and driving of posts, stakes, rods, poles, or sheet piles.

Hand Augering: Use of a manual auger to make a cavity or depression in the earth’s surface.

Hand Digging: Use of manual digging tools and equipment (shovel, trowel, or post-hole-digger) to make a cut, cavity, trench, or depression in the earth’s surface.

High Value/High Hazard: Subsurface structures, including electrical conductors/cable equal or greater than 110 volts, fiber optic cable, gas lines, petroleum pipelines, or structures containing hazardous substances.

Point Disturbance: Ground-disturbance activities associated with a distinct and definable location that, in general, will result in a ground disturbance that has a larger vertical extent (i.e., depth) than lateral extent (i.e., disturbed surface area). Examples include, but are not limited to, locations involving the following activities: soil sampling, soil borings (regardless of diameter), and methods involving any of the following types of tools/techniques: hand digging, hand auger, drilling, direct-push, or Geoprobe®), well installation, and well over-drilling.

Point Disturbance Clearance: Methods used to identify the presence or absence of subsurface structures at a particular point disturbance location by removal of overburden and direct observation and/or contact. Approved point disturbance clearance methods include: compressed air excavation, pressurized water excavation, hand digging, hand auger, and soil probe.

Pressurized Water Excavation: The use of pressurized water to make a cut, cavity, trench or depression in the earth’s surface.

Site Services Model: A depiction of both the aboveground and underground utilities and services that are present or unaccounted for at a site. The site services model is developed from all available sources of information including, but not limited to: discussions with knowledgeable contact persons, review of maps and as-built drawings, observation of visual clues, and information obtained from utility locate services.

Soil Probe Rod: A blunt-nosed probe with a T-handle that is pushed manually into the ground to check for obstructions that may indicate the presence of subsurface structures.

SSC Experienced Person (EP): An ERM employee with requisite qualifications and experience in performing SSC activities who will ensure execution of the SSC process, both in the planning stages and in the field.

SSC General Employee (GE): An ERM employee that works on, manages, serves as Partner-in-Charge (PIC), or is responsible for issuing waivers or making other safety-critical decisions on projects where ground-disturbance activities are performed, but does not serve in the role of SSC EP.

Subsurface Structures: Man-made structures (excluding man-made debris) located beneath the surface of the ground or within or below engineered surfaces., These may include, but are not limited to: pipes, cables, conduits, drains, galleries, tanks or other containers, wells, or any other useful property (as defined later in this section).

Useful Property: A subsurface structure that, if damaged, would need to be repaired or replaced, regardless of who makes the repairs or who is liable for the cost.

Unexploded Ordnance (UXO)/Munitions and Explosives of Concern (MEC): Ammunition that was fired but did not explode, or munitions (unfired ammunition, land mines, etc.) that could explode.

2. EQUIPMENT AND MATERIALS

- Field forms and field book;
- Field Sampling Plan, Health and Safety Plan (HASP), Subsurface Clearance (SSC) Plan;
- Personal protective equipment (PPE) in accordance with the project HASP;
- Clipboard;
- Permanent ink and waterproof pens; and
- Ground disturbance tools (to be supplied by the subcontractor).

3. HEALTH AND SAFETY

SOPs are designed to provide technical guidance and do not provide detailed or comprehensive guidance related to health and safety, nor do they represent guidance on safe work procedures for the tasks described. Appropriate tips related to health and safety issues associated with specific tasks may be included within technical descriptions for information's sake only.

Health and safety aspects of all projects and project tasks should be assessed and planned using ERM's established Health and Safety planning procedures. Drilling and other subsurface intrusive work presents specific hazards and proper safety precautions must be observed performing any subsurface work. These hazards, as well as those associated with constructing and installing monitoring wells, should be addressed by a Site-specific HASP. The safety guidelines within the HASP should be used to complement the judgment of an experienced professional. For all subsurface drilling activities, the project-specific health and safety requirements must be reviewed by ERM field staff and subcontractors.

4. PROCEDURE

The primary objective of the SSC process is to develop a complete understanding of the subsurface structures that are present at a project site. This is done by developing a Site Services Model, as defined in Section 2. The activities outlined in this section are performed in order to construct a Site Services Model. These activities are presented in the general order they should be conducted.

4.1 Assignment of an SSC EP to the Project

All SSC planning and field execution activities must be performed or directly overseen by an ERM employee who has an active SSC EP certificate. The name of the SSC EP must be documented in the SSC Project Plan. The SSC EP role can be shared on a project, provided all employees serving in the role are currently certified as an SSC EP and listed in the SSC Project Plan.

4.2 Gathering and Review of Site Information

The following steps are required:

1. Identify any local regulatory, industry, or client requirements that are not otherwise covered by the ERM SSC Procedure. Document these additional SSC requirements in the SSC Project Plan.

2. Assess the potential for the presence of UXO/MEC. If UXO/MEC is present or potentially present, specialist technical assistance must be obtained to assist with project planning and Site clearance. In the case of sites where UXO/MEC risks are present, adherence to the clearance plan developed by the specialist provider may supersede certain requirements of the SSC process. If the UXO/MEC clearance plan deviates in any way from this SSC Procedure, a project-specific variance plan must be developed by the project team and approved by the Regional CEO and Local Managing Partner (MP).

3. Identify any contact persons knowledgeable of the subsurface and/or historical operations at the work location. Request any available information from them and review the preliminary SSC Project Plan with them. Request the participation of the contact person(s) during the Site walk and visual clues survey.

4. Obtain all available (and in particular the most recent) as-built drawings and/or Site plans showing subsurface structures. Requests should be made and followed up diligently until all available documents are received, or a positive confirmation is given that no such documents are available.

5. Where available and/or required by local legislative or regulatory requirements, obtain as-built drawings from third-party public agencies or private companies with subsurface structures in the area where ground disturbance will occur. Requests should be made and followed up diligently until all available documents are received, or a positive confirmation is given by the entities contacted that no such documents are available.

6. Obtain and review any additional Site-related information such as easements, rights-of-way, historical plot plans, current and historical aerial photographs, fire insurance plans, tank (dip) charts, SSC information obtained as part of previous Site investigations or Phase I environmental Site assessments, soil surveys, boring logs, etc., as relevant to the planned ground-disturbance activities.

7. Document the available preliminary information about the presence of known or suspected subsurface structures at the work location in the SSC Project Plan. This must include a Site plan or map (drawn to scale) that identifies:

a. The routes and locations of known services;

b. Gaps – those services suspected but not yet located based on currently available information;

c. Any Critical Zones and/or Excavation Buffers; and

d. The preliminary disturbance location plan (boring location map, excavation plan, etc.) accounting for any Critical Zones, Excavation Buffers, gaps in subsurface information, and project objectives.

4.3 Public Utility Locates

The following steps are required:

1. Where they exist, the public utility locator(s) must be contacted to provide all available information and services. In jurisdictions where they provide this service, they should also be asked to physically mark utilities at and/or in the vicinity of the work location, in accordance with local regulatory requirements.

2. Ensure compliance with local regulations and guidelines governing public utility locates, including, but not limited to:

   a. The process and required lead times for contacting public utility locators;

   b. Marking planned ground-disturbance areas at the work location;

   c. Maintaining any required permits or dig tickets and ensuring public locator markings remain clear and visible for the duration of the project;

   d. Any additional requirements for high hazard/high value subsurface structures;

   e. Any restrictions for excavating within close proximity to underground structures (i.e., “tolerance zones”); and

   f. What to do if a subsurface structure or utility is encountered and how to report damage.

3. Determine if there are utility owners/operators (including municipal water and sewer) that are not subscribers to the public utility service. If there are utility owners/operators that do not subscribe to the service or if a public one-call service is not available, identify and contact the owners/operators of known or suspected utilities in the vicinity of the work area and request they mark area lines.

4. Verify a response by each public utility locator prior to proceeding with any ground-disturbance activities.

5. If at any time during ground disturbance activities the public utility locator markouts are not clear or visible, do not agree with other available sources of information, or are suspected to be inaccurate for any reason; the locators must be called back to the Site to confirm their markouts.

6. Document the activities performed and results of the public utility locate in the SSC Project Plan.

4.4 Site Walk and Visual Clues Survey

The following steps are required:

1. A visual survey of all planned ground-disturbance locations and surrounding areas must be conducted to identify signs of potential subsurface structures.

2. During the Site walk, the routes and locations of services should be confirmed using visual clues, which include, but are not limited to, the following:

   - Utility poles with conduit leading to the ground
   - Lights
   - Signage
   - Sewer drains/cleanouts
   - Cable markers
   - Utility boxes
   - Manholes
   - Pavement scarring
   - Pipeline markers
   - Vegetative evidence (e.g., linear patterns or areas of distressed vegetation)
   - Remote buildings with no visible utilities
   - Equipment locations
   - Fire hydrants
   - Sprinkler systems
   - Water meters
   - Natural gas meters
   - Sewer manholes and drop inlets
   - Underground storage tanks fill ports and vent pipes
   - Steam lines
   - Solar panels/wind power generation

   Elevation changes across the Site must also be noted and factored into clearance depth determinations.

3. Confirm overhead clearances with equipment operators for safely deploying equipment to the location. The minimum horizontal distance from any point on the equipment to the nearest overhead utility line must adhere to the minimum clearance requirements stipulated by regulation, utility companies, client requirements, and/or local industry best practice. If the equipment is closer than the minimum clearance distance to the overhead utility, the utility must be de-energized or an alternate plan developed with approval from the PIC and client/Site owner.

4. Where possible and practical (i.e., active industrial Sites), work with the Site contact(s) to identify the location and individual(s) responsible for key energy isolation devices and shutoff valves for Site services. This information is to be included in the SSC Project Plan as part of emergency/contingency planning.

5. Whenever available, Site contact person(s) are to participate in the Site walk and approve planned ground-disturbance locations. Approval (or lack thereof) must be documented on the SSC Project Plan.

6. Any proposed changes to ground-disturbance locations made by a Site contact person must be assessed by the SSC EP using the other available lines of evidence and only accepted after a determination is made that the change is safe. The SSC Project Plan must be updated and the changes approved by the PIC.

7. Similarly, follow-up communication must be made to the Site contact person when any changes are made to approved ground-disturbance locations without their direct knowledge.

8. Document the activities performed and results of the visual clues survey in the SSC Project Plan.

4.5 Private Utility Markouts

The following steps are required:

1. Engage a qualified private utility locate subcontractor or a trained and competent ERM employee to locate and mark subsurface structures on the project Site.

2. If using a private utility locate subcontractor, they must be prequalified and approved to conduct private locates through the ERM subcontractor prequalification process. The PIC and Project Manager must make sure the subcontractor work order details the type of equipment to be used,

mode of operation, reporting requirements (field summary and final), and method of markouts. Confirm documentation of relevant and currently valid training and experience of all subcontractor personnel to be used. The SSC EP must be present on-Site to directly oversee the private utility locate subcontractors.

3. If using an ERM employee to locate and mark subsurface structures, they must have current training documented on ERM Academy to operate the detection equipment to be used, and must be approved by the PIC in the SSC Project Plan.

4. All available and Site-appropriate detection equipment and methods must be used, and documented in the SSC Project Plan, including noting any limitations in the methods and equipment used.

5. Verify that all detection equipment (whether ERM-owned, rented, or brought to the Site by subcontractors) is:

   a. Maintained according to manufacturer specifications with maintenance records available;

   b. Calibrated according to manufacturer specifications (calibrations must be documented); and

   c. Calibrated or tested at the start of each work day and confirmed to be in proper working condition.

6. A Job Hazard Analysis (JHA) must be developed that covers all utility locating tasks. The JHA must be specific to the equipment and methods to be used, and must be reviewed by the SSC EP and PIC.

7. Clear any vegetation, vehicles, equipment, or other obstructions to facilitate private utility markouts.

8. Using detection equipment, confirm the locations and routes of all identified or suspected subsurface structures, based on the data gathered during the other steps in the SSC process.

9. Using detection equipment, scan the area within a minimum 10-foot (3-meter) distance around each planned ground-disturbance location (a larger, more inclusive distance may be specified in the SSC Project Plan based on input from SSC EP and PIC), to assess the potential presence of any as-yet unknown subsurface structures.

10. When using electromagnetic tools and equipment such as a cable avoidance tool, scanning should be done using passive – “power” mode, passive – “radio” mode, and active mode using conductive or inductive methods with the signal generator. Scanning should confirm the locations of known or suspected structures, as well as assess for the presence of any as yet unknown structures.

11. Mark all subsurface structures identified within the defined boundaries of the work area with paint or other semi-permanent markings whose meaning is understood by the project team. Markings must remain clear and visible for the duration of the ground-disturbance activities, and re-marked if necessary. Note that markings should be assessed by the SSC EP by evaluating the method(s) used to mark the utility locations, any limitations, and whether or not other lines of evidence corroborate or conflict with the markings.

12. The results and findings of the private utility locate must be documented in the field by either the subcontractor or the SSC EP. If using a subcontractor, ask that they provide a signed and dated report including a summary of equipment used, mode(s) of operation, names of operators, and a general map/sketch of findings.

13. Document the activities performed and results of the private utility locate in the SSC Project Plan.

4.6 Final Critical Zone Determination

The following steps are required:

1. In conjunction with Site contact person(s), public and private utility locators, and any other knowledgeable persons identified during the Site walk, confirm the status of all identified services (e.g., energized/de-energized, active/inactive, idled, abandoned/decommissioned, etc.).

2. Use the information gathered from all previous steps in the SSC process to determine the final Critical Zones near each planned ground-disturbance location. Update the SSC Project Plan.

3. If any disturbance locations (or boundaries of disturbance areas) fall within a Critical Zone, they must be re-located or a waiver must be approved to proceed with work inside the Critical Zone. Any waivers must be documented in the SSC Project Plan.

4. For any work inside a Critical Zone, energized pipes or cables must be de-energized. If this is not possible, a specific JHA must be developed that covers the specific task steps, equipment, and methods associated with work around these energized structures. Appropriate safety measures, including the need for specialized personal protective equipment (PPE), must be evaluated with input from subject matter experts (SMEs). JHAs must be reviewed by the SSC EP and PIC.

4.7 Review Meeting and Approval of Completed SSC Project Plan

The SSC Project Plan must be reviewed and approved by the PIC after completion of the SSC process steps in Sections 3.1 through 3.6, and BEFORE any further SSC or ground-disturbance activities occur. This review must be completed through a verbal conversation, whether in-person or by phone or video conference. Documentation of review can be via e-mail initially, but must be followed up with signatures in the final SSC Project Plan. A copy of the SSC Project Plan must be maintained at the work location for the duration of ground-disturbance activities and filed in the project folder upon completion of the field activity.

4.8 Concrete Coring/Cutting

In the case where concrete coring or cutting must be performed prior to ground disturbance, the following steps are required:

1. The preferred course of action is to use a prequalified and approved subcontractor. Where concrete coring/cutting services are not available for hire, the PIC must determine if there is a sufficiently trained and experienced ERM employee to accomplish the task using rented or ERM-owned equipment. Training documentation must be current on ERM Academy and attached to the Health and Safety Plan (HASP), with written approval from the PIC.

2. A JHA must be developed that covers all concrete coring/cutting tasks. The JHA must be specific to the equipment and methods to be used, and be reviewed by the SSC EP and PIC.

3. Concrete coring/cutting equipment must:

    a. Be inspected prior to use and maintained according to manufacturer specifications with maintenance records available;

    b. For rig- or stand-mounted coring equipment, be anchored to the floor using proper anchors;

    c. Be operated with ground fault circuit protection;

d. Be operated by trained and qualified personnel; and

e. Any additional safety requirements for this equipment must be outlined in the task-specific JHA.

4. Concrete core diameters must be large enough to allow for visual inspection during subsequent point-disturbance clearance. For point-disturbance locations that will be advanced with mechanical equipment (e.g., drill rig or direct-push) after initial clearance, core diameters must meet or exceed the larger of: 4 inches or 125 percent (%) of the outside diameter (OD) of the largest downhole tool to be used.

4.9 Point-Disturbance Clearance

Approved equipment and methods to be utilized for point-disturbance clearance include the following, listed in order of preference:

- Compressed air excavation;
- Pressurized water excavation;
- Hand digging tools;
- Hand augering tools; and
- Soil probe rod.

Blades on shovels and post-hole diggers must have rounded or blunt noses. Pick axes, pointed spades, or any other tool that comes to a point are not to be used for point-disturbance clearance. Crow bars, pinch bars or pry bars must not be used to break hardened soil or backfill. The ERM EP or field staff lead may authorize the use of bars only to loosen materials like bricks or larger stones so that removal of these materials is possible. Bars must not be used with excessive force.

The following steps are required when clearing point-disturbance locations:

1. A JHA must be developed that covers all clearance tasks. The JHA must be specific to the general location of the project as well as the equipment and methods to be used. Unless the project team can positively determine that no subsurface structures are present, all tools and equipment used in the clearance process must be selected based on the potential risks (i.e., energized electrical lines, fiber optic cables, natural gas pipeline, etc.) that cannot be ruled out. In addition to selecting tools and equipment, appropriate safety measures, including the need for specialized PPE, must be evaluated with input from SMEs. JHAs must be reviewed by the SSC EP and PIC.

2. Re-verify that appropriate overhead clearance requirements can be maintained at ground-disturbance locations prior to mobilizing any equipment.

3. In the case of sites where UXO/MEC risks are present, review and adhere to the clearance plan developed by the specialist provider, which will supersede the instructions in this section.

4. The SSC EP must consider Site-specific conditions and soil types when determining the equipment to be used.

5. If a hand auger will be used, an SSC EP must select the appropriate cutting head(s) based on the soil type, and if resistance is encountered that would require an inordinate/atypical amount of force to be applied for advancement, then augering must not continue.

6. For point-disturbance locations that will be advanced with mechanical equipment (e.g., drill rig or direct-push) after initial clearance, clearance must be performed as follows:

    a. Clear the location using one of the approved methods outlined in this section. The selected clearance method must be documented in the SSC Project Plan. ERM's preferred clearance method is compressed air excavation. If this method is not used, the rationale and approval for using one of the other approved methods must also be documented in the SSC Project Plan.

7. Clear to a minimum depth as follows:

    a. Outside Critical Zones, to 5 feet (1.5 meters).

    b. Inside Critical Zones, to 8 feet (2.4 meters) at a minimum. However, clearance MUST extend at least 2 feet (0.6 meters) beyond the known or suspected bottom depth of all subsurface structure(s) in the Critical Zone; therefore it may be necessary to clear to depths greater than 8 feet for deeper structures.

    c. For locations with frozen soils, to 2 feet (0.6 meters) beyond the bottom of the frost line at the Site.

    d. Clear to a minimum diameter that is the LARGER OF:

        - 4 inches (10 centimeters); or

        - At least 125% of the OD of the largest downhole mechanized tool (e.g., drilling auger, direct-push sampler) to be advanced.

        In all cases, clearance diameters must be large enough to allow visual inspection of the cleared hole. If hand augers are used to clear, multiple holes may need to be advanced to achieve clearance diameters.

    e. For angled (non-vertical) drilling, clear to a minimum diameter of 125 percent of the OD of the largest downhole mechanized tool, taking into account the angle of the boring.

    f. For locations where difficult soil or geologic conditions prevent the full clearance of a point-disturbance location, a waiver must be obtained prior to proceeding with mechanized equipment. The waiver can be applied to multiple point-disturbance locations across the Site, provided each location is specified in the SSC Project Plan.

8. During clearance (and subsequent ground-disturbance activities), watch for any warning signs indicating non-native soil, fill materials, and/or the presence of unexpected subsurface structures. If warning signs are observed, work must be stopped, the Project Manager and PIC contacted, and this change managed per the requirements outlined in Section 8. Warning signs may include, but are not limited to:

    a. Any at-grade or above-grade visual clues;

    b. Refusal;

    c. Warning tape;

    d. Pea gravel/sand/non-native materials;

    e. Red concrete ;

f. Colored plastic covers;

g. Voids/cavities, or abrupt absence of soil;

h. Any unexpected change from native soil;

i. Any signs of damaged utilities in cuttings (broken materials, odors, etc.); and

j. Any other unexpected condition.

4.10 Excavations

Blades on shovels and post-hole diggers must have rounded or blunt noses. Pick axes, pointed spades, or any other tool that comes to a point are not to be used for excavation. Crow bars, pinch bars or pry bars must not be used to break hardened soil or backfill. The ERM EP or field staff lead may authorize the use of bars only to loosen materials like bricks or larger stones so that removal of these materials is possible. Bars must not be used with excessive force.

The following steps are required:

1. JHAs must be developed that cover all excavation/trenching tasks. The JHA must be specific to the general location of the project, as well as the equipment and methods to be used. Unless the project team can positively determine that no subsurface structures are present, all tools and equipment used must be selected based on the potential risks (i.e., energized electrical lines, fiber optic cables, natural gas pipeline, etc.) that cannot be ruled out. In addition to selecting tools and equipment, appropriate safety measures, including the need for specialized PPE, must be evaluated with input from SMEs. JHAs must be reviewed by the SSC EP and PIC.

2. For excavation involving removal or working in close (2 feet [0.6 meters]) proximity to subsurface structures (including those that are abandoned/decommissioned), the JHA must include appropriate emergency response measures, any additional PPE, and safe excavation and removal methods to prevent spills, damage to other structures, etc.

3. Inform all ERM field staff and excavation subcontractor(s) of information regarding the location of subsurface structures, Critical Zones, and Excavation Buffers. Verify that the following are clearly marked and communicated to all field staff, for all subsurface structures crossing through the excavation/trench perimeter or located within the Critical Zone around the excavation/trench perimeter:

    a. Locations/routes, including Excavation Buffers; and

    b. Expected excavation depths to the Excavation Buffer.

4. During ground-disturbance activities, watch for any warning signs indicating non-native soil, fill materials, and/or the presence of unexpected subsurface structures. Warning signs may include, but are not limited to:

    a. Any at-grade or above-grade visual clues;

    b. Refusal;

    c. Warning tape;

    d. Pea gravel/sand/non-native materials;

e. Red concrete;

f. Colored plastic covers;

g. Voids/cavities, or abrupt absence of soil;

h. Any unexpected change from native soil;

i. Any signs of damaged utilities in cuttings (broken materials, odors, etc.); and

j. Any other unexpected condition.

5. Material inside an Excavation Buffer can ONLY be removed by the following methods (this is not subject to waiver):

   a. Compressed air excavation or pressurized water excavation (only with documented approval from the owner/operator of the utility or structure, and where allowed by law); and

   b. Hand digging tools.

5. WAIVERS

There are four waivers to the SSC Procedure that can be granted:

1. Waive the requirement for direct ERM supervision of ground-disturbance activities as follows:

   a. Waive the requirement for a certified SSC EP to oversee execution of the SSC process, and allow instead for an SSC GE to do so (this could include the entire project or specific tasks); or

   b. Waive the requirement for direct ERM oversight of subcontractors, provided the scope of work is restricted to ground disturbance on a Remote/Greenfield site or will only involve shallow hand digging no deeper than 1.5 feet (0.5 meters). The use of subcontractors without direct ERM oversight shall be done in accordance with ERM's Subcontractor Basic Use Standards (SUBS) process.

2. Waive the requirement for private utility locates (performed by ERM subcontractors or ERM employees);

3. Waive the requirement for clearance of point-disturbance locations prior to advancing with mechanized equipment (including no clearance or partial clearance); and

4. Waive the requirement prohibiting ground-disturbance activities within a Critical Zone.

Both the Project PIC and Local MP (or designee) must approve any waivers, with documentation in the ERM SSC Project Plan (can be documented in the field via notation of verbal approval or e-mail, with signature after project completion). If the Local MP is also the PIC on the project, then they must delegate the second review to another SSC-certified Partner (certified to GE or EP level) and BOTH must approve the waiver. To reiterate: two separate SSC-certified Partners must review and approve all waivers.

PICs and Local MPs (or designees) must work with the SSC EP and broader project team to make sure the SSC Procedure is executed and to use available information to make safe decisions regarding waivers. A member of the Health and Safety (H&S) Team and/or a locally identified SME may also be consulted regarding waiver decisions, in particular when the project involves some degree of complexity or uncertainty.

Waivers should only be issued when exceptional circumstances limit the execution of parts of the SSC Procedure. PICs and Local MPs (or designees) cannot waive compliance with any legislative or regulatory requirement; nor can they waive any client-mandated requirements without prior discussion with, and documented approval by, the authorized client representative.

6. TRAINING AND COMPETENCY REQUIREMENTS

There are two levels of certification for ERM staff engaged in SSC activities:

- **SSC GE Certification:** SSC GEs must be certified by completing all of the requirements of the SSC GE Certification on ERM Academy and maintaining a status of “Certified/Renewal in Progress.”
- **SSC EP Certification:** Employees who will serve in the role of SSC EP must be certified as SSC EPs by completing all of the requirements of the SSC EP Certification on ERM Academy and maintaining a status of “Certified/Renewal in Progress.”

The Local MP must assess the skills and experience level of all prospective SSC EPs and provide documented approval to the ERM Academy Team in order for an employee to become fully certified as an SSC EP. The Local MP may also revoke SSC EP certification, at their discretion, based on feedback from others, inability of the EP to demonstrate competency, or other identified performance issues.

SSC GEs that lack the qualifications and experience to be SSC EPs must participate in mentoring to develop the skills and experience to become SSC EPs. SSC GEs can utilize the “SSC Mentorship Card” template to document field mentoring received by different SSC EPs.

ERM employees and subcontractors operating detection equipment must have experience and current training specific to the equipment they will be operating. Documentation of currently valid training must be obtained and included with the project HASP and in the project files.

Training records for ERM employees must also be documented in ERM Academy.

If subsurface or overhead utilities will be de-energized by ERM employees or subcontractors, they must have formal and documented training for their role as required by local legislation and/or regulation.

Each region must develop a list of approved instructors for ERM SSC training, to be approved by the Regional H&S Leader in consultation with the regional management team.

Any changes to SSC training requirements are communicated to all affected employees via the ERM Academy Certification process.

7. DOCUMENTATION

Thorough and complete documentation of the execution of the SSC Procedure must be maintained at the project Site for the duration of ground-disturbance activities, with copies maintained in the project files.

The SSC Procedure must be documented in the SSC Project Plan (ERM-1511-FM1). This plan is required for each phase of ground-disturbance activities at a project site. The SSC Project Plan includes the scope of authorized ground disturbance and SSC activities to be performed, available sources of information, summary of subsurface structures, documentation of SSC field activities, and approval of any waivers. The completed SSC Project Plan must be reviewed and approved by the PIC before any point-disturbance clearance or ground-disturbance activities may begin. If waivers will be granted, the SSC Project Plan must also be approved and signed by the Local MP (or designee). Approvals can be initially documented in the field via notation of verbal approval or e-mail, with signature after SSC completion.

8. MANAGEMENT OF CHANGE

Any change that occurs during the execution of the SSC Procedure or subsequent ground-disturbance activities must be managed safely and effectively. Examples of change may include, but are not limited to:

- Changes to the location, scope, extent, or depth of ground-disturbance activities;
- Changes to the equipment or methods used;
- Changes in personnel;
- Changes in schedule;
- Changes in encountered field conditions, including subsurface conditions (e.g., change in soil type or refusal); and
- Safety events.

To manage change:

1. Work must be stopped or paused and the PIC and Project Manager contacted. As warranted based on the nature of the change (see below for additional guidance), a member of the Safety Team should also be contacted.
2. A re-assessment of the risks must be conducted with the input of the PIC, Project Manager, and SSC EP (or field staff lead for sites with no EP assigned). Additional input must be sought from the Local MP (or designee) for waivers, and a member of the Safety Team should also be consulted as warranted based on the nature of the risks involved.
3. SSC project documentation must be updated as necessary to reflect the change(s). The HASP, JHA(s), and other Safety planning documents must also be updated as necessary.
4. Any site or client contacts must also be notified of the change(s).
5. Work cannot be re-started without the concurrence of the PIC, Project Manager, and SSC EP (or field staff lead for sites with no EP assigned).

Standard Operating Procedure #05: Field Screening Using a Photoionization Detector

Version #1.1
September 2023

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to establish procedures for field screening using a photoionization detector (PID) for Roto-Finish Co., Inc. in Portage, Michigan. The PID is a portable, nonspecific, vapor and gas detector that uses photoionization to detect a variety of chemical compounds, both organic and inorganic, in air. PIDs will be used at the Site for two main purposes: health and safety monitoring for field staff, and field screening for various environmental samples, including soil, soil gas, and indoor air.

The PID responds to most vapors that have an ionization potential less than or equal to that supplied by the ionization source, which is an ultraviolet lamp. Typical lamps range between 8.4 and 11.7 electron volts (eV), and should be selected based on the ionization potential of expected compounds of interest. As described in the Field Sampling Plan, a PID equipped with 11.7 eV lamp has been selected for use at the Site, due to its ability to detect a broad range of compounds, including known compounds of interest at the Site.

2. EQUIPMENT AND MATERIALS

- Field forms and field book;
- Site Health and Safety Plan (HASP);
- PID capable of reading parts per billion (ppb), equipped with 10.6 eV lamp (ppbRAE 3000, or equivalent);
- PID battery charger and spare batteries;
- External filters (to prevent moisture from entering the PID);
- Calibration gas (e.g., 100 parts per million [ppm] isobutylene gas);
- Tedlar® gas bags; and
- Equipment user manual.

3. HEALTH AND SAFETY

PIDs will be used for health and safety monitoring of field staff conducting investigation activities, as described in the HASP, and summarized below.

- During drilling activities, the PID will be kept in the sampling area and near the field staff breathing zone (between 3 to 5 feet off the ground) to monitor the ambient air that field staff may be reasonably exposed to.
  - For ambient PID readings below 1 ppm, sustained for 1 minute, Level D personal protective equipment (PPE) is acceptable.
  - For ambient PID readings between 1 and 10 ppm, sustained for 1 minute, Level C PPE should be used (full-face or half-mask, air-purifying respirator).
  - For ambient PID readings above 10 ppm, sustained for 1 minute, STOP WORK and re-evaluate working conditions before proceeding.
- Any elevated ambient air PID readings and responses taken will be noted in the field book.

4. PROCEDURE

4.1 Calibration

Field staff will inspect and calibrate PID equipment at the start of each field day the instrument is being used, at a minimum. The PID will be re-calibrated if readings appear to drift over the course of the day or if a spike results and the PID reading doesn't recover.

The following steps will be taken for PID calibration, in accordance with the ppbRAE User Manual:

1. Enter the calibration mode.
2. First, select Zero Calibration.
3. Connect the instrument to a "fresh" air source or use clean ambient air without detectable contaminants.
4. Select start calibration; the instrument will perform the calibration automatically.
5. When the Zero Calibration is complete, record the reading.
6. Second, select Span Calibration.
7. Fill the Tedlar® bag with 100-isobutylene by connecting the bag to the connection on the 100-isobutylene cylinder and open the gas valve. Do not fill the Tedlar bag completely.
8. Once the Tedlar® bag has been filled, connect the bag to the inlet port of the instrument.
9. Enter the Span Calibration and start the calibration; the instrument will perform the calibration automatically.
10. When the Span calibration is complete, record the reading.
11. Exit the calibration menu.

4.2 Air and Soil Gas Screening

The PID may be used to collect screening readings during vapor intrusion activities, including indoor and outdoor air sampling, and sub-slab and exterior soil gas sampling, as described below.

- If collecting a reading from a soil gas probe, inspect the soil gas probe for damage, paying special attention to conditions that may compromise the atmospheric integrity of the soil gas probe such as cracked or heaved surface seals, bent or cracked riser pipes, or frozen valves or riser pipes. Refer to the SOP for Soil Gas Probe Installation and Sampling for additional steps on checking probes for leaks prior to sampling (SOP #12). Readings may be collected from a Tedlar® bag or may be collected directly from the probe. If collecting readings directly from the probe, install flexible tubing into hose barb connection at the inlet port and connect to the soil gas probe, if applicable.
- Monitor the soil gas probe or indoor/outdoor ambient air for vapors until the readings remain stable for approximately 45 seconds. Record the stabilized reading, as well as any peak/highest reading. The peak/highest reading may occur at the onset of monitoring if there is an accumulation in the casing, but in most cases occurs as the reading stabilizes. Therefore, it is not uncommon for the peak and stable reading to be the same. Reading from a probe screened in a silt layer could take an hour or more to stabilize if an appropriate monitoring pump is not used.

- In addition to recording the gas concentrations on the sampling form, record the sample location, date, time, observed weather conditions, and barometric pressure. Atmospheric pressure data can be obtained from a local weather station for the monitoring period.
- Allow the instrument to return to atmospheric conditions after collection of a soil gas probe sample, and prior to collecting indoor or outdoor ambient air samples.

4.3 Headspace Field Screening

The PID may be used to collect headspace field screening readings during drilling activities, as described below.

- Cut open the liner of each soil core with a utility knife.
- Fill a dedicated re-sealable bag (e.g., Ziploc®) approximately 1/2 to 2/3 full with soil.
- Seal the bag.
- Manually break the soil within the bag to aid the release of volatile organic compounds (VOCs) from the soil matrix.
- Allow the sample to equilibrate for several minutes out of direct sunlight in a 60 to 80 degrees Fahrenheit (°F) temperature environment (i.e., automobile or field office location).
- Insert the probe of the PID into the bag without opening the bag significantly (e.g., through a small hole in the bag).
- Observe the PID display for the maximum organic vapor reading.
- Record the sample number, depth, and maximum headspace reading in the field book and boring log form.

Standard Operating Procedure #06: Drilling Oversight

Version #1.2
September 2023

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to provide standard procedures for drilling oversight activities at Roto-Finish Co., Inc. in Portage, Michigan. Currently proposed drilling techniques at the Site include direct-push for piezometer installation and Waterloo^{APS} profiling, and sonic drilling for borehole advancement and well installation.

Drilling services will be provided by qualified drilling subcontractor(s), who are licensed by the State of Michigan, and after performing utility clearance as described in the SOP for Subsurface Clearance (SOP #04). Drilling activities will be performed in accordance with all local and state-level regulations, including contacting the Michigan Utility Notification Center (MISS DIG System) and obtaining all necessary permits.

2. EQUIPMENT AND MATERIALS

- Field forms and field book;
- Site Health and Safety Plan (HASP) and Subsurface Clearance Project Plan;
- Personal protective equipment (PPE) in accordance with the project HASP;
- Permanent-ink and waterproof pens, clipboard, and drawing template;
- Whiteboard and marker;
- Safety cones, traffic tape, and/or barricades;
- Documentation of any local permits or contract documents;
- Spatula for cutting/removing soil samples from liner;
- Stainless steel trowel and/or shovel;
- 6-foot folding ruler;
- Trundle wheel or long field measuring tape;
- Safety knife;
- Hand lens;
- 50-foot or longer (depending on the drilling depth) metal tape with weight;
- Water level meter (Solinst® 102 or equivalent);
- Photoionization detector (PID) equipped with a 10.6 electron volt lamp (such as a ppbRAE 3000 or equivalent), fitted with a moisture filter to reduce moisture interference;
- Re-sealable plastics bags;
- Rags, probe wipes;
- Lumber marking crayon (do not use spray paint, it contains toluene);

- Decontamination supplies (e.g., non-phosphate detergent [Liquinox® or equivalent] and distilled water);
- Transit and/or level, tripod, survey rod, if ERM field staff will perform relative elevation survey;
- 55-gallon steel drums (for drill cuttings and fluids) and labels for drums (non-hazardous, hazardous, awaiting classification);
- Decontamination station for drilling equipment/rig decontamination; and
- Spill response equipment (if needed).

3. HEALTH AND SAFETY

Drilling and other subsurface intrusive work presents specific hazards and proper safety precautions must be observed performing any subsurface work. These hazards, as well as those associated with constructing and installing monitoring wells, should be addressed by a Site-specific HASP. The safety guidelines within the HASP should be used to complement the judgment of an experienced professional. For all subsurface drilling activities, the project-specific health and safety requirements must be reviewed by ERM field staff and subcontractors.

Health and safety requirements specific to the tasks described in this SOP may include the following:

- During drilling, all field staff within the exclusion zone should pay close attention to all rig operations. Rotating drilling tools can catch or snag loose clothing causing serious injury. Sampling hammers can often create pinch points and/or crush hazards. Improper handling of casing can also create potential pinch points (hands and feet), crush hazards, and back strain.
- Clear communication signals must be established with the drilling crew, since verbal communication may not be heard during the drilling process. Hearing protection should be used during all drilling operations.
- ERM field staff must stop work immediately and order all direct subcontractors to stop work wherever an unsafe condition is recognized. Contact the Project Manager (PM) immediately. Work cannot continue until the unsafe condition is corrected.
- If any non-drilling personnel enter the exclusion zone, work should be immediately stopped until the person can be briefed on safety procedures.
- In a situation where an unsafe condition exists that is beyond the control of the ERM field staff (such as an unsafe practice by an independent contractor not under ERM supervision) but is potentially dangerous to the ERM field staff or subcontractors, stop work, evacuate the area, and contact the PM immediately.
- ERM field staff are not authorized to drive contractor trucks or operate or borrow their equipment.

4. PROCEDURE

This section addresses the basic requirements and procedures involved with oversight of direct-push and sonic drilling. These sections include information on the selection of methods and equipment, planning and preparation requirements, health and safety requirements, drilling procedures, and key practices for ensuring quality. As stated above, this SOP will not address well installation, for procedural details related to well installation, please refer to the SOP for Monitoring Well Installation and Development (SOP #08).

The details within this SOP should be used in conjunction with project-specific work plans. Information regarding anticipated total depths of soil borings, sampling methodologies, and equipment to be used should be outlined in the project-specific work plan.

4.1 Selection of Methods and Equipment

During project coordination, the ERM PM and/or Field Staff Lead will evaluate the project Site to determine the type of equipment that is appropriate for the project based on anticipated subsurface lithology, boring location and accessibility, and anticipated depth of the boring among other Site-specific factors. There are several equipment considerations that can generally be applied to direct-push and sonic technologies, including:

- Use of track-mounted versus truck-mounted drilling rigs. Track-mounted sonic rigs, sometimes referred to as all-terrain-rigs, are positioned on a pair of tracks and can be utilized in areas where access is not feasible by truck or in otherwise uneven terrains. Overhead utilities should be considered when selecting the type of rig, as track-mounted rigs generally have lower clearance.

- Lubricating compounds. Only PFAS-free thread compounds may be used to lubricate auger bolts or threaded portions of any drill string assembly. No other compound may be used unless otherwise directed in the project work plans. Such directed use in the project work plans should take into account applicable regulatory agency requirements and/or approval.

- Proper sampling string apparatus are to be available at the sizes and lengths needed to properly drill the desired diameters in the formation(s) to be encountered.

- During drilling, no additives (except potable water) may be added to the borehole and interior portion of the auger string without appropriate regulatory approval and/or concurrence with project-specific requirements. Only potable water may be added to the borehole and interior portion of the drill string, and only after discussion with and approval by the ERM field staff overseeing drilling. In the event of water addition during drilling, the volume of water used for each borehole should be recorded and documented in the field notes. If water samples are to be collected during or upon completion of the drilling activities, a conservative tracer such as bromide should be added to the drilling water to verify that the collected water is predominantly aquifer water. The concentration of the tracer in the drilling water must be estimated, either by calculating the mixing ratios or through analytical testing. The concentration of the tracer in the collected groundwater samples should be tested in the laboratory. The tracer concentrations in drilling water and collected water samples should be documented and reported along with laboratory results for other parameters.

4.2 Drilling Site Mobilization

To the extent possible, basic Site preparation should be performed before mobilization to the Site (e.g., clearing brush, utility surveys). The project team, including at least one member of the field staff and management teams, coordinate these efforts with the client contact as needed. A list of basic Site preparation and mobilization requirements and procedures are as follows:

- A decontamination area should be established. The area should be located so that it does not interfere with Site operations or expose clean drill tooling and other equipment to potential cross contamination. Prior to advancement of any boring, drilling and sampling equipment should be decontaminated as specified in the SOP for Equipment Decontamination (SOP #13).

- The logistics of drilling, logging, sampling, cuttings/fluid containment, and/or well construction should be determined before mobilizing. The Site should be prepared in accordance with the project work plans.
- Before mobilization, the client contact and ERM field staff should assess the drilling Site. This assessment should identify potential hazards (e.g., slip/trip/fall, overhead, soft or sloping ground, etc.) and determine how drilling operations may impact the environment (e.g., dust, debris, noise). Potential hazards should be evaluated and corrected, or the borehole location changed or shifted in accordance with the project work plans.
- Before drilling begins, utility clearance must be completed as described in the SOP for Subsurface Clearance (SOP #04).
- Overhead obstructions such as trees, tall shrubs, and building overhangs should be evaluated and avoided for safety reasons, as they can impair the proper function of drill mast components.
- Once Site preparation is completed, the rig is mobilized to the Site and positioned over the identified borehole location. The rig should then be leveled with a set of hydraulic pads at the front and rear of the equipment. Once the rig is leveled, the mast should be raised slowly and carefully to prevent tipping or damaging the rig and to avoid hitting any obstructions or hazards.
- The driller and the ERM field staff should inspect the drilling equipment for proper maintenance and appropriate decontamination. All clutches, brakes, winches, and drive heads should be in proper working order. Cables and hydraulic hoses should be in good condition. Tooling connections, bolts (if applicable), sampling rod joints, and plug rod joints should be in good condition with no significantly worn threads, cracked or worn joint connections, or other signs of excessive wear. ERM field staff should measure the length and diameter of the drill tooling to confirm it is appropriate for the project scope-of-work.
- Appropriate barriers and markers should be in place prior to drilling, in accordance with the project HASP. Plastic sheeting may be required beneath the rig and around the drilling area. When plastic is placed in the general vicinity of rotating equipment, extra precaution may be necessary to make sure that the plastic does not pose a safety hazard or unwarranted distraction or nuisance to the drill crew.
- Any leakage of fluids from the rig should be immediately repaired, and any lost fluids and impacted soils should be containerized for proper disposal. If the rig requires additional decontamination, it should be removed from the drilling area and decontaminated before it is allowed to remobilize to the Site.
- Appropriate containment for cuttings and other investigation-derived waste should be set up on-Site prior to the commencement of drilling.

4.3 General Drilling Requirements and Procedures

The ERM field staff should not leave the drill Site whenever drilling operations are conducted and the borehole is being advanced. ERM field staff should be present at all times when subcontractor personnel are on the project Site. The ERM field staff will fully describe and record all tasks performed in support of drilling activities in a field book or log sheet, including logging the samples, monitoring drilling operations, recording water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the temporary well installation procedures of the rig. Details regarding well installation are included in the SOP for Monitoring Well Installation and Development (SOP #09, Appendix A of the Field Sampling Plan).

The following key practices should be followed to ensure the quality of proper boring advancement and installation:

- Immediately prior to drilling, safety sampling and monitoring equipment should be calibrated according to manufacturer's specifications and appropriate project-specific requirements and/or procedures. The field staff breathing zone should be monitored with a photoionization detector (PID) and 4-gas meter based on the applicable HASP requirements.
- Establish a datum for measuring borehole depth (top of drill platform, stake in ground, etc.). The borehole depth is determined by keeping track of the length of rod/bit assemblies and comparing the position relative to the established datum.
- During drilling operations, as the borehole is advanced, ERM field staff will generally do the following:
  - Observe and monitor rig operations;
  - Conduct all health and safety monitoring and sampling, and supervise health and safety compliance; and
  - Document drilling progress and other appropriate observations on appropriate forms.
- Prepare a boring log from cuttings or soil samples as specified by applicable ERM SOPs and project-specific requirements.
- Supervise the collection and preparation of any samples.
- As drilling progresses, ERM field staff should observe and be in frequent communication with the driller regarding drilling operations. Conditions noted should include relative rates of penetration (as indicated by fast or slow drilling), rotation speeds, chattering and bucking of the rig, hard or sticky drilling, drilling refusal, water use during drilling, etc. These conditions, including penetration and water use rates, should be recorded in the field book.
- Drilling should not be allowed to progress faster than the ERM field staff can adequately observe conditions, compile logs, and supervise safety and sampling activities.
- ERM field staff should also observe the fitting and placement of drill string connections, as well as the make-up and tightening of drill rods for the center plug and/or sampling string. Any observed drilling problems and causes, including significant down time, should be recorded on the appropriate forms.
- Cutting and fluid containment during drilling should be observed and supervised by the ERM field staff in accordance with the project work plan.
- Petroleum jelly, Teflon tape, or lithium grease shall not be used on the threads of downhole drilling equipment. If a lubricating agent is required, the proposed lubricant must be reviewed for approval by ERM field staff. Adequate time and information, such as Safety Data Sheets (SDS), must be provided for the ERM's review. Food grade vegetable oil is an example of an approved lubricant. Additives containing either lead or copper will not be allowed. In addition, polychlorinated biphenyls (PCBs) will not be contained in hydraulic fluids or other fluids used in the drilling rig, pumps, or other field equipment and vehicles.
- Surface runoff or other fluids will not be allowed to enter any boring or well during or after drilling/construction. Likewise, re-circulated drilling fluids will be contained in the work area during installation of borings and not allowed to runoff into the surrounding areas.

- Antifreeze used to keep equipment from freezing will not contain rust inhibitors and sealants. If antifreeze is added to a piece of machinery in contact with drilling fluid, the antifreeze will be completely purged from the equipment before used in drilling, mud mixing, or any integral part of the overall drilling operation.

4.4 Direct-Push Drilling for Waterloo^{APS} Profiling

Waterloo^{APS} activities will include collection of a continuous hydrostratigraphic log and discrete-depth groundwater samples using the Waterloo^{APS} hydraulic profiling tool.

The following procedure will be used for the advancement of the Waterloo^{APS}:

1. The drilling subcontractor will assemble the direct-push drill rig in accordance with the manufacturer’s instructions.
2. The drilling subcontractor will decontaminate non-dedicated sampling equipment prior to first use and following sampling of each location. All parts of the equipment coming in contact with groundwater must be decontaminated with high-pressure steam cleaning within a designated area on-Site.
3. The Waterloo^{APS} profiler tip will be assembled for peristaltic mode or gas drive mode, depending on the estimated depth to water, by the subcontractor per the manufacturer’s instructions.
4. The Waterloo^{APS} profiler tip will be added the bottom of the drill rod as the drive point with the stainless-steel tubing threaded through the estimated amount of drill rods.
5. The hydraulic conductivity profiling system and water quality monitoring system will be calibrated and assembled by the drilling subcontractor per manufacturer’s instructions then attached to the stainless-steel tubing.
6. The drilling subcontractor will advance the borehole while hydraulic conductivity data is collected in real time.
7. The drive rod will be stalled when zones of high conductivity are located, or every five feet (whichever occurs first).
8. Water will be purged through the system to obtain water quality parameter data from the water quality monitoring system.
9. Samples will be collected at depths and locations in accordance with the Field Sampling Plan, or as adjusted in the field based on further Site knowledge. Samples will be collected using a peristaltic pump under low flow conditions (generally between 100 and 300 milliliters per minute), or a gas drive pump if the potentiometric head is too deep for the use of a peristaltic pump. Samples will be stored in a cooler with ice, pending shipment. Field modifications or variations from the FSP should be documented and communicated to the agencies.
10. All data will be recorded by the drilling subcontractor and provided in electronic format to ERM in a timely fashion (i.e., on a daily basis).
11. Boreholes will be completed to the target depth, hard refusal, or push-rate refusal, as defined by the driller. After completion, the WaterlooAPS tooling will be removed from the subsurface and the borehole will be pressure-grouted from the bottom to ground surface using tremie grouting methods.

12. ERM will coordinate the shipment of samples in coolers to the analytical laboratory under proper chain of custody procedures as described in the SOPs for Chain of Custody and Sample Packing and Shipping (SOP #02 and SOP #03).

4.5 Soil and Rock Boring Logs

During drilling, the ERM field staff will compile a boring log that includes the following:

- Borehole location (distance to nearest landmarks and latitude/longitude);
- Name of the field staff, drilling company, and driller;
- Dates and times of drilling events, including when drilling began, the total depth and when it was reached, intermediate milestones, and any changes in equipment;
- Sampling depths and recovery of soil or rock samples;
- PID readings;
- Water content in soil;
- Percentages of gravel, sand, and fines in soil;
- Lithologic data and descriptions in accordance with the SOP for Solid Matrix Logging and Sampling (SOP #07);
- Premature total depth due to refusal and the cause of refusal (if known); and
- Any other observed drilling conditions, such as observed groundwater levels, zones of hard or soft drilling, flowing sands, etc.

4.6 Sonic Drilling in Alluvium

The following procedure will be used for the advancement of sonic borings:

1. The drilling subcontractor will assemble the sonic drill rig in accordance with the manufacturer’s instructions.
2. Prior to sampling and between sampling locations, the sample equipment must be decontaminated according to the procedures in the SOP for Equipment Decontamination (SOP #18, Appendix A of the Field Sampling Plan).
3. Establish a convention with the driller to consistently identify and orient the "top of sample".
4. An inner (core) barrel is advanced into the subsurface to collect a soil core sample. Generally, the core barrel is 4-inches in diameter and 10 feet in total length; however, 5-foot and 20-foot sections may also be used.
5. After the inner barrel has been advanced to the terminal depth of the sample run, a larger diameter outer drill rod (typically 6-inches in diameter) is advanced over the inner barrel. The larger diameter rod acts as temporary casing supporting the borehole from collapse while the inner barrel is removed from the borehole.
6. The inner barrel is then removed from the borehole and the soil core is extruded from the barrel into plastic sheathing for examination by the ERM field staff. The subcontractor will mark or note the

depth range of the run on the plastic sheathing, and the ERM field staff should also confirm the interval for each core.

7. The sequence (Step 2 through 4) is repeated to collect the next length of soil core.

8. Each time a soil core is extracted, the ERM field staff should record the depth interval of the full core.

9. A weighted tape should be used to verify the depth of the boring within the casing. Measurement should be made with reference to the ground surface. It is important to measure depth at the start of sampling intervals and at total depth of the boring. If slough is present, it should be removed by forcing a sampler into it and retrieving and emptying the sampler of slough. If water is introduced to the boring, the drilling subcontractor may also use mechanical means to clear the borehole of slough. Slough is generally easy to identify based on jumbled internal textures, lighter density, macroscopic and unmineralized void spaces, greater softness and malleability, and decreased cohesion, as compared to in situ material that has not been dislodged prior to the sampling process.

10. Retrieve the soil core bag and transport it to the sample management location. Sample and describe the core in accordance with the SOP for Solid Matrix Logging and Sampling (SOP #07).

11. Photograph each core, including a scale (e.g., tape measure) and location name and depth of top and bottom of each interval (e.g., using a dry erase board)

4.7 Basic Rock Coring Procedure

Borings at locations selected for installation of new bedrock monitoring wells will be advanced into rock only after characterization of the alluvium has been completed. For wells to be completed in both alluvium and bedrock, the outer casing used to over-drill the temporary alluvial casing will be 10 inches in diameter. Once the 10-inch casing is set approximately 5 feet into bedrock, an 8-inch diameter drill casing will then be used to advance through rock. Similar to the alluvium, the core barrel will be advanced in 10-foot increments to retrieve continuous 4-inch diameter sections of rock core. While portions of the core may exhibit increased disintegration from the vibratory drilling, we anticipate being able to recover intact sections of core up to about 3 feet in length.

1. The drilling subcontractor will assemble the core barrel according to manufacturer's instructions and inspect the core barrel for wear, dents, galls, and clearances.

2. Prior to sampling and between sampling locations, the core barrel, inner tube, drill rods, and any tools to be used down the borehole or to handle the cores must be decontaminated as specified in the SOP for Equipment Decontamination (SOP #13).

3. Establish a convention with the driller to consistently identify and orient the "top of sample".

4. The inner tube of the core barrel is inserted and the lead drill rod and core rod (with core barrel) is attached to the drill mechanism through the spindle or below the drill head.

5. The drilling subcontractor starts drill-head rotation, and drills in 10-foot increments. Drilling speed should also be appropriate for the material to be cored.

6. Rotation and down-force pressure are stopped when the required depth is reached, slightly raising the core barrel off the borehole bottom.

7. The drill rods are raised and the core barrel and core are removed from the borehole (if not using a wire line).

8. The core barrel is disassembled and the core is removed.

9. The drilling subcontractor checks the core barrel for wear or damage, reassembles the core barrel and drill rod and returns them to the borehole. The use of two core barrels can greatly speed up the coring operations. When one core barrel is in use the other can be cleaned and reassembled.

10. Retrieve the rock core and transport it to the sample management location. Sample and describe the core in accordance with the SOP for Solid Matrix Logging and Sampling (SOP #07).

11. Photograph each core, including a scale (e.g., tape measure) and location name and depth of top and bottom of each interval (e.g., using a dry erase board).

12. The sequence (Step 4 through 11) is repeated to collect the next length of rock core. Drilling depth is increased by adding drill-rod sections to the top of the previously advanced drill-rod column.

The rock core shall be recovered continuously from the borehole. If core recovery drops below an acceptable level, the drilling procedure should be modified to increase recovery to the extent feasible by adjusting the drilling revolutions per minute (RPM), down-feed pressure, or drilling fluid type. The type and size of core barrel and bit used may be changed until core recovery is improved to a level acceptable to the project field staff. Mechanical breaks in the core should be minimized as much as possible. In many instances, 100 percent recovery of core is not possible and significant intervals of no recovery occur during coring. This may be due to a variety of factors related to the formations encountered and drilling and coring methods used. If problems with core recovery occur, the ERM field staff should consult with the driller to determine if core recovery can be improved and what actions should be taken to improve recovery. If it is determined that recovery cannot be improved with any corrective action, the coring may continue after consultation with the PM, or designee. The corresponding decision(s) and rationale to continue coring should be documented on the appropriate forms and records.

Once the total depth of the borehole is reached and the coring is completed, the borehole should be abandoned according to the project work plan.

4.8 Core Handling, Care, Preservation, Packaging, and Storage

The following tasks should be completed for core samples requiring routine care:

1. Remove the core from the core barrel with a minimum of disturbance.

2. Mark the top and bottom of the core with a felt-tip or other permanent marker.

3. Photograph the core in color and with a color strip-chart in the picture for reference.

4. Perform initial core logging, including identification of the borehole and field staff, equipment used, datum, coring depth, contact depths, and any information required or useful for the detailed logging.

5. Place the core in rigid wooden or waxed boxes with appropriate partitions. Mark the top and bottom and core depths inside the box. Orient the core segments to their original relative positions by fitting tops and bottoms of adjacent core segments together to the extent feasible. Once the core is oriented to the extent feasible, mark entire length of cores with adjacent felt-tip markers of two different colors to preserve their relative positions. Optionally, place the core in loose-fitting polyethylene sleeves following marking.

6. Add core blocks/spacers (Photo 1) for intervals of no recovery; add packing to the core box and seal.

***Photo 1**: Core Blocks/Spacers*

7. Mark both the top and one edge of the core box with the following information: company name, project name, drill-hole number or location, core box number in sequence down the hole, and depths from a specified datum to the top and bottom of the core.

8. Handle the core boxes gently and transport them by company vehicles, if possible, to avoid core damage. Protect the core from excess heat and freezing during transportation.

9. Store the core in an environment that will not cause alteration of physical properties and structure.

10. Catalog the core and maintain a record of the core, including company and project name, drill hole number and location, orientation of the borehole, elevation of the datum, dates of coring, core box number and depth intervals, date and name of the person doing the initial logging, boring log, and photographs of the core.

4.9 Collection and Disposal of Drill Cuttings

The drilling contractor will be responsible for containerizing all drill cuttings and other wastes generated during drilling activities. An accumulation area for all investigation-derived wastes should be coordinated with the Site contacts prior to initiating drilling activities. The project-specific scope of work will outline details regarding proper containerization, transport, and disposal for derived wastes.

Standard Operating Procedure #07: Solid Matrix Logging and Sampling

Version #1.1
March 2022

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to provide standard procedures for solid matrix sample logging and sampling activities at Roto-Finish Co., Inc. in Portage, Michigan. Solid matrix samples will be recovered during drilling, as described in the SOP for Drilling Oversight (SOP #06). Samples will be collected from select locations, as detailed in the Field Sampling Plan. This SOP provides the standard practice for collecting samples from the cores and logging soil classifications. The SOP includes the minimum recommended steps and quality checks that employees are to follow when performing the task.

The goal of solid matrix sample logging and sampling is to obtain representative data and samples that meet project data quality objectives and industry acceptable standards of accuracy, precision, comparability, and completeness. Data collected during the sampling process (e.g., field observations and core description) may be used to infer subsurface conditions and assist in interpreting laboratory analytical results and developing a conceptual Site model.

2. EQUIPMENT AND MATERIALS

- Field forms and field book;
- Permanent-ink and waterproof pens, drawing template, and engineering scale;
- Clipboard;
- Stainless steel knife spatula for cutting/removing soil samples from liner;
- Digital camera;
- Measuring tape or rule;
- Field Sampling Plan, Health and Safety Plan (HASP), Subsurface Clearance Plan;
- Personal protective equipment (PPE) in accordance with the project HASP;
- Grain-size chart, Unified Soil Classification System (USCS) guide, Munsell color chart, and other aids for field classification of soils;
- Hand lens;
- Appropriate sample containers (e.g., laboratory-provided);
- Cooler and ice (if samples are to be collected);
- Labels, chain of custody (CoC), and custody seals;
- Bubble wrap, shipping papers and shipping tape (if shipping instead of via courier); and
- Decontamination supplies (e.g., non-phosphate detergent [Liquinox® or equivalent] and distilled water).

3. HEALTH AND SAFETY

SOPs are designed to provide technical guidance and do not provide detailed or comprehensive guidance related to health and safety, nor do they represent guidance on safe work procedures for the tasks described. Appropriate tips related to health and safety issues associated with specific tasks may be included within technical descriptions for information's sake only.

Health and safety aspects of all projects and project tasks should be assessed and planned using ERM's established Health and Safety planning procedures. Drilling and other subsurface intrusive work presents specific hazards and proper safety precautions must be observed performing any subsurface work. These hazards, as well as those associated with constructing and installing monitoring wells, should be addressed by a Site-specific HASP. The safety guidelines within the HASP should be used to complement the judgment of an experienced professional. For all subsurface drilling activities, the project-specific health and safety requirements must be reviewed by ERM field staff and subcontractors.

4. PROCEDURE

4.1 Soil Sample Collection

Prior to sampling, field staff will ensure that the amount and type of sample containers selected and the various preservation techniques to be used are in compliance with the requirements established in the QAPP.

The following procedure will be used for the collection of soil samples:

- Following retrieval of the soil core bag, the ERM field staff will use a decontaminated safety knife to cut the plastic open parallel to its length to expose the core.
- Don a clean pair of nitrile gloves and open the sample tool. If the sample is removed from a re-usable sampling tool, place the core into a clean, decontaminated sample tray. If the sample was collected using an expendable liners, zip-cut the liner lengthwise to expose the soil core.
- Using a clean, decontaminated stainless steel knife or spatula, scrape the wall of the soil core to expose a clean surface. Identify and discard any obvious slough from the top of the soil core.
- Using a clean, decontaminated stainless steel knife or spatula, collect aliquots for headspace screening or run the photoionization detector (PID) along each core, as required by the FSP. The procedure for headspace field screening is described in the SOP for Field Screening Using a Photoionization Detector (SOP #05).
- For soil samples required by the FSP, place samples in laboratory-provided sample containers for the analyses listed in the QAPP.
- Record the sample name, sample type, analytical methods, sample date, sample time, and sampler name on the boring log, label, and CoC, as applicable.
- Bag, label, and store additional soil samples at a designated location for further testing, if required.
- Decontaminate the sampling equipment as specified in the SOP for Equipment Decontamination (SOP #13).

- Label, package, and ship coolers to the analytical laboratory under proper CoC procedures as described in the SOPs for Chain of Custody and Sample Packing and Shipping (SOP #02 and SOP #03).

4.2 Soil Classification

In general, soil descriptions will be written in the following format, using the procedures based upon the USCS, United States Department of Agriculture, or Burmister Classification System as directed by the Project Manager to meet the project's needs.

Major components will be shown in capital letters (e.g., SAND), as following example demonstrates: hard brown silty CLAY with a trace of sand and gravel, moist, fractured. Attached Figure 1a and Figure 1b depict soil characterization guidance charts for reference.

Record the following soil characteristics based on visual examination of the soil cores in the field:

1. Soil type and grain size based on the USCS, including degree of sorting/grading of coarse-grained materials (e.g., gravel, poorly sorted sand, silt);
2. Color;
3. Angularity and sphericity (i.e., angular vs. well rounded; flat vs. spherical);
4. Stratification, when appropriate, using the following terms:
    a. Massive—thickness greater than 3.3 feet (1 meter);
    b. Bedded—thickness of 0.5 inches to 3.3 feet (1 centimeter to 1 meter); and
    c. Laminated—thickness of 1 millimeter to 0.4 inches (1 centimeter).
5. Moisture (i.e., dry, moist, wet, saturated);
6. Depth at which water is encountered;
7. PID screening value (where appropriate); and
8. Other distinguishing or notable features (e.g., presence of organic material, unusual colors, noticeable odors, or any other unusual features or observations).

4.3 Rock Core Sample Collection

General sample collection methods are listed below.

- Retrieve the sampling tool and transport it to the sample management location.
- Don a clean pair of nitrile gloves and open the sample tool. If the sample is removed from a re-usable sampling tool, place the core into a clean, decontaminated sample tray. If the sample was collected using an expendable liner, zip-cut the liner lengthwise to expose the core.
- Place samples in laboratory-provided sample containers for the analyses listed in the QAPP.
- Record the sample name, sample type, analytical methods, sample date, sample time, and sampler name on the boring log, label, and CoC, as applicable.

- Decontaminate the sampling equipment as specified in the SOP for Equipment Decontamination (SOP #13).
- Samples will be labeled, packaged, and shipped in coolers to the analytical laboratory under proper CoC procedures as described in the SOPs for Chain of Custody and Sample Packing and Shipping (SOP #02 and SOP #03).

4.4 Logging Rock Core

The Rock Coring Log should include general information such as the name of Site and project number, Site location, ERM field staff name, drilling subcontractor company and name of contractor field lead driller, reference sketch for the drilling location, date and time for the start and completion of the boring, type and model of drill rig used (e.g., sonic or cable-tool), weather conditions, method of drilling (e.g., air-rotary), size of the borehole, and the length, diameter, and type of all downhole casing and sampling materials.

The following standard procedure should be followed when describing rock core:

1. Field screen the rock core by running the PID along each 10-foot core at a distance of 0.5 to 1 inch above the core. The highest PID results from the 10-foot interval, in parts per billion, will be recorded on field forms for each sample depth and location.
2. Photograph each core, including a scale (e.g., tape measure) and location name and depth of top and bottom of each interval (e.g., using a dry erase board).
3. Describe the rock name in capital letters (e.g., SHALE, LIMESTONE) followed by additional descriptions.
4. Describe the color of the rock.
5. Record the recovery and rock quality designation (RQD). The recovery is the total amount recovered divided by the total length of the run. RQD is calculated by adding up the total number of intact sections that are a minimum of 4 inches long divided by the length of the run. RQD is a proxy for rock weathering and quality where high RQD (>75%) generally indicates a fresh or slightly weathered rock.
6. Describe any bedding, foliation, or banding. Bedding thickness should be included in the description according to the following table.

Term	Bed Thickness/Spacing
Thinly Laminated	<2 mm
Laminated	2–6 mm
Very Thin	6–20 mm
Thin	20–60 mm
Moderately	60–200 mm
Thin	0.2–0.6m
Thick	0.6–2 m
Very Thick	>2 m

m = meters; mm = millimeters

7. Describe the degree of rock weathering using the following criteria:

a. Fresh or unweathered: rock mass shows no loss of strength or discoloration;

b. Slightly weathered: rock mass is not significantly weather than fresh rock, some discoloration and defect;

c. Moderately weathered: rock is significantly weaker than fresh rock and is discolored;

d. Highly weathered: most of the original mass strength is lost, materials are discolored;

e. Extremely weathered: original rock strength is lost and the rock mass has been changed to a soil through chemical decomposition or physical disintegration; rock fabric (e.g., bedding layers) remains intact; and

f. Residual soil: rock is completely changed to a soil, fabric has been completely weathered.

8. Describe the strength of the rock using the following table.

Grade	Description	Field Identification
R6	Extremely Strong	Rock may not be chipped with hammer
R5	Very Strong	Rock requires many blows to fracture
R4	Strong	Rock requires one blow of a hammer
R3	Medium Strong	Cannot be peeled or scraped with a knife, can be fractured with single blow of hammer
R2	Weak	Can be peeled with knife easily or shallow indentations made with blow of the hammer
R1	Very Weak	Crumbles easily or can be peeled with a pocket knife

9. Describe any fracture and the fracture spacing. Fracture descriptions should include the following:

   a. Density: Very slightly (core lengths >3 feet [ft.]), slightly (core lengths 1 to 3 ft.), moderately (core lengths 4 inches to 1 ft.), highly (core lengths 1 to 4 inches), very highly (mostly chipped and fractures);

   b. Infilling (e.g., clay or none);

   c. Fracture bedding (e.g., planar, stepped, smooth);

   d. Fracture angle; and

   e. Mark mechanical breaks on the core with 2 lines perpendicular to the break using a felt-tip marker. Mechanical breaks should not be included in the fracture analysis.

10. Miscellaneous Notes: This section of the field form should be used to log general observations during the drilling process. Examples include, but are not limited to: information about color and consistency of cuttings, required air pressures to cut rock, notes on drilling rig (e.g., “chatter” while drilling), depth to water, and other observations made by the drilling subcontractor.

11. Write the entire description sequence in lower case except for the rock type and name. For example: SANDSTONE, coarse grained, high quartz content, dark brown, slightly weathered, very hard, no bedding or BASALT, very thickly bedded, black, fresh, hard, slightly fractured.

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART		
COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size		Clean Gravels (Less than 5% fines)
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
		Gravels with fines (More than 12% fines)
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size		Clean Sands (Less than 5% fines)
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
		Sands with fines (More than 12% fines)
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

Source: California Department of Transportation's Unified Soil Classification System: https://dot.ca.gov/-/media/dot-media/programs/maintenance/documents/office-of-concrete-pavement/pavement-foundations/uscs-a11y.pdf.

Figure 1a: Soil Characterization Guidance Chart

Source: United States Department of Agriculture's Natural Resources Conservation Service Guide to Texture by Feel: *https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054311.*

Figure 1b: Soil Texture Characterization Guidance Chart

Standard Operating Procedure #09: Fluid Level Gauging

Version #1.2
September 2023

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to establish procedures for conducting fluid level gauging for at Roto-Finish Co., Inc. in Portage, Michigan. Fluid level gauging data may be used to support the creation of groundwater table or potentiometric surface maps, and to calculate hydraulic gradient(s) and horizontal groundwater flow direction(s) across the Site.

The objective of fluid level gauging is to accurately measure depth to water relative to a surveyed data point on monitoring wells and piezometers, generally top of casing (TOC), to determine groundwater elevation. New and temporary well locations will be surveyed following installation by a licensed surveyor in relation to the nearest permanent benchmark. Existing well locations may also be re-surveyed on a periodic basis, if deemed necessary by the project team.

2. EQUIPMENT AND MATERIALS

- Field forms and field book;
- Site Health and Safety Plan (HASP);
- Traffic protection equipment (e.g., traffic cones, barriers, and high visibility vests);
- Personal protective equipment (PPE) for splash protection (e.g., gloves and safety glasses);
- Tools for removing the bolt down cover or manway, well cap, and keys for lock on well cap;
- Small manually operated hand pump, or small cup for evacuating standing water from around the well casing, if water is above top of well casing within manway or well cover;
- Non-phosphate detergent solution (Liquinox® or equivalent), buckets, rinse water (distilled water), and clean paper towels;
- Water level meter(s), marked every 0.01 feet, and of sufficient length to measure total depth of the deepest well on-Site (Solinst® 102, or similar);
- Boring logs, completion diagrams, and/or a summary table that describes the well diameter, well depth, stickup, ; elevation of the Top of Casing, the ground surface elevation, screen interval and the elevation of the top and bottom of the well screens and
- Extra batteries for the water level meter.

3. HEALTH AND SAFETY

SOPs are designed to provide technical guidance and do not provide detailed or comprehensive guidance related to health and safety, nor do they represent guidance on safe work procedures for the tasks described. Appropriate tips related to health and safety issues associated with specific tasks may be included within technical descriptions for information’s sake only.

Health and safety aspects of all projects and project tasks should be assessed and planned using ERM’s established health and safety planning procedures.

4. PROCEDURE

4.1 Pre-Gauging Activities

The following procedures should be followed in preparation for fluid level gauging activities:

1. Prior to first use, calibrate the water level meters. Unravel the probe and measure it against one, 500-foot reference water level probe to confirm the probe's length. The reference probe will be stored on-Site in a climate-controlled office and will not be used for any field measurements to protect its integrity. Any difference between the probe and the reference probe will be recorded on the associated calibration form so that any necessary adjustments to fluid level measurements can be made following gauging. Probe serial numbers will be noted on the calibration form, gauging form, and sampling forms for tracking purposes. Each water level meter will be re-calibrated on an annual basis.

2. Develop a gauging plan. Measurements should be taken within a 24-hour period or less. The gauging plan should also consider:

    a. Known information about the wells and historical water levels from previous field events (field notes should be reviewed if available);

    b. Other relevant activities to be undertaken at the same time and specific requirements relating to these, including the sequencing of events;

    c. Potential difficulties in accessing the wells, such as:

        i. Are any of the wells located within process areas requiring permits from the facility?

        ii. Are well cover bolts or well cap locks rusted?

        iii. Are there restrictions to access, such as stream crossings or heavy brush with associated physical and biological hazards?

        iv. Are wells located in or near roadways requiring a traffic management plan and/or appropriate PPE (e.g., reflective vests)?

    d. Presence of high concentrations of dissolved-phase constituents in each well. Despite the use of decontamination techniques, it is prudent to proceed in gauging and sampling from least-impacted wells to the most-impacted wells, if known. If unknown, the suspected source area wells should be gauged last.

4.2 Gauging Activities

The following procedures should be followed during fluid level gauging activities:

1. All stick-up wells will be vented by placing a small hole in each well cap to allow the well to equilibrate to ambient air pressure. It is not uncommon in some domains to encounter poisonous insects/spiders or snakes in well boxes, thus care should be taken when opening well boxes, vault lids, or manways.

2. Prior to use, decontaminate the water level meter and the portion of the tape that is likely to contact the water using paper towels and a non-phosphate detergent, rinsing with distilled water, and wiping dry with paper towels.

3. If the water level meter has a grounding wire, attach it to the manway cover, the well box, or to a metal rod driven into the ground prior to gauging. In the absence of a grounding wire, the technician should touch a grounded metal object to discharge built up static electricity.

4. The depth to water should be measured relative to an established surveyed reference point on the top of the well casing. The reference point on the well casing should be marked; as a default, if not marked, the TOC is presumed to be the north side of the casing and should be noted in the field forms or field book. The measurements should be collected after the water level is equilibrated.

5. To measure the depth to water, slowly lower the probe into the well until a signal (intermittent or constant beep) is heard. Repeat the recording three times by raising and then lowering the probe again across the water table (does not measure while raising the probe, as surface tension may result in aberrant readings). Record the depth to water in feet to two decimal places or meters to three decimal places (i.e., to the millimeter level).

6. The total depth of the well should be measured to determine if the well is silting or damaged. This is done by lowering the probe into the well until the tape just becomes slack and recording the depth from the TOC. If the well is to be sampled for metals, gauging of total depth should not be conducted until sampling has been completed due to potential to create turbid conditions within the well.

7. At the completion of fluid level and/or total depth measurements at each well, the water level meter tape should be retrieved carefully, decontaminated using paper towels and a non-phosphate detergent, rinsed with distilled water, and wiped dry with paper towels.

4.3 Post-Gauging Activities

Following fluid level gauging activities, groundwater elevation data will be compiled and calculated using the following formula:

Groundwater Elevation = TOC – DTW

Where:
TOC = Top of Casing Elevation
DTW = Measured Depth to Water

If any discrepancies were noted during the water level meter calibration, the measured depth to water will be compensated accordingly.

5. REFERENCES

American Society of Testing and Materials (ASTM) D4448 – 01. 2013. Guide for Sampling Ground-water Monitoring Wells.

United States Environmental Protection Agency (USEPA). 2020. Groundwater Level and Depth Measurement Operating Procedure. LSASDPROC-105-R4. Region 4, Laboratory Services and Applied Science Division, May. Available online at: https://www.epa.gov/sites/production/files/2017-07/documents/groundwater_level_and_well_depth_measurement105_af.r3.pdf. Accessed 4 August 2020.

Standard Operating Procedure #10: Groundwater Sampling

Version #1.2
September 2023

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure (SOP) is to establish a consistent methodology for collecting representative groundwater samples from monitoring wells at Roto-Finish Co., Inc. in Portage, Michigan. Two groundwater sampling techniques will be used: low flow sampling at traditional single screen monitoring wells and positive displacement sampling for FLUTe™ Cased Hole Sampler (CHS) multi-level well systems.

The goal of low-flow groundwater sampling is to purge a monitoring well at a similar or lower rate than recharge of the well, thereby obtaining samples that are representative of undisturbed groundwater while minimizing the amount of purge water generated. This technique involves pumping the groundwater at a low flow rate through an in-line flow cell where water quality parameters are monitored until stabilization, after which a groundwater sample is collected and submitted for laboratory analysis.

The positive displacement sampling method involves purging water from each sampling port within a CHS well system using compressed nitrogen gas, until a specified volume of purge water has been achieved. Water quality parameters are not monitored for stabilization criteria prior to collecting samples since the well storage is purged repeatedly and recharged with formation water.

2. EQUIPMENT AND MATERIALS

- Field forms and field book;
- Site Health and Safety Plan (HASP);
- Personal protective equipment (PPE) in accordance with the project HASP;
- Safety cones, traffic tape, and/or barricades;
- A table with monitoring well completion information, or borehole logs and/or well completion diagrams;
- Keys for any locks on well boxes or well caps;
- Hand tools, such as:
  - Socket wrench to open bolt-down well covers;
  - Crescent wrench to tighten valves for CHS sampling;
  - Large wrench (or spanner) to open drum lids;
  - Pry bar or screwdriver to lift manway (well) covers; and
  - Bolt cutters and replacement locks to cut and replace locks from wells without keys or locks that are inoperable.
- Water level meter, marked every 0.01 feet (Solinst® 102 or equivalent);
- Submersible bladder pump with air compressor and controller (QED Environmental Systems Well Wizard® pump Model Numbers P1101M and P1150, or similar);
- Power source for pump (e.g., battery, generator, air compressor) and extra batteries for water quality meter and water level meter;

- Compressed nitrogen gas canister with manifold, valves, and regulator for CHS sampling;
- Tubing – inert tubing compatible with constituents of concern in groundwater (commonly polyethylene, nylon, or Teflon®); 1/4 inch or 3/8 inch (inside diameter) tubing is recommended;
- Flow measuring equipment (e.g., graduated cylinder and stopwatch);
- Multi-parameter water quality meter with flow cell, capable of measuring temperature, pH, specific conductance, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity (YSI ProDSS, or equivalent);
- Field filters:
  - 0.45 micron in-line filters (Waterra® brand, or equivalent); and
  - Laboratory-provided syringe filter kit for hexavalent chromium.
- Laboratory-provided sample bottles:
  - Sufficient number of bottles for all wells to be sampled plus 10 percent extra for potential breakage; and
  - Bottles for quality assurance/quality control (QA/QC) samples as required per the Quality Assurance Project Plan (QAPP), which may include blind duplicates, matrix spike/matrix spike duplicates, field blanks, rinsate blanks, equipment blanks, and trip blanks.
- Distilled water for field and equipment blanks;
- Labels, chain of custody(CoC) forms and custody seals;
- Coolers and ice;
- Bubble wrap, re-sealable bags for ice, and shipping tape (if shipping instead of via courier);
- Container to collect purge water (such as a 5-gallon plastic bucket), preferably with graduated measurements for accurate volume measurements;
- Clamps to secure tubing to buckets while purging;
- Large volume vessel(s) (such as 55-gallon drums or plastic totes) to store purge water pending characterization and disposal; and
- Decontamination supplies (i.e., non-phosphate detergent [Liquinox® or equivalent] and distilled water).

3. HEALTH AND SAFETY

SOPs are designed to provide technical guidance and do not provide detailed or comprehensive guidance related to health and safety nor do they represent guidance on safe work procedures for the taks described. Appropriate tips related to health and safety issues associated with specific tasks may be included within technical descriptions for information's sake only.

Health and safety aspects of all projects and project tasks should be assessed and planned using ERM's establish health and safety planning procedures.

4. PROCEDURE

4.1 Preparation for Groundwater Sampling Event

It is recommended that low-flow sampling be conducted when the air temperature is above 32 degrees Fahrenheit (°F) (0 degrees Celsius [°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. Minimize the length of tubing exiting the monitoring well to reduce the amount of groundwater exposed to ground surface conditions.

The following tasks should be completed before the groundwater sampling event:

1. Contact facility Site manager or property owner to confirm date of sampling event and arrange for clear access to wells and work permits (if required). Confirm any Site-specific health and safety training, PPE requirements, or other facility requirements (e.g., inspection of equipment).

2. Perform all necessary health and safety pre-planning as dictated by ERM and client-specific requirements. Pre-planning should include a review of the project HASP by all field staff.

3. Check availability of equipment and supplies either from in-house or outside sources and place order for rental and purchased equipment/supplies at least one week in advance of the sampling event to allow for shipping/stock delays. Longer lead time may be needed.

4. Ensure that you have keys for any locks on well boxes or well caps. If the condition of the locks is not known, bolt cutters and replacement locks may be required.

5. Upon receipt of equipment and supplies, check for proper operation, calibration of equipment, and quantities and sizes of supplies.

6. Place bottle order with laboratory at least one week in advance of field work – include enough bottle sets to cover all wells in the sampling program, all QA/QC samples, and a few contingency bottles. If shipping bottles or samples via air freight, check with laboratory regarding special handling and shipping requirements.

7. Prepare paperwork for the field event, including HASP, field forms or field books, Site plan showing all sample locations, previous monitoring data (if available), and any other required permits, forms, etc.

8. In order to reduce potential for cross-contamination, review previous groundwater monitoring results (if available), and if feasible, plan to sample wells in order of lowest to highest concentrations.

4.2 Calibration Activities

The water quality meter will be calibrated daily prior to use for DO, specific conductivity, pH, and ORP, at a minimum. Turbidity will be checked daily, and calibrated as needed, if outside of acceptance criteria. Calibration and calibration check procedures are described below.

4.2.1 Calibration Check

Calibration checks are performed by immersing a sensor into calibration solution, and comparing the readings to the value of the solution. The water quality probe will be pre-rinsed with a small amount of calibration solution prior to the check, and double-rinsed with distilled water in between checking each parameter. If either of the following water quality parameters have drifted past the applicable acceptance criteria, calibrate them during the next part of the procedure.

Turbidity will be checked using a one-point check, using an appropriate solution (i.e., 124 Formazin Nephelometric Units [FNU] calibration solution). The calibration check will be accepted and no further calibration necessary if the reading is within 10 percent (%) of the calibration solution value.

4.2.2 Calibration

Prior to calibration, check that the sensors and calibration cup are clean and free of debris. The water quality probe will be double-rinsed with distilled water in between calibration of each parameter. All calibration results must be recorded on the appropriate calibration field form.

- Temperature will be factory-calibrated and may be checked by comparing it to a traceable thermometer or other known reference in a water bath. Temperature cannot be calibrated in the field, nor is it expected to be required. However, for optimal performance, it is important to keep the temperature sensor free of any deposits. If deposits have formed, use mild soapy water (such as Liquinox®) and a soft bristle cleaning brush.

- DO will be calibrated using a one-point water saturated air calibration, by placing a moist sponge or a small amount of clean water in the calibration cup. Make sure the sensor is in air, not water, and that there are no water droplets on the sensor cap or temperature sensor. Put the probe in the calibration cup without tightening to enable venting to the atmosphere. Turn the instrument on and wait approximately 5 to 10 minutes for the calibration cup to become completely saturated and to allow the sensors to stabilize. Record initial and final DO as a percent and in milligrams per liter (mg/L).

- Specific conductivity will be calibrated using a one-point calibration, using an appropriate solution (i.e., 1413 microsiemens per centimeter [µS/cm]). Pre-rinse the calibration cup and sensors with a small amount of calibration solution and discard. Following the pre-rinse step, fill the calibration cup with fresh calibration solution to above the vent holes on the side of the conductivity sensor. Wait at least 40 seconds for the specific conductivity readings to stabilize, before accepting the calibration point. If the calibration is not accepted by the instrument, verify the calibration solution is fresh, the correct value has been entered into the handheld, or try cleaning the sensor.

- pH will be calibrated using a three-point calibration, using 4, 7, and 10 pH calibration solutions, starting with 7 pH, as recommended by the manufacturer. Pre-rinse the calibration cup and sensors with a small amount of the first calibration solution and discard. Following the pre-rinse step, fill the calibration cup with fresh calibration solution so the pH and temperature sensors are immersed in solution. Wait at least 40 seconds for the pH to stabilize within the range of acceptable millivolts (mV), as listed below, before accepting the calibration point. Repeat this step for each of the pH solutions. The probe will be rinsed with distilled water between each pH calibration point. If the calibration is not accepted by the instrument, verify the calibration solution is fresh, check the glass bulb or electrode body for damage, or clean and recondition the sensor.

  Acceptable pH mV Ranges:
  pH 7 mV value = 0 mV +/- 50 mV
  pH 4 mV value = +165 to +180 from pH 7 buffer mV value
  pH 10 mV value = -165 to -180 from pH 7 buffer mV value

- ORP will be calibrated using a one-point calibration, using a Zobell calibration solution or equivalent. If using the Zobell calibration solution, note that it is temperature-specific, and a chart of solution values per temperature should be consulted before proceeding with calibration. Pre-rinse the calibration cup and sensor with a small amount of calibration solution and discard. Following the pre-rinse step, fill the calibration cup with fresh calibration solution so the ORP and temperature sensors are immersed. Wait at least 40 seconds for the ORP to stabilize before accepting the calibration point. If the calibration is not accepted by the instrument, verify the calibration solution is fresh, or clean and recondition the sensor.

- If turbidity was outside the acceptance criteria in the calibration check above, it will be calibrated using a two-point calibration, using 0 (or distilled water) and 124 FNU calibration solutions. The sensor guard must be used when calibrating turbidity. Pre-rinse the calibration cup and sensors with a small amount of the first calibration solution and discard. Following the pre-rinse step, fill the calibration cup with fresh calibration solution so the turbidity sensor is immersed in solution. Pour the calibration solution slowly down the side of the cup, and tilt the calibration cup when inserting the sensor, to avoid introducing air bubbles into the sample. Wait at least 40 seconds for the turbidity to stabilize before accepting the calibration point. The probe will be rinsed with distilled water between each turbidity calibration point. If the calibration is not accepted by the instrument, verify the calibration solution is fresh, check if that the calibration cup is free of any reflective material, and make sure that the metal sensor guard bottom on the inside of the calibration cup is free of scratches.

4.3 Sampling Activities

Groundwater samples will be collected via low flow sampling for traditional single screen monitoring wells, and via positive displacement sampling for CHS well systems. It is expected that one sampler will be required per monitoring well. Each sampling procedure is described in detail below.

For both types of monitoring wells, the following basic tasks should be completed prior to commencement of sampling:

1. Establish work area at each well upon arrival – ensure safety precautions are implemented in accordance with the HASP (e.g., traffic cones, barricades, and positioning of vehicle).

2. Check the condition of the well(s) upon arrival, and make a note on the field form or in the field book of any observed damage, water in flush mounted roadbox, or potential surface contamination. If there is water in the well box, remove all water to below the top of well casing before removing the well cap to avoid allowing potentially contaminated surface water from entering the well. Note: it is not uncommon to encounter poisonous spiders or other harmful insects in well boxes; use caution when removing lids and visually inspect the well box before you proceed.

3. Measure the depth-to-water before undertaking purging or sampling, in accordance with the SOP for Fluid Level Gauging (SOP #09).

4.3.2 Low Flow Sampling

The following procedures will be used for low flow sampling:

1. Once the well cap is removed and the depth-to-water has been recorded, lower the bladder pump and tubing into the well, or connect the tubing to the air compressor, if the well already has a dedicated bladder pump and tubing installed. The pump intake should be placed in the middle of the submerged portion of the well screen.

   If there are concerns with the well going dry, pumps will be placed 2 to 3 feet from the bottom of the well to permit reasonable drawdown without disturbing the bottom of the well. For most of the monitored groundwater zones, the pump will be set within the well's screened interval. The exception is within wells with very deep screened intervals that may require drop tubes to be set within the screened interval. A table that includes water levels, intake depths, purge rates, etc. from previous sampling events is a useful reference to maintain consistency between sampling events.

2. Measure the depth-to-water again with the pump/tubing in place and use this measurement as your drawdown reference during purging. Leave the water level meter probe in the well to facilitate collecting water level measurements during purging.

3. Connect the discharge tube from the pump to the inlet of the flow cell. Secure the discharge tube from the flow cell so it discharges into a bucket or other collection vessel (i.e., with clamps).

   Start the pump (noting the time on the Sample Collection Form) and measure and record the flow rate using a graduated cylinder and stopwatch (or similar). The ideal flow rate is between 200 and 500 milliliters per minute (mL/min) and should be adjusted if excessive drawdown of the water level occurs. The United States Environmental Protection Agency (USEPA) guidelines indicate a maximum drawdown target of approximately 0.3 feet. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

4. Begin recording water quality parameters on the Groundwater Sampling Log. Each record should include time of measurement, depth-to-water, and approximate flow rate. Note any changes to the visual clarity of the water during purging, as well as any unusual properties or odors. Record water quality parameters every 3 to 5 minutes, so that at least one flow cell volume is turned over between measurements. For example, if using a 500 mL flow cell and purging at a flow rate of 100 mL/min, the monitoring frequency would be once every 5 minutes.

   If questionable measurements are noted (e.g., negative DO readings or high DO along with negative ORP), check calibration of the instruments. If questionable measurements continue, contact the Project Manager to discuss whether the sampling should be discontinued until replacement meters are available.

5. Continue purging until the water quality parameters stabilize over three consecutive readings. The stabilization criteria are as follows:

Table 1: USEPA Recommended Water Quality Parameter Stabilization Criteria

Parameter	Stabilization Criteria
pH	± 0.1 standard units
Specific Conductivity	± 3% μS/cm
Temperature	± 3% degrees Celsius
ORP	± 10 mV
DO	± 10% mg/L (when DO >0.5 mg/L); considered stable if 3 readings <0.5 mg/L
Turbidity	± 10% FNUs (when >10 FNUs); considered stable if 3 readings <10 FNUs

Notes: DO = dissolved oxygen; FNU = Formazin Nephelometric Units; mg/L = milligrams per liter; mV = millivolts; μS/cm = microsiemens per centimeter

6. Once the parameters have stabilized, collect the samples in the order described in Section 3.4. Put on fresh disposable gloves, and fill sample bottles directly from the discharge tube. Disconnect the pump discharge tube from the flow cell to ensure that water samples are collected before water passes through the cell.

   The pumping rate should be adjusted as necessary to provide a laminar (non-turbulent) flow into the sample bottles to reduce aeration of the sample, and the water should be allowed to run smoothly down the inside of the bottle. Additional considerations during sample collection are listed in Section 4.5.

If parameters have not stabilized after 2 hours, one of three optional courses may be taken:

a. Continue purging until stabilization is achieved.

b. Discontinue purging and do not collect any sample and record in field 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.

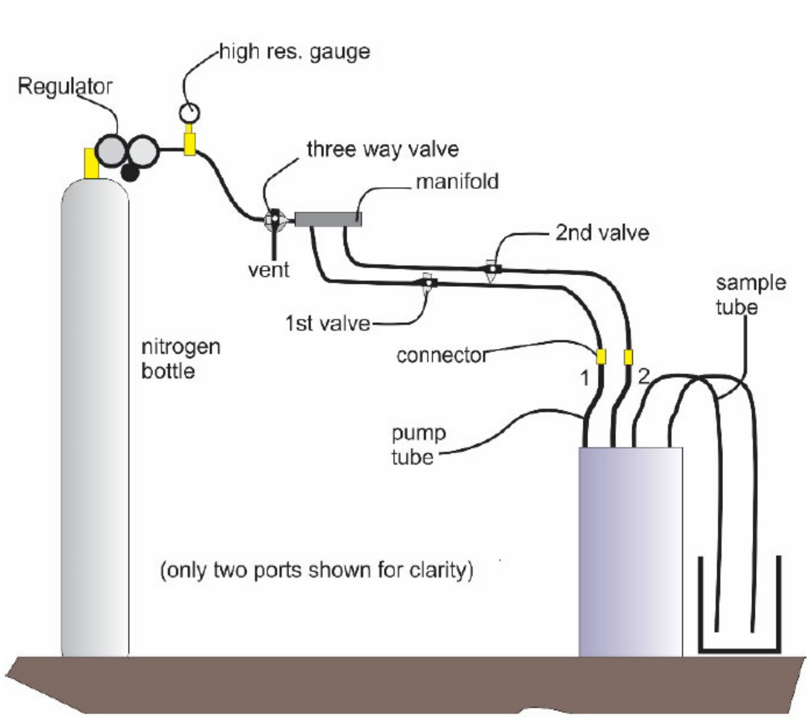
7. If the well goes dry while purging or sampling, the sample may be taken after the well has recovered a sufficient amount (generally 90% of its initial volume). If the well goes dry prior to stabilization, water quality parameters will be measured and recorded at the time of sampling but will not be considered stabilized. All attempts should be made avoid purging a well dry, and purging should be discontinued as soon as possible to prevent air from entering the formation.Once all sample bottles have been filled, switch off the pump and disconnect the tubing from the air compressor. Take a final water level measurement (and total depth if required).

4.3.3 Positive Displacement Sampling

The following procedures will be used for positive displacement sampling, in accordance with FLUTe™ guidance:

1. Set up a compressed nitrogen gas canister in the work area near the CHS well system. Attach the pressure regulator to the canister and tighten with a crescent wrench (no more than one half turn).

2. Connect the manifold system to the regulator. Tighten each connection with a crescent wrench (no more than one half turn). A simplified diagram of the CHS well system and manifold set up is shown below in ***Figure 1***.



Source: FLUTE™

Figure 1: Simplified diagram CHS well system and manifold set up

3. Close the three-way valve by turning the handle to point to the vent. This blocks the gas flow into the system.

4. Open the valve on the top of the gas canister.

5. Adjust the regulator to the “purge pressure” as seen on the high resolution gauge. Each well system will have a specified purge pressure, based on calculations provided by FLUTe™.

6. Connect the connectors to the pump tubes of the CHS system and close the separate valve for each port. Each port is labeled on the manifold and on the sample tubing. Use clamps to secure each port’s tubing to an individual bucket.

7. Turn the three-way valve handle to point to the nitrogen bottle. This pressurizes the manifold. Open the valve for each port until all are opened. Water will begin to flow out of each sample tube.

8. When gas is begins spurting from a sample tube, close the valve for that port to perpendicular to the tube, stopping the gas flow to that pump tube. Do the same for each port as the gas spurts out of the sample tube.

9. When all valves are closed, turn the three-way valve toward the vent. This drops the pressure in the manifold.

10. Open each port valve to allow the gas pressure release in that tube in order to allow refill of the pump from the port.

11. To pump a second stroke, simply open the three-way valve again toward the manifold.

12. Repeat steps 7 through 9 until the prescribed purge volume has been developed from each port (generally 3 gallons per port). If preferred, by controlling the port valves, one can pump individual or groups of ports simultaneously. Simply keep the port valve closed for a port to not be pumped with each pressure application.

13. Take note of the purge volumes in subsequent strokes of the system. The longer the wait between strokes of the system, the more completely the pump tubes refill, but complete refill is slower and not necessary. The amount of water ejected by each port is a measure of whether the refill time was sufficient.

14. Once the required volume has been purged, set the regulator to the “sample pressure”. Each well system will have a specified sampling pressure, based on calculations provided by FLUTe™. The gas will need to be vented at the three-way valve to allow the gas pressure in the regulator to be reduced. Then close the three-way valve and decrease the regulator setting to the sample pressure.

15. Turn the three-way valve toward the manifold. To transition from purging to sampling, open the valve for one port and let the “discard volume” (to be determined for each port by FLUTe™) flow from the tube into a calibrated cup until the prescribed discard volume is collected. This initial discard volume cannot be used for sample collection.

16. Collect the samples in the order described in Section 3.4. Put on fresh disposable gloves, and fill sample bottles directly from the discharge tube. The sample can be collected at any time after the required volume has been discarded. After the first sample stroke is complete, water will stop flowing out of the discharge tube, but will not spurt aerated water as seen with the purge strokes. When water stops flowing from the discharge tube, the gas pressure can be vented at the three-way valve to allow the system to refill. Turning the three-way valve with the same port valve open will continue the sample water flow. No discard after the first stroke is needed, since none of the water flowing has been exposed to the gas. Repeat this step until all the samples have been collected.

17. After collection of the necessary sample volume, vent the gas pressure at the three-way valve to allow the system to refill. Connect the discharge tube to a flow-through cell with a multi-parameter probe inserted and tightened. Turn the three-way valve to apply gas pressure and allow water to fill and pass through a flow-through cell until the water stops flowing at the pre-set gas pressure. All water quality parameters will be recorded on the applicable field form.

For low-yield sampling intervals, multiple attempts may be required to collect sufficient volume for all analyses. Once sampling has commenced, the field sampler may return multiple times to collect additional samples, to the extent practical.

4.4 Sampling Order

For both conventional low-flow sampling and positive displacement sampling, groundwater samples should be collected in the same order for consistency. In general, samples are collected in order of decreasing volatility and samples for corresponding total and dissolved compounds are collected as concurrently as possible (without removing the field filter) to maximize comparability. If QA/QC samples (blind duplicates and matrix spike/matrix spike duplicates) are to be collected from a given well, samples should be collected in conjunction with the base sample (i.e., collect all volatile organic compound (VOC) samples first, then all the semi-volatile organic compounds (SVOCs), etc.).

Samples collected for hexavalent chromium analysis will be collected after the sample for total metals and will be filtered in the field using a laboratory-provided syringe kit. Immediately following field filtering, the sampler will add the laboratory-provided preservative to the sample container and cap, prior to storing the sample in the cooler. Field preservation will be noted on the associated sampling form. Put on fresh disposable gloves after handling the syringe kit.

Samples for dissolved metals, radiological analyses (excluding tritium), and organic carbon will be filtered in the field using a clean, unused 0.45-micron in-line filter. Each in-line filter will be pre-conditioned by running approximately 25 mL of sample water through the filter prior to collecting the sample. One filter will be used per well, unless the flow rate decreases to 10 percent or less of the initial sample flow rate due to the filter becoming clogged by elevated particulates. Put on fresh disposable gloves after handling the field filter.

Groundwater samples will be collected in the following order, assuming sufficient recharge for the required sample volume:

1. VOCs;
2. Dissolved gases;
3. SVOCs;
4. Total metals;
5. Total organic carbon, ammonia, nitrate and nitrite, phosphorous;
6. Alkalinity, total dissolved solids;

Field analyses by ERM field technicians for the parameters:
- Sulfide and ferrous iron.

The first time a well is sampled, attempts will be made to collect sufficient sample volume for all analyses, to the extent feasible. If possible, all samples will be collected from a given well on the same day for comparability.

4.5 Additional Sampling Considerations

While collecting groundwater samples using the methods described above, the following considerations should be taken into account:

- Ambient conditions, such as direct sunlight, may heat up groundwater in the tubing and flow cell, which may result in degassing of VOCs and dissolved gases. When working in warmer conditions, the sampling equipment should be set up in a shaded area, or under an umbrella or tent. If possible, avoid sampling on hot days, or during the hottest time of the day. Minimize the length of tubing exiting the monitoring well to reduce the amount of groundwater exposed to ground surface conditions.

- For samples requiring no headspace (VOCs, dissolved gases, and TPH), each vial must be filled using one single stroke from the bladder pump, or one single stroke from the CHS sampling manifold, resulting in a positive meniscus (i.e., above the rim of the vial) to eliminate the formation of bubbles and headspace before capping. Once the cap is screwed on, turn the vial upside down and gently tap the side of the bottle to see if any air bubbles are present. If there are bubbles, remove the cap, top off the vial and attempt again, or discard the vial and use a fresh vial. Use appropriate care while screwing on the cap, in tapping the vial, and in general handling of the glassware. Do not over tighten sample bottle lids as the bottles may shatter and become a cut hazard.

- For QA/QC purposes, it is preferable to use sample bottles that are pre-preserved by the laboratory (with the exception of hexavalent chromium). Care should be taken during sampling to prevent overflow of water in sample bottles containing acid preservative, as the acid preservative may be washed out. If preserved sample bottles overflow, that bottle should be discarded, and replaced with a new bottle.

4.6 Post-Sampling Activities

Once sample collection is complete, the following steps will be taken:

- The collected samples should be labeled with the appropriate information, and placed immediately in an ice-filled cooler pending shipment or delivery to the laboratory, in accordance with the SOPs for Field Documentation, Chain of Custody, and Sample Packing and Shipping (SOPs #01, 02, and 03).
- Any non-disposable, non-dedicated equipment should be decontaminated between each well, in accordance with the SOP for Equipment Decontamination (SOP #13).
- The purge water from each well should be stored in an appropriate container on-Site pending characterization and disposal.
- The final recorded water quality parameters from low flow sampling and CHS sampling will be submitted in digital format to the project database (EQuIS^{TM}).

5. REFERENCES

Flexible Liner Underground Technologies (FLUTe). 2019. Use of FLUTe Manifold for Simultaneous Purging of Sampling Systems.

United States Environmental Protection Agency (USEPA). 2002. Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers. (EPA/542-S-02-001). (Yeskis and Zavala).

USEPA. 2006. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. (EPA/540/s-95/504). (Puls and Barcelona).

USPEA. 2017. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. EQASOP-GW-001. Region 1. Revision No. 4. Available online at: https://www.epa.gov/sites/production/files/2017-10/documents/eqasop-gw4.pdf. Accessed 27 July 2020.

Standard Operating Procedure #13: Equipment Decontamination

Version #1
November 2021

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure is to establish guidelines and procedures for decontamination of sampling equipment at Roto-Finish Co., Inc. in Portage, Michigan. Decontamination of reusable, non-dedicated equipment is essential to maintain chemical integrity between sampling locations.

Non-dedicated sampling equipment used to collect environmental samples will be decontaminated prior to its initial use and between each sample location. If visual signs such as discoloration indicate that decontamination was insufficient, the equipment will again be decontaminated. If this observance persists, the equipment will be removed from service until adequate decontamination can be verified.

Verification of the non-dedicated sampling equipment cleaning procedures will be documented by the collection of field blanks, as described in the Quality Assurance Project Plan.

2. EQUIPMENT AND MATERIALS

- Field forms and the Site Health and Safety Plan (HASP);
- Non-phosphate detergent (Liquinox®, or equivalent);
- Distilled water;
- Spray bottles;
- Paper towels;
- Buckets and/or 55-gallon steel drums for containerizing decontamination fluids;
- High temperature, high pressure steam cleaner (provided by the drilling subcontractor); and
- Plastic sheeting and bags.

3. HEALTH AND SAFETY

Standard operating procedures are designed to provide technical guidance and do not provide detailed or comprehensive guidance related to health and safety, nor do they represent guidance on safe work procedures for the tasks described. Appropriate tips related to health and safety issues associated with specific tasks may be included within technical descriptions for information's sake only.

Health and safety aspects of all projects and project tasks should be assessed and planned using ERM's established health and safety planning procedures.

4. PROCEDURE

4.1 General Procedures

Heavy equipment will be decontaminated in a designated area (i.e., decontamination pad), in an area known or believed to be free of surface contamination. The pad should be constructed on a level, paved surface, and should be lined with plastic sheeting to avoid leaking. Water should be removed from the decontamination pad on a regular basis.

Sampling equipment and probes will be decontaminated in an area covered by plastic sheeting near the sampling location. Fluids generated during the decontamination process will be collected into the decontamination pad or other containment vessel and placed in properly labeled Department of Transportation–approved 55-gallon steel drums. The drums will be staged in a designated and secured area for subsequent transport and disposal to a licensed facility.

Disposable sampling equipment will be properly disposed of in drums. Drilling equipment and drilling rods shall be steam-cleaned and rinse blanked prior to mobilization to the Site. Monitoring well construction materials (casing and screens) shall be delivered to the Site sealed in boxes and stored until the time of well construction.

Extraneous contamination and cross-contamination shall be controlled by wrapping the sampling equipment in polypropylene bags or high-density polyethylene (HDPE) plastic sheeting when not in use and the sampler shall change and appropriately dispose of gloves between sample locations and/or intervals.

Decontamination of sampling equipment shall be kept to a minimum in the field, and wherever possible, dedicated sampling equipment shall be used. Field staff directly involved in equipment decontamination shall wear appropriate personal protective equipment, as outlined in the HASP. Used personal protective equipment will be disposed of in accordance with the Field Sampling Plan.

4.2 Drilling Equipment

Drilling equipment shall be decontaminated by steam-cleaning prior to performance of the first intrusive activity at the Site and between all subsequent borings/well installations. This shall include all hand tools, casings, augers, drill rods and bits, and other related tools and equipment. Tremie pipes mobilized to the Site shall be of new, dedicated construction and thoroughly decontaminated between each location.

Water used during drilling operations shall be from an approved potable source. The drilling subcontractor is responsible for obtaining all permits from the local potable water provider and any other concerned authorities, and provision of any required back-flow prevention devices.

4.3 Solid Matrix Sampling Equipment

Solid matrix sampling equipment, such as hand trowels, will be decontaminated prior to and in between use at each sample locations.

The following procedures will be used for decontamination of non-dedicated soil sampling equipment:

1. Non-phosphate detergent wash (Liquinox®, or equivalent);
2. Distilled water rinse; and
3. Air dry or dry with paper towels.

4.4 Groundwater Sampling Equipment

In general, disposable or dedicated equipment will be used for groundwater monitoring, which minimizes the need for decontamination of groundwater sampling equipment. At a minimum, water level meters will be reused between groundwater sampling locations.

The following procedures will be used for decontamination of non-dedicated groundwater sampling equipment:

1. Non-phosphate detergent wash (Liquinox®, or equivalent);
2. Distilled water rinse; and
3. Air dry or dry with paper towels.

5. REFERENCES

United States Environmental Protection Agency (USEPA). 2020. Field Equipment Cleaning and Decontamination. LSASDPROC-205-R4. Region 4, Laboratory Services and Applied Science Division, June. Available online at: https://www.epa.gov/sites/production/files/2017-07/documents/groundwater_level_and_well_depth_measurement105_af.r3.pdf. Accessed 4 August 2020.

Occupational Safety and Health Administration (OSHA). 2019. Decontamination. Available online at: https://www.osha.gov/SLTC/hazardouswaste/training/decon.html. Accessed 23 October 2019.

Standard Operating Procedure #14: Management of Investigation Derived Waste (IDW)

Version #1
March 2023

ROTO-FINISH CO., INC.
3700 E. Milham Road, Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

The purpose of this standard operating procedure #14 (SOP#14) is to establish guidelines and procedures for management of Investigation-Derived Waste (IDW) at Roto-Finish Co., Inc. in Portage, Michigan (the Site).

The objective is to establish consistent methods to handle and manage all IDW to achieve acceptable standards of representativeness and completeness. As a result, this SOP outlines procedures for labeling, sample collection, tracking, management, and documentation in sufficient detail to allow all ERM and subcontractor personnel to manage waste handling consistently.

2. DEFINITIONS

Designated Waste: A solid or liquid waste which is not defined as hazardous, but which may still present a threat to groundwater, and which requires handling differently than a nonhazardous waste.

DOT: Department of Transportation. Referred to when specifying a type of container that is approved for transporting hazardous substances, either materials or waste, on public streets.

Hazardous Waste: Soil, liquid, or other wastes generated from site investigations that exhibit toxic, ignitable, corrosive, or reactive characteristics as defined by applicable state or federal regulation or which is otherwise classified as hazardous. Such waste requires special handling and documentation of disposal.

IDW: Investigation-Derived Waste. Typically solid (soil) or liquid (groundwater or decontamination fluids) wastes resulting from field activities.

Nonhazardous Waste: A waste that does not exhibit characteristics of a hazardous waste and which is not otherwise classified as hazardous. Nonhazardous waste can be designated as inert waste.

POTW: Publicly-Owned Treatment Works

PPE: Personal Protective Equipment. Worn by workers during field activities.

RCRA: Resource Conservation and Recovery Act

3. EQUIPMENT AND MATERIALS

The following is a typical list of equipment that is required to manage IDW at the Site:

- Level D PPE;
- Containers for waste (e.g., 55-gallon drums, roll-off bins);
- Secondary containment pallets and plastic sheeting;
- Drum labels (hazardous, nonhazardous, pending analysis);
- Permanent marking pens (i.e., paint pens or grease pens);
- Tools (e.g., gas-powered generator, pump, drum wrench, etc.);
- Photoionization detector (PID), gas detector;

- Forklift and/or drum dolly;
- Sampling supplies (e.g., jars, tubes, caps, Teflon tape, Chain of Custody, etc.);
- Gloves, safety glasses, steel-toed boots, and any other PPE required in the site-specific HASP; and
- Drum log, field notes, and any other documentation forms required.

4. HEALTH AND SAFETY

SOPs are designed to provide technical guidance for conducting work and do not provide detailed or comprehensive guidance related to health and safety nor do they represent guidance on safe work procedures for the tasks described. Where considered appropriate, tips related to health and safety issues associated with specific tasks may be included within technical descriptions for information's sake only.

Health and safety aspects of all projects and project tasks should be assessed and planned using ERM's established Health and Safety planning procedures.

Soil boring, auguring, and other subsurface intrusive work presents specific hazards, and proper safety precautions must be observed while performing any subsurface work. These hazards, as well as those associated with soil sample collection, should be addressed by a site-specific Health and Safety Plan (HASP). The safety guidelines within the HASP should be used to complement the judgment of an experienced professional.

Safe Work Practices for subsurface obstruction and utility clearance (collectively, Subsurface Clearance Procedure [SSC]) requirements must be used to prevent injury and avoid contact with subsurface structures prior to or during project-related ground disturbance activities. The SSC process has been developed to be broadly applicable across the jurisdictions in which ERM operates. However, it may sometimes be necessary to augment portions of this process by taking into account applicable legislative, regulatory, or client-specific requirements that may augment ERM protocol. Compliance with such requirements is not optional.

5. WASTE MANAGEMENT PROCEDURE

All waste characterization and management procedures shall comply with applicable RCRA and Part 111 (Hazardous Waste Management) of the Natural Resources and Environmental Protection Act, Act 451 of 1994, as amended, regulations.

5.1 Health and Safety

All work will be performed in accordance with the site-specific HASP and associated Job Hazard Analyses. All waste will be handled using proper PPE. The minimum PPE for the Site is steel-toed boots, safety glasses, reflective vest, and a hard hat. While performing any work in which hands will come in contact with IDW, nitrile gloves will be worn. Work gloves will be worn while opening drums to prevent pinched fingers.

Drums that potentially contain volatile organic compounds (VOCs) shall be screened with a PID prior to fully opening the drum. If the PID reading exceeds 1 part per million by volume (ppmv) in the breathing zone, step back from the drum until the PID reads below 1 ppmv. Wait 1 minute, and then take another reading in the breathing space over the drum. Do not fully open the drum until the reading is below 1 ppmv. If the PID reading does not drop below 1 ppmv in the breathing space (sustained for 1 minute), place the drum lid back in place and contact the Task Manager to assess respiratory protection. Respiratory protection will need to be worn if VOC concentrations are between 1 and 10 ppmv. Work will be stopped if the VOC concentration exceeds 10 ppmv.

Used personal protective equipment will be disposed of in accordance with the approved Field Sampling Plan (ERM. July 2022).

5.2 Documentation and Labeling

5.2.1 Drum Labeling

All IDW containers must be properly labeled as soon as the waste is placed into the container. Waste characteristics are known to be either hazardous, nonhazardous, or unknown - pending analysis. Field staff shall verify before starting field work that drum labels are available.

The following information shall be placed on all IDW labels:

- Description of waste (e.g., purge water, soil cuttings, etc.);
- Generator of waste;
- Site Address;
- Contact phone number and name;
- Date when the waste was first accumulated;
- Drum identification (see below); and
- If the IDW is hazardous waste, a United States Environmental Protection Agency (USEPA) identification number must also be obtained and included.

Waste labels should be constructed of weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container since the top is more subject to weathering. In addition, write the drum identification with the waste description on the top of the drum with a grease pen or a paint pen.

Each container of waste generated should be recorded in the field notes and drum log by the field representative responsible for labeling the waste. Record in the field notes the boring or well identification numbers associated with the generated waste, along with the drum ID.

Label all drums with the following identification system:

- Drum-Study Area-Accumulation Date –Waste Type-Number (i.e., for the first drum generated on 11 November 2022 in the Roto-Finish Study Area, the ID will be Drum-RFSA-11022022-SO-01).

Use the following abbreviations:

Waste Type:

- SO = Soil;
- W = Water;

- C = Concrete or grout;
- DM = Drilling mud;
- PPE = Personal protective equipment; and
- N = Nonaqueous-Phase Liquid.

5.2.2 Field Notes

All IDW will be recorded in field notes on the day generated. Notes will contain the drum or roll-off bin number, and source of the IDW (e.g., boring number for soil, or well purged for water), and any observed odor or other evidence of impact.

Document in the field notes when a sample is collected, and which drums are represented by that sample.

5.2.3 Drum Log

Record all drums retained on site in the drum log kept in the field office. Record the following information for each drum:

- Drum ID (Section 5.2.1);
- Drum Location (where the drum is stored);
- Accumulation Start Date;
- Drum Contents; and
- Chain of Custody Number for associated drum sample.

If a drum has not yet been sampled, add in Chain of Custody Number once a representative sample has been collected from the drum.

5.3 Types of Site Investigation-Derived Waste

Different types of waste can be generated during site investigations that may require special handling. These include solid, liquid, and used PPE.

5.3.1 Solid Waste

Soil cuttings and drilling mud generated during investigation activities should be kept on site in containers (drums, roll-off bins, etc.). Covers should be included on the containers, must be secured at all times, and only opened during filling and sampling activities. The containers should be labeled in accordance with this SOP, logged in the field notes and drum log where appropriate, and communicated to the Task Manager.

5.3.2 Liquid Waste

Groundwater generated during monitoring well installation, development, purging, sampling, and decontamination can be collected in truck-mounted containers and/or other transportable containers (drums). Alternatively liquid wastes may also be sent to the POTW if permitted. Drums must be secured at all times and only opened during filling or pumping activities. The containers should be labeled in accordance with this SOP, logged in the field notes and drum log where appropriate, and communicated to the Task Manager. All hazardous waste drums with liquid waste must be kept in secondary containment.

5.3.3 Personal Protective Equipment

PPE that is generated throughout investigation activities shall be placed in garbage bags and stored in secure containers. The containers shall be properly sealed and labeled according to this SOP. If the solid or liquid waste is characterized as hazardous waste, then the corresponding PPE should also be disposed of as hazardous waste. If not, all PPE should be disposed of as nonhazardous waste at an appropriate facility.

5.4 Waste Sampling and Analysis

5.4.1 Sample Labeling

Each sample will be labeled prior to collection. The sample label will be filled out with waterproof ink. Each sample label contains the following information:

- Project number;
- Company name;
- Site/Project name;
- Sample identification;
- Sampler's name;
- Date and time the sample was collected; and
- Parameters for analysis.

5.4.2 Sample Collecting

All samples will be collected in sample containers appropriate for the type of analysis to be performed. Sample containers may include glass jars or stainless-steel sleeves with caps and Teflon tape, as appropriate.

For sampling drums, a minimum of one sample will be collected per three drums of soil created, as long as the drums contain similar material. If all three drums contain different material, one sample will be collected from each drum. The sample name will be the same as the drum identification the sample was collected from. On the date of sampling, document in the field notes which drums are represented by which sample.

For sampling roll-off bins, one four-point composite sample will be collected per bin. If the sample is collected from a roll-off bin, use the following sample identification:

- Bin-Study Area-Sample Date–Waste Type-Number.

5.4.3 Sample Packing and Transportation

Samples will be packaged and stored in a manner that will prevent damage to each sample container. After collection, samples will be immediately stored on ice in a sample cooler.

The samples will be hand delivered to the Eurofins laboratory courier or shipped overnight to the laboratory on the date of sample collection, or as soon afterwards as possible.

5.4.4 Sample Analysis

Depending on the location of investigation, samples should be analyzed for some or all of the following constituents:

- Metals (USEPA Method 6010 and 6020, total and TCLP);
- Mercury (USEPA Method 7471, total and TCLP);
- VOCs (USEPA Method 8260B, total and TCLP);
- SVOCs (USEPA Method 8270, total and TCLP);
- Flashpoint/Ignitability (ASTM Method D-93);
- pH/Corrosivity (USEPA Method 9045);
- Reactivity (USEPA Section 7.3);
- Organochlorine Pesticides (USEPA Method 8081B, total and TCLP); and
- Herbicides (USEPA Method 8151, total and TCLP).

Other constituents may be analyzed as required (e.g., POTW discharge permit requirements). Constituents for analysis should be verified with the Task Manager prior to beginning fieldwork.

5.4.5 Sample Tracking

A Chain of Custody form will be completed in the field as each sample is collected and placed in the sample cooler, and will accompany each shipment of samples to the Eurofins analytical laboratory. The purpose of the Chain of Custody form is to document possession of a sample from the time of collection in the field to its final disposal by the laboratory.

The laboratory will enter the following information:

- Name of person(s) receiving the sample;
- Date and time of sample receipt;
- Sample condition; and
- Temperature upon receipt.

All corrections to the Chain of Custody will be initialed and dated by the person making the corrections.

Each Chain of Custody form will include signatures of the appropriate individuals indicated on the form, along with the date of the signature. The originals will follow the samples to the laboratory and copies documenting each custody change will be received and kept on file by ERM.

5.5 Waste Transport

Nonhazardous or unclassified waste may be transported onsite using appropriate tools such as a drum dolly, forklift, or truck. The containers must be properly closed during transport and must be secured so they do not move in an uncontrolled manner.

Hazardous waste may be moved on site using the same precautions as above. However, it may not be transported using a vehicle in the public right-of-way. A state-certified hazardous waste hauler must transport all wastes classified as hazardous.

5.6 Waste Disposal

Solid and PPE waste will be characterized for disposal through the use of site knowledge, laboratory analytical data from investigation samples gathered during field activities, and/or composite samples from individual containers. Groundwater will be pumped into suitable containers.

All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations.

All wastes classified as hazardous will be disposed of at a licensed treatment storage and disposal facility (TSDF). The licensed TSDF will be selected by the Responsible Party. The laboratory analytical package shall be submitted to the TSDF for the development of a profile and hazardous waste manifest. Verify that the hazardous waste manifest corresponds to the profiled waste. All hazardous waste manifests shall be signed by the Responsible Party or its designated representative. References

6. REFERENCES

Code of Federal Regulations. Title 40, Section 262.32, Standards Applicable to Generators of Hazardous Wastes.

Occupational Safety and Health Administration (OSHA). 2019. Decontamination. Available online at: https://www.osha.gov/SLTC/hazardouswaste/training/decon.html. Accessed 23 October 2019.

APPENDIX B WATERLOO SOP

STANDARD OPERATING PROCEDURE

CTS-6.43.8

Operation of the Waterloo Advanced Profiling System

SOP Number: CTS-6.43.8 Date Issued: 4/19/18
Revision Number: 8 Date of Revision: 1/13/20

1.0 OBJECTIVE

Groundwater profiling is conducted to assess the distribution of contaminants and hydrogeologic conditions of a given aquifer at a scale much smaller (several centimeters) than the conventional monitoring well system. This method uses the Waterloo Advanced Profiling System (Waterloo^{APS,} or APS) to collect groundwater samples at multiple discrete depths as the profiler is advanced vertically through unconsolidated, saturated porous media at a given location. The Waterloo^{APS} is a direct push tool used to collect samples and other data at multiple depths within a single hole without withdrawing and decontaminating the tool between samples. The profiling system can generate the following data in addition to the collection of groundwater samples for analysis:

1) Index of Hydraulic Conductivity (I_k)
2) Depth to potentiometric surface (water table)
3) Specific conductance
4) pH
5) Dissolved oxygen
6) Oxidation/reduction potential
7) Temperature

The Index of Hydraulic Conductivity (I_k) provides a real-time indication of the relative changes in hydraulic conductivity which allows for assessment of the hydro-stratigraphy across the site and depths to collect groundwater samples.

There are two types of profiler configurations: 1) a peristaltic pump configuration with a single downhole stainless steel tube and 2) a gas drive pump configuration with three downhole stainless steel tubes.

The peristaltic pump can be used when the depth to water is less than the suction limit (typically around 25 feet below ground surface). The gas drive pump system must be used when the depth to water is greater than 25 feet below ground surface (ft bgs)..

1.1 POLICIES

- An experienced, qualified Cascade Technical Services (CTS) staff member will train all CTS staff using this SOP.
- CTS staff will read the most current version of this SOP and other appropriate SOPs prior to starting fieldwork.

2.0 TABLE OF CONTENTS

3.0 DEFINITIONS

KPRO – Hydraulic Conductivity Profiling

APS – Waterloo^{APS}

I_k – Index of Hydraulic Conductivity

4.0 SAFETY CONSIDERATIONS

The corporate Health and Safety Plan and the Site Health and Safety Plan specify the procedures to be followed and equipment to be used during site activities. The following is a brief and general overview of safety issues.

- Potential Safety Issues include:
  - Noise Levels
  - Heavy equipment (drill rigs or direct push rigs) hazards
  - Overhead utility hazards
  - Underground utility hazards
  - Traffic/ motor vehicle hazards
  - Hazards associated with exposure to various chemicals
  - Slip, trip and fall hazards
  - Pinch point hazards
  - Compressed gas hazards
  - Fire hazards from hot work (e.g., grinding) or open flames (torpedo heaters, brush burners, propane torch)
  - Gasoline and diesel hazards (filling trucks and generator)
- CTS staff and others under contract with CTS that may be present on-site will wear a hardhat whenever overhead hazards are present or when working near the drill rig.
- Appropriate eye protection should be worn
- Hearing protection shall be worn whenever the drill rig is actively advancing profiling equipment.
- Steel toed boots will be worn.
- Nitrile gloves shall be worn when handling contaminated water or soil.
- CTS staff will read the site specific health and safety plan (HASP) prior to beginning a project.

- Additional personal protective equipment shall be worn in accordance to the site specific health and safety plan.

5.0 PROCEDURE

5.1 Equipment

The Waterloo^{APS} Equipment Checklist is included as Attachment 1. This list includes the equipment used for the peristaltic pump configuration and the gas drive pump configuration.

5.1.1 Drive Platform and Related Equipment

A Geoprobe is the preferred method for advancing the APS tooling, although any device that vibrates, hammers, or pushes drill tools can be used to advance the APS tooling. The type of drive platform selected is a function of the type of material to be sampled and the depth to which the APS tooling needs to be advanced. Typical drive platforms include a Geoprobe 66 or 78 series probe rigs or similar. A Geoprobe 80 or 32 series (non-sonic) or equivalent is recommended to drive the 2.25" tip and rods. Field staff must ensure that the proper adaptors and subassemblies are provided for the particular drive platform to be used prior to taking to the field.

5.1.2 APS Sampling Tip

This system is comprised of a 1.75 or 2.25-inch diameter tip that is attached to 5' long 1.75 or 2.25-inch Geoprobe or quick thread style drill rod. The 1.75-inch rod is the standard rod size that CTS uses for the APS.

1.75", 2.25" APS Profiling Tips and 1.75", 2.25" APS/EC Tips

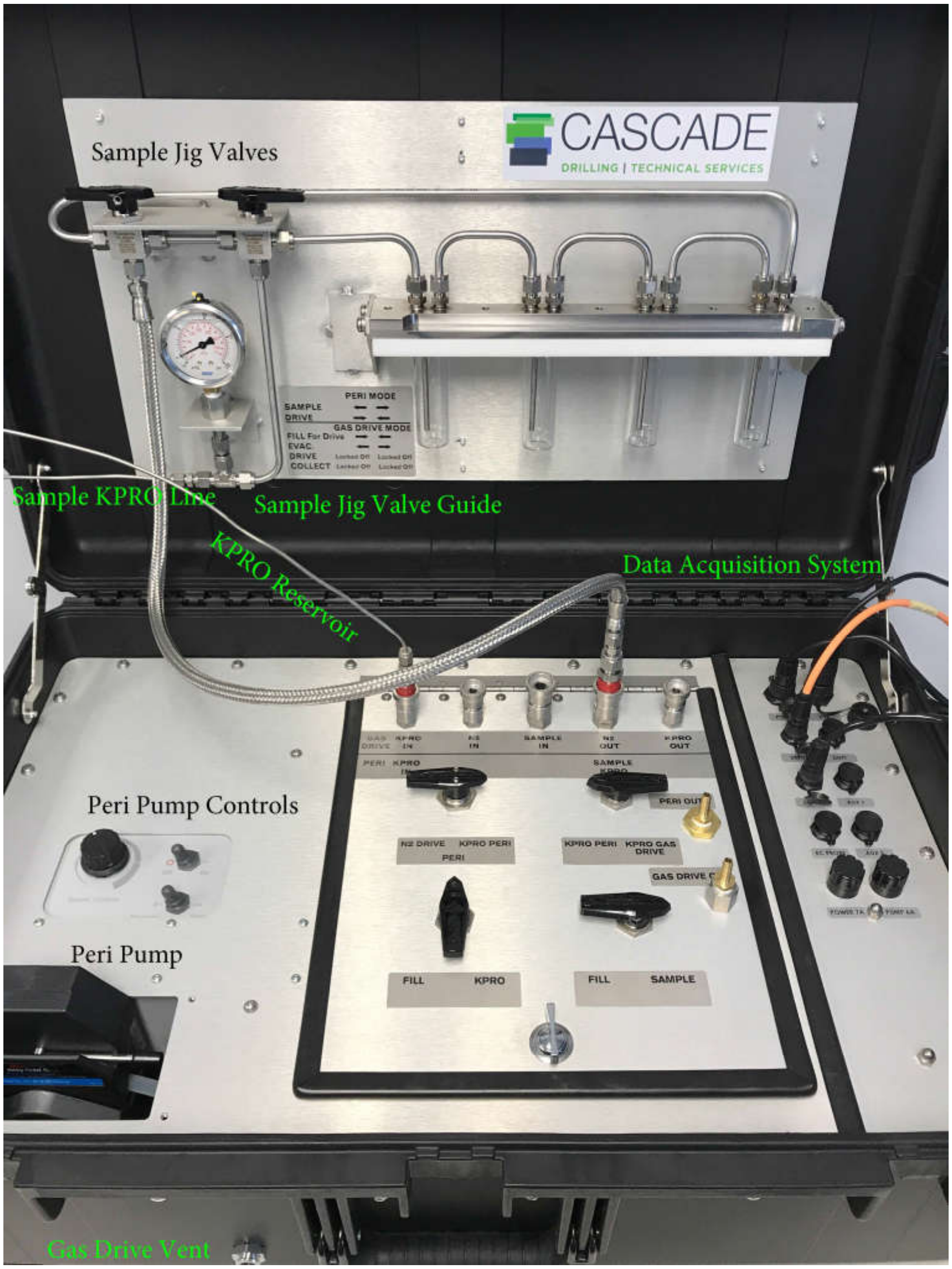
The 1.75-inch sampling tips contains 4 removable plates that allow groundwater to pass into the tip and for water to flow out the tip during tooling advancement and I_k collection. The 2.25-inch tip contains 6 plates. The 1.75" EC tip contains 2 plates and the 2.25" EC tip contains 5 plates. Groundwater samples are collected using either a peristaltic pump or a gas-drive system (see below for a schematic of these two configurations).

5.1.3 Volatile Organic Analysis (VOA) Vial Filling System

The Vial Filling System (or sample jig) contains four vials connected in-series using stainless steel tubing and specially designed vial holders. The system is designed to mitigate loss of volatile organic compounds (VOCs) by ensuring that no exposure to the atmosphere occurs while the sample is collected. The vial filling system has been incorporated into the APS box. Although the APS box utilizes a peristaltic pump, the sample vials are located on the *down hole side of the pump* so that groundwater is pumped through the vials before going through the head of the pump.

5.1.4 Waterloo^{APS} Data Acquisition System

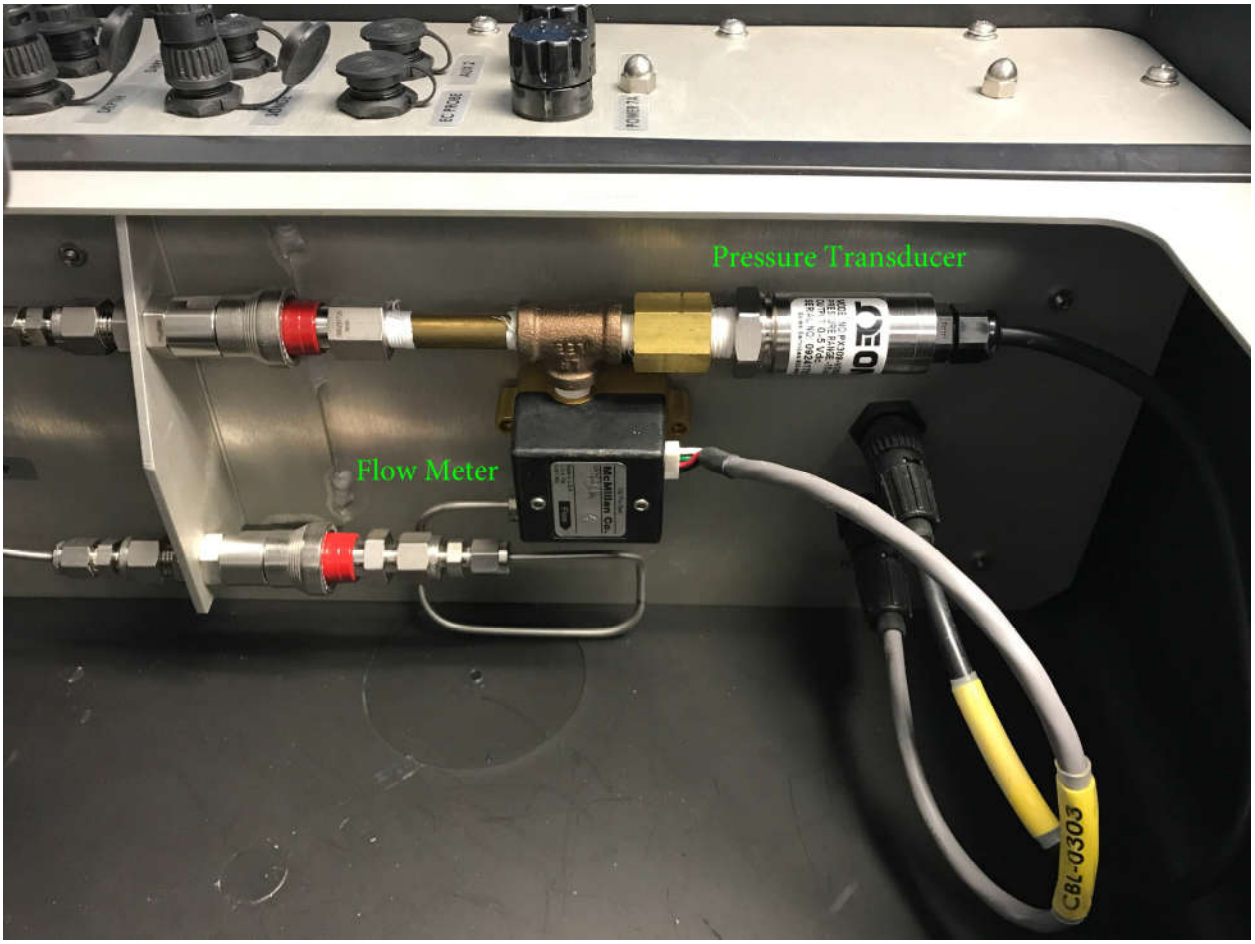
The APS box consists of several valves, an electronic data acquisition system, flow meter, pressure transducer, peristaltic pump and vial filling system (referred to as the sample jig). The valves can be oriented in a variety of ways in order to send water down and out of the APS tip or to collect a groundwater sample in both peristaltic and gas drive modes. The data acquisition system has 6 inputs for the string pot, down hole pressure transducer (DHPT), water quality sonde and three auxiliary inputs (for Ion Selective Electrode or Electrical Conductivity probe). The following photo illustrates the box setup in peristaltic mode:



APS Box in Peristaltic Mode

The APS Data Acquisition System consists of the following components:

- Cable ports for Power, USB, String pot, and Sonde
- Cables for USB/data, string pot, DHPT and power supply
- Hydrolab Quanta Water Quality Sonde with 4 sensors (Dissolved Oxygen, Specific Conductance, pH and ORP).
- McMillan Model 102-4 (20-200mL/min) Flow Sensor
- Omega Model PX309-V050G5V (0-50 psi) Pressure Transducer
- Unimeasure Model HXE-PA-100-S10-N1S-1BC String Potentiometer
- GeoTech Model Geopump Peristaltic Pump
- Labview APS Software Program
- Data acquisition computer (Panasonic Toughbook or other)
- USB mass storage unit for data backup (thumb drive)
- Use, Maintenance and Calibration Log



Flow Meter and Pressure Transducer

The following photo illustrates how the entire system looks when it is set up in the truck:

5.1.5 Sonde Water Quality Monitoring Systems

The APS system has been designed to exclusively use the Hydrolab Quanta multiparameter sonde. Specific instruction regarding the use, calibration and maintenance of Hydrolab Quanta can be found in CTS SOP 5.32.0. When coupled with the APS, calibrations and verifications are performed weekly rather than daily. If required a verification check may be performed at the start and / or finish of a field day or as needed, however, since these systems are in situ and used to verify three readings prior to sampling, full calibrations are not performed on a daily basis. All maintenance and calibrations are recorded in the dedicated Use, Maintenance and Calibration Log for each sonde.

Calibration solutions are assigned a lot number by the manufacturer and Certificates of Analyses are provided for each lot number. The lot number must be recorded in the Use, Maintenance, and Calibration log for each sonde for each calibration. The procedure for archiving the Certificates of Analysis are included in Section 6.

The Hydrolab Quanta Water Quality Monitoring System consists of the following components:

- Use, Maintenance and Calibration Log
- pH/ORP and Standard Reference Probe
- Specific Conductance Probe
- Temperature Probe
- Dissolved Oxygen Probe
- Circulator
- Depth Probe
- Custom Made Flow-Through Cell.

5.1.6 Record Keeping Materials

- Use, Maintenance and Calibration Log (dedicated to APS box).
- Groundwater Profiling Log (paper field log).
- Pens
- USB mass storage unit

5.2 General Procedure

The procedure for operating the APS in both peristaltic pump mode and the gas drive mode consists of 6 main steps:

1. Set up of the APS box and associated equipment
2. Tip / Pump assembly
3. Adding rod and tubing
4. Advancing the tool and acquiring I_k data
5. Purging water from the system and obtaining physico-chemical data from the sonde.
6. Collecting samples and recording data.

5.3 APS Box Set Up

5.3.1 Set up common to both Peristaltic and Gas Drive Modes

1. Open the APS box and plug in the power cable.
2. Plug the USB cable into the APS box and the computer.

3. Plug one end of the string potentiometer (string pot) cable into the “Depth” receptor on the APS box and attach the other end to the string pot.
4. Unpack the water quality sonde from its case. Detach the calibration cup and attach the flow through cell. Plug the communication cable and into the “Sonde” receptor on the APS box. Connect a length of poly tubing to the APS box effluent (either Peri Out or Gas Drive Out) and the other to the bottom connection on the flow through cell. Connect a second length of tubing to the upper fitting on the flow cell. The other end of this tubing will go into a graduated cylinder.
5. Connect a male swage quick connect to a five foot length of stainless steel tubing and plug it into the female quick connect labeled “KPRO IN” on the APS box. Connect the other end to the “out” port on the stainless steel reservoir using a quick connect fitting (black band).
6. Fill the stainless steel reservoir with analyte free water (distilled or spring water). Seal the top and close the pressure release valve.
7. All analyte free water used to fill the reservoir and for equipment blanks needs to be assigned a lot number. Each time a supply of water is purchased a new lot number is to be assigned to all containers purchased at that time. The lot number, date of purchase, manufacturer and place of purchase need to be recorded on the field form, and the lot number is to be written on all containers from that lot. When filling the reservoir the date and lot number of the water should be recorded on the field form.

5.3.2 Set up specific to Peristaltic Mode

1. Attach a low-pressure regulator (0-60 psi) to the nitrogen cylinder.
2. Attach a five-foot length of tubing to the “In” (white) port on the stainless steel reservoir using a quick connect fitting. Attach the other end to the outlet port on the nitrogen tank regulator. Open the valve on the nitrogen cylinder and set the regulator to 30 psi.
3. Attach a 20-foot length of stainless steel tubing to the inlet side of the SwageLok® fitting at the bottom of the pressure/vacuum gauge on the top panel. Tighten firmly. This line is the KPRO / sample line and is referred to as the harness.
4. On the APS box plug the male quick connect that is attached to the sample jig to the “KPRO Out” female quick connect on the APS box (Second from the right).

5.3.3 Set up specific to Gas Drive Mode

1. The gas drive system utilizes two regulators attached to the cylinder by a "T" adaptor. One of the regulators is low pressure (0-60 psi) and the other is high pressure (0-200 psi).
2. Attach a five-foot length of tubing to the "In" (white) port on the stainless steel reservoir using a quick connect fitting. Attach the other end to the outlet port on the low-pressure nitrogen tank regulator. Open the valve on the nitrogen cylinder and set the regulator to 30 psi.
3. Connect a five-foot length of tubing to the high pressure regulator. Attach a male swage quick connect to the other end and insert into the "N2 In" female quick connect on the APS box. Set the regulator to 60 psi.
4. On the APS box, plug the male quick connect that is attached to the sample jig to the "Sample In" female quick connect on the APS box (middle connection).
5. The harness for gas drive mode consists of three stainless steel tubes which are labeled with colored zip ties. Plug the KPRO line male quick connect (blue) into the "KPRO Out" quick connect on the APS box and plug the Nitrogen line (red) quick connect into the "N2 Out" quick connect. The Sample line (yellow) does not have a quick connect. This line connects to the 1/8" Swage fitting on the pressure gauge of the sample jig.
6. Attach a one end of a length of poly tubing (FEP or other) to the "Peri Out" port located at the bottom right of the APS box and put the other end into a plastic 1L graduated cylinder. Attach a similar length of tubing to the "Gas Drive Out" port and connect this to the bottom port on the flow cell of the water quality sonde.
7. Inside each APS box is a vent tube, which is a length of poly tubing attached to a quick connect that is used to vent excess nitrogen during the sampling process. Connect this tube to the port located on the outside front of the APS box.

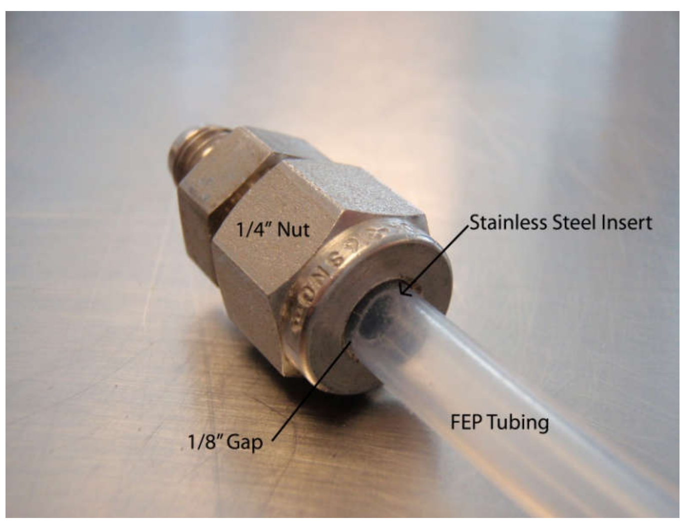
5.4 Tip and Pump Assembly for Peristaltic and Gas Drive Modes

The 1.75-inch APS tip has 4 plates and the 2.25-inch tip has 6. Behind the plate is a removable mesh screen. The size of the inner screen can be changed to prevent fine-grained sediment from entering the tip or to maximize flow. Screen mesh sizes range from 40 (coarse) to 120 (fine). 80 size screens are usually the default screen size and can be changed depending on site geology.

5.4.1 Peristaltic Mode

A ¼-inch outside diameter fluorinated ethylene propylene, or FEP, tube is fitted into the threaded hole in the center of the profiler tip by means of a ¼- inch NPT thread to ¼- inch SwageLok® fitting. The following procedure will outline the procedure for assembling the tip and adding rod and drive hardware.

1. Wrap the NPT threads of the ¼- inch NPT to ¼- inch SwageLok® fitting with Teflon tape and thread into the tip. With the tip locked into a vise, tighten the fitting as tight as you can with a 9/16" wrench by hand. Most APS tips already have this fitting installed and if so, there is no need to remove it unless the outer threads are damaged.
2. Each tip has plates that are attached to the tip via T-25 torx plus screws. Under each plate is a mesh screen (40-120 slot). The smaller the slot size the larger the opening is in the screen. The most common screen size used is 80 slot. First place the mesh screen into the space for the plate making sure to line up the screw holes. Put on the plate and tighten the screws as tight as possible using only a T handle screwdriver or similar tool. Do not use an impact driver as it will over tighten the screws. If you are using a tip that already has the plates installed, double check that the screws are tight.
3. Cut a 6-8" length of FEP tubing and insert a steel barb into each end.
4. For this step it is best to lock the tip into a vise. On the end of the FEP that will attach to the tip, slide a ¼- inch SwageLok® nut onto the FEP and then slide on a ¼" nylon ferrule. Insert the end of the FEP tubing into the ¼" fitting on the tip making sure that it is inserted as far as it can go. Using a $^{9}/_{16}$" wrench, tighten the ¼" nut until there is approximately $^{1}/_{8}$" vertical gap between the top of the steel insert and the nut as shown in the following photo:



5. For the other end of the FEP, slide on another ¼" SwageLok® nut and ¼" nylon ferrule. Insert the end of the FEP into a ¼ "to $^{1}/_{8}$" SwageLok®

reducer. Using a ½” and $^{9}/_{16}$” wrench, tighten the nut as before. Be careful to keep the FEP seated tightly into the fitting while tightening. A completed tip can be seen in the following photo:

6. Gently pull on the reducer after the fittings have been attached to make sure that it is attached properly. If the fittings are over tight then the FEP can snap; if they are too loose than the FEP can pull out of the fitting.
7. A five-foot length of 1.75-inch diameter rod is slipped over the stainless steel tubing with the pin end up and is threaded into the APS tip. If the thread style on the tip (Geoprobe) is the same as that on the rods the tip can be directly screwed into the rod. There may be times when quick thread rod (ECT style) rods are used. In this case an adaptor needs to be used. This union should also be “stepped on” using pipe wrenches to ensure that it does not vibrate loose.
8. The slotted drive cap is then placed over the threads and fitted into the bottom of the hammer on the drive platform. There are two types of slotted caps, one for ECT style rods and one for Geoprobe style rods.

5.4.2 Gas Drive Mode

1. Wrap the NPT threads of the ¼- inch NPT thread to ¼- inch SwageLok® fitting with Teflon tape and thread into the tip. With the tip locked into a vise, tighten the fitting as tight as you can with a $^{9}/_{16}$” wrench by hand. Most APS tips already have this fitting installed and if so, there is no need to remove it.
2. Each tip has plates that are attached to the tip via T-25 torx plus screws. Under each plate is a mesh screen (40-120 slot). The smaller the slot size the larger the opening is in the screen. The most common screen size used is 80 slot. First place the mesh screen into the space for the plate making sure to line up the screw holes. Put on the plate and tighten the screws as tight as possible using only a T-handle screwdriver or similar tool. Do not use an impact driver as it will over tighten the screws.

If you are using a tip that already has the plates installed, double check that the screws are tight.

3. Instead of FEP tubing, the gas drive system utilizes a ¼" stainless steel tube ("piston"). This piston needs to be 5.5"-6" in length. To attach the piston, slip a ¼" swage nut and ¼" steel ferrule onto one end of the piston. Insert this end into the ¼" fitting on the tip. It is best to have the tip locked in a vise for this step. Use a $^{9}/_{16}$" wrench and tighten the nut as tight as you can.

4. The gas drive pump body has three parts, the bottom (which has the KPRO line), the middle and top (which has the sample and nitrogen lines). Look into the narrow part of the pump bottom from the bottom. The piston on the tip will eventually be inserted into this end of the pump. There should be two very small rubber o-rings (size 010) seated into two slots. If they are present, it is a good idea to replace them. If the o-rings get worn or dry out you will not get a proper seal between the piston and pump.

5. Remove the O-rings with an angled pick and discard. Rinse out the slots with water. Replace the O-rings using the same pick.

6. Place an O-ring (size 115) at the base of the threads of the top and bottom pump pieces and wrap the threads with Teflon® tape. One or two wraps is sufficient.

7. Trim a reed valve and place it onto the stub on the top of the pump bottom. In order for the reed valve to fit inside the middle pump piece, the flange of the valve must be trimmed.

8. Thread the middle pump body onto the top and bottom pump pieces. Lock the middle of the pump into a vise and tighten the top and bottom pump pieces with a $^{9}/_{16}$" open ended wrench until tight. The O-rings should squeeze out of the joint slightly.

9. Slide the plastic bushing and spring over the three stainless steel tubes so it rests snug on the top of the pump. Make sure that the KPRO line is located into the slot on the bushing.

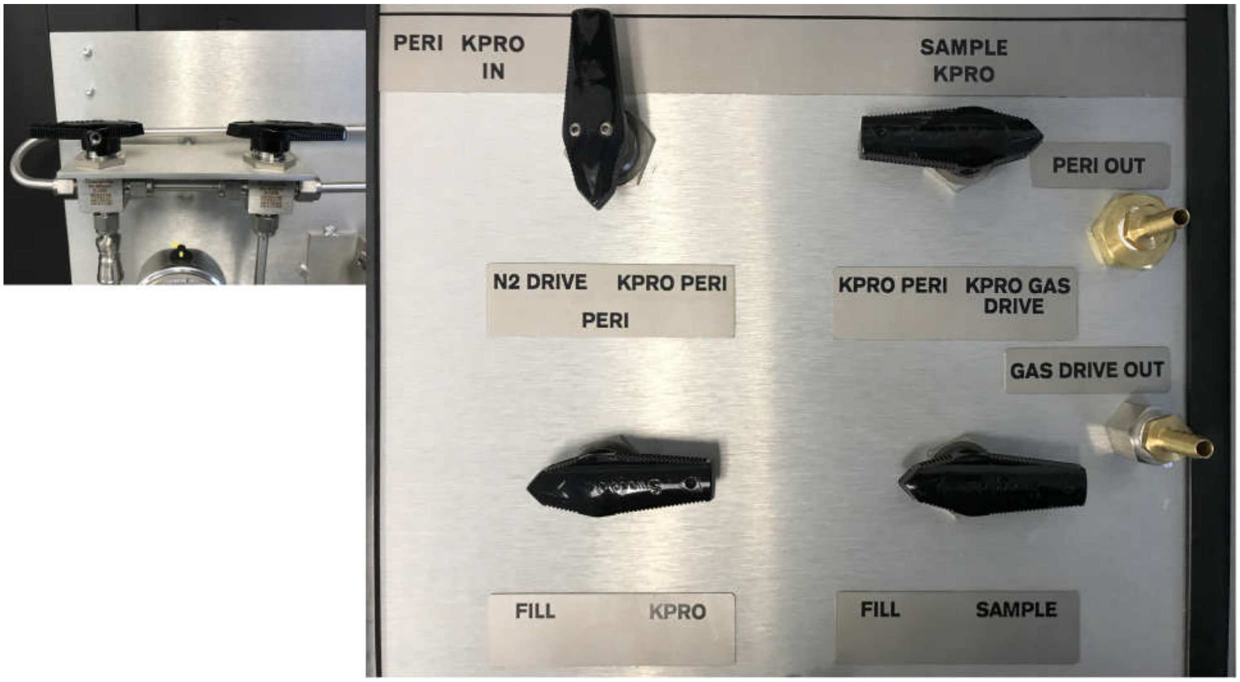
10. The pump housing is comprised of three pieces: the middle 2.4-foot section of rod (with female ECT style threads on both ends), the bottom sub which has female Geoprobe threads to connect to the tip and male ECT style threads to go into the housing, and the top sub which has male ECT style threads to go into the housing and either male ECT or Geoprobe threads to connect to the rod. Insert the bottom spring into one end of the middle pump housing. Apply Teflon tape to the male

threads on all of the pump housing pieces as well as the APS tip and first drill rod. This will prevent silt from migrating into the pump housing. Screw in the bottom housing piece so that the extended end is inside the pump. Make sure that the spring is at this end of the pump. Insert the pump into the housing. Screw on the top housing piece.

11. Take the APS tip and slide the ¼-inch stainless steel tube up into the receptacle in the pump bottom. Screw the tip onto the pump housing.
12. With the pump in a vertical position and the tip on the ground, grasp the three stainless steel lines and push them down. You should feel the springs move up and down smoothly. If they don't, the pump must be taken out of the housing and checked. It is very important that the springs are free to move. If they cannot, the vibration of the hammer will damage the pump.
13. **Pressure testing the Gas Drive Pump:** The pump must be pressure tested before it is used to make sure that the O-rings and the reed valve have been installed properly. It is usually a good idea to pressure test the pump after collecting the equipment blank or decontaminating the APS box since the pump is attached and full of water. The following steps will lead you through this:

    a. Connect the pump to the tubing harness (all three tubes). You will notice that the three lines coming out of the pump are at three different lengths. The difference in length is the only way to be able to differentiate between them. The KPRO line is the longest, the nitrogen line is the shortest and the sample line is in the middle.

    b. Arrange the valves according to the following photo and turn on the peristaltic pump to start filling the pump:



c. When a steady stream of water is flowing out of the Peri Out tubing on the APS box then the pump is full. Turn the two valves on the sample jig so that they are closed (facing the back of the box). Turn the bottom left valve 90 degrees to shut off the flow. Turn the top left valve to N2 Drive. Turn off the peristaltic pump. The pressure on the gauge will rise to where it is set on the regulator. Make sure the pressure is set to around 60-100 psi or the expected working pressure.

d. Disconnect the N2 Out quick connect on the APS box and watch the pressure gauge. If the needle on the gauge is steady, then the pump is holding pressure. **Note**: The pressure may drop slightly initially, but if it holds afterwards, it is working properly. If the pressure continues to drop then there is a leak. Check that all the fittings on the harness/pump are tight and refill and pressurize the pump. If that does not work, there is a leak in the pump itself (either an O-ring or reed valve) or possibly there is a leaky valve in the APS box.

e. **Testing the Bottom O-rings.** If there is not a tight seal between the small O-rings at the bottom of the pump and the piston, KPRO water will not be able to flow into the tip, which will result in inaccurate I_K data, sampling of the water inside of the drilling rods and a clogged tip.

To determine if there is a leak: check for air bubbles flowing through the vials while collecting the equipment blank. Double check that all of the fittings on the harness, APS box and pump are tight. Double check that the VOA vials are tight in the sample jig. If there are still bubbles then the small O-rings in the bottom of the pump need to be checked. Refer to section 4.9.3 on equipment blank procedures.

14. Add a 20-foot length of stainless steel tubing to each tube fitting leading from the pump.
15. Slide a 5' drill rod over the stainless steel tubing and screw it into the pump.
16. Tighten all joints by firmly by standing on the pipe wrench. To do this put one pipe wrench so that it is resting on the ground. Place the middle of the pump into the wrench. Put the other wrench on the tip and stand on it, making sure that the other end of the rod is weighted down (have a helper stand on it). This will tighten the tip and the bottom pump housing piece. Repeat for the top of the pump and rod.
17. The slotted drive cap is then placed over the threads with the three pieces of stainless steel tubing protruding through the center of the drive cap and fitted into the bottom of the hammer on the drive platform. There are two types of slotted caps, one for ECT style rods and one for Geoprobe style rods.

5.5 APS Software Calibration and Startup

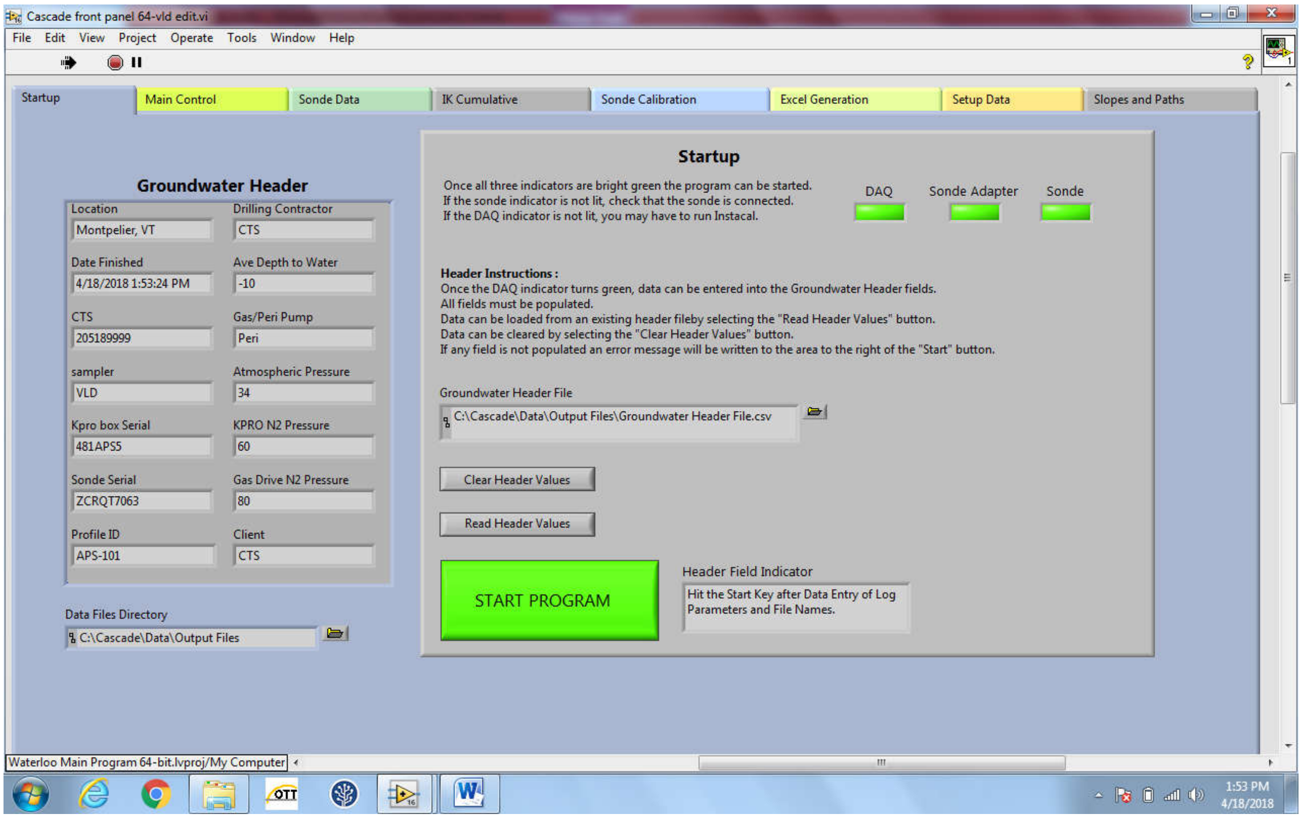
5.5.1 Calibration

The APS box should be calibrated at the beginning of a new project and once weekly (or every 5 days if there is a longer shift). If an individual sensor or entire APS box is replaced, then there should be a recalibration. The calibration is saved on the field computer, so if the APS box was calibrated with a different computer then it needs to be recalibrated.

1. At this point the computer should be plugged in and booted up. If not, do so now.
2. Locate and start the Instacal program. After the program starts, select "OK" twice. Instacal will discover the data acquisition hardware in the APS box.

Instacal must be run when an APS box and computer have not been used with each together.

3. Find the APS program executable shortcut located on the desktop. If there is no shortcut, the executable can be found in the C:\Program Files\Waterloo folder. A screenshot of the startup screen of the software is included below:



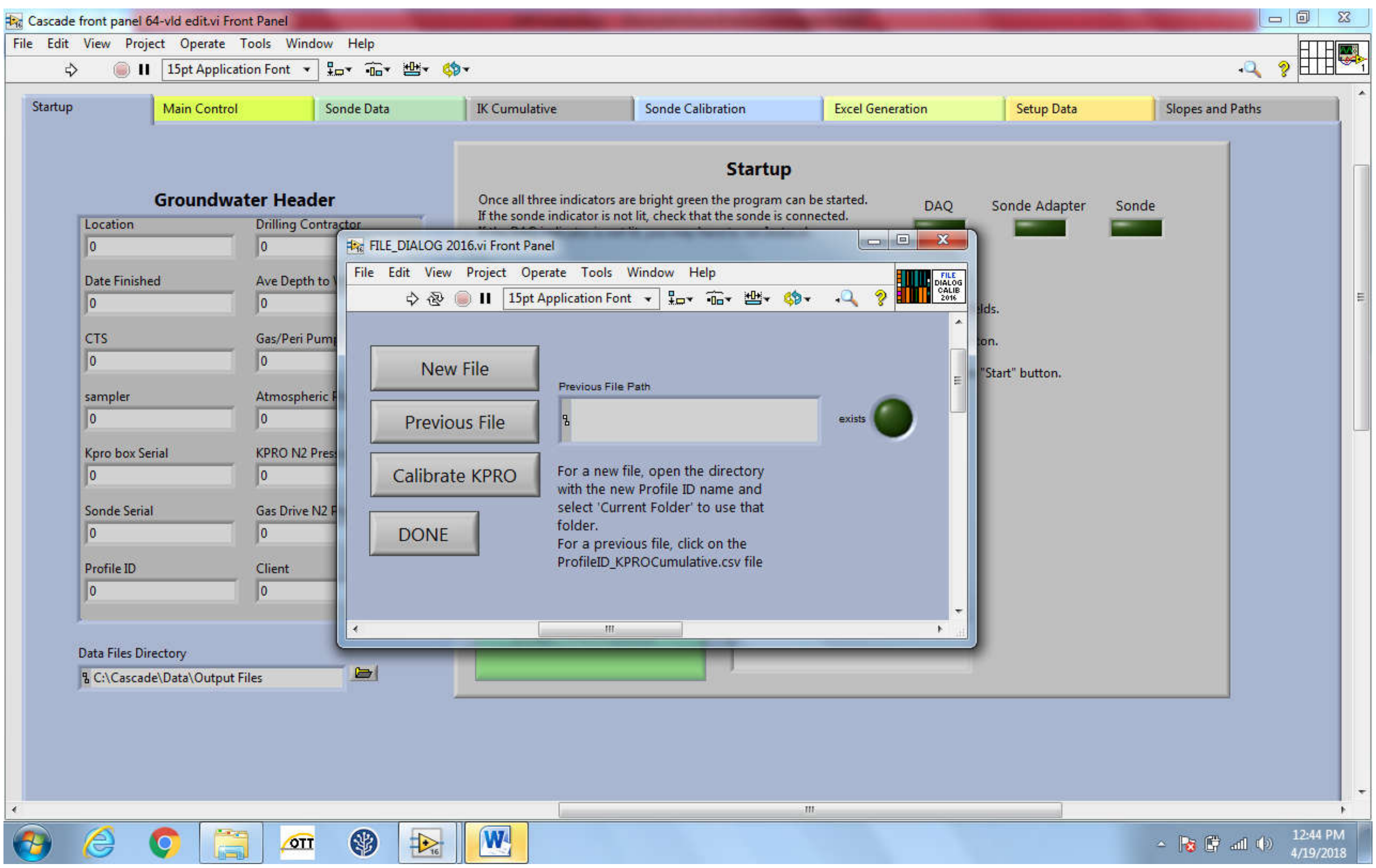
APS Software

4. As soon as the executable opens, the software will connect to the APS box and sonde automatically. Wait for the 3 indicators in top right-hand corner to change from gray to green (it can take 30 seconds). If any of the three indicators do not change to green, then there is a problem – most likely the APS box is not powered up, the sonde is not connected to the APS box or the data cable is not plugged in to the computer. It is possible to run the software without the sonde but it will not work if it is not connected to the APS box.

5. The Labview software is organized into a series of tabs. When the software is opened, the "Startup" tab is enabled. Populate every box in the Groundwater Header section. The program will not start otherwise. You can

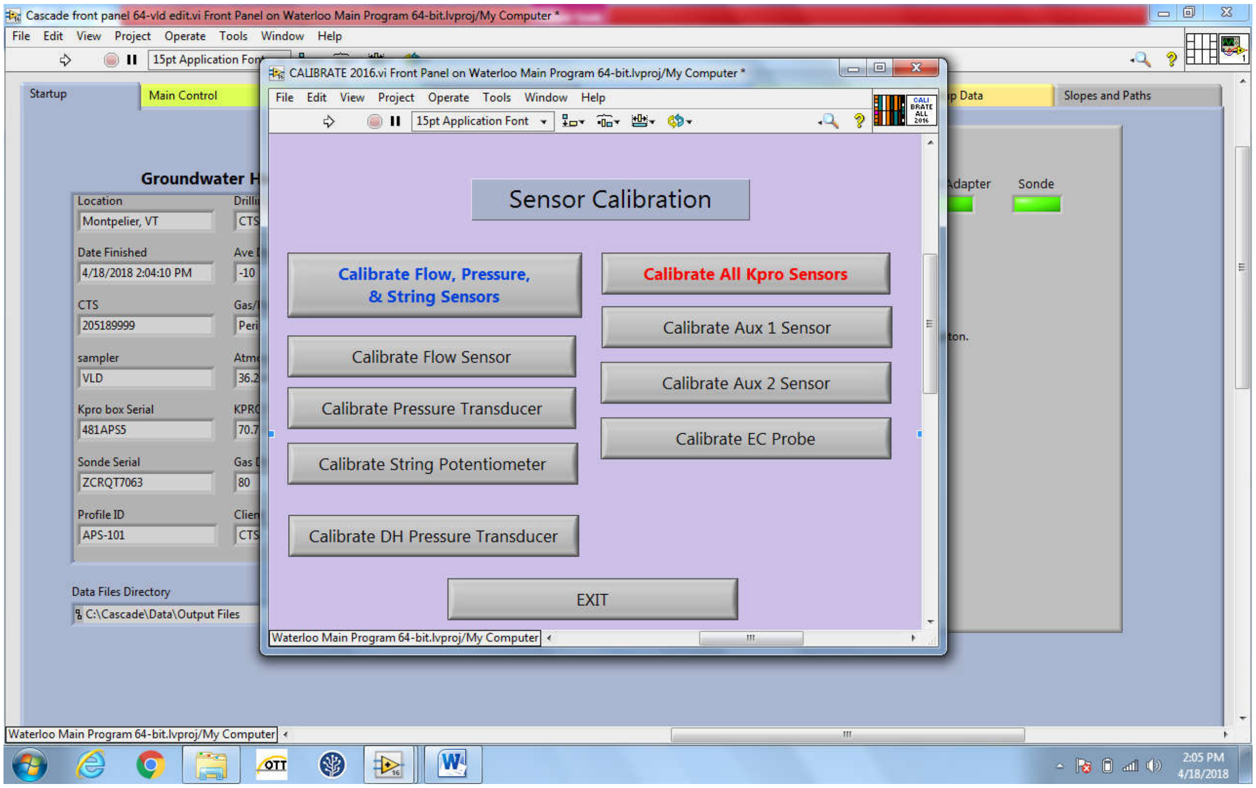
also select the “Read Groundwater Header File” button to populate the section with previously used data.

6. The APS software now needs to be initialized by clicking on the “Start Program” button. Even though the executable is running, the software will not begin the process of initialization and data collection until it is started. If any of the fields in the Groundwater Header are not complete, an error message will be displayed to the right of the “Start Program” button.
7. A window opens and prompts you to enter the Profile ID. The text box will contain the value that was entered in the Groundwater Header. Enter a new Profile ID or leave the value unchanged.
8. The next screen is prompts you to select New file, Previous File or Calibrate KPRO.



9. Select Calibrate KPRO. Make sure that there is a 20’ foot length of stainless steel tubing attached to the APS box when calibrating. This will ensure accurate calibration of the flow and pressure. Using a shorter or longer piece of tubing can adversely affect the validity of the calibration.

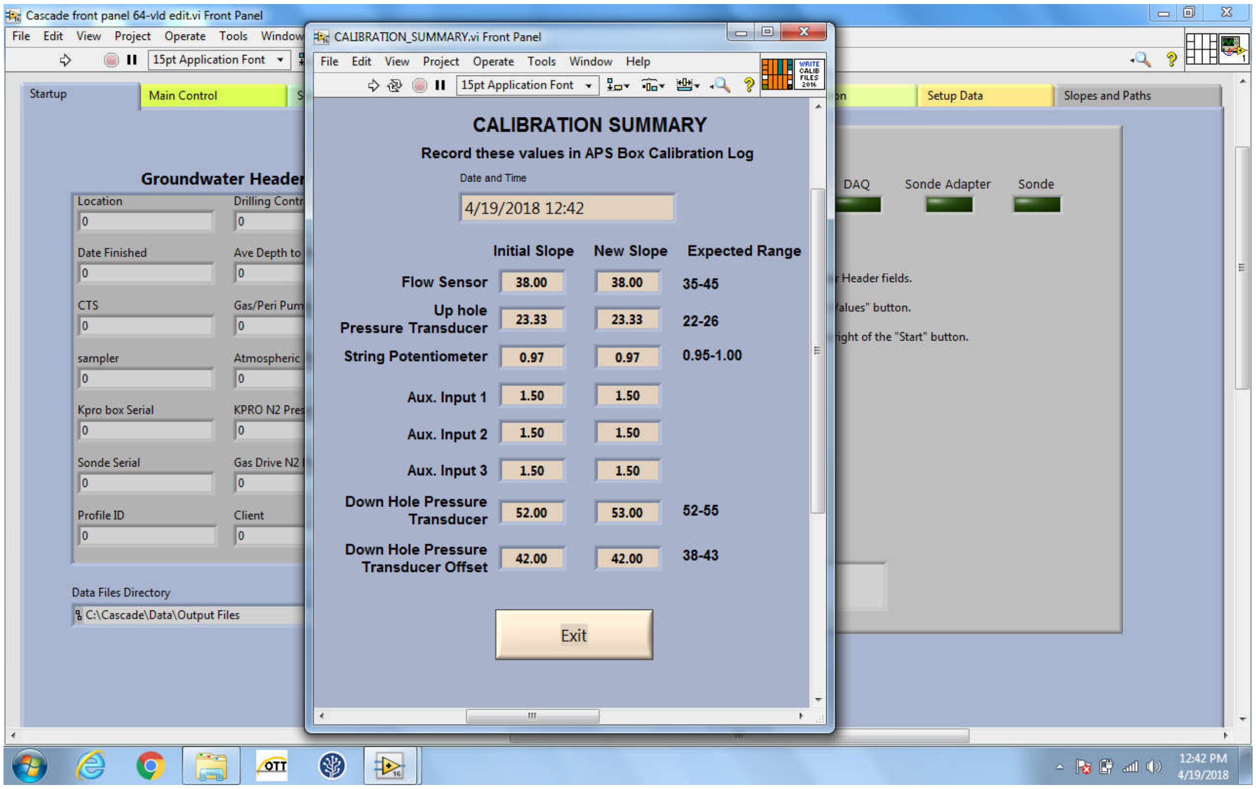
10. The next screen allows you to calibrate all the sensors or each individual sensor (string pot, flow, pressure, DHPT).



Calibration

11. Select the "Calibrate Flow, Pressure, & String Sensors" or the button corresponding to each individual sensor (if you do not need to calibrate all the sensors). The program will then lead you through the calibration. Follow the directions on the screen to calibrate the flow, pressure and string pot. After calibration is complete, if you feel that one or more of the sensors was not calibrated correctly, you can repeat the entire calibration or just repeat the calibration for an individual sensor. If you decide to recalibrate one or all the sensors, be aware that the program will use the original slopes and not the newly calibrated slopes for the recalibration.

12. After calibration, a summary screen will open.



Calibration Summary

13. Record the initial and new slopes in the Use, Maintenance and Calibration Log for the APS box you are using. Slope values should be within the following ranger: string pot – 0.97, flow 35-42, and up hole pressure 22-28. If the slopes deviate from these values, the sensors should be recalibrated. If that does not work, you may need to change out the pressure transducer, flow meter or string pot. Select the OK button to exit this screen.

14. The APS software records the slope values in a file located in the C:\Cascade\Data\Output_Files folder. The file is named "slopes.csv" and is used by the APS software to import the slopes the next time it is started and after calibration. Do not delete the files or any of the data in them or move them to a different folder. **Note**: If the calibration slopes are off due to a calibration error, simply go through the calibration process again. If you are having problems calibrating, see the APS Problem Solving Guide for more information. It may be necessary to delete bad slope values from the slopes.csv file in order to calibrate the APS box. The software uses the previous slope to calculate the new slope, so if the slope that the software is using is way off, it may not be possible to get a good new slope using this

value. If this seems to be the case, open the slopes.csv file and delete the entire line of bad data. Save and close the file. The slopes file can be found in C:\Cascade\Data\Output Files\slopes.csv.

5.5.2 Startup

1. **New File:** After calibration or after clicking on the start button, the startup screen will load (Figure 4.5-2). If you are starting a new location, select New File/Folder. The software will create a folder with the name of the Profile ID you just entered in the C:\Cascade\Data\Output Files folder. Open the folder and select Current Folder (not the Save Button). The software will create 6 files in the new folder –
    a. ProfileID_IK failure.csv – this file stores the I_k behavior data.
    b. ProfileID_KPROcumulative.csv – this is the main data file and stores all data related to depth, pressure, flow, I_k, etc.
    c. ProfileID_KPROsession.csv – temporarily stores data that is eventually written to the cumulative file.
    d. ProfileID_Sample failure.csv – stores data related to failed sample attempts.
    e. ProfileID_SondeData.csv – stores the sonde data sample parameters.
    f. ProfileID_Static Ik.csv – currently not used.
2. **Previous File:** If you are continuing a file select Previous File and select the folder with the name of the location you want to continue. Select the ProfileID_KPROcumulative.csv file and select Save.
3. The first window that appears is for setting the atmospheric pressure. Follow the instructions on screen to set the pressure. The atmospheric pressure reading should be between 33-35 feet of water. If the reading is higher or lower, the pressure transducer needs to be calibrated. This value can also change depending on elevation and weather conditions.
4. The next window is for setting the water vessel pressure. Follow the instructions on screen to set the pressure. If the pressure is too high, turn the handle on the regulator counter-clockwise and release some pressure from the vessel by using the valve on the top of the vessel. If the pressure is too low, turn the handle on the regulator clockwise and allow pressure to

stabilize. After adjusting the pressure make sure that the pressure has stabilized and is not falling or climbing before clicking the OK button.

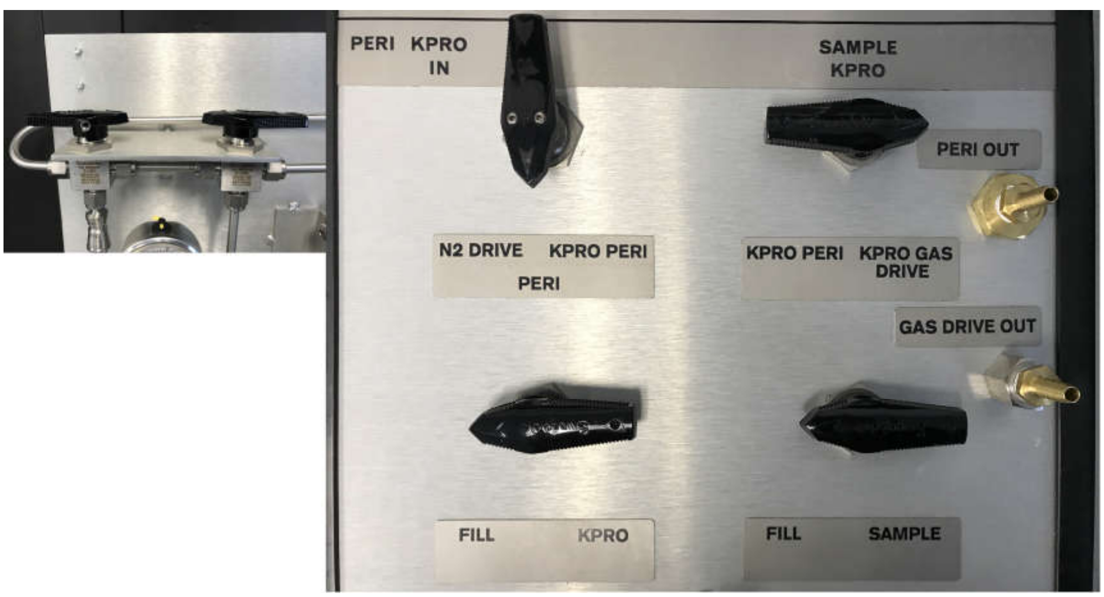
5. The next window will prompt you to enter the start depth. If you are continuing a profile, the last recorded depth will be provided. You can use this depth or enter a different depth. When entering a depth you can enter a positive or negative value; the program will change it to negative regardless of the sign that was entered.
6. The next window will prompt you to enter the height of the sample box above the APS location. Measure the height from the ground to the pressure transducer and enter it. On level ground and working out of a box truck the height is 7 feet. When working out of a van, the height is 5.5 feet. The height will be different if you are profiling out of a different vehicle or other situation (cart, wagon, etc). If the ground between the truck and location has a significant slope, this also must be accounted for.
7. The next window will prompt you to enter the depth to water. If you are continuing a profile, the last recorded depth to water will be provided. You can use this depth or enter a different depth. If you do not know the depth to water, you must make an educated guess or ask the client. You can enter a more accurate depth later. When entering a depth you can enter a positive or negative number. Make sure you enter the depth to water from ground surface, not from the height of the APS box.
8. The last window will prompt you to zero the pressure to the ground at the APS location. Make sure that the graduated cylinder is placed on the ground as close to the same elevation of the location as possible. Follow the instructions on the screen and select OK. The setup is now complete and tooling advancement can begin.

5.6 Advancing the APS to Acquire I_k data for both Peristaltic and Gas Drive Modes

1. Attach the harness to the stainless steel tube or tubes sticking up out of the top of the profiler rod at the drive platform. Place the string pot on the ground next to the drill rig and weigh it down with a pipe wrench or the rod puller. Pull out the string and attach it to head of the drill dig.
2. **Peristaltic Mode**: turn on the flow by arranging the valves as shown below:

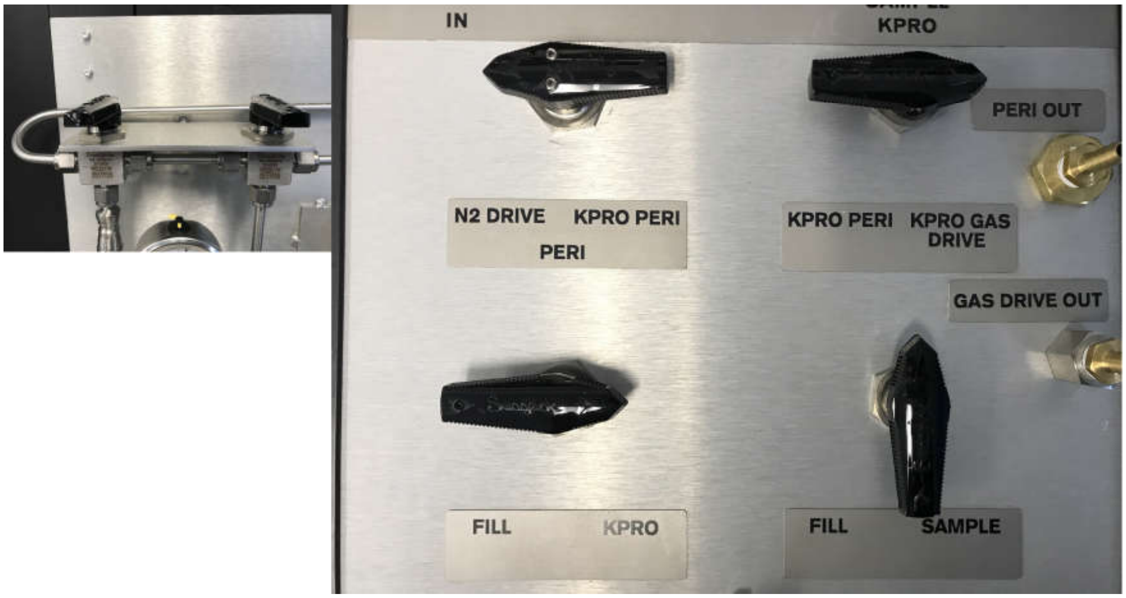
Peri Mode - Drive

Gas Drive: The pump must be filled with water and pressurized with nitrogen before it can be advanced. Fill the pump by arranging the valves per the photo below and turning on the peristaltic pump:



Gas Drive Fill Pump

When the pump is full and a steady stream of water is flowing out of the Peri Out, lock off the pump (turn the valves on the sample jig so they face the back of the box), pressurize the pump, turn off the peristaltic pump, and turn on the flow per the following photo (make sure to lock off the pump first). The pump should pressurize at the pressure set on the high range regulator. For advancement the pressure should be set between 50 and 80 psi, this will prevent the KPRO water from flowing up into the pump instead of out the tip.



Gas Drive – Driving

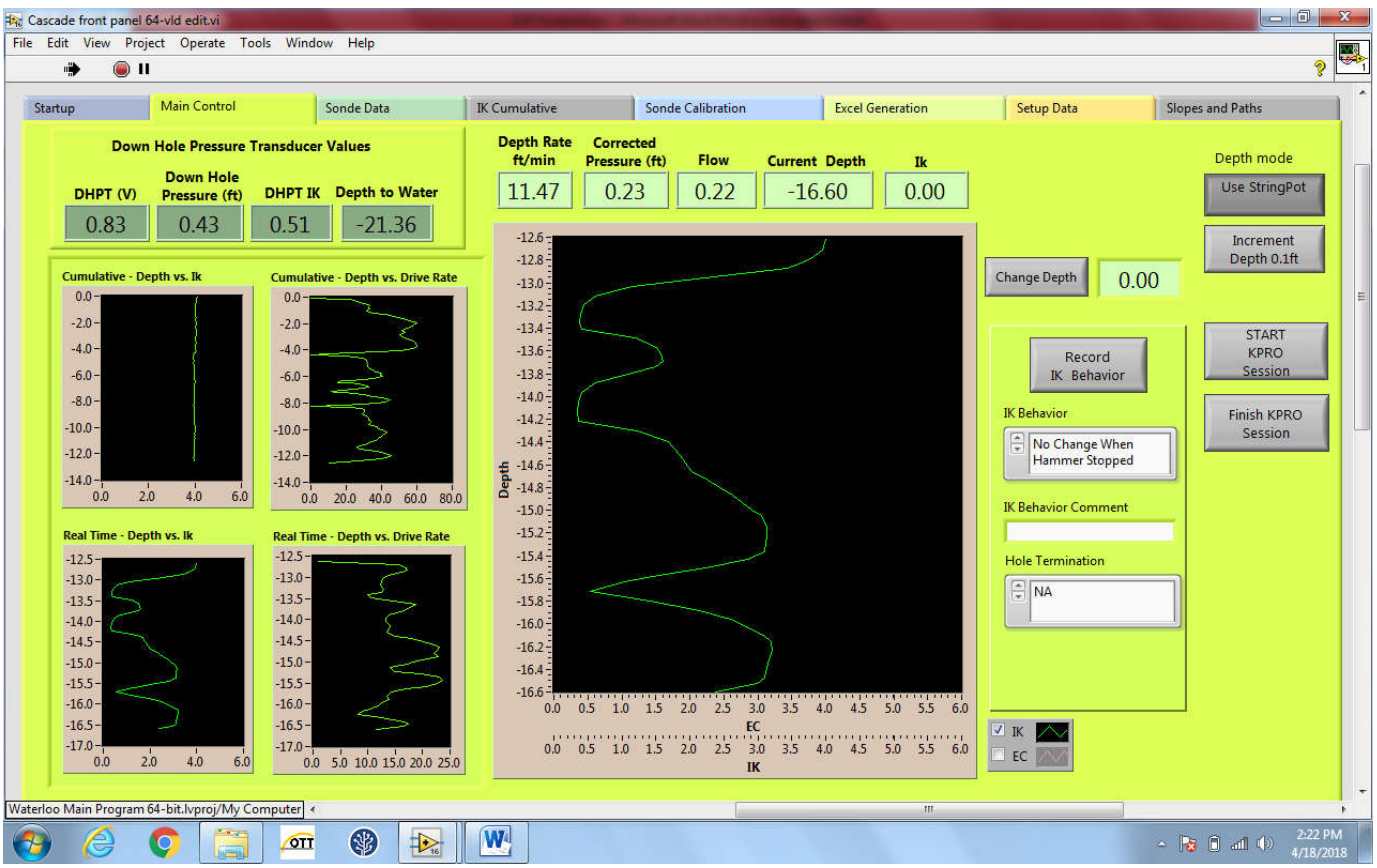
3. With the flow on, put the APS tip / rod assembly into the pre-cleared hole or so that the tip rests vertically. Have the driller lower the head of the probe so that the anvil of the probe rests on the drive cap. At this point the driller will adjust the probe so that the drill rod and probe are straight and level. **Note:** Make sure that the driller has broken through any surface concrete or asphalt. Driving through either of those will damage the tip.
4. Select the “Main Control Tab” on the software. Make sure that the string pot is extended, and the head of the drill rig is resting fully on the drive cap When the flow value stabilizes click on the “Start KPRO Session” button at the top right of the screen. If the flow is zero or unusually low, check for clogs before advancing the tooling.
5. A window will open asking the depth to water. If this is the first drive, the depth provided is the depth entered during the startup procedure. If this is your second drive and the head measurement collected at the first sample location is different from the value originally entered, a new depth can be entered here. Enter a new depth or select OK. A window will open showing

the feet of stainless steel tubing. Set the feet of SS tubing to the correct feet of tubing used, including the 20' harness.

6. Select the "Go" button and then signal to the probe operator that you are ready to commence driving the tooling.

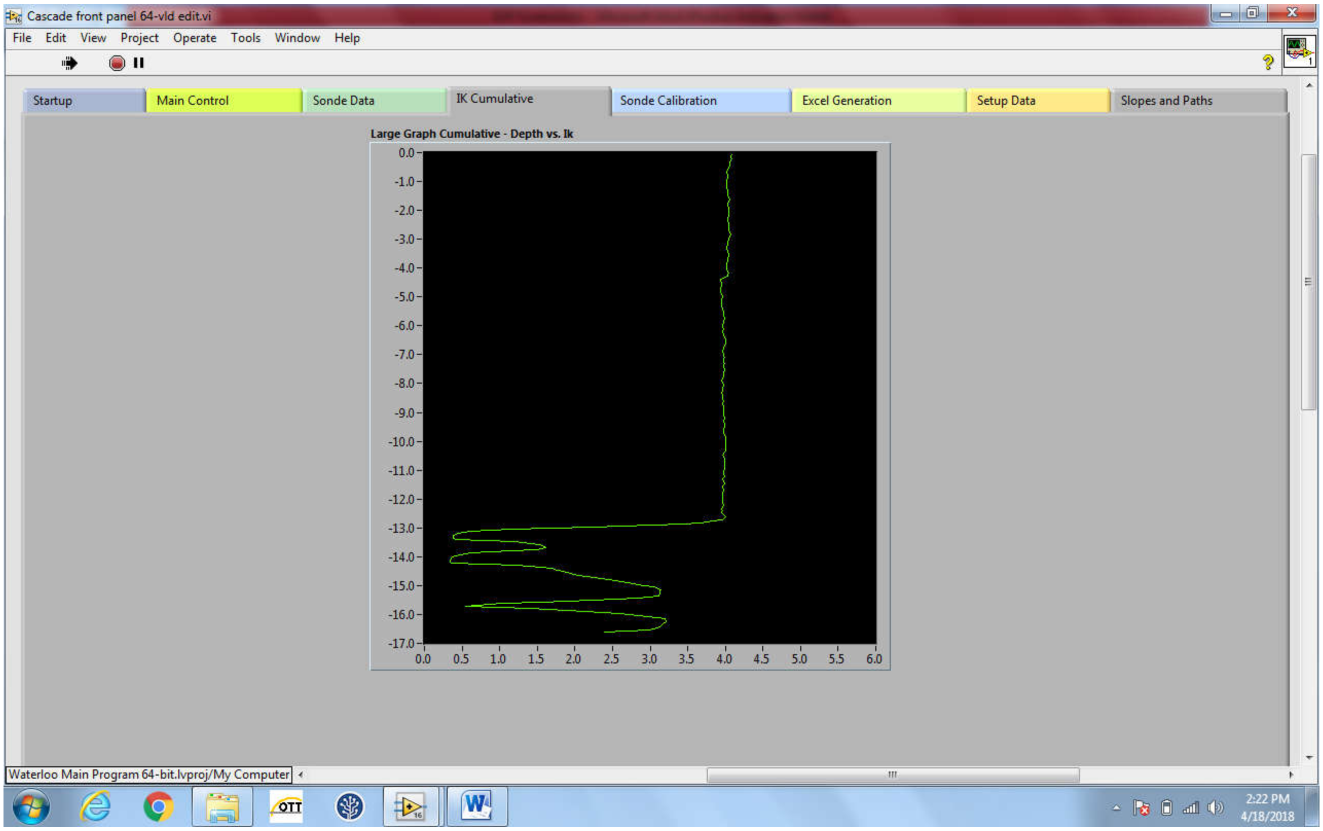
   Notes on the string pot: 1. The APS software will only record data while the string pot is moving. 2. If during a drive the driller needs to lift the head of the probe off the drive cap, there is no need to stop the APS software. The software will only record data once the string pot has moved past the last recorded depth.

7. Observe the I_k plot on the screen as the tool is advanced as shown in the following figure:



APS Software Screen While Driving

The I_k for the current drive is displayed in real time in the large graph on the right side of the screen. The current I_k, depth, flow, and pressure are displayed above this graph. The cumulative I_k for the entire profile is displayed in the small graph at the top left. The drive rate (feet/minute) for the current drive is displayed in the small bottom right graph, and the cumulative drive rate is displayed in the small top right graph. A larger cumulative I_k plot can be seen by clicking on the “Ik Cumulative tab”. The screen looks like this:



Large Cumulative Depth vs. I_k

Notes on I_k: The typical I_k range is from 0 to 6. Fine grained soils (silts and clay) or compacted sediment will have an I_k towards the lower end, and sands, gravels and looser material towards the middle to higher end. The software will correct the I_k for the feet of stainless steel tubing using a head loss equation, so I_k should remain relative for the profile regardless of how much stainless tubing is attached (even though the flow is lower and the pressure is higher). I_k is only calculated and recorded by the software if the string pot is moving. In some cases, the flow will drop or rise after hammering has stopped, which results in a different I_k. The software can calculate a “Static” I_k based on the flow and pressure after the probe hammer has stopped by selecting the Record I_k Behavior button. This procedure is described below.

8. When you reach a depth that you wish to sample, signal to the rig operator to stop advancing the tooling. When the drilling stops, select the "Finish KPRO Session" button.

9. **Determining a Sample Interval:** Observe the flow after the probe hammer has stopped. If the flow drops significantly it may be an indication that the sample interval will not yield a timely sample. If the flow stays high or increases, then it is probably a good interval to sample.

   I_k Behavior: Each time the hammer is stopped (to add rod, sample, determining whether to sample), the I_k Behavior must be recorded. The software can record this data. There are two places that this data can be collected, one place is for during a drive and the other is at the end of the drive.

   If you are not sure if the interval is going to produce a good sample, stop the Geoprobe but do not select the "Finish KPRO Session" button. Keep the flow on and observe, if the flow falls to where a sample does not seem possible, select the appropriate I_k Behavior from the drop-down menu on the "Main Control" tab (located to the right of the large graph). The choices in the drop-down menu are "No Change When Hammer Stopped", Ik Decreased" or "IK Increased". If desired, a comment can be entered in the comment box located below the drop-down menu. Select the "Record Ik Behavior" button and record the depth and I_k behavior on the paper field log. The I_k behavior data is written by the software to the ProfileID_Ik failure.csv file. Instruct the Geoprobe operator to drive the tooling.

   If the sample interval looks like it will produce a sample, select the Finish Kpro Session button. See Step 12 for recording Ik Behavior at the end of a drive.

   It will take experience to get a feel for which intervals will yield fast samples and which will not. The I_k and flow are a good indication as to which samples will be fast or slow but remember that the flow decreases with the amount of stainless tubing that is attached. So at shallower depths a flow of 60 ml/min may be slow but at a depth of 60 feet it may be fast.

10. Turn off the flow by turning the rotating left valve from the "KPRO" label one quarter turn to an off position (not labelled).

11. Measure the stick up from the ground surface to the shoulder of the rod in tenths of feet. Subtract the stick up from the total length of rod in the ground including tip and/or pump. For peristaltic, the tip length used is 0.3 feet. For gas drive, the length of the tip and pump is 3.1', so add this to the length of

rod in the ground. **Note:** The length of the tip/pump is always measured from the center screw on the tip.

12. Compare the measured value to the depth reading on the screen:

Correct Depth

If the measured depth is different than the depth given in the "Original Uncorrected Depth" box, enter the correct depth into the "Input Corrected Depth" box and select the "Enter New Depth" button. You can also change the feet of stainless if required.

Ik Behavior – on the right side of the window there is a drop down for Ik Behavior, a comment box and a drop down for Hole Termination. Before selecting the "Done Entering Data" button, select the IK Behavior from the drop down. If this is the last drive of the APS location, select the Hole Termination and enter a comment if needed. The choices for Hole Termination are "ROP Below Threshold" (ROP is Rate of Penetration), "Sudden Hard Refusal", "Reached Target Depth", "Broken Down Hole Equipment" or "NA". "NA" is the default value, if the drive is not the last drive leave the value as the default.

If no other data needs to be corrected, select the "Done Entering Data" button on the software. **Note:** It is common practice to round to the nearest tenth of a foot when correcting the depth. This is done not only for ease, but because we do not want to mislead the client into thinking we have accuracy to the hundredth place.

13. **Measuring Hydraulic Head**: Turn off the flow and observe the Corrected Pressure (ft) box. When this value equilibrates, record the value on the field form along with the depth (Attachment 2). The water in the stainless steel tubing will equilibrate to the head of the groundwater when the flow is turned off. Turn on the flow and leave it on for 30 seconds. Turn off the flow and again observe the Corrected Pressure and wait for equilibration. If this value matches the first value, the head measurement is valid. If it is different, repeat turning the flow on / off until two successive head readings are obtained. Be sure to also record the head manually on the paper field form.

    Recording the head value with the software: When the head measurement has equilibrated, select the "Sonde Data" tab. Located on the bottom left of the tab is the Record Head Pressure button and Head Pressure variable. If using the uphole transducer (Peri mode) make sure that the button displays "Use Up Hole Pressure". If it does not, select the button to change it. Select the "Record Head" button. The Head Pressure variable will be updated to match the Corrected Pressure from the Main Control tab and the Head Pressure will be recorded to the ProfileID_SondeData.csv.

    Note: When the water table is at a depth of more than 25' the head value is not valid. When using gas drive mode this is often the case. If so do not record the head value. However, using the DHPT in gas drive mode will allow you to collect head values no matter how deep the water table is.

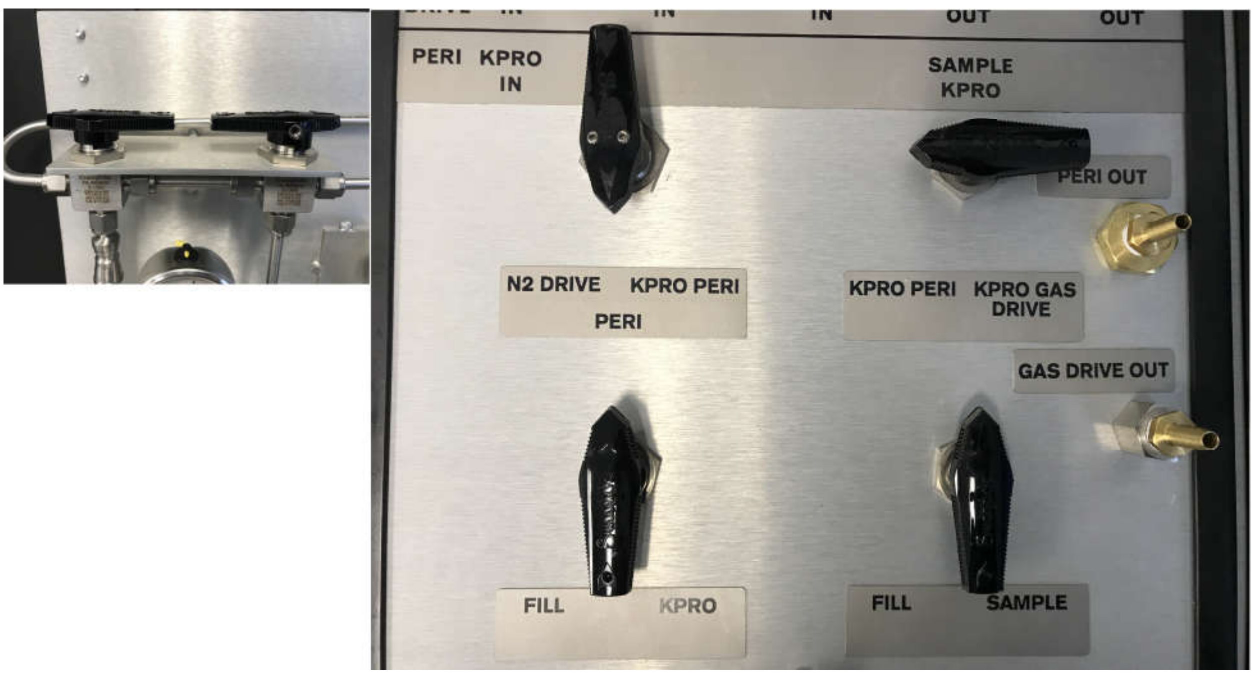
14. **Missing a sampling interval**. It may be required to pull the tip up to sample an interval that was passed on the way down. To do this first make sure that the "Finish KPRO Session" button has been selected. For Peri mode make sure that the flow is on, and in gas drive mode make sure that the pump is pressurized and the flow is on before pulling the tooling up.

    Determine the interval you would like to sample. Hold a measuring stick next to the drill rod as the driller pulls back on the rod and have the operator stop when the depth is achieved. Check the flow on the software to be sure that the interval will yield a timely sample. It is also possible to watch the flow on the APS software as the driller pulls the rod up. When the flow increases, tell the driller to stop. Measure the stickup and record in the paper log that the profiler was pulled up and record the new depth. Before your next drive you will have to correct the depth in the APS software. To change the depth, enter the new depth in the "Update Depth" box and select the "Update Depth" button. This will create duplicate data in the KPROcumulative.csv file that must be deleted when the location is finished. You can also mark the rod before pulling it back and then drive the rod back to that depth (with the flow on) before starting the program.

5.7 Purging and Sample Collection

5.7.1 Purging in Peristaltic Mode

1. Turn on the peristaltic pump.
2. Set the valves to the positions shown below.

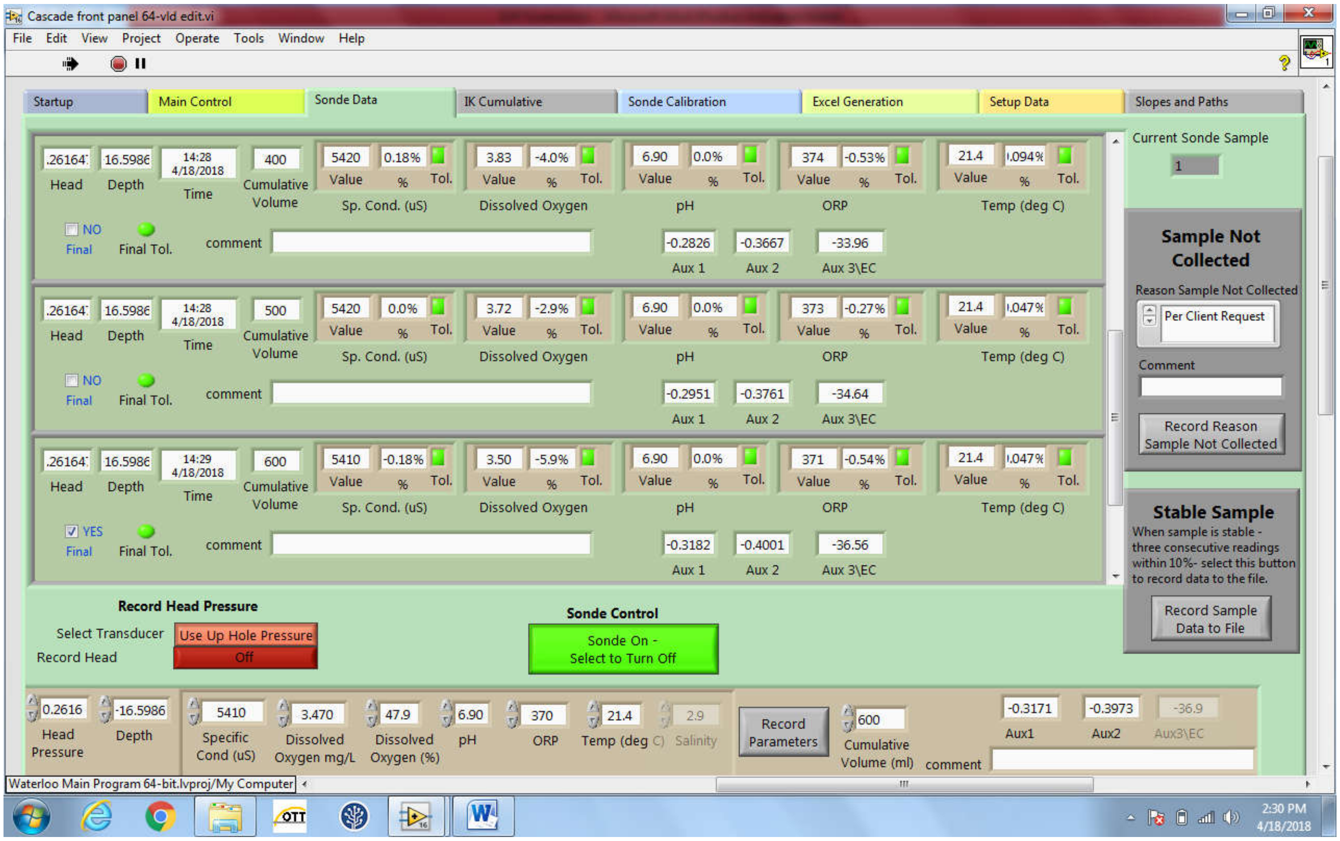


Peri Mode Purging

3. Observe the vacuum gauge. A vacuum should build toward -30 inches of mercury
4. Observe water flowing through the bottles. The water will be clear at first but should become silty. This is because there is some KPRO water still in the tubing.

5. If vacuum does not build and water does not flow it is possible that there is a leak in the system. Refer to the Problem Solver's Guide on how to proceed.
6. Select the "Sonde Data" tab. Click the red "Sonde On/Off" button to turn on the sonde (button will change from red to green).
7. Observe that the parameters at the bottom of the screen are updating. They will briefly all change to zero before the live parameters are displayed. Readings can be recorded every 50 or 100 ml for Peri mode. Enter the volume of water in the graduated cylinder into the Cumulative Volume box and select the "Record Parameters" button. The current values for the parameters will be entered by the software into the embedded spreadsheet on the screen. It may take several seconds for the line of data to be written to the embedded spreadsheet.
8. Observe the volume of water in the graduated cylinder into which the purge water discharges. If the sample purge rate is slow (less than 50 ml after waiting 5 minutes) then the sample interval may not produce a sample in a reasonable amount of time. It may be necessary to pull up the rods or drive to a better sampling interval. Consult with the client on how to proceed.

9. When all the physico-chemical parameters stabilize on three successive readings (indicated by a green light next to the parameter value) select the Final Value check box on the left-hand side of the last line of data in the embedded spreadsheet. Select the "Record Sample Data to File" button. The sample data will be written to the ProfileID_Sonde Data.csv file. You should also record the depth, time, head value, total volume purged and the final values of the physico-chemical parameters on the paper field form. The paper log serves as a backup in case there is a problem with the electronic files. The following photo illustrates what the data looks like for a sample that has equilibrated.



Sample Log Showing Equilibrated Sample

Notes on Purging the Sample: Make sure to purge at least 500ml before collecting a sample. The first few physico-chemical readings may indicate that the sample has equilibrated but that is because the tubing contains the analyte free water and there is still water from the previous sample interval in the flow cell of the sonde. The volume of the flow cell is 200 ml, so it will take some time for the groundwater from the current interval to replace the water in the flow cell from the previous sample.

There are conditions where stabilization of Dissolved Oxygen and ORP values may not be practical. When Dissolved Oxygen values are less than 1 mg/L and ORP values approach 0 after an acceptable volume of water has been purged (usually 500ml for peristaltic and 600ml for gas drive), a small change in the value can result in a change greater than the stabilization criteria of 10%. In these situations, the sampler can collect the sample before these values have stabilized if Specific Conductance and pH are stable.

10. If no sample was collected and parameter values have been recorded to the embedded spreadsheet, select the “Record Sample Data to File” button located on the right-hand side of the screen. Record the volume purged, depth, time and a comment on the paper field log. On the right side of the screen is a dropdown menu where the reason for not sampling and a comment can be entered. Select from the dropdown menu, type in a comment and then select the “Record Reason Sample Not Collected” button. This data is written to the ProfileID_Sample failure.csv.

    If no parameters were collected, select the reason from the dropdown menu, enter a comment is needed and select the “Record Reason Sample Not Collected” button.

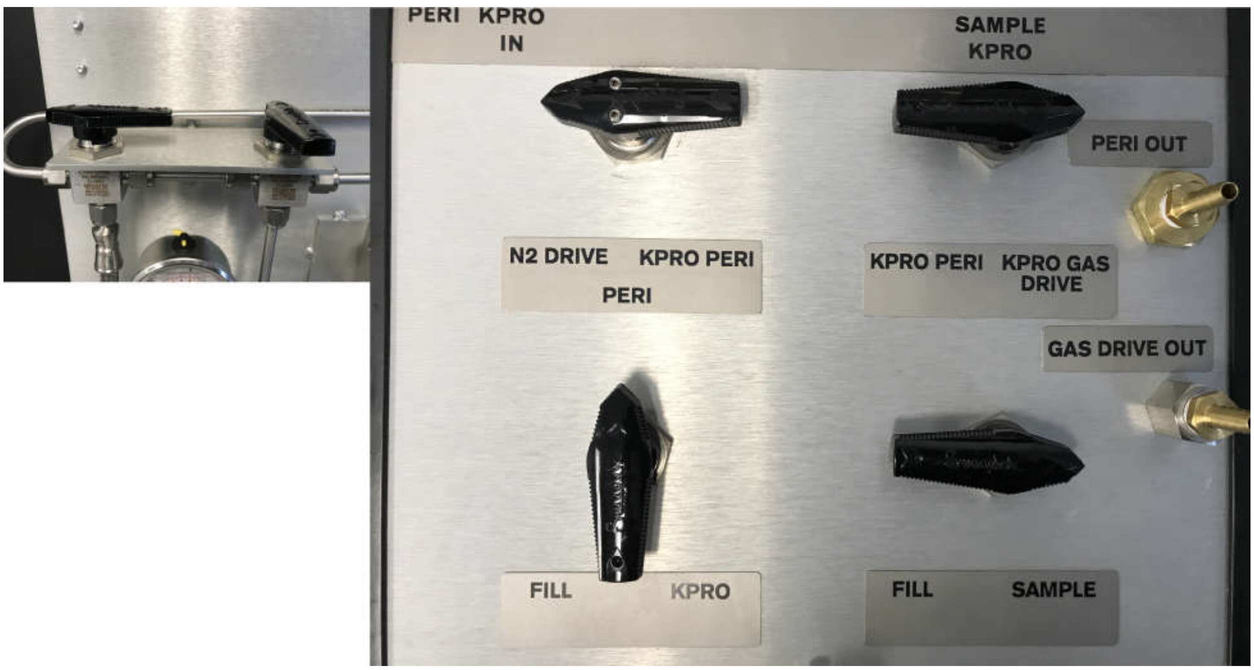
5.7.2 Collecting the Sample in Peristaltic Mode

1. Turn the top right valve on the sample jig so that it is locked off (pointing towards the back of the box). There are two options to collecting the sample.
2. Option 1:
    1) Reverse the direction of the pump.
    2) Run the pump backward for 2 to 3 seconds
    3) Shut off the pump
    4) Remove the VOA vial on the left-hand side of the sample jig.
    5) Hold the VOA vial under the stem and run the pump in reverse slowly until you have a mounding of water on top of the vial. If the vials are to be preserved with HCL, add 5-6 drops of HCL to the VOA before topping it off.
    6) Repeat for other vials. Typical VOC analysis requires two VOAs, but be sure to check with the client on how many vials they require.
3. Option 2:
    1) Remove the third VOA vial from the left first. It is important to remove this vial first to prevent air bubbles from flowing through your sample due to depressurization.
    2) Remove the second VOA vial from the left.
    3) Remove the first VOA vial.
    4) Top off the sample vials with the first vial that you removed.

4. Carefully screw the cap on the vials. The vial cannot have any air bubles trapped under the cap. To check, turn the vial upside down and tap the vial lightly on the palm of your hand. If there are any bubbles present, you must uncap the vial and repeat the procedure
5. Label the vials appropriately.
6. Replace the vials with new vials. Prepare to drive as before after adding tubing and rod as necessary.

5.7.3 Purging in Gas Drive Mode

1. At this point the pump is already pressurized from advancing the APS tooling. Arrange the valves per the following photo:



Pressurized Gas Drive Pump Ready to Purge

Turn the top right valve on the sample jig slowly to the right. This allows the nitrogen to push the water up from the pump and through the sample jig. The pressure on the gauge will drop and stabilize as the water flows.

2. Observe the pressure gauge. Just before the pump body is completely emptied, the pressure will start to rise. When you observe the rise, turn the top left valve on the APS box one quarter turn clockwise, which will stop the flow of nitrogen and vent the gas out of the pump (you will hear a hissing sound).

3. Watch the pressure gauge and when the pressure drops close to zero, lock off the right valve on the sample jig and spin the top left valve on the APS box clockwise to Peri. Make sure that the peristaltic pump is on. At this point the pump is depressurized and is filling with groundwater. These three steps complete one pump purge, or “whack”.
4. Observe the volume of water in the graduated cylinder into which the purge water discharges.
5. Select the “Sonde Data” tab. Click the red “Sonde On/Off” button to turn on the sonde (button will change from red to green).
6. Observe that the parameters at the bottom of the screen are updating. They will briefly all change to zero before the live parameters are displayed. Readings can be recorded after each whack for gas drive mode. Enter the volume of water in the graduated cylinder into the Cumulative Volume box and select the “Record Parameters” button on the right of the screen. The current values for the parameters will be entered into the embedded spreadsheet on the screen.
7. Observe the volume of water in the graduated cylinder into which the purge water discharges.

   This data is used as a benchmark for future readings. The first whack will be larger than most because the pump and lines are already filled with water. If after the second whack the amount of sample discharged is less than 80 ml then you need to wait longer between evacuations (3-4 minutes). If after waiting 5-6 minutes the pump evacuation yields less than 50 ml, it may not be prudent to collect a sample at that location. Check with the client oversight to see if they want you to continue sampling or drive to a better sampling interval. If the volume is significantly larger (150-200ml) you can evacuate the pump more often (1-2 minutes). If no sample was collected, select a reason for ending the sample attempt from the drop-down menu and select the “Record Reason Sample Not Collected” button.

   Note on purge volume: The volume of the gas drive pump is 100 ml. The volume of the stainless steel tubing is 0.8 ml/ foot, and there are two lines (the sample and gas lines) that are full of water (water from the previous sample and water used to fill the pump). For example, if you have 60 feet of tubing attached, the volume would be 100ml + (2 *60*0.8), for a total of 196 ml. When purging a sample this water will be purged first so the physico-chemical parameters may appear to be stable. It is common to see the parameters rise (previous sample water left in pump), then fall (analyte free water used to fill the pump) before starting to equilibrate (fresh groundwater

8. After the previous whack, allow some time (as explained in step 7) for the pump body to fill such that you receive at least 50 mL of sample on subsequent evacuation (Step 7).

9. To purge the pump, turn the top left valve on the APS box to N2 and watch the pressure gauge. When the pressure crosses zero, turn the top right valve on the sample jig to the right. You are now back at Step 1. Follow the rest of the steps to complete the whack and record the parameters.

10. When all of the physico-chemical parameters stabilize on three successive readings (indicated by a green light next to the parameter value) select the Final Value check box on the left-hand side of the last line of data in the embedded spreadsheet. Select the “Record Sample Data to File” button. You should also record the depth, time, head value, total volume purged and the final values of the physico-chemical parameters on the paper field form. The paper log serves as a backup in case there is a problem with the electronic files. The following photo illustrates what the data looks like for a sample that has equilibrated.

    Note: There are conditions where stabilization of Dissolved Oxygen and ORP values may not be practical. When Dissolved Oxygen values are less than 1 mg/L and ORP values approach 0 after an acceptable volume of water has been purged (usually 600ml for peristaltic and 800ml for gas drive), a small change in the value can result in a change greater than the stabilization criteria of 10%. In these situations the sampler can collect the sample before these values have stabilized as long as Specific Conductance and pH are stable

11. If no sample was collected and parameter values have been recorded to the embedded spreadsheet, select the “Record Sample Data to File” button located on the right-hand side of the screen. Record the volume purged, depth, time and a comment on the paper field log. On the right side of the screen is a dropdown menu where the reason for not sampling and a comment can be entered. Select from the dropdown menu, type in a comment and then select the “Record Reason Sample Not Collected” button. This data is written to the ProfileID_Sample failure.csv.

    If no parameters were collected, select the reason from the dropdown menu, enter a comment if needed and select the “Record Reason Sample Not Collected” button.

5.7.4 Collecting the Sample in Gas Drive Mode

1. Arrange the valves as you would for purging the pump. When the pressure builds do not open the valve on the sampling jig.
2. Remove the sample bottle on the left most vial on the sample jig.
3. Hold the sample vial under the straw for the first vial holder on the sample jig. Slowly open the right valve on the sample jig. Water will flow out of the straw and into the vial. When you have a mounding of water on the top of the vial, shut the valve and cap the vial. Repeat this process for subsequent vials. Check for bubbles by inverting the vial and lightly tapping it on the palm of your hand. If there are bubbles, uncap the vial and fill again. If the vials are to be preserved with HCL, add 5-6 drops of HCL to the VOA before topping it off.
4. Label the vials appropriately.
5. Replace the vials with new vials.
6. Prepare to drive as before after adding tubing and rod as necessary by filling and pressurizing the pump. Refer to section 4.6 above for the procedure.

5.8 How to Determine the End of the Profile

There are several ways to determine the end of a location. Some locations may have a predetermined depth set by the client. The end of the profile location is most often determined by the Drive Rate. As the profiler is advanced into the ground the drive rate will decrease as the skin friction of the rod in the ground increases. There are also stratigraphic layers that are more compact than others (clays, tills) that can slow the drive rate. It is important not to drive the profiler once the drive rate gets below 1.0 ft per minute. If the rods, tips and drive hardware are hammered on too much they can fatigue and break, crack or bend. The skin friction can also become too great so that the profiling rods cannot be pulled back out of the ground. Consult with the driller/probe operator during profiling to determine when to stop drilling.

It is also possible to drill into bedrock or other subsurface objects (boulders, cobbles, concrete chunks or slabs, etc.). In this case the drive rate can drop very quickly or stop suddenly. Stop hammering immediately and discuss with the driller and client how to proceed.

After a hole is complete, select the Hole Termination type from the drop down menu when selecting the IK Behavior. Record the hole termination type on the paper field log.

Excel File Creation. The software combines all of the data saved in the associated csv files for the APS location into one file. See Section 5.10 for instructions.

5.9 Decontamination

The only decontamination step required between samples in the same hole is to flush the line with analyte free water (distilled or spring water) while driving to the next depth. There are required decontamination procedures for the tip and pump, drill rod, stainless steel tubing and APS box that need to be completed at the end of a profile. Some sites and clients may require that all the down-hole tooling be decontaminated using a steam cleaner. If this is the case remove the plates and screens from the tip and take the pump out of the housing so that all of the parts can be cleaned. Often the drillers will provide the steam cleaner and will have a decontamination pad set up on site.

5.9.1 Tip and Pump Decontamination

The tip and pump need to be disassembled and cleaned prior to reuse. For the tip, remove the plates and screens. The screws can be reused if they are not rusted or stripped. It may be required to use an impact driver to remove the screws if they are stuck. Rinse out the inside of the tip (through the sampling ports and the fitting on the top) the screens and plates with Alconox and water to remove all sediment. Scrub the tip and plates with a firm brush or use a pipe cleaner to clean the inside of the tip. Carefully check the plates to make sure that the sampling ports are clear. Use a pick to remove any sediment from the sampling port holes. Remove and replace the FEP tubing. The piston for the gas drive system can be reused unless it shown sign or wear or is bent.

For the pump: unthread the tip from the pump housing and unthread the top and bottom housing pieces. Remove the pump body from of the housing. Use a brush and bucket of Alconox and water to clean the inside and outside of the housing pieces and pump as well as the springs and plastic bushing. Disassemble the pump body and discard the o-rings, reed valve and Teflon tape. Rinse out the inside of the pump with Alconox and water followed by clean water. Check the small o-rings at the narrow end of the pump bottom and replace if necessary.

5.9.2 Drill Rod and Stainless Steel Tubing Decontamination

Upon completion of the sampling and grouting of the hole, the drill rods should be cleaned by steam cleaning, pressure washing or by washing with Alconox and water. It is important to clean the inside, outside and threads of the rod. The stainless steel tubes should be clear of any grout, drilling mud or soil removed from the outside using a steam cleaner, pressure washer or Alconox and water. The inside should be rinsed with analyte free water (distilled or spring water). It is very important that before the stainless steel tubing is reused that it is checked for clogs by using a garden sprayer with an adaptor.

5.9.3 APS Box Decontamination and Equipment Blank Procedure

The APS box should be decontaminated at the end of each profiling location to make sure that there is no possibility of cross contamination between profiles.

1. The four o-rings located at the top of each bottle holder on the sample jig should be replaced at the completion of the profile. Remove any vials from the sample jig and discard them. Remove the o-rings located at the top of each bottle holder with a straight or slightly angled pick, being careful not to score the threads on the plastic bottle holder. Alconox and water should be squirted up into the top of each bottle holder before the new o-rings are installed.
2. After changing out the o-rings on the sample jig, the box and jig should be flushed out with at least 1L of Alconox and water and 1L of clean water. This can be done in conjunction with the collection of an equipment blank (as required). All analyte free water used to fill the KPRO reservoir and for equipment blanks needs to be assigned a lot number. Each time a supply of water is purchased a new lot number is to be assigned to all containers purchased at that time. The lot number, date of purchase, manufacturer and place of purchase need to be recorded on the field form, and the lot number is to be written on all containers from that lot. When collecting an equipment blank the date and lot number of the water should be recorded on the field form.
3. For peristaltic mode, connect a clean APS tip to the APS box via the harness. Place the tip into a clean vessel containing Alconox and water (the vessel needs only to be as deep as to make sure all of the ports on the tip are submerged). Screw four new vials into the sample jig and arrange the valves on the box to the same orientation for sample collection. Turn on the peristaltic pump. Top off the water in the vessel as the water is pumped through the box. Once you have pumped 1L of Alconox and water, place the profile tip into a second clean vessel containing only clean, analyte free water and pump 1L of clean water through the box.
4. For gas drive mode, connect all three stainless steel tubes from the pump to the corresponding tubes on the harness and place the tip of the pump in a clean vessel containing Alconox and water. Screw four new vials into the sample jig and arrange the valves on the box to the same orientation for sample collection in peristaltic mode. Disconnect the N2 Out quick connect from the APS box. Disconnect the Sample In quick connect and connect it to the N2 Out quick connect and turn on the peristaltic pump. Top off the water in the vessel as the water is pumped through the box. Once you have pumped 1L of Alconox and water, place the profile tip / pump into a

second clean vessel containing only clean, analyte free water and pump 1L through the box.

5. If an equipment blank is required, simply collect the required number of VOA vials from the sample jig as you would if you were collecting a groundwater sample using the peristaltic mode. If no equipment blank is required, the decontamination process is complete.
6. Record on the paper Groundwater Profile Log that the box has been decontaminated with 1L of Alconox and water and 1L of clean water. Record the date, time and name of the equipment blank (if required).

5.10 APS Field Data Deliverables

One of the biggest advantages to using the Waterloo APS is that field data can be quickly processed in the field and given to the client in a matter of minutes. At the end of the profile the raw data needs to be processed so that a field log can be sent to the client or entered into gINT.

The data should be processed as soon as possible after finishing a profile; either during the decontamination of the APS box or during the collection of the first few samples of the following profile. All efforts should be made to get the data to the client by the end of the working day unless otherwise directed. These are the steps:

1. At the completion of the APS location and before the software is closed, select the "Save Files and Write Create Excel" button located on the "Excel Generation" tab. **NOTE – Only do this when the location is complete and no more data is to be collected. Selecting this button will shut down the software.**
2. The software will combine the data from the 5 csv files into one file named "ProfileID_Groundwater Profliling Log.xlsx" that is saved in the associated folder for the APS location. This process can take several minutes if there is a lot of data. After selecting the button, you will see the Excel icon in the bottom menu bar flash twice. Do not select this icon or open excel. Screenshots of the excel workbook tabs are included below:

Client: CTS

GROUNDWATER PROFILE LOG

CASCADE
DRILLING | TECHNICAL SERVICES

Profile Location: APS-100

	Started	Completed
Dates:	3/17/2018	3/17/2018
Location:	Montpelier, VT	
CTS #:	205189999	
Sampler(s):	VLD	

KPRO Box Serial # / Acquisition Laptop: 481APS4
Sonde Serial #: ZCRQT7057
Drilling Contractor: Cascade
Average Depth to Water: -7.21

Gas Drive or Peri Pump: Peri Pump
Atmospheric Pressure: 34.00
KPRO N_2 Pressure (set via P transducer): 70.00
Gas Drive Pump N_2 Pressure: NA

PHYSICOCHEMICAL PARAMETERS

Depth (ft)	Date / Time	Volume Purged (mL)	Head (ft)	SC (uS/cm)	DO (PPM)	pH	ORP (mV)	COMMENTS
-7.30	03/17/2018:10:03:13	550	-6.83	857	3.28	4.38	212	
-10.20	03/17/2018:10:50:00	1000	-7.09	2320	0.77	6.78	93	
-13.20	03/17/2018:11:16:38	1000	-7.12	1650	0.76	6.65	73	
-16.20	03/17/2018:11:54:46	1000	-7.22	1257	0.73	6.66	60	
-19.20	03/17/2018:12:22:14	1000	-7.21	1473	0.69	6.68	65	
-22.20	03/17/2018:12:53:29	1000	-7.29	1348	0.65	6.74	48	
-25.10	03/17/2018:13:23:13	1000	-7.20	2230	0.64	6.96	29	
-28.40	03/17/2018:13:56:41	1000	-7.26	9640	0.63	6.83	36	
-30.10	03/17/2018:14:37:43	900	-7.26	11850	0.68	6.82	31	
-32.80	03/17/2018:15:16:43	900	-7.28	5390	0.67	6.95	26	
-35.80	03/17/2018:15:53:49	900	-7.27	5090	0.75	6.97	-55	
-39.10	03/17/2018:16:19:17	900	-7.29	11010	0.62	6.74	-18	
-42.10	03/17/2018:16:49:11	800	-7.33	25800	0.64	6.57	-13	
-45.20	03/17/2018:17:18:26	800	-7.35	35700	0.68	6.79	-90	

Front Tab

Ik Behavior Log

CASCADE DRILLING | TECHNICAL SERVICES

Client:	CTS			Profile Location:	APS-100
Date:	3/17/2018	KPRO Box Serial #:	481 APS4	Gas Drive or Peri Pump:	Peri Pump
Location:	Montpelier, VT	Troll Serial #:	ZCRQT7057	Atmospheric Pressure:	34.00
CTS #:	2051819999	Drilling Contractor:	Cascade	KPRO N_2 Pressure (set via P tranducer):	70.00
Sampler(s):	VLD	Depth to Water:	-7.21	Gas Drive Pump N_2 Pressure:	NA

Depth (ft)	I_K Behavior Type		Flow		Feet of Stainless Steel	Static IK	Time	COMMENTS	Hole Termination Type
-5.20	No Change When Hammer Stopped		135		60	3.18	3/17/2018:09:21:06		
-7.30	No Change When Hammer Stopped		122		60	2.67	3/17/2018:09:22:22		
-10.20	No Change When Hammer Stopped		139		60	3.20	3/17/2018:10:07:39		
-10.20	No Change When Hammer Stopped		124		60	2.71	3/17/2018:10:30:31		
-13.20	IK Decreased		112		60	2.36	3/17/2018:10:57:05		
-15.20	No Change When Hammer Stopped		116		60	2.47	3/17/2018:11:34:04		
-16.20	No Change When Hammer Stopped		120		60	2.61	3/17/2018:11:35:45		
-19.20	No Change When Hammer Stopped		133		60	3.01	3/17/2018:12:05:53		
-22.20	No Change When Hammer Stopped		133		60	3.02	3/17/2018:12:37:39		
-25.10	No Change When Hammer Stopped		133		60	3.02	3/17/2018:13:08:09		
-28.40	No Change When Hammer Stopped		133		60	3.02	3/17/2018:13:38:31		
-30.10	IK Decreased		111		60	2.34	3/17/2018:14:11:10		
-32.80	No Change When Hammer Stopped		117		60	2.51	3/17/2018:14:58:36		
-35.10	IK Decreased		97		60	1.95	3/17/2018:15:26:31		
-35.80	IK Decreased		99		60	2.02	3/17/2018:15:28:43		
-39.10	No Change When Hammer Stopped		126		60	2.78	3/17/2018:16:01:03		
-42.10	No Change When Hammer Stopped		130		60	2.92	3/17/2018:16:33:10		
-45.20	No Change When Hammer Stopped		121		60	2.63	3/17/2018:17:00:02		Reached Target Depth

IK Behavior Tab – Displays Ik Behavior and Hole Termination Type as well as the Static IK

Sonde Sample Attempt Log

CASCADE
DRILLING | TECHNICAL SERVICES

Client: **CTS**

Profile Location: **APS-100**

Date:	3/17/2018	KPRO Box Serial #:	481APS4	Gas Drive or Peri Pump:	Peri Pump
Location:	Montpelier, VT	Troll Serial #:	ZCRQT7057	Atmospheric Pressure:	34
CTS #:	2051819999	Drilling Contractor:	Cascade	KPRO N_2 Pressure (set via P tranducer):	70
Sampler(s):	VLD	Depth to Water:	-7.21	Gas Drive Pump N_2 Pressure:	NA

Depth (ft)	**Time**		**Unsuccessful Sample Attempt**				**COMMENTS**
-10.00	3/17/2018:09:21:06		Could Not Yield Water				Sample stopped coming in after 15 minutes
-15.00	3/17/2018:12:20:06		Yield Deemed Too Slow				

Sample Attempt Tab

PARAMETER EQUILIBRATION LOG

Client: CTS

Profile Location: APS-100

Location: Montpelier, VT
CTS #: 2051819999
Sampler(s): VLD

KPRO Box Serial #: 481APS4
Troll Serial #: ZCRQT7057
Drilling Contractor: Cascade
Depth to Water: -8.00

Gas Drive or Peri Pump: Peri Pump
Atmospheric Pressure: 34.00
KPRO N_2 Pressure (set via P tranducer): 70.00
Gas Drive Pump N_2 Pressure: NA

PHYSICOCHEMICAL PARAMETERS

Depth (ft)	Head (ft)	Date and Time	Volume Purged (mL)	SC (uS/cm)	SC %Change	DO (PPM)	DO %Change	pH	pH %Change	ORP (mV)	ORP %Change	Temp deg C	Temp %Change	COMMENTS
-10.20	-7.09	03/17/2018 10:38:24	200	534	-37.7	3.76	14.6	4.86	11.0	192		20.4	-0.9	
		03/17/2018 10:39:53	300	603	12.9	4.18	11.2	4.82	-0.8	183	4.7	20.4	0.0	
		03/17/2018 10:41:33	400	970	60.9	3.64	-12.9	5.15	6.8	168	8.2	20.3	-0.6	
		03/17/2018 10:42:44	500	1700	75.3	2.68	-26.4	6.05	17.5	133	20.8	20.2	-0.1	
		03/17/2018 10:44:18	600	2120	24.7	1.70	-36.6	6.52	7.8	114	14.3	20.2	-0.1	
		03/17/2018 10:45:41	700	2290	8.0	1.24	-27.1	6.69	2.6	105	7.9	20.2	0.0	
		03/17/2018 10:47:21	800	2310	0.9	1.02	-17.7	6.74	0.7	99	5.7	20.2	0.0	
		03/17/2018 10:48:32	900	2320	0.4	0.89	-12.7	6.75	0.1	96	3.0	20.3	0.1	
		03/17/2018 10:50:00	1000	2320	0.0	0.77	-13.5	6.78	0.4	93	3.1	20.3	0.1	

Sample Tab Showing Stabilization Parameters

3. The new file needs to be quality control checked.
    a. Check the header cells of the “Front” tab. Make sure all of the data is correct.
    b. Check the “I_k Behavior” tab and “Sample Attempt” tabs. Make sure the depths and comments are correct.
    c. Check the sample tabs for correct dates and times, head values and parameter values and comments.
    d. Check the “Processed I_k” tab.

4. This is where alterations or corrections can be made to the Processed I_k data. You can revise the depth to water, feet of stainless or other parameters that the software uses to calculate the I_k. You can also edit and delete any inaccurate I_k data.

5. Carefully check the I_k plot for any errors or inaccurate data. Inaccurate data can be generated a variety of ways and should be deleted from the plot. Examples of this data are: driving the tooling with the flow off (flow is zero), driving the tooling without starting the KPRO Session (no data is recorded), not stopping the KPRO Session after a drive, entering the wrong depth after a drive, large I_k jumps when drilling stops, etc. If any of these things happen, delete or revise the data from the Processed I_k tab. Leave a blank row where the data was deleted so that the I_k Plot does not connect the data with a straight line.

   There are other cases where after adding a length of stainless tubing the flow drops resulting in a horizontal line on the plot. Sudden jumps in I_k can be changed by scaling data up or down so it aligns with the other data. Consult the Data Manager or Project Manager on how to correctly edit the I_k data.

At the end of the day email the data (Groundwater Profiling Log excel document, all associated csv files, and a scan or photo of the paper field form) to the Project Manager and/or Data Manager and back up the entire project folder to a data stick. Draft data can be given to the client in the field. Make sure that the file is named with the suffix "_Draft".

5.11 End of Project of Shift

At the end of a project or a work shift, the APS consumables need to be inventories, any broken equipment needs to be accounted for, and the APS equipment and vehicle need to be cleaned and organized. The Waterloo^{APS} End of Shift Checklist is included as Attachment 2. This form must be completed at the end of a shift or at the end of a project when the equipment returns. For the end of the shift, the form must be completed and left in the sampling vehicle for the next APS operator. A scan or photo of the form must be sent to the APS service line manager. If it is the end of a project, the original form can be submitted.

5.12 Final Data Deliverables

The final data package is completed by the APS Data Manager and consists of a brief narrative describing the scope of work, a table that lists the deviations from the standard operating procedure, copies of the stabilization parameter page of the Physchem Log, gInt plots of the I_k, physico-chemical parameters and I_k behavior. The final data package goes through a secondary review process by the APS Data Manager before it is delivered to the client. The secondary review is documented in the "Waterloo APS Secondary Data Reviewer Checklist". The completed checklist is maintained with the project file and can be made available for external review.

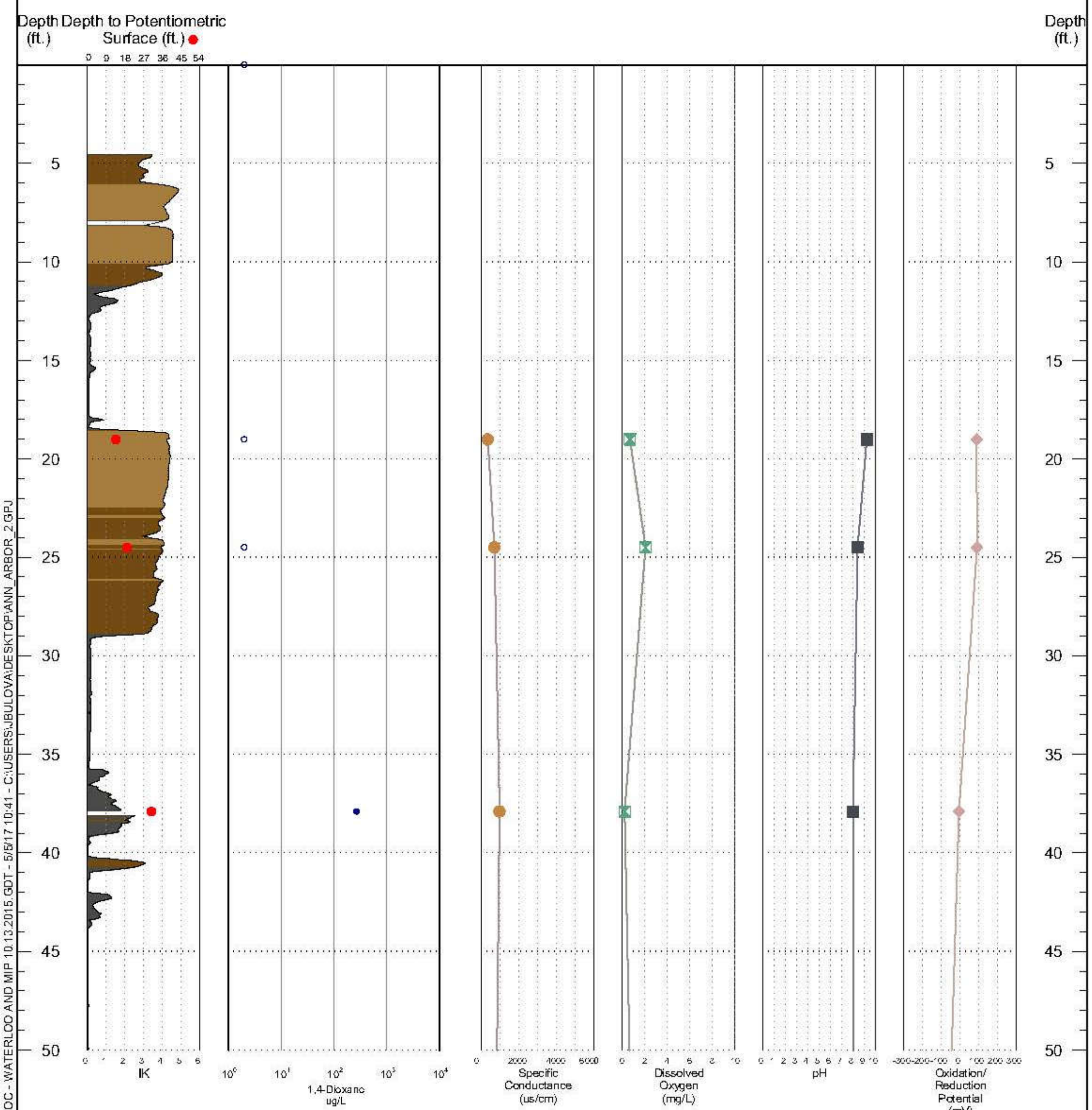
Waterloo APS-D™ ADVANCED PROFILING SYSTEM

BORING NAME: APS-001

Total Depth 65.6 ft.

Project Name APS Project
Client CTS
Cascade Project Number 205189999
Project Location Montpelier, VT

Date Completed 3/29/2018
Sampler(s) VLD
Drilling Contractor Cascade
Gas Drive or Peri Pump Gas Drive



WATERLOO ONLY 1 VOC - WATERLOO AND MIP 10.13.2015.GDT - 5/5/17 10:41 - C:\USERS\JBULOVA\DESKTOP\ANN_ARBOR_2.GPJ

IK Scale

0 to 0.1
0.1 to 2
2 to 4
4 to 6
>6

Legend

All results given as ug/L
Detects noted by filled symbol
Non Detects are noted by open symbols at the detection limit

PAGE 1 OF 2

gInt Plot of Final APS Data

5.13 Cold Weather Operation

During the winter months when temperatures fall below freezing special precautions need to be taken to protect and successfully operate the Waterloo^{APS} equipment, APS box, and associated equipment.

5.13.1 Exposed Stainless Steel Tubing and Rods

While attempting to collect a groundwater samples with below freezing temperatures a cold weather harness may be required. The cold weather harness is a combination of heat tape and pipe insulation wrapped around the stainless steel tubing exiting the APS Box. In extreme cold the rod stickup and stainless steel tubing exposed between the cold weather harness and the ground may need to be heated using either a brush-burner or torpedo heater. Flexible duct work can be used to cover the stainless steel and exposed rod to direct the heat from the torpedo heater and to help insulate.

5.13.2 Leaving the Site Overnight

If freezing conditions will occur overnight the APS Box needs to be winterized. The flow meter and pressure transducer should be removed and stored where temperatures will not fall below freezing. The APS box and cold weather harness should be drained of water:

1. Disconnect the stainless steel tubing harness from the down-hole tubing.
2. Place the "U" piece of steel tubing with male quick connects on each end where the flow meter and pressure transducer were.
3. Disconnect the nitrogen "in" (white) KPRO vessel quick connect.
4. Remove the water "out" (black) KPRO vessel quick connect.
5. Turn the regulator dial counter clockwise so that regulator is off. Attach the stainless steel piece that was connected to the "out" (black) quick connect to the low pressure regulator on the nitrogen tank.
6. In the peristaltic pump mode set up the valves on the box as if you were in drive mode and slowly turn the knob on the regulator clockwise slowly until a small amount of nitrogen is flowing. After a few seconds you should see water being pushed out of the harness. After all of the water has been pushed out turn off the nitrogen regulator.
7. In gas drive mode you need to blow out the APS box as well as all three of the harness lines. To blow out the nitrogen line, simply turn the 5 way valve to the N2 Out and wait for all of the water to be pushed out of the nitrogen line on the harness. To blow out the sample line (middle tube on the

harness), arrange the valves as you would if you were filling the pump. Disconnect the N2 In and KPRO in quick connects on the APS box. Connect the N2 In to the KPRO In. Slowly turn the knob on the regulator clockwise slowly until a small amount of nitrogen is flowing and wait for all of the water to be pushed out of the sample line. To blow out the KPRO line, set up the valves on the box as if you were in drive mode and slowly turn the knob on the regulator clockwise slowly until a small amount of nitrogen is flowing. After a few seconds you should see water being pushed out of the harness. After all of the water has been pushed out turn off the nitrogen regulator.

The flow meter and pressure transducer, KPRO vessel, “out” (black) quick connect, Sonde water quality monitoring system, and calibration solutions should be stored where temperatures will not fall below freezing.

5.14 Other Profiling Configurations

It is possible to set up the APS box on a table, cart, tailgate or other surface in order to profile in locations that cannot be accessed with the truck. A portable gasoline powered generator is the preferred power source. If a generator is not available, it may be necessary to power the equipment using a battery. Do not use a standard car battery as repeated draining and charging will diminish its capacity over time. It is better to use a deep cycle RV or similar battery that is designed to power devices and not for starting engines. It is possible to power the APS box (including peristaltic pump) and field computer off of a battery for an entire 10 hour day as long as the battery is charged at night. The APS Box and computer will need to be connected to a DC to AC power inverter that is connected to the battery.

5.15 Sampling for PFCs

A few alterations must be made to the KPRO system when sampling for Perfluorinated Chemicals (PFCs). When using the peristaltic collection method, the FEP tubing connected to the profiling tip must be replaced with a High Density Polyethylene Tubing (HDPE). Any Teflon tape must be American-made or an alternative must be found. Any plastic (poly or Tygon tubing) must be replaced with HDPE or stainless steel tubing. Any water that is to be used either as injection water or decon water must be from a PFC free source (i.e. Spring water purchased for the project must be tested and approved).

6.0 DOCUMENT CONTROL SYSTEM

All logbooks, paper field forms, Certificates of Analysis for sonde calibration solutions and electronic field forms will be tracked in the Document Control System.

6.1 Maintenance Log Books

All maintenance log books associated with the APS boxes and water quality sondes will be numbered and recorded in the "Document Control Record" spreadsheet that is maintained in the "GLP_NELAP\Controlled Document Management" folder on the Cascade network. Logbooks will be tracked based on the following:

1. Assign a unique Document Control Number to each logbook that records a specific activity - this ID does not change for the life of the activity. Maintenance logs will be named "NFS" for "Notebook, Field Sampling" followed by a number (example: NFS001).

2. For an activity that has been assigned a specific Document Control Number, the first book issued is revision "0", the second book issued is revision "1", and the third book issued would be revision "2" and so forth. The ID does not change but the date and revision number do change with each book issued. For example, the first book issued would be NLB001.04.20.2017.00 (assigned on April 20, 2017), the second book issued for the same piece of equipment would be NLB001.07.20.201701 (assigned on July 20, 2017).

3. Print a label or handwrite this Document Control Number on the front cover of the logbook.

4. Enter the date issued in the spreadsheet; this is the date the book was created. The date issued and closed do not need to be recorded on the book, but do need to be recorded in the tracking system.

5. Enter the closed date in the spreadsheet - this is the last date the book was used.

6. Date issued and closed date do not need to be the same day; however, there should be no gaps in the chronological record.

7. Archive Location – retired logbooks will be kept in a file drawer in the Lab Quality Assurance Manager's office.

8. Disposal Date - the earliest date the book can be disposed of, which is 10 years for books that recorded analytical or field procedures.

9. Once a book is archived, if the book is removed from the file cabinet, it should be signed out and back in again when it is returned. A sign in/out sheet will be located in the file cabinet where the logbooks are archived.

6.2 Paper and Electronic Field Forms

All paper field logs will be scanned or photographed and emailed to the APS Data Manager at the conclusion of each APS location. These electronic versions will be saved in the project folder on the Cascade network, along with any other electronic data pertaining to a specific project (e.g., electronic spreadsheets and raw data). The original forms will be returned to the APS Data Manager at the conclusion of the project and will be stored in a folder dedicated to that project. The folder will be labelled with the project name, number and date and will be stored in a dedicated file cabinet in the archive room.

6.3 Certifications of Analysis for Calibration Solutions

Certifications of analysis (COA) will be retained for each lot of calibration solution received. This certification applies to a particular lot number, which is printed on the side of the calibration solution bottle. This certificate will be scanned or photographed and stored in a file on the Cascade network. The lot number of the calibration solution used must be recorded in the Maintenance and Calibration Logbook for each sonde.

6.4 Electronic Field Forms

Versions of electronic field forms will be tracked in the "Document Control Record" spreadsheet that is maintained in the "GLP_NELAP\Controlled Document Management" folder on the Cascade network. Each version of the form will be recorded on the spreadsheet and given a unique ID. The current version of the forms will be stored on the Cascade network and made available to all field sampling staff.

7.0 TRAINING DOCUMENTATION

A Waterloo^{APS} Training Outline and Checklist will be completed by the trainer for each trainee. The completed checklist will be scanned and saved in the employee's training folder on the Cascade network and a hard copy will be stored in the employee's physical training folder.

8.0 RESPONSIBILITIES

1. It is the responsibility of the individual employee to read SOPs and document training associated with the area of work they are performing.
2. It is the responsibility of the individual employee to follow SOPs covering activities in his/her work area or to identify a deviation from the written SOP.

3. All personnel will legibly record data and observation to enable others to reconstruct project events and provide sufficient evidence of activities conducted.
4. All personnel will label each page with the date, the signature of the person taking notes (initials may also be appropriate), and the page number. All notes, signatures, and other observations should be entered in the field at the time the notes are taken.
5. CTS field staff should take care to ensure proper data management and integrity of samples.

9.0 REFERENCES

None

10.0 ATTACHMENTS

Attachments:

1. Attachment 1: APS Equipment List
2. Attachment 2: APS End of Shift Checklist
3. Attachment 3: APS Quick Reference Guide

11.0 AUTHORIZATION

Revised by:____________________________________ Date:____________

Casey Moore, Waterloo^{APS} Service Line Manager

Approved by: ___________________________________ Date:____________

Attachment 1

Waterloo APS Equipment Checklist

Vehicle ______________________ **Date** ______________________

CRS Project No. ______________________

Gas Drive / Peri: __________
Estimated Target Depth: __________
Number of Samples/Hole: __________
Onsite / Offsite Lab: __________

Upon Completion of the Checklist, please turn leave this form in the profiling truck. Scan a copy and email to the APS Manager.

Profiling Drive Hardware

	Have	Need
- Profiler Tips (4)		
- 5' x 1.75" Drill Rod (2 x max. anticipated depth)		
- Drive Cap (3)		
- Geoprobe Pull Clamp for 1.75" Rod		
- Mushroom Pull Cap (optional)		
- Swivel Pull Cap (deep profiling only)		
- Quick Clamp		
- Rod Wiper		
- Rod Wiper Plate		
- 24" Pipe Wrenches (2)		
- 1/8" SS Tubing (2x anticipated depth, 6x depth for gas drive)		

Pump / Tip Assembly (not including swage box items)

	Have	Need
- FEP Tubing (1/4" OD x 3/16 ID, 1' per location)		
- Stainless Steel Mesh for Tips (4 per tip plus extra)		
- 80 x 80		
-100 x 100		
-120 x 120		
- Screws for tip (3/8" #10/32, flathead T-25, 2 full boxes)		
- Bicycle Tubes (only if dropping into casing)		

Gas Drive Only

	Have	Need
- 2.4' x 1.75" Female - Female Pump Housing (3-4)		
- Male - Male Housing Pin (Bottom) (3-4)		
- Male - Female Housing Pin (Top) (3-4)		
- Springs (2 Per Pump)		
- Nylon Bushing (1 Per Pump)		
- Pump Bottom (3)		
- Pump Body (3)		
- Pump Top (3)		
- Reed Valves (use special deep valves for profiles over 150')		
- O-Rings for Pump Body (30)		
- O-Rings (small for piston) for Pump Bottom (30)		
- 1/4" SS Gas Drive Piston (5+) - 0.5' long for male geoprobe tip		

APS Box and Related Equipment

	Have	Need
- APS box		
- Backup APS box		
- Waterproof bag with cables		
- Maintenance and Calibration Log Book		

- DPT/EC pigtail cable		
- COM Data Cable		
- Power Cable		
- String Pot Cable		
- Backup cables		
- String Pot (2)		
- Dual Phase Regulator (0-60 psi) for KPRO (2)		
- Pressure Vessel (2)		
- Pressure Vessel Quick Connects		
- White - N_2 Side with Stainless		
- Black - Water Side with Stainless		
- Spare Delrin Block Vial Holder for Jig		
- 1 Liter Graduated Cylinder (Plastic - 2)		
- Silicon Tubing for Peri Pump (10 Feet)		
- Tygon Tubing (2 feet)		
- Compressed N2 Tank		
Gas Drive Only		
- Additional Dual Phase Regulator (0-600 psi) for Gas Drive (2)		
- "T" for Regulator (2)		
- Pressure Release Quick Connect		
- Short 1/8" SS Tubing piece w/ male quick connect for regulator		

Swage Box

	Have	Need
- Ferrules		
- 1/4" Nylon (20-30 depending on # of holes)		
- 1/8" Stainless Steel (30-40)		
- 1/4" Stainless Steel (10-20)		
- Profiler Tip Plates (16)		
- O-Rings for KPRO Reservoir (1 Large and 2 Small)		
- Hose Clamps (5+)		
- NPT Male to Compression Fittings		
- 1/4" NPT to 1/8" Compression Straight/Elbow (3 of each)		
- 1/8" NPT to 1/8" Compression Straight/Elbow (1 of each)		
- 1/8' Compression to 1/8" Barb		
- 1/4" Female NPT to 1/8" Compression		
- 1/8" Compression to Tube fitting (3)		
- 1/4 Compression to Tube fitting		
- Spare 5-Way Valve		
- Spare 3-Way Valve 1/4"		
- 1/8" SS Tube Caps (many for gas drive)		
- 1/8" Swage Nuts (20-30)		
- 1/8" Swage Unions (20-30)		
- 1/4" Compression to 1/8" Compression Fitting (5+)		
- 1/4" Swage Nuts (10)		
- 1/8" Swage to Quick Connect (3-4)		
- 1/8" Quick disconnect for Stainless (3-4)		
- 3/8" Quick Connect		
- 3/8" Quick Disconnect		
- Barbed Inserts for FEP Tubing, SS (3/16" OD) (15-20)		
- Spare Pressure Vessel Quick Connects (White and Black)		
- Torx Bits, (5-6) T-25, (1-2) T-30		

Hand Tools / Tool Box

	Have	Need
- 7/16" Wrenches (4), 9/16" (2), 1/2" (1), 5/8" (1)		
- Screw Drivers, Regular and Phillips (2 sizes of each)		
- Impact Wrench		
- Allen Wrenches (Standard)		
- Crescent Wrench (Large and Small)		
- 9/16" Socket, Open Ended for Removing Fittings From Tip		
- Taps for Profile Tip Screws		
- Tap Handle		
- Tap for Profile Tip		
- Torx Wrench		
- Picks (Straight, Right Angle, Curved)		
- Pliers (Standard, Needle Nose, and Channel Lock)		
- Vise Grips		
- Tin Snips		
- Files (Flat and Rounded)		
- Safety Knife		
- Extra Blades		
- Tubing Cutter		
- Scissors		
- Sledge Hammer, 3lb		

Other Tools and Power Equipment

	Have	Need
- Wire Strippers		
- Electrical Multi-meter		
- Soldering Iron		
- Flux Solder		
- Rosin-core Solder		
- Impact Driver Drill (optional)		
- Drill (optional)		
- Drill Bits		
- Carbide Bit for Reaming SS Tubing (optional)		
- Angle Grinder		
- Die Grinder		
- Dremel		

Decontamination Equipment

	Have	Need
- 5-Gallon Buckets with lids for Purge Water/Decon (2)		
- Large Elephant Brush		
- Steel Wire Brush		
- Pipe Cleaning Brush		
- Alconox		
- Squirt Bottles (2)		
- Plastic Sheeting - optional		
- Contractor Garbage Bags		

Auxiliary Equipment

	Have	Need
- Zip Ties		
-Colored Zip Ties for Gas Drive		
- Ratchet Straps		

- Bungee Cords		
- Assortment of Clips		
- 6 ft. Folding Wooden Ruler in tenths		
- Electrical Tape		
- Teflon Tape		
- Paper Towels		
- Broom		
- Extension Cords		
- Surge Protector		
- Traffic Cones		
- Cascade Safety Sign		
- Chair / Stool		
- Saw Horse (Legs optional) or Wood Pallet		
- Halogen Work Lights (optional)		

Personal Protective Equipment / Safety Equipment

	Have	Need
- Nitrile Gloves (2 Boxes)		
- Leather Work Gloves		
- Safety Glasses		
- Hardhat (1 Per Person + Spare)		
- Reflective Vests		
- Emergency Eyewash - check expiration date		
- First Aid Kit		
- Fire Extinguisher - check expiration date		
- Flashlight		

Computer

	Have	Need
- Field Computers (2)		
- USB Data Stick		
- External Mouse, USB		
- USB Hub (Optional)		
- Power Cable		

Sonde (Quanta)

	Have	Need
- Water Quality Sonde		
- Com Cable		
- Power Cable		
- Flow Cell		
- Calibration Cup		
- Calibration Standards (pH 4,7, Sp. Cond. 447,1413, ORP)		
- Maintenance Kits for Probes (optional)		
- Use, Maintenance and Calibration Log Book for Sonde		

Sample Collection / Paperwork

	Have	Need
- Quatro-Rings for Sample Jig		
- 40mL VOA Vials (2-3 cases)		
- Vial Labels		
- Binder with Groundwater Profiling Logs		
- Safety Forms		
- Pens and Sharpies		

Winter Gear

	Have	Need
- Cold Weather Harness		
- Quick connect "U" for blowing out the APS box		
- Pipe Insulation		
- Heat Tape		
- Propane Torch		
- Kerosene Heaters (aka salamander)		
- Flint		
- Propane Tank		
- Brush Burner		
- Canvas Tarp		
- Space heater		
- Cotton Liner Gloves (4-6 Pairs)		

DOT Required Equipment

	Have	Need
- Electronic Logging Device (ELD)		
- Spare Bus Fuses		
- Reflective Triangles		
- Fire Extinguisher in Cab - MOUNTED		
- Windshield Wiper Fluid		
- Flashlight		

Vehicle Maintenance Equipment

	Have	Need
**** Check oil pans and make sure they are empty!!****		
- Generator Maintenance Log		
- Truck Maintenance Log		
- Owners / Shop Manual (Generator and Truck)		
- Oil Pan		
- Spare Oil for Generator (6 qts)		
- Spare Oil Filters for Generator		
- Antifreeze		
- Oil Filter Wrench (Generator and Truck)		
- Oil Funnel		
- Quick connect tube for emptying oil		
- Spare absorbant pads		
- Spill kit		
- Wheel Chocks		
- Jumper Cables		

Rental Truck Gear / Out of Truck Profling

	Have	Need
(In Addition to the Equipment Listed Above)		
- Portable Honda Generator (5.5 KW)		
- Folding Tables		
- Storage Bins for Bulky Gear		
- Tool Box for Hand Tools		
- Ratchet Straps and Bungee Cords		
- Shop Lights		
- Cart		
- Easy Up / Tent		
- Battery - Deep Cycle (optional)		

- Battery Charger (optional)		
- Invertors / Connectors for Battery (optional)		
- Additional Extension Cords / Power Strips		
- GFCI Cord		
- Small Compressed N2 Tank (2)		

Downhole Pressure Transducer

	Have	Need
- Pressure Transducer Sensor		
- DPT Tubing		
- 1/4" to 1/8" Compression Union (at least 2 per DHPT)		
- 5' SS Tubing sections (2)		
- 3' SS Tubing section		
- 100' Orange Geoprobe Trunk Line (2)		
- 3-Way valve Quik-Connect for KPRO OUT		
- Electrical Tape (5 rolls)		
- 3-Way valve for DHPT Calibration		

Electrical Conductivity

- EC Profiling Tips		
- Geoprobe EC Trunk Line (2)		
- EC Data module (Field Computer, Field Instrument, etc)		
- Dipole Tester		

KPRO Box Calibration

Box # ________ Date: ______________

	Expected	Old	New
Flow Meter	~35-41	______	______
Pressure Transducer	~22-25	______	______
String Pot	~0.97	______	______

KPRO Box Calibration

Box # ________ Date: ______________

	Expected	Old	New
Flow Meter	~35-41	______	______
Pressure Transducer	~22-25	______	______
String Pot	~0.97	______	______

Name and Sign: ____

Attachment 2

PROFILING CONSUMABLES SHIFT CHECKLIST

Truck Used: 2625 / 3956 / Rental / ATV

Date(s): ______________________

Cascade Project #: ______________________

Employee: ______________________

KPro Box # & Swage Box #: ______________________

Peri or Gas Drive: ______________________

Expected duration of project: ______________________

Approximate # of consumables as follows? (If amount is clearly sufficient, put check)

Tips	Pumps	Pump Housings
String Pot	Cables (sp, data, power)	
Tip Screws (boxes)	Tip Plates	Tip Screens
Unions/1/8" SS ferrules	¼" Nylon ferrules	Ft. of Tubing (FEP)
Reed valves	VOAs	Jig Quattro O-rings
Gas drive O-rings	Nitriles	Cal Solutions
5 way valves	3 way valves	Inserts for FEP
SS tubing	Rod	Drive Caps
Down Hole Transducer	Trunk Line	Rod Puller

List any items that were replaced or taken out of service (tips, pumps, flow meter, pressure transducer, string pot, computer)

____

____

List items that might need replacing (bad quick connects, valves, SS)

____

Provide a detailed narrative for the next field staff which includes any issues with the equipment, any special instructions for collecting samples (intervals, sample volume, client limits on time or volume) or any other general notes.

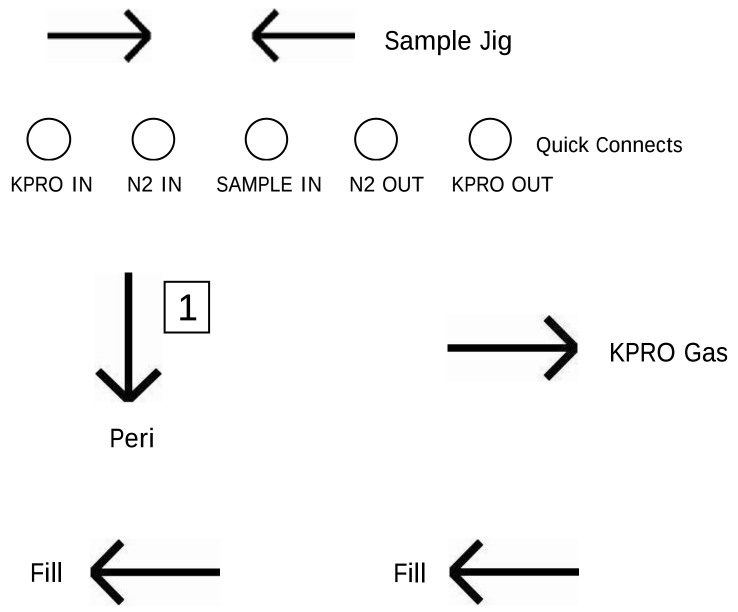
____

____

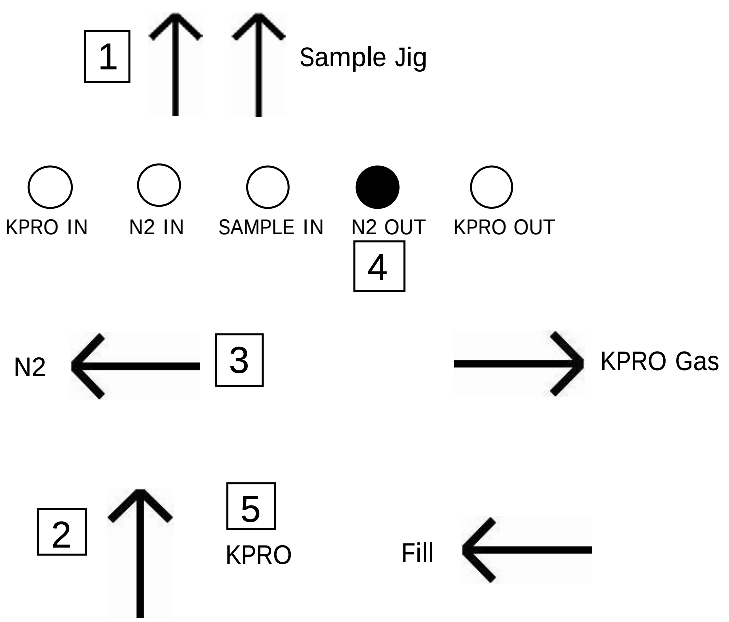
Attachment 3

KPRO Quick Reference Guide

Gas Drive - Filling For Drive / Pressure Testing the Pump



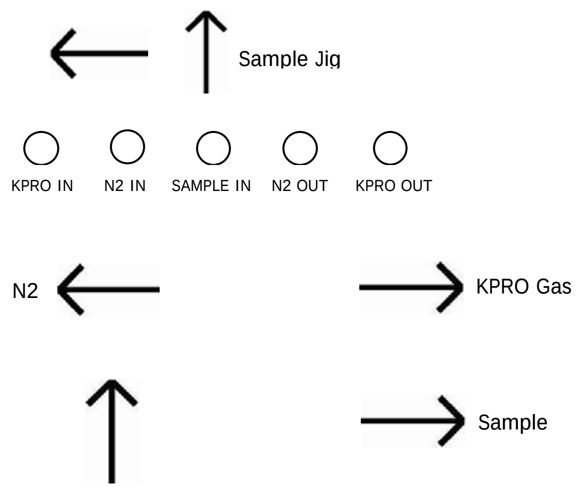
1. Connect the pump to the harness.
2. Arrange the valves as shown. Always turn the 5-way valve clockwise (the top left valve on the bottom, labeled as 1).
3. Make sure that the regulator on the nitrogen tank that supplies the nitrogen to the "N2 IN" is set to the pressure the pump will be used at (to find the pressure, halve the depth, so for 400 feet set the regulator at 200 psi).
4. Turn on the peristaltic pump.
5. The pump is now filling with KPRO water. When the pump is full, you will see a steady stream of water flowing out of the "PERI OUT" tube located at the bottom right hand corner of the KPRO box. This can take several minutes depending on depth. The deeper you are, the longer it will take.
6. Let the water flow out until there are no air bubbles and you get a steady stream.



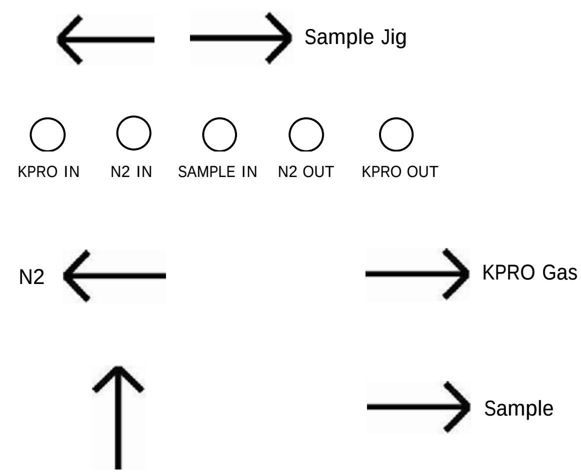
1. Lock off the valves on the sample jig by turning them towards the back (perpendicular to the tubing).
2. Turn off the flow by turning the bottom left valve one quarter turn (which may be to the right or left depending on how the valve was installed..
3. Turn on the nitrogen by turning the top left valve one quarter turn clockwise. You will see the pressure on the gauge rise to the approximate pressure set on the regulator.
4. Disconnect the "N2 OUT" quick connect from the KPRO box. (Second from the right). Observe the pressure gauge. The pressure should drop slightly, then hold. This means that the pump is holding pressure. If the pressure drops significantly then there is a leak. Double check that the fittings connecting the harness to the pump are tight. If this doesn't work, then double check the O-rings and reed valve. If there is still a leak it could be the 5-way valve. Check the Problem Solving Guide for troubleshooting tips./
5. If the pump holds pressure, reconnect the N2 out and turn the flow on by turning the bottom left valve one quarter turn clockwise to "KPRO".

Gas Drive - Sampling / Purging The Pump

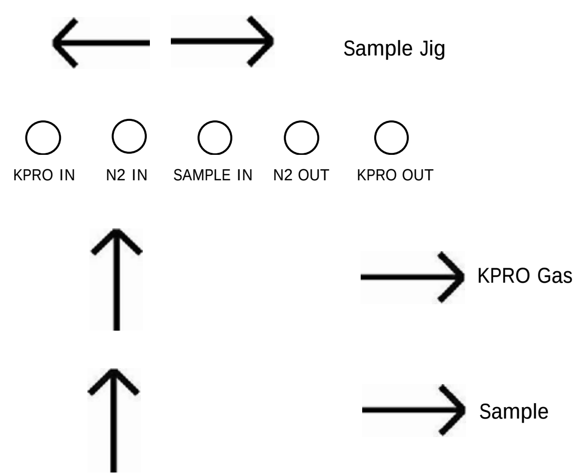
1. After driving to the sample depth and hitting the “Finish” button on the KPRO software, arrange the valves as shown below by turning the left valve on the sample jig to the left and the bottom right valve one half turn clockwise to “Sample”. Make sure the Peri pump is on. The Peri pump will help the sample to come in faster at depths up to around 200 feet. Samples deeper do not require the Peri pump to be on.



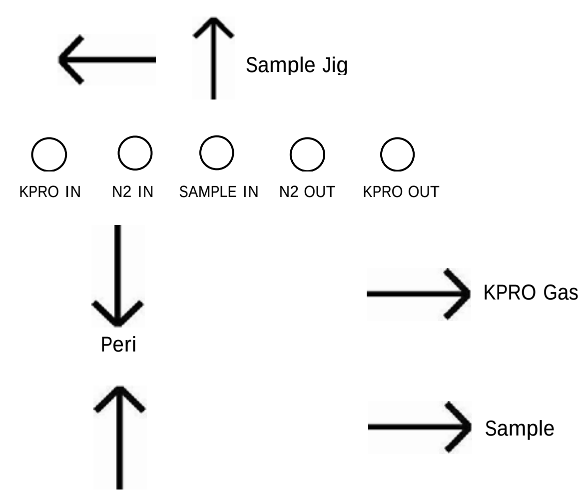
2. Since the pump is already pressurized, turn the right valve on the sample jig so it is facing to the right. This will allow the nitrogen to push the water up from the pump through the sample jig. You should see the VOAs begin to fill. The pressure on the gauge will drop and stabilize.



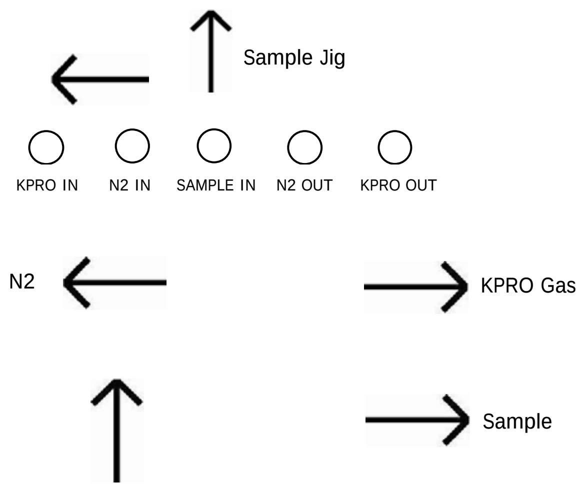
3. Keep a close eye on the pressure gauge. When the pressure gauge starts to move up, turn the top left valve a quarter turn clockwise. This will vent the nitrogen, which will make a hissing sound.



4. After venting the nitrogen, the pressure gauge will drop. When it crosses zero, turn the right valve on the sample jig towards the back (locked off). Wait for all of the gas to vent (the hissing sounds will dissipate) and turn the top left valve one half turn clockwise so it is on “Peri”. Record the physchem values.



5. After waiting three minutes (or more or less, depending on how much water was purged during the previous whack) turn the top left valve one quarter turn clockwise to "N2". This will send nitrogen down to pressurize the pump. This is called a "whack". Watch the pressure gauge. When it moves up past zero, turn the right valve on the sample jig to the right. Go back up to step 3 above and follow the sequence.



6. Once the physchem parameters have stabilized and the sample vials have been collected, the pump needs to be filled and pressurized again for driving. Go back up to that section for instructions.
7. To collect the sample vials: Pressurize the pump as shown in Step 5 but do not open the top right valve on the sample jig. Unscrew the left most vial and hold it under the straw. Slowly open the right jig valve allowing a small amount of water to flow out to top off the vial. Cap the vial and check for bubbles.

Some notes:
After driving, the stainless steel lines and pump are filled with KPRO water. This water needs to be purged before formation water will appear. To calculate how much KPRO water is in the tubing and pump, multiply the amount of stainless by two, then by 0.8, then add 100. (This accounts for the volume of the tubing going down, coming back up and the pump. There is 0.8 ml per foot of tubing). The first whack should produce almost all of this volume of water.
A good whack should yield 50-60 ml minimum. If you do not get this volume after waiting 3 minutes, wait longer (4 minutes, then 5, etc). If you get more volume than 50-60, do the whacks more often (2 minutes). If you do not get 50-60 ml after waiting 5 or 6 minutes, you may want to drive to a better sampling interval.

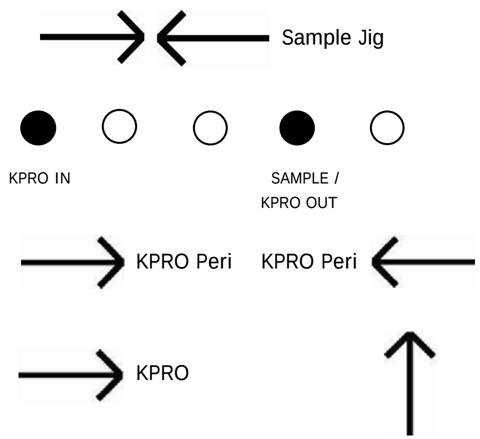
If after the first whack you have purged the volume of KPRO that is in the pump and tubing, and after waiting longer between whacks you get nitrogen coming back up instead of water, chances are the sampling interval will not yield a sample. To double check, refill the pump with KPRO water and start the purging/sampling process again.

If you have just added stainless and notice that the flow is a lot lower than it was at the end of the previous drive, you may have a blocked or kinked piece of stainless. Before driving, disconnect the stainless and blow it out with water to make sure all the lines are clear.

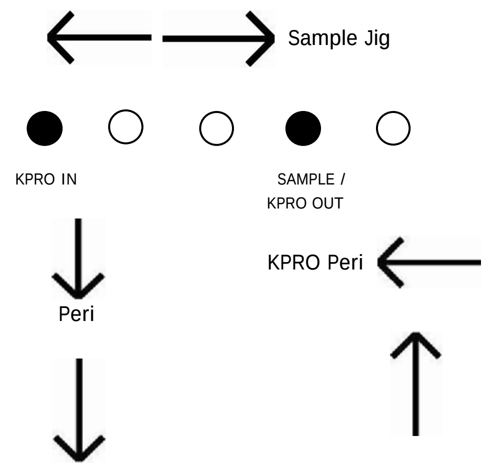
Please see the Problem Solving Guide if you have problems that aren't listed here, or if you can't figure it out call the office or somebody to help.

Peristaltic – Driving and Sampling

1. Driving – Arrange the valves per the diagram below. For head measurements turn the bottom left valve 90 to shut off the flow. The two right valves are not used once they are set to the configuration below.



2. Sampling – Arrange the valves as below. Turn on the peristaltic pump. To collect the sample vials lock off the top right valve on the sample jig. Turn off the pump, reverse the direction and turn back on for 2 seconds. Unscrew the left most vial and hold under the straw. Turn on the pump in short bursts to top off the vial. Cap and check for bubbles.



APPENDIX C FIELD FORMS

GROUNDWATER FORMS

FLUID LEVEL GAUGING FORM

Project Name: ______________________ Personnel: ______________________

Equipment Info (water level meter model, serial number): ______________________

Well ID	Date	Time	Depth to Water (feet below measuring point)	Measuring Point	Total Depth	Notes

WELL INSPECTION FORM

Page ___ of ___

Project Name: ____________________ Personnel: ____________________ Equipment Info (water level meter model, serial number): ____________________

Date: ____________________ Weather: ____________________

Well ID	Depth to Water (feet below measuring point)	Measuring Point	Total Depth (feet below measuring point)	Label Present?	Padlock Present?	Well Lid Present?	Bolts/Threads Present?	Gasket Present?	Expansion Plug Present?	Inner Casing Condition	Outer Casing Condition	Concrete Pad Condition	Bollard Condition	Notes (repairs needed, equipment in well, accessibility issues?)
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	
				Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Good / Poor	Good / Poor	Good / Poor	Good / Poor	

GROUNDWATER SAMPLING LOG

Project Name: ______ Date: ______ Equipment Info (model, serial number, etc)

Well ID: ______ Weather: ______ Water Level Meter: ______

Sampler Name: ______ Sampling Method: Low-Flow Positive Displacement (for multi-level locations) Pump Type: ______

Total Depth: ______ Grab (recharge after pumping dry) Other (explain) Water Quality Meter: ______

Initial Depth to Water: ______ Purge Start Time: ______ Other Equipment: ______

Measuring Point (MP): Top of Casing Other (explain) Purge End Time: ______ Tubing Type: ______

Well Diameter: ______ Total Volume Purged: ______

Pump Intake Depth: ______ Filter(s) Used: ______ Other Notes or ______

Minimum Volume to Be Removed (for CHS): ______ QA/QC Sample? ______ Observations: ______

Well Condition: ______ QA/QC ID ______

			Water Quality Parameters						
Time	Depth to Water (ft below MP)	Flow Rate (mL/min)	Temp. (^{o}C) +/- 3%	D.O. (mg/L) +/- 10% (if >0.5 mg/L)*	Sp. Cond. (μS/cm) +/- 3%	pH (standard units) +/- 0.1 su	ORP (mV) +/- 10 mV	Turbidity (FNU) +/- 10% (if >10 FNU)*	Notes

Notes:

If collecting samples using low flow method, flow rate should be adjusted to maintain minimal drawdown (no more than 0.3 feet), and water quality parameters will be recorded at a frequency that allows the flow cell to turn over at least once between measurements (generally every 3-5 minutes).

Stabilization criteria based on three most recent consecutive measurements. If D.O. is <0.50 mg/L for 3 consecutive readings or if turbidity is <10 FNU for 3 consecutive readings, consider those parameters stable.

No stabilization criteria are given for samples collected using grab method (recharge after pumping dry), or positive displacement method at multi-level locations. Depth to water is not measured when sampling using the positive displacement method.

Samples Collected:

Analytical Method	Number and Type of Bottles	Preservative	Field Filtered?	Lab

DRILLING FORMS

Subsurface Clearance Project Plan

ERM

Site/Project Name: ____________________

Client: ____________________

ERM Project No.: ____________________

This Subsurface Clearance (SSC) Project Plan must be completed for each phase of ground disturbance activities at a project location. A copy of this document must be maintained at the project location for the duration of ground disturbance activities. The ERM Partner-in-Charge (PIC) and SSC Experienced Person (EP) or field team lead must review and approve the completed SSC Project Plan **prior to any point disturbance clearance or ground disturbance activities** (all approvals appear on final page of this document).

Administrative Information	Date Plan Started: Date Plan Completed:	Field Work Start Date: Field Work End Date:
	Project Manager:	Partner In Charge:
	SSC EP [1] / Field Team Lead:	Local MP or designee (for any waivers):
	List any additional SSC General Employees (GEs) working on this project:	
	Describe the Scope of Ground Disturbance Activities:	*Check all that apply:* ☐ Point disturbances (manual / hand digging only) ☐ Point disturbances (using mechanized equipment) ☐ Excavation / trenching / grading ☐ Removal / coring / drilling of concrete, asphalt, etc. ☐ Other - Describe:

Project Information Summary	Yes	No	N/A	Comments
Knowledgeable Contact Person(s) identified, and presence requested during site walk. SSC Project Plan reviewed with knowledgeable contact person(s)	☐	☐	☐	Who:
As-built drawings, site plans, maps, aerial photographs, and other information sources available and reviewed	☐	☐	☐	List (including dates):
Other information obtained (e.g., easements, right-of-ways, historical plot plans, current/historical aerial photographs, fire insurance plans, tank (dip) charts, SSC information obtained as part of previous site investigations, soil surveys, boring logs	☐	☐	☐	List (including dates):
All subcontractors (including ground disturbance, private utility locating, concrete coring, etc.) prequalified and approved	☐	☐	☐	List Private Utility Locate Subcontractor(s):
Specific SSC scope of work items in all work orders for subcontractors involved in SSC and ground disturbance activities (i.e. point disturbance clearance methods and required tools, field documentation and utility markout methods for private utility locate subcontractors, etc.)	☐	☐	☐	List all Ground Disturbance Subcontractors:
Additional client and/or regulatory requirements apply to the project and have been incorporated into H&S plan documents	☐	☐	☐	If yes, specify:
ERM / client / regulatory SSC requirements have been communicated to all field personnel including subcontractors (refer to SSC Review Checklist for Subcontractors - *ERM-1511-FM5*)	☐	☐	☐	
Current and valid SSC training certifications confirmed for all ERM staff (including PIC and PM)	☐	☐	☐	
Current and valid additional training certifications (e.g., detection equipment operation) confirmed for all ERM staff and subcontractor personnel	☐	☐	☐	List additional trainings:
UXO/MEC risks assessed: UXO/MEC is present or potentially present	☐	☐	☐	If Yes, stop work and contact PIC
Project location meets criteria for Remote/Greenfield Site	☐	☐	☐	If Yes, project teams can elect to complete the SSC Project Plan for Remote/Greenfield Sites (ERM-1511-FM2) instead of this form

[1] SSC EP not required for Remote / Greenfield sites, as defined in the ERM Global SSC Procedure (ERM-1511-PR1).

Subsurface Clearance Project Plan

Site Walk					
Identified Visual Clue	**Yes**	**No**	**Identified Visual Clue**	**Yes**	**No**
Lights			Pipeline markers		
Signage			Fire hydrants		
Sewer drains / cleanouts / drop inlets			Sprinkler systems		
Cable markers			Water meters		
Utility poles with conduit leading to the ground			Natural gas meters		
Utility boxes			UST fill ports and vent pipes		
Manholes			Equipment locations		
Pavement scarring			Steam lines		
Distressed vegetation or vegetation in linear pattern			Remote buildings with no visible utilities		
Overhead utility lines			Other (specify):		
Solar panels / wind power generation			Other (specify):		
Comments:					

	Yes	No	N/A	Comments
Visual clues / site features (below) integrated into Site Services Model				

Utility Markouts	Yes	No	N/A	Comments
Public Utility Locates completed (where available)?				
Responses received from ALL companies notified?				
List utilities notified:				

	Yes	No	N/A	Comments
Private Utility Locates completed [2] (waiver required if "NO")				
Utilities clearly marked with agreed method?				
Private locate findings documented?				

Private Utility Locate Performed by:	Date of most recent training on equipment operation:
Type of equipment / methods used:	
Date of most recent calibration of detection equipment:	
Note any limitations (e.g., sources of interference, geology, etc.):	

[2] Not required for Remote / Greenfield sites, except where required by local regulations or client procedures.

Subsurface Clearance Project Plan

Site Services Model Attach a site plan or drawing (to scale) showing planned ground disturbance location(s), the locations / routes of all identified or suspected subsurface and above-ground utilities and structures, and associated critical zones and excavation buffers.								
	Present?				Located?			
Utility / Structure	Yes	No	Un-known	Anticipated depth (note units)	Yes	No	Status (active, inactive, abandoned / decommissioned, etc.)	Comments (For each, describe how the utility or structure was located – such as as-built drawings, private locate, public locate, visual clues, etc. – and quality of information available)
Electricity								
Gas								
Petroleum Pipeline								
Other Pressurized Lines								
Process Sewer								
Sanitary Sewer								
Storm Sewer								
Potable Water								
Telephone / Communication								
Fiber Optic								
Plant air / steam								
Fuel / oil								
Reclaimed / waste water								
Fire suppression								
Underground tank(s)								
Other (Describe):								

Additional Notes on Site Services Model including identification of any data gaps:

Contact Person(s) Approval of Ground Disturbance at All Locations			
Name (Print)	Company	Name (Sign)	Date / Time

Final Critical Zone Determination					
Are there any ground disturbance locations <u>known</u> or <u>suspected</u> to be inside Critical Zones?	☐	**YES**	PIC and Local MP (or designee) must BOTH grant waiver for work within the Critical Zone. A sketch map must be developed for EACH ground disturbance location inside a Critical Zone (refer to template on last page)	☐	**NO**

Subsurface Clearance Project Plan

Overhead Clearance	Yes	No	N/A	Comments
Overhead utility lines in the general vicinity of ERM work onsite?				If NO, check N/A for remaining items in this section
If overhead utilities are present, has nominal voltage been determined? If yes, list in comments section.				Voltage:
Overhead clearances confirmed with equipment operators for safely deploying equipment to the location?				Clearance distance(s):
Proximity alarms, spotters, and /or warning signage necessary to ensure safe clearances?				
If the equipment is closer than the minimum clearance distance to the overhead utility, can utility be de-energized?				
If utility cannot be de-energized, alternate plan developed with approval from the PIC and client/site owner?				

Plan for point disturbance clearance at location(s): ______________________ *(Note that this plan must be reviewed and approved by the PIC before any clearance activities commence)*	*Attach additional sheets to completely describe clearance method, tools and depth if these will vary during the process from location to location.*			
	Yes	**No**	**N/A**	**Comments**
Clearance technique to be used (indicate which method): ☐ Compressed air excavation *(ERM preferred method)* ☐ Pressurized water excavation ☐ Hand digging ☐ Hand augering ☐ Soil probe rod *Pick axes, pointed spades, or any other tool that comes to a point are NOT to be used for point disturbance clearance.* *Note: a waiver is required if no clearance will be performed prior to use of mechanized equipment*				Provide rationale if NOT using preferred method of compressed air excavation: ☐ Scope of work limited to hand digging only ☐ Equipment not available ☐ Cannot meet technical objectives (e.g., vapor pins) ☐ Other (describe):
For locations that will be advanced with mechanized equipment (e.g., drill rig or direct-push) after initial clearance: Diameter of clearance must be to LARGER OF: 4 inches (10 cm), or at least 125% of the diameter of largest downhole tool to be used				Specify diameter (include units) of largest downhole tool: Specify diameter (include units) to be cleared:
For locations that will be advanced with mechanized equipment (e.g., drill rig or direct-push) after initial clearance: Depth of clearance: ☐ Outside Critical Zones, to 5 feet (1.5 meters). ☐ Inside Critical Zones, to 8 feet (2.4 meters) at a minimum, and deeper if necessary to clear to depths greater than 8 feet for deeper utilities and structures ☐ For locations with frozen soils, to 2 feet (0.6 meters) beyond the bottom of the frost line at the site.				Specify depth(s) and units:
Concrete coring / cutting – personnel performing these activities have been verified as trained and competent?				Describe risk mitigation techniques to be employed:

Excavation Plan *(Note that this plan must be reviewed and approved by the PIC before any disturbance activities commence)*	Yes	No	N/A	Comments
Communicate excavation plan and 2-foot (0.6-meter) Excavation Buffer location(s) to subcontractor(s). Delineate all Excavation Buffers.				
If possible, work with contact person / site owner to de-energize subsurface services prior to beginning excavation				
Risk mitigation measures reviewed and acceptable?				Describe:

Approvals

Review Meeting
The SSC Project Plan must be reviewed with the PIC BEFORE any point disturbance clearance or ground disturbance activities occur. This review must be completed through a verbal conversation, whether in person or by phone or video conference. Documentation of review can be indicated as "verbal" or be received via e-mail initially, but must be followed up with signatures in the final SSC Project Plan.

Reviewed by	Signature	Date of Review	Comments
SSC EP or Field Team Lead (required review):			
PIC (required review):			
Project Manager (optional review):			

Waiver Approvals
Two separate Partners are required to approve waivers. Both Partners must be SSC-certified (either GE or EP)

SSC Component Being Waived:	Waived By (PIC)	Waived by (Local MP)	Date	Rationale
Requirement for direct ERM supervision of ground disturbance activities: • SSC EP to oversee execution of the SSC Process (can include the entire project or specific SSC-related tasks), or • Direct oversight of subcontractors for Remote/Greenfield sites or shallow hand digging no deeper than 1.5 feet / 0.5 m)				Specify scope of waiver:
Performance of private utility markouts				
Clearance of point disturbance locations prior to advancing with mechanized equipment (including no clearance or partial clearance)				Indicate specific locations and scope of waiver:
Prohibition of ground disturbance inside a Critical Zone				Indicate specific locations:

SSC Project Plan Close-out (SSC EP or Field Team Lead)

Name (Print)	Name (Sign)	Date / Time

Additional Notes or Learnings

ERM

Subsurface Clearance
Project Plan – Critical Zone Sketch Map

Site/Project Name: ______________________

Client: ______________________

ERM Project No.: ______________________

SSC EP / Field Team Lead: ______________________

A sketch map must be developed for each ground disturbance location inside a Critical Zone (one map per location – attach additional maps as needed). Disturbance within a Critical Zone can only proceed with both PIC and Local MP (or designee) approval.

GROUND DISTURBANCE LOCATION ID:

GROUND DISTURBANCE LOCATION DESCRIPTION:

Instructions:

1. Create a sketch of the disturbance (in the space to left or attach) that is drawn to scale and contains the following information:
   a. The disturbance location
   b. Surface landmarks and overhead obstructions (buildings, roads, overhead lines, etc.)
   c. Subsurface utilities and structures that are:
      i. Identified in the Site Service Model
      ii. Marked by public and private utility locators
      iii. Communicated by knowledgeable contact person(s)
   d. Any surface visual clues as to potential underground services (junction boxes, drains, disturbed concrete, signage, etc.)
2. Use your sketch to mark Critical Zones (3m / 10 feet) around underground utilities and structures.
3. For excavations, use your sketch to mark Excavation Buffers (0.6m or 2 feet) from subsurface utilities and structures.

DRILLING LOG

Location:

Page ___ of ___

Project Name: ____________________
Project Number: ____________________
Client: ____________________
Start Date & Time: ____________________
End Date & Time: ____________________
Weather:

Logged By: ____________________
Contractor: ____________________
Driller: ____________________
Drilling Method: ____________________
Boring Diameter: ____________________
Boring Depth:

PID Model: ____________________
PID Serial Number: ____________________
Notes, observations: ____________________

ERM

DEPTH (FT)	RUN			LITHO DEPTH (FT)		DESCRIPTION										PID (ppb)	LAB SAMPLE COLLECTION
	TOP (FT)	BOT (FT)	REC (IN)	TOP	BOT	COLOR	PRIMARY GRAIN	CONNECTOR	SECONDARY GRAIN	SORTING	QUALIFIER	DIAMETER	STRENGTH/ PLASTICITY	MOISTURE/ MOTTLING	OTHER		

ROCK CORING LOG

Location:

Project Name: ______________
Project Number: ______________
Client: ______________
Start Date & Time: ______________
End Date & Time: ______________
Weather: ______________

Logged By: ______________
Contractor: ______________
Driller: ______________
Drilling Method: ______________
Boring Diameter: ______________
Boring Depth:

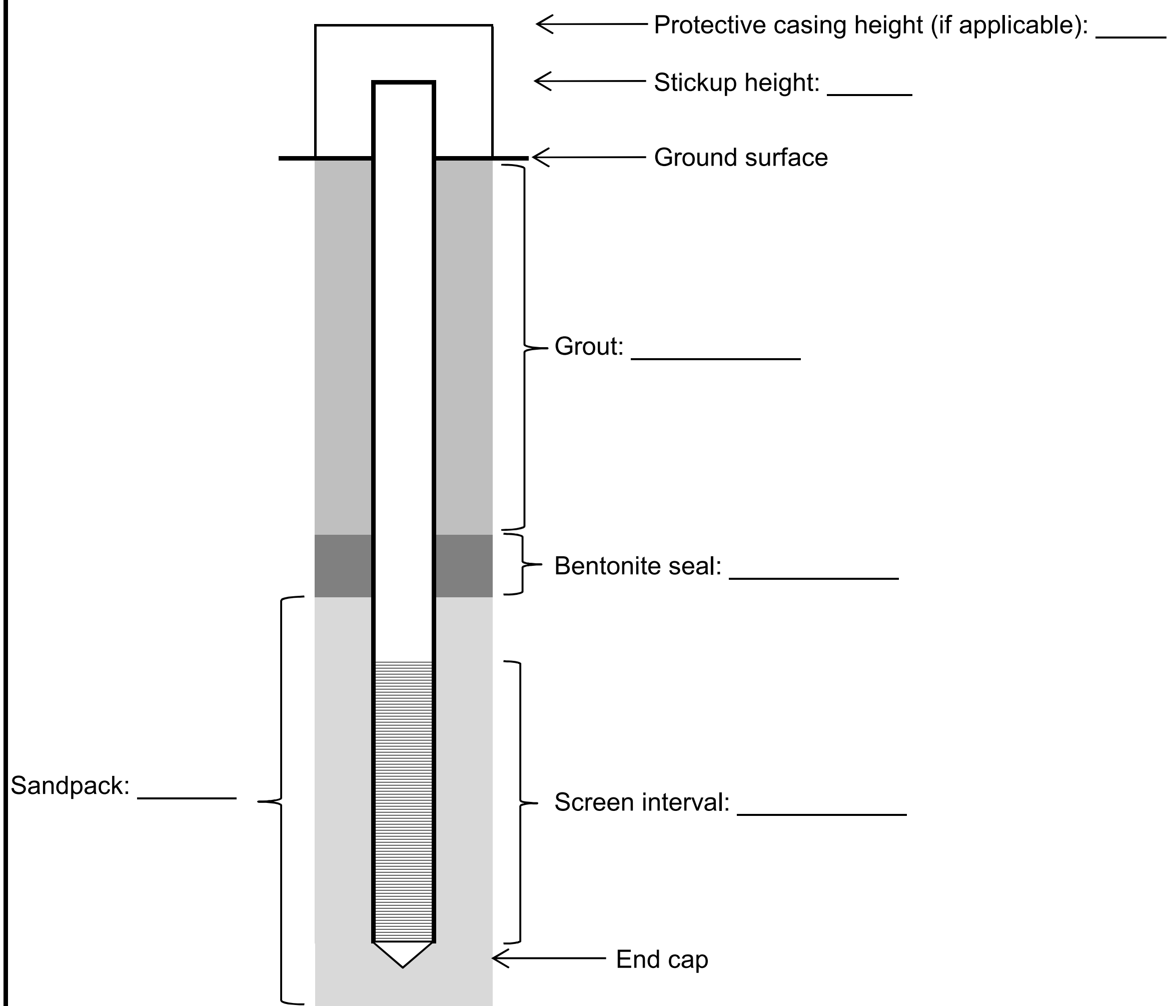
PID Model: ______________
PID Serial Number: ______________
Notes, observations: ______________

ERM

DEPTH (FT)	RUN			LITHO DEPTH (FT)		DESCRIPTION										PID (ppb)	LAB SAMPLE COLLECTION
	TOP (FT)	BOT (FT)	REC (IN)	TOP	BOT	COLOR	PRIMARY	RQD DESCR.	FIELD STRENGTH	TEXTURE	STRUCTURE TYPE	STRUCTURE ANGLE	DECOMPOSITION	DISINTEGRATION	FRACTURES		

MONITORING WELL CONSTRUCTION LOG (SINGLE SCREEN)
Location:

Project Name: ____________________ Logged By: ____________
Project Number: ____________________ Contractor: ____________
Client: ____________________ Driller: ____________
Start Date and Time: ____________________ Drilling Method: ____________
End Date and Time: ____________________ Boring Diameter: ____________
Weather: Boring Depth:



RISER & SCREEN
Type: ____________________
Schedule: ____________________
Diameter: ____________________
Screen Slot Size (in): ____________________

GROUND SURFACE COMPLETION
Type: ____________________
Other info (padlock added, etc):____________________
____

GROUT & BENTONITE
Grout Type: ____________________
Hydration Details: ____________________
Bentonite Type: ____________________
Hydration Details:

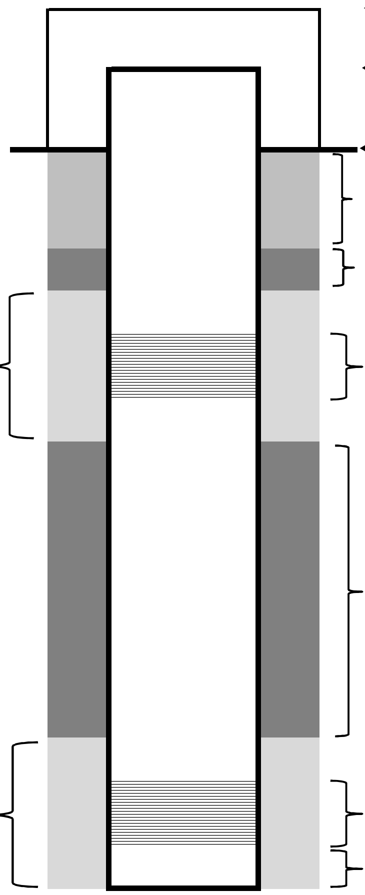
SANDPACK
Type: ____________________

OTHER NOTES ____________________

MONITORING WELL CONSTRUCTION LOG (MULTI-LEVEL - 2 SCREENS)
Location:

Project Name: ____________________ Logged By: ____________
Project Number: ____________________ Contractor: ____________
Client: ____________________ Driller: ____________
Start Date and Time: ____________________ Drilling Method: ____________
End Date and Time: ____________________ Boring Diameter: ____________
Weather: Boring Depth:

ERM



Protective casing height (if applicable): _____
Stickup height: ______
Ground surface
Grout: ____________
Bentonite seal: ____________
Sandpack: _______
Screen interval: ____________
Bentonite seal: ____________
Sandpack: _______
Screen interval: ____________
Sump: ____________

RISER & SCREEN
Type: ____________________
Schedule: ____________________
Diameter: ____________________
Screen Slot Size (in): ____________________

GROUND SURFACE COMPLETION
Type: ____________________
Other info (padlock added, etc): ____________________
____

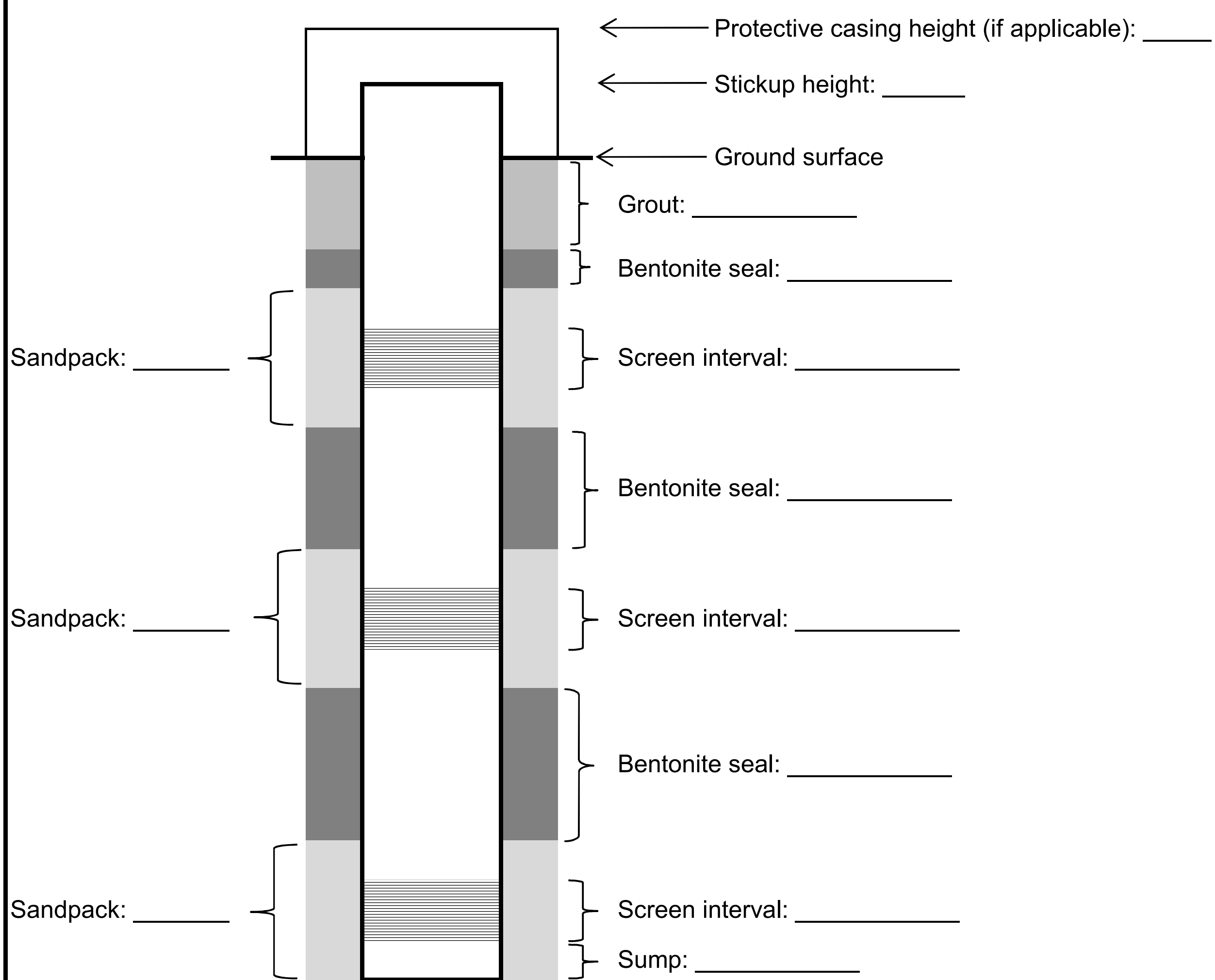
GROUT & BENTONITE
Grout Type: ____________________
Hydration Details: ____________________
Bentonite Type: ____________________
Hydration Details:

SANDPACK
Type: ____________________

OTHER NOTES ____________________

MONITORING WELL CONSTRUCTION LOG (MULTI-LEVEL - 3 SCREENS)
Location:

Project Name: ______________________ Logged By: __________
Project Number: ______________________ Contractor: __________
Client: ______________________ Driller: __________
Start Date and Time: ______________________ Drilling Method: __________
End Date and Time: ______________________ Boring Diameter: __________
Weather: Boring Depth:



RISER & SCREEN
Type: ______________________
Schedule: ______________________
Diameter: ______________________
Screen Slot Size (in): ______________________

GROUND SURFACE COMPLETION
Type: ______________________
Other info (padlock added, etc): ______________________

GROUT & BENTONITE
Grout Type: ______________________
Hydration Details: ______________________
Bentonite Type: ______________________
Hydration Details:

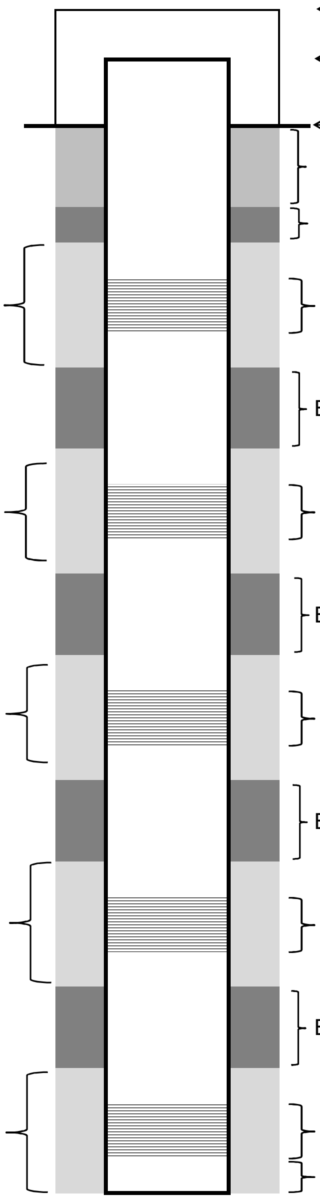
SANDPACK
Type: ______________________

OTHER NOTES ______________________

MONITORING WELL CONSTRUCTION LOG (MULTI-LEVEL - 5 SCREENS)
Location:

Project Name: ______	Logged By: ______
Project Number: ______	Contractor: ______
Client: ______	Driller: ______
Start Date and Time: ______	Drilling Method: ______
End Date and Time: ______	Boring Diameter: ______
Weather:	Boring Depth:

ERM



Protective casing height (if applicable): _____

Stickup height: ______

Ground surface

Grout: ____________

Bentonite seal: ____________

Sandpack: _______

Screen interval: ____________

Bentonite seal: ____________

Sandpack: _______

Screen interval: ____________

Bentonite seal: ____________

Sandpack: _______

Screen interval: ____________

Bentonite seal: ____________

Sandpack: _______

Screen interval: ____________

Bentonite seal: ____________

Sandpack: _______

Screen interval: ____________

Sump: ____________

RISER & SCREEN
Type: ______
Schedule: ______
Diameter: ______
Screen Slot Size (in): ______

GROUND SURFACE COMPLETION
Type: ______
Other info (padlock added, etc): ______

GROUT & BENTONITE
Grout Type: ______
Hydration Details: ______
Bentonite Type: ______
Hydration Details:

SANDPACK
Type: ______

OTHER NOTES ______

WELL DEVELOPMENT LOG

Project Name:	______	Date:	______	Equipment Info (model, serial number, etc)	
Well ID:	______	Weather:	______	Water Level Meter:	______
Sampler Name:	______	Purge Start Time:	______	Pump Type:	______
Total Depth:	______	Purge End Time:	______	Water Quality Meter:	______
Initial Depth to Water:	______	Pump Intake Depth:	______	Other Equipment:	______
Well Diameter and Casing Type:	______	Well Condition:	______	Tubing Type:	______
Minimum Volume to Be Removed:	______		______	Other Notes or	______
Total Volume Removed:	______		______	Observations:	______

Time	Depth to Water	Volume Purged (gallons)	Well Volume(s) Removed	Turbidity (FNU)	Notes (color, odor, etc)

CHAIN OF CUSTODY FORM

CHAIN OF CUSTODY / SAMPLE ANALYSIS REQUEST	COC No:	Cooler No. of

Site ID	**Turnaround Time**	Filtered
Site Address	**Lab Name**	
Project Number	**Lab PM**	Preserve
Project Name	**Lab Phone**	
Project Manager	**Shipping Company**	Analysis
Project Manager Email Address	**Airbill No.**	
Sampler	**Shipping Date**	

Items No.	Sample ID	Sample Location	Matrix	G=Grab C=Comp	Depth	Sample Date Time	# of Containers	Comments Lab I.D.																	

Additional Comments/Special Instructions:	RELINQUISHED BY / AFFILIATION	Date Time	ACCEPTED BY / AFFILIATION	Date Time
	SHIPPING METHOD: (mark as appropriate)		SAMPLER NAME AND SIGNATURE	Date Time
Email Report To :				
Email Invoice To :				

Eurofins Burlington
30 Community Drive
Suite 11
South Burlington, VT 05403-6809
phone 802.660.1990 fax 802.660.1919

Chain of Custody Record

eurofins Environment Testing America

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Eurofins Environment Testing America

	Project Manager:				COC No:
Client Contact	**Email:**	**Site Contact:**		**Date:**	_______ of ______ COCs
Your Company Name here	**Tel/Fax:**	**Lab Contact:**		**Carrier:**	TALS Project #:
Address	**Analysis Turnaround Time**				Sampler:
City/State/Zip	☐ CALENDAR DAYS ☐ WORKING DAYS				**For Lab Use Only:**
(xxx) xxx-xxxx Phone	TAT if different from Below ________				Walk-in Client:
(xxx) xxx-xxxx FAX	☐ 2 weeks				Lab Sampling:
Project Name:	☐ 1 week				
Site:	☐ 2 days				Job / SDG No.:
P O #	☐ 1 day				

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)																		Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ____________

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for__________ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No | Custody Seal No.: | Cooler Temp. (°C): Obs'd:_________ Corr'd:__________ Therm ID No.:____________

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Pace® Location Requested (City/State):

CHAIN-OF-CUSTODY Analytical Request Document

Chain-of-Custody is a LEGAL DOCUMENT - Complete all relevant fields

LAB USE ONLY- Affix Workorder/Login Label Here

Scan QR Code for instructions

Company Name:	Contact/Report To:
Street Address:	Phone #:
	E-Mail:
	Cc E-Mail:
Customer Project #:	Invoice to:
Project Name:	Invoice E-mail:
Site Collection Info/Facility ID (as applicable):	Purchase Order # (if applicable):
	Quote #:
Time Zone Collected: [ ] AK [ ] PT [ ] MT [ ] CT [ ] ET	County / State origin of sample(s):

Data Deliverables:

[ ] Level II [ ] Level III [ ] Level IV

[ ] EQUIS

[ ] Other________________________

Regulatory Program (DW, RCRA, etc.) as applicable:

Rush (Pre-approval required):

[ ] 2 Day [ ] 3 day [ ] 5 day [ ] Other__________

Date Results Requested:

DW PWSID # or WW Permit # as applicable:

Field Filtered (if applicable): [ ] Yes [ ] No

Analysis:

Specify Container Size **

**Container Size: (1) 1L, (2) 500mL, (3) 250mL, (4) 125mL, (5) 100mL, (6) 40mL vial, (7) EnCore, (8) TerraCore, (9) Other

Identify Container Preservative Type***

*** Preservative Types: (1) None, (2) HNO3, (3) H2SO4, (4) HCl, (5) NaOH, (6) Zn Acetate, (7) NaHSO4, (8) Sod. Thiosulfate, (9) Ascorbic Acid, (10) MeOH, (11) Other

Analysis Requested

Lab Use Only

Proj. Mgr:
AcctNum / Client ID:
Table #:
Profile / Template:
Prelog / Bottle Ord. ID:

* Matrix Codes (Insert in Matrix box below): Drinking Water (DW), Ground Water (GW), Wastewater (WW), Product (P), Soil/Solid (SS), Oil (OL), Wipe (WP), Tissue (TS), Bioassay (B), Vapor (V), Other (OT), Surface Water (SW), Sediment (SED), Sludge (SL), Caulk

Customer Sample ID	Matrix *	Comp / Grab	Collected (or Composite Start)		Composite End		Res. CL2	Number & Type of Containers												Sample Comment	Preservation non-conformance identified for sample.
			Date	Time	Date	Time		Plastic	Glass												

Customer Remarks / Special Conditions / Possible Hazards:

Collected By:

Printed Name

Signature

Additional Instructions from Pace®:

# Coolers:	Thermometer ID:	Correction Factor (°C):	Obs. Temp. (°C):	Corrected Temp. (°C):

Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:	
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:	Tracking Number:
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:	Delivered by: [ ] In- Person [ ] Courier
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:	[ ] FedEX [ ] UPS [ ] Other
				Page: of

FIELD AUDIT CHECKLIST FORM

Field Audit Checklist for Investigation and Remediation Work
(Drilling / Sampling / Soil Gas or Groundwater Remediation)

Project no.:	PiC:
Date of audit:	Auditor(s):
Project information (Site / Type of work / Name of Subcontractors):	

No.	Observation	Yes	No	N/A
1	**Planning and Risk Assessment**			
1.1	ERM HASP available / complete / up-to-date / signed by field staff?			
1.2	Are technical and organisational safety measures, including emergency procedures identified in the HASP appropriate to the risks?			
1.3	Is PPE identified in the HASP appropriate to risks?			
1.4	Does HASP include a requirement to report accidents and near misses?			
1.5	Work permits or specific risk assessments required / complete / compliant?			
2	**Site Access, Registration and Induction**			
2.1	Are all persons accessing the work site, including ERM staff, visitors and subcontractors registered in the work site logbook?			
2.2	Did all site workers attend a site orientation and sign off the HASP?			
2.3	Have all persons temporarily accessing the work site received a safety induction and are unauthorised persons prevented from entering the work site?			
2.4	Are daily toolbox meetings conducted?			
3	**Layout and Condition of Work Area**			
3.1	Work site appropriately delineated (cones / fencing / tape)?			
3.2	Size and location of delineated work site adequate?			
3.3	If works are on or near public or on-site roads, is the work site appropriately marked and secured against traffic impact? Safety zone appropriate? Traffic control plan required / present?			
3.4	Have obstacles or other hazards (such as holes or excavations) within the work area been removed or secured and are warning signs in place and appropriate for hazards which cannot be mitigated?			
3.5	Are materials stored /stacked safely and orderly to prevent hazards from falling, rolling or collapsing materials and trip hazards? Are storage areas appropriate?			
3.6	Storage of hazardous materials (incl. hazardous wastes) on work site appropriate (contained, labelled)? Wastes appropriately collected and disposed of?			
3.7	Have areas with specific fire risks within or close to the work site been identified (flammables' or gas storage areas etc.) and are minimum distances kept?			
3.8	Facility emergency installations in the work area (including emergency escape routes, hydrants, fire extinguishers) accessible / unblocked?			
3.9	Fire extinguishing equipment in place? Appropriate?			
3.10	Worker hygiene facilities, toilets, hand-wash stations, lunch areas present and ok?			
3.11	First aid kits / facilities available?			
3.12	Emergency phone numbers displayed / available?			
3.13	ERM staff and subcontractors familiar with site-specific emergency procedures, escape routes, assembly points, contact nos.?			
3.14	Specific site procedures adhered to (such as speed limits, smoking, eating, cell phone policies)?			
3.15	Is the work site appropriately lighted?			
3.16	General housekeeping at the work site appropriate?			

4	**Subsurface Clearance (SSC) and Overhead Risks**			
4.1	Responsible person for supervision of SSC procedure appointed?			
4.2	Competent and trained?			
4.3	Plans of utility lines and other subsurface structures obtained?			
4.4	Drilling locations approved by knowledgeable site contact?			
4.5	Locations cleared with cable avoidance tool or other suitable means?			
4.6	SSC protocol completed and signed off by all appropriate parties?			
4.7	Hand-digging or hand augering performed to 1.2 m for each borehole?			
4.8	If hand digging has to be waived, has a similar safety level been achieved? How? Please describe on page 3.			
4.9	Overhead risks (e.g. power lines) addressed?			
5	**Subcontractors**			
5.1	Are only pre-approved subcontractors used?			
5.2	Subcontractor performance (housekeeping, adherence to rules, PPE) appropriate?			
6	**Personal Protective Equipment**			
6.1	Appropriate and sufficient PPE available on site?			
6.2	Safety vests, hard hats and safety goggles worn by everybody at the work site?			
6.3	Other PPE worn as stated in HASP (see also 7.4)? Used correctly?			
6.4	PPE clean and in good technical condition?			
6.5	All staff trained on proper use of PPE?			
7	**Chemical Exposure**			
7.1	Has the potential for exposure to hazardous substances been identified, including intervention thresholds for chemicals and explosive atmosphere?			
7.2	Monitoring equipment (such as PID, gas detectors, explosion meters) present, well-maintained and used as required by HASP?			
7.3	Emergency showers or eyewash facilities available if contact with corrosive substances has been identified as a risk in the HASP?			
7.4	Do field staff know the intervention thresholds as well as PPE requirements, potential emergency procedures after accidental contact with chemicals?			
7.5	Are workers and equipment decontamination procedures followed as required?			
7.6	Is appropriate safety information (MSDS) available for chemicals used on site?			
8	**Machinery, Equipment and Vehicles**			
8.1	Do ERM staff and subcontractors have the required training and authorisations to operate equipment and vehicles (such as driving or operating licenses)?			
8.2	ERM and subcontractor machinery, equipment and vehicles in good condition?			
8.3	Regularly maintained and inspected as required?			
8.4	Have risks from moving equipment and/or parts been addressed (e.g. being struck or hit by vehicles, caught by augers etc.), is machinery appropriately guarded and are emergency switch off devices present and accessible from the danger zone?			
8.5	Are electrical tools and connections in good condition, appropriate for the usage conditions (wet / rough environment) and corresponding to national standards?			
8.6	Is portable electrical equipment in wet / rough environment connected via residual current devices (RCDs) and are RCDs regularly inspected?			
9	**Specific Hazards and Safety Procedures (please provide additional details on page 3 in case any of these apply)**			
9.1	Lone working procedures required / established / followed?			
9.2	Procedures for work at or near water required / established / followed?			
9.3	Lockout / tagout / de-energisation procedures required / established / followed?			
9.4	Entering of confined spaces required? Procedures established and followed?			
9.5	Hot work performed? Permits obtained from site contact?			
9.6	Work in explosion-protected areas required? Procedures established / followed?			
9.7	Work at heights performed? Fall prevention measures in place? Collective measures (scaffolding) preferred to individual measures (safety harnesses)?			
9.8	Lifting / hoisting required? Hoisting plan in place? Equipment ok?			

Accidents / Incidents / Near Misses Recorded for the Project	***Comment***

Other observations / Auditor's Notes:

Positive observations:

Field safety audits should be regularly performed by PiCs for their own projects, by peers and by H&S experts. The aim of a field audit is to verify that appropriate H&S measures are implemented at the field site and to identify opportunities for improvement. The audit should include observations, spot-checks of pertinent documentation (such as training or inspection records) and interviews with site staff. Auditors should ensure that interviewees understand that the aim of the audit is to improve safety and should encourage interviewees to speak openly. Please use the Action Plan on page 4 to describe the finding for each item that has not been marked "Yes" or "N/A" on pages 1 and 2. In exceptional cases, use the auditor's notes section to explain why an element that is marked "No" does not require an Action Item. Corrective action measures should be developed by the PiC and the PM for the project with support by the H&S Advisor, and the Action Plan should be signed off by the PiC upon closing out all findings. Where an action has been addressed immediately on site, this should also be stated.

Audit Findings Action Plan				
Finding *(please provide checklist ref.)*	**Corrective Action**	**Responsible**	**Target date**	**Completed (Initials / Date)**

Date and Signature of PiC after completion of follow-up:

____

Corrective and Preventive Action Procedure

Version #1.0
May 2022

ROTO-FINISH CO., INC.
Portage, MI
EPA ID: MID005340088

Prepared for:
U.S. Environmental Protection Agency, Region 5
Ralph H. Metcalfe Federal Building
77 West Jackson Blvd.
Chicago, IL 60604

Prepared by:
ERM, Inc.
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008-4242

CONTENTS

1. INTRODUCTION

This Procedure establishes the process for addressing circumstances when things have not progressed as intended or planned. Not every unintended or unplanned circumstance has a material impact on the business performance and a risk based approach is taken to help prioritize actions.

2. PROCEDURE

Step #	By Whom	Action and Guidance	By When
1	Anyone (Identifier)	**Identify an unintended or unplanned circumstance** in a process, document, or business outcome. This is called a non-conformance. *The non-conformance can arise from feedback from Clients, ERMers, ERM Subcontractors, or Suppliers. It can arise in the course of your work, or working with others. It can relate to a process, an outcome, a document, or a behavior, or a combination of these.*	During the course of conducting business
2	Identifier	**Bring the non-conformance to the attention** of your supervisor. *If your supervisor is not available then approach their supervisor, a Function Leader (e.g., HR Manager, Financial Controller), or a Partner.*	As soon as possible after identifying it
3	Identifier and Supervisor	**Evaluate the importance** of the non-conformance and decide if it is important or not. Use a risk-based approach and consider: ■ Whether you know enough about the non-conformance to evaluate its impact on the business; ■ Whether you need other people's input to help you evaluate its impact on the business (e.g. a Partner or Function Leader); ■ The benefit of addressing the non-conformance; ■ The dis-benefit of not addressing the non-conformance; and ■ If the non-conformance relates to a process, an outcome, a document, or a behavior (or a combination of these).	As soon as possible after knowing about it
4	Identifier and Supervisor	**Decide the importance and record** your assessment, use a risk-based approach to assess the potential impact on achieving business objectives if the non- conformance is important. If the non-conformance is not important, then stop. If the non-conformance is important, then record it and include: ■ What you did immediately to correct the non-conformance (Corrective Action) and when; ■ What the non-conformance relates to (a process, an outcome, a document, or a behavior (or a combination of these); ■ What you recommend should be done so that the non-conformance is unlikely to happen again (Preventive Action); and ■ Who you think is best to carry out the Preventive Action.	As soon as possible after knowing about it
5	Identifier	**Advise the relevant part of the business about the non-conformance and CAPA. For example for:** ■ Health and safety issues contact your PIC and enter the CAPA in ECS or Observation or Project Audit Form; ■ Project performance issues contact your PM or PIC and record the CAPA in the project folder; ■ Business performance issues contact the Managing Partner; ■ For Client feedback issues contact the PIC and Managing Partner; ■ For CMS process or document issues contact the Managing Partner; ■ For personnel or behavioral issues contact your PIC and the HR Manager; and ■ For ethical issues for which you are uncomfortable to share with your supervisor contact the Global Compliance Officer.	As soon as you decide it is important

Step #	By Whom	Action and Guidance	By When
6	CAPA Owner	**Communicate the CAPA to those people who need to know about it.** Publish key findings on Minerva. If a database exists then use that (e.g. ECS for health and safety CAPAs). Note that some of the CAPAs may be commercial-in-confidence and so care needs to be taken with how they are communicated.	As required

CALIBRATION FORMS

CALIBRATION LOG FOR WATER QUALITY METER

Project Name: ______________ Date: ______________________ Time (start): ________________ Water Quality Meter Model: _________

Field Technician: ______________ Weather: ______________________ Time (finish): ________________ Water Quality Meter Serial Number: _________

Notes: ____

Parameter	Action	Barometric Pressure (mmHg)			Temperature (°C)	Pre-Cal Reading	Post-Cal Reading	Pass?		Comments
DO (saturated air)	Calibrate daily							Yes	No	
Parameter	**Action**	**Standard Lot #**	**Standard Expiration Date**	**Value of Standard**	**Temperature (°C)**	**Pre-Cal Reading**	**Post-Cal Reading**	**Pass?**		**Comments**
pH (7)	Calibrate daily							Yes	No	
pH (4)	Calibrate daily							Yes	No	
pH (10)	Calibrate daily							Yes	No	
ORP (mV)	Calibrate daily							Yes	No	
Specific Conductivity (µS/cm)	Calibrate daily							Yes	No	
Parameter	**Action**	**Standard Lot #**	**Standard Expiration Date**	**Value of Standard**	**Temperature (°C)**	**Pre-Cal Reading**	**Post-Cal Reading**	**Pass?**		**Comments**
Turbidity (0 FNU)	Check calibration daily							Yes	No	
	Calibrate							Yes	No	
Turbidity (124 FNU)	Check calibration daily							Yes	No	
	Calibrate							Yes	No	

Notes:

Turbidity will be checked on a daily basis. Acceptance criteria are within 10% of the standard.

All other parameters will be calibrated on a daily basis.

CALIBRATION LOG FOR PHOTOIONIZATION DETECTOR

Project Name: ____________ Date: ____________________ Time (start): ______________ PID Model: ____________________

Field Technician: ____________ Weather: ____________________ Time (finish): ______________ PID Serial Number: ____________________

Notes: ____

	Action	Barometric Pressure (mmHg)	Temperature (°C)	Pre-Cal Reading	Post-Cal Reading	Pass?		Comments
Fresh Air (0.0 ppm)	Calibrate daily					Yes	No	
Isobutylene Gas (100 ppm)	Calibrate daily					Yes	No	

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Chile	Portugal
China	Puerto Rico
Colombia	Romania
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India	South Korea
Indonesia	Spain
Ireland	Sweden
Italy	Switzerland
Japan	Taiwan
Kazakhstan	Thailand
Kenya	UAE
Malaysia	UK
Mexico	US
The Netherlands	Vietnam

ERM's Rolling Meadows Office
1701 Golf Road, Suite 1-700
Rolling Meadows, IL 60008

T: +1 (847) 258-8900
F: +1 (847) 258-8901
www.erm.com

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