Memorandum

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973779

Subject: **MW-19 Area Investigation Work Plan**

Project Name: Velsicol Chemical Corporation Superfund Site Remedial Design

Attention: Tom Alcamo, EPA Region 5

From: CH2M HILL, Inc.

Date: March 1, 2022

DCN: GLAES -R5-21F0106-02003

CH2M HILL, Inc. (CH2M) has prepared this Investigation Work Plan (IWP) Technical Memorandum (TM) for the U.S. Environmental Protection Agency (EPA) to describe the methods, procedures, and rationale for the completion of a predesign investigation for the MW-19 Area at the Velsicol Chemical Corporation/Pine River Superfund Site (site) located in St. Louis, Michigan. As described in the accepted technical proposal, *Technical Proposal – Velsicol Chemical Superfund Site, St. Louis, Michigan, Remedial Design* (Jacobs, 2021), additional data collection is required to effectively design the remedial components described in the June 22, 2012, Record of Decision. The data collected during this predesign investigation will be used to evaluate the need for installing a dense nonaqueous phase (DNAPL)/groundwater collection trench (GWCT) on the west side of the site near monitoring well MW-19.

This IWP describes only the remedial design (RD) activities associated with the initial MW-19 Area investigation. A follow-up investigation, if needed based on the results of the initial investigation, will be described in a separate IWP. This work is being performed under Great Lakes Architect and Engineering Services II Contract 68HE0519D0007, Task Order Number: 68HE0521F0106.

1. Site Description

The site (National Superfund Database Identification Number MID00722439) encompasses approximately 100 acres in St. Louis, Michigan and includes the Former Plant Site (FPS) and a residential area referenced as the adjacent or nearby properties (ANP). The lead agency for the remedial investigation (RI)/feasibility study was the Michigan Department of Environment, Great Lakes, and Energy (EGLE). EPA is the lead agency for the RD and remedial action (RA).

A chemical manufacturing plant formerly occupied the FPS from the mid-1930s until it was demolished in 1978. Industrial operations at the plant, which included manufacturing of pesticides and fire retardants, resulted in widespread contamination on the FPS. In 1982, the Velsicol Chemical Corporation entered into an administrative order of consent with the United States and the State of Michigan. Pursuant to the administrative order of consent, the Velsicol Chemical Corporation constructed a containment system for the FPS, which included the installation of a low-permeability cap and a 2-foot-thick, low-permeability slurry wall around the entire 52-acre FPS.

The FPS is fenced and is bordered on the south and east by the ANP, with Washington Avenue (M-46) along the southern edge. Watson and North Street mark the eastern edge, and the Pine River and Mill Pond form the western and northern boundaries. The ANP spans approximately 12 blocks and is primarily composed of residential properties that lie south and east of the former plant boundary. A small number of commercial properties are also located south of the FPS, along M-46 and East Washington Avenue.

The site consists of four Operational Units (OUs) (Figure 1) and are described as follows:

- OU1—FPS and ANP, for which RD and RA activities are in progress.
- OU2—Pine River and Mill Pond sediment adjacent and upstream from the St. Louis hydroelectric dam, for which RA activities were completed in 2006.
- OU3—Pine River sediments stretching from the St. Louis hydroelectric dam to approximately 1.25 miles downstream of the dam, for which RI activities are ongoing.
- OU4—Pine River sediments stretching from approximately 1.25 miles downstream of the St. Louis hydroelectric dam to the confluence of the Pine, Chippewa, and Tittabawassee rivers, for which RI activities are ongoing.

The MW-19 Area predesign investigation activities described in this TM will occur in OU1 within the FPS.

2. Previous Investigations

The following documents summarize previous investigations completed on the FPS, including the MW-19 Area, and will be consulted throughout the MW-19 Area investigation activities as needed:

- *Feasibility Study Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2011)
- *Remedial Investigation Addendum Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2009)
- *Remedial Investigation Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2006)
- *Source Migration Investigation Report, Velsicol Chemical/Pine River Site, OU1, St. Louis, Michigan* (CH2M, 2005)

3. Objectives

Based on the RI findings, mobile nonaqueous phase liquid (NAPL) may be present along the till unit near MW-19. Groundwater and NAPL (if present) in this area of the FPS is not currently captured by the existing DNAPL/GWCT, which is located on the northeast area of the site. This predesign investigation will assess the presence or absence of mobile or potentially mobile NAPL, which may be present in the shallow unit surrounding MW-19. If mobile NAPL is identified, the ability to extract the material from the subsurface will also be assessed.

Based on the results of this predesign investigation, a follow-up MW-19 Area investigation may be performed to refine the lateral distribution of mobile NAPL in the shallow unit. The follow-up investigation will be detailed in a future IWP. The results of the predesign investigation(s) will be evaluated to determine whether there is a need to design and install provisions for NAPL collection in the MW-19 Area of the site. If constructed, collected fluids will be conveyed to a water treatment plant

(WTP) for treatment or final disposition. The data collected during the predesign investigation(s) will support future RDs for the DNAPL/GWCT and WTP, both of which will be performed under a separate contract and/or task order(s).

4. Predesign Investigation Field Activities

The MW-19 Area predesign investigation field activities will include the following elements:

- Drilling investigation to facilitate subsurface soil characterization, soil sample collection, NAPL screening, and NAPL sample collection if encountered.

- Monitoring well installation to facilitate groundwater sample collection, static water-level monitoring, and NAPL groundwater screening.

The investigation area is shown on Figure 2. Table 1 summarizes the media that will be sampled during this investigation and supporting laboratory analyses to be completed. Investigation activities are detailed in the following subsections.

4.1 Drilling Investigation

Sixteen soil borings will be advanced to the top of the underlying till unit to approximately 20 to 25 feet below ground surface (bgs) using direct-push technology (DPT). Proposed soil boring locations are shown on Figure 2. The locations of the proposed soil borings are based on the results of previous soil borings and monitoring wells installed in the MW-19 area. These previously completed soil borings indicate that chemical odors were noted throughout all soil borings completed in the area, with free product observed only in the MW-19DR soil boring. NAPL has not been identified in any of the monitoring wells in the MW-19 area during groundwater level gauging or sampling events. Therefore, the proposed soil boring locations for this investigation were placed equidistant between the existing slurry wall and the NAPL/1,2-dibromo-3-chloropropane (DBCP) Area 1 treatment boundary. Only two borings are proposed south of WMW-19I and WMW-19D2 because multiple borings were advanced south of those monitoring wells during the NAPL/DBCP Area 1 remedial design investigation.

The CH2M geologist will log soil from each boring in accordance with the Unified Soil Classification System (USCS) and record the information on field soil boring logs following procedures outlined in the Field Operating Procedure (FOP) *Soil Boring Logging* (Attachment 1). Soil attributes such as color, particle size, consistency, moisture content, structure, plasticity, odor (if obvious), and organic content (if visible) will be noted. Significant observations should be also recorded in the fieldbook. In addition to USCS logging procedures, soil will be continuously screened for organic vapors using a photoionization detector (PID), photographed, and evaluated for the presence of NAPL.

4.1.1 Field Screening for NAPL

The CH2M geologist will visually identify the presence of NAPL in the field as soil borings are logged (refer to FOP *Identification of NAPL in Environmental Media* [Attachment 1]). Visual observations may include the following: coated, stained, or otherwise discolored soils; NAPL-saturated soils; presence of sheens in the saturated zone; and the presence of NAPL or NAPL staining on drilling equipment, as well as noting high PID readings. In addition, up to five NAPL soil test kits (Sudan IV dye or equivalent) will be completed for each soil boring. The NAPL soil test kits will be performed on intervals where NAPL is suspected but difficult to identify visually.

The soil test kits will be used according to manufacturer instructions and recommended procedures. Instructions for Oil-In-Soil Sudan IV test kits (available at http://www.oil-in-soil.com/files/125504496.pdf) indicate the test can determine the presence of NAPL in 30 to 60 seconds. To confirm that the Sudan IV dye in the soil test kit has thoroughly reacted with tested material, any test kit yielding a negative result will be labeled by sample location and retained for re-examination 48 hours after collection to verify test results. Following re-examination, test kits and media samples exposed to Sudan IV dye will be disposed in accordance with waste management procedures described in Section 5 of this TM. Test kits that provide an immediate indication of the NAPL will be discarded following soil boring completion.

The following field classifications will be used to document the absence or presence of NAPL in site soil samples:

- **No evidence of NAPL** – No visual evidence of NAPL and negative NAPL soil test kit result.
- **Evidence of NAPL (staining or sheens)** – Soils exhibit signs of being coated or stained, drilling, or sampling equipment stains or sheens noted. Positive NAPL soil test kit result.
- **Evidence of NAPL (oil-coated soils)** – Soils are either saturated with NAPL or exhibit signs of NAPL ganglia. Soils are discolored and readily stain sampling and drilling equipment. Generally, NAPL is not observed to readily flow out of soil unless agitated. Positive NAPL soil test kit result.
- **Evidence of NAPL (free NAPL)** – NAPL is present as free phase liquid, or soils are visibly saturated with NAPL. NAPL readily flows from the soil with little or no agitation. In these cases, an NAPL soil test kit result is not required.

Soil field screening results will be recorded on boring logs, and continuous photographs will be taken of the entire soil column. The boring ID, depth interval, presence or absence of NAPL identified, date, and time will be recorded in the fieldbook and in a photo log (Attachment 2).

4.1.2 Soil Sample Collection

During drilling operations, the geologist will use the NAPL field screening results to select representative soil samples for laboratory analysis. Up to two samples will be collected from each soil boring and submitted for laboratory analysis. Specifically, samples will be collected from intervals exhibiting elevated PID readings, positive NAPL test kit results, visual NAPL observation, or from intervals exhibiting the greatest degree of visual discoloration or staining. If field screening results do not indicate the presence of contaminants, then one sample will be collected from just below the cap material (approximately 5 feet bgs) and one sample will be collected from the interval just above the glacial till. It is anticipated that up to 40 soil samples will be collected and submitted for laboratory analysis. Soil samples will be analyzed for volatile organic compounds (VOCs) (including DBCP), semivolatile organic compounds (SVOCs), pesticides (including hexabromobenzene [HBB], polybrominated biphenyls [PBBs], and total dichlorodiphenyltrichloroethane isomers [DDx]) and total Resource Conservation and Recovery Act (RCRA) metals. Soil samples will be collected in accordance with FOP *General Soil Sample Collection* and *VOC Soil Sample Collection*, which are included in Attachment 1 and recorded in a sample table in the fieldbook.

Upon completion of core logging and sampling operations, soil cuttings from each boring will be drummed and handled in accordance with Section 5 of this IWP.

Soil borings will be backfilled with hydrated bentonite and witnessed with a labeled stake boring label so that each location can be identified and surveyed at a later time. The DPT rig, all nondisposable sampling equipment, and personnel will be properly decontaminated following the *Field Equipment Cleaning and Decontamination Procedures* FOP (Attachment 1).

Field data will be continuously evaluated by the project team in direct consultation with the EPA Task Order Contracting Officer's Representative (TOCOR) throughout the drilling phase of the investigation. As necessary and directed by the TOCOR, additional borings will be completed to further refine the extent of contamination while the equipment and personnel are mobilized in the field. After receipt and validation of the analytical data and consultation with EPA and EGLE, a determination will be made whether additional soil sampling will be required for the RD.

4.2 Monitoring Well Installation and Development

Five new monitoring wells are proposed for installation to further assess groundwater contaminants that may be present in the area and potentially collected by the new DNAPL/GWCT and conveyed for treatment at the WTP. Monitoring well locations will be determined by the CH2M geologist based on soil boring observations and the evidence of NAPL as previously defined.

New monitoring wells will be 2 inches in diameter and constructed of schedule 40 polyvinyl chloride (PVC) with 5-foot-long, 0.010-slot PVC screens. Following well completion activities and before sampling, each well will be developed to remove fines around the screen and refine the filter pack. The *Monitoring Well Installation* and *Monitoring Well Development* FOPs are included in Attachment 1.

All wastes generated during monitoring well installation and development will be handled in accordance with Section 5 of this IWP.

4.3 Groundwater Monitoring and Sampling

4.3.1 Monitoring Well Inspections and Maintenance

Existing monitoring wells within and surrounding the study area will be inspected for damage to the concrete pad (if present), well casing, outer protective cover, lock, and well cap before monitoring and sampling activities. If damage is observed, these items may be repaired or replaced. If significant damage is observed that prevents sampling or may alter the integrity of samples or monitoring data, damage will be recorded by photograph and within the fieldbook. Groundwater samples or water-level data will not be collected from wells where signs of damage or tampering are apparent.

4.3.2 Manual Groundwater Level Monitoring in Wells

Groundwater elevations will be measured in monitoring wells before sampling activities. The FOP for Water Level and Total Depth Measurements is included in Attachment 1.

4.3.3 Groundwater Sample Collection

Two groundwater sampling events will be performed to collect groundwater samples from the 5 new monitoring wells and 5 existing monitoring wells located within the study area (total of 10 monitoring wells per event).

Groundwater samples will be submitted to the subcontract laboratory for VOCs (including DBCP), SVOCs, pesticides (including HBB, PBBs and total DDx), and total and dissolved RCRA metals analysis.

Groundwater sampling will be performed in accordance with the following three FOPs included in Attachment 1: (1) *Field Water Quality Measurements and Calibration,* (2) *Groundwater Sampling Procedures,* and (3) *Field Equipment Cleaning and Decontamination Procedures*. Groundwater samples will be documented in the sample table in the fieldbook. All wastes generated will be handled in accordance with Section 5 of this IWP.

4.3.4 Field Screening for NAPL

The CH2M geologist may use the following procedures to identify NAPL in groundwater samples:

- Collect water samples and look for iridescent sheen.
- Look for irregular blobs of free product if a floating layer of NAPL was intercepted, and determine the thickness of the free product.
- Look for small, discrete particles that sink to the bottom of the water sample. This may indicate the following:
  - Presence of DNAPL.
  - Weathered light nonaqueous phase liquid (LNAPL): One of the weathering processes of LNAPL is sedimentation, caused by the evaporation of the lighter NAPL fraction. The remaining heavier fractions can adhere to particulate matter, such as sand or clay, and sink.
- Collect a sample of water and seal the container. Place the container in the sun and let it sit undisturbed. Look to see if there are phase separations in the sample.

Photographs of groundwater samples will be taken to document visual evidence of potential NAPL or lack thereof. The monitoring well ID, presence or absence of NAPL identified, date, and time will be recorded in the fieldbook and in a photo log. The FOP *Identification of NAPL in Environmental Media* is included in Attachment 1.

4.4 NAPL Sample Collection

Previous investigations have identified NAPL underlying the MW-19 investigation area. The collection of NAPL samples will allow for chemical and physical analyses that will support the RDs for the DNAPL/GWCT and WTP.

Up to four NAPL (free product) samples will be collected and submitted for laboratory analysis. If NAPL is identified, the CH2M geologist will instruct the drilling subcontractor to stop activities. An attempt will be made to measure the thickness of NAPL using an interface probe (drilling only). If the NAPL thickness is sufficient, a clear, disposable bailer may initially be used to attempt to collect an NAPL sample. If the bailer method is unsuccessful, a peristaltic pump or similar device may be used to collect a sample. Clean, disposable tubing will be lowered to the bottom of the boring or bottom of the excavation. The pump will be turned on, and the geologist will have appropriate sampling bottles available. The pump will continue pumping until all bottles are filled or the NAPL supply is drained, whichever occurs first. Before NAPL sampling, personnel within 10 feet of the boring should wear proper personal protective equipment (PPE) as stated in the site-specific *Health and Safety Plan* (HASP) (CH2M, 2021b). The FOP for NAPL collection, *Non-aqueous Phase Liquids Collection*, is in Attachment 1. NAPL samples will be recorded in a sample table in the fieldbook.

NAPL samples will be analyzed for VOCs (including DBCP), SVOCs, polychlorinated biphenyl (PCB), pesticides, herbicides, RCRA metals, pH, flashpoint, and density.

4.5 Quality Assurance/Quality Control Samples

The predesign investigation field activities will follow quality assurance (QA) procedures in accordance with the CH2M QAPP (CH2M, 2021a). The FOP for *Field Quality Assurance/Quality Control Sample Collection* is located in Attachment 1. All QA and quality control (QC) samples will be recorded in the appropriate sample table(s) in the fieldbook.

4.5.1 Field Duplicate (Replicate) Samples

Field duplicates (FDs) are two field samples taken at the same time in the same location. They are intended to represent the same population and are taken through all steps of the analytical procedure in an identical manner. These samples are used to assess precision of the entire data collection activity, including sampling, analysis, and site heterogeneity. Duplicate samples are collected simultaneously or in immediate succession using identical recovery techniques and treated in an identical manner during storage, transportation, and analysis.

Soil FD samples will be collected from the same sample interval and location following sample homogenization. Groundwater FD samples will be collected as individualized grabs. Duplicate samples will be analyzed at a rate of at least 1 per every 10 samples collected. Duplicate samples will not be collected for NAPL samples.

4.5.2 Equipment Blanks

Equipment blanks will be collected and analyzed to determine the effectiveness of equipment decontamination procedures. Equipment blanks will be included for each sampling event as appropriate, and at a minimum, at a frequency of one per week or one per event, whichever is more frequent, per sampling crew for each decontaminated equipment type. Equipment blanks will be collected immediately after the equipment has been decontaminated.

A consistent volume of demonstrated analyte-free distilled and deionized water will be poured directly into or over the decontaminated sampling equipment and then collected in a sample container as a rinsate sample. The sample bottles will be labeled as described in 7.3 Sample Nomenclature of this IWP. No equipment blank samples will be collected for NAPL samples.

4.5.3 Field Blanks

Field blanks will be collected and analyzed to assess the potential introduction of contaminants from the surroundings. These samples are designed to detect potential sample contamination that may occur during field operations or during shipment. Field blanks will be included for each sampling event as appropriate, and at a minimum, at a frequency of one per week or one per event. The samples will be analyzed for the same parameters specified for the corresponding matrix.

Field blank samples are collected by pouring deionized water directly into the sampling containers while out in normal field conditions. The sample bottles will be labeled as described in 7.3 Sample Nomenclature of this IWP. No field blank samples will be collected for NAPL samples.

4.5.4 Matrix Spike/Matrix Spike Duplicate

Matrix spike (MS)/matrix spike duplicate (MSD) is an aliquot of sample spiked with known concentrations of specific analytes. The spiking occurs before sample preparation and analysis at the laboratory. MS/MSD samples will be used by the laboratories to assess the precision and accuracy of sample analysis. Two extra volumes of samples are required for each combination of MS/MSD samples. Sample containers will be filled and stored in the same manner as FD samples. The frequency for MS/MSD sample collection and analysis will be at least 1 for every 20 samples collected, or 5%. MS/MSD samples will not be collected for NAPL samples.

4.5.5 Trip Blanks

Trip blanks are used to assess the potential introduction of contaminants to sample containers during the field collection event, including transportation and storage procedures. The trip blank consists of a VOC sample vial filled in the laboratory with laboratory-grade deionized water, transported to the sampling site, handled like an environmental sample (without being opened), and returned to the laboratory for analysis. Trip blanks will be used only when VOC samples are taken and will be analyzed only for VOC analytes. One trip blank will accompany each cooler of soil and aqueous samples sent to the laboratory for VOC analysis.

4.5.6 Temperature Blanks

A temperature blank will be included in each cooler to allow the laboratory receiving the shipment of samples to determine whether the samples have been maintained at the proper temperature. Temperature blanks will consist of an unpreserved sample container filled with distilled water. One temperature blank will accompany each sample cooler being shipped to the laboratory.

4.6 Field Instrument Calibration

Before each workday, field instruments that will be used during the day will be calibrated. A PID (MiniRAE unit, MultiRAE unit, or equivalent) will be used during air monitoring activities to detect the potential presence of VOCs in ambient air within and surrounding the work zone. Field monitoring devices will also allow for the assessment of a hazardous atmosphere during intrusive activities and soil screening operations. Daily calibration using compressed gas cylinders will be conducted per manufacturer instructions. Calibration results will be recorded on the Instrument Calibration Log (Attachment 2) as a record of equipment accuracy and consistency. If equipment calibration does not meet manufacturer specifications or if equipment is not operating correctly, it will not be used. Refer to the *MultiRAE Photoionization Detection Calibration and Operation* FOP (Attachment 1) for further instruction.

Calibration of the YSI-600 water quality meter and HACH turbidity meter for groundwater parameter monitoring will be performed daily following the FOP *Field Water Quality Measurements and Calibration* (Attachment 1). Calibration will be performed using standardized calibration materials. Calibration results will be recorded in the field logbook as a record of equipment accuracy and consistency.

4.7 Field Documentation

The Field Team Leader (FTL) or designee(s) will record information pertinent to field activities in a field logbook. The following information will be included:

- Heading including date, project name and specific task, client, and physical location.
- Site conditions, health and safety tailgate topics, and quality tailgate topics.
- Names, titles, and organization of personnel onsite and names and titles of visitors and times of visits.
- Field observations; time of specific activities; sampling activities details including type and time of sampling and sample numbers; references to field forms used or type of document generated; and lists and descriptions of photographs taken to document field activities.
- Specific problems including equipment malfunctions and their resolutions.
- Unexpected or adverse field conditions that may inhibit the field team's ability to perform the day's activity or that may affect the accuracy of the data collected.

- Decontamination.

Additional information may be recorded at the discretion of the logbook user. Erroneous markings will be crossed out with a single line and initialed and dated by the author.

4.7.1 Standard Field Data Forms

Standard forms will be completed in the field, as applicable, in addition to the field logbooks. Some project-specific field forms are provided as attachments to the FOPs in Attachment 1. Others are included in Attachment 2. The following standard field data forms will be completed as necessary:

- Soil boring logs will document percent recovery, soil type, color, moisture content, texture, grain size and shape, density, visible evidence of staining, and any other observations. The standard soil boring log form is included as an attachment to the *Soil Boring Logging* FOP in Attachment 1.
- Monitoring well installation locations will be determined in the field by the CH2M geologist. The CH2M geologist will fill out a well completion diagram, which is included as an attachment to the *Monitoring Well Installation* FOP, and a well development log, which is included as an attachment to the *Monitoring Well Development* FOP for each monitoring well that is installed.
- A monitoring well field data sheet will be completed during groundwater sampling events for each monitoring well that is sampled. This form is included as an attachment to the *Groundwater Sampling Procedures* FOP.
- Equipment calibration records (Attachment 2).
- Air monitoring field forms (Attachment 2).
- Photo log (Attachment 2).
- Waste inventory log (Attachment 2).

The field forms ensure necessary data are recorded consistently throughout the field task. No blank spaces will appear on completed forms. If information requested is not applicable, the space will be marked with a dashed line or marked “N/A.”

Field personnel will complete, sign, and date forms in the field and submit them daily to the FTL/Field Quality Manager (FQM). The FTL/FQM will review the data sheets to ensure all necessary information has been recorded. Dates and times will be compared across field documentation (sample labels and chain-of-custody forms will be compared to field data sheets and fieldbook) to ensure consistency. Completed and reviewed field forms will be filed onsite in a project-specific file.

At the conclusion of the event, scanned copies of all field records, chain-of-custody forms, and photos will be also uploaded to a specified location on the project’s Teams site.

5. Investigation-derived Waste

Soil boring cuttings, PPE, expended NAPL test kits containing Sudan IV dye, and liquid investigation-derived waste (IDW; purge and decontamination water) generated during predesign investigation activities will be placed in Department of Transportation-approved 55-gallon drums. Wastes generated will be handled in accordance with the *IDW Handling and Disposal* FOP (Attachment 1).

All containers will be inspected upon arrival at the site for signs of disrepair or contamination and to verify that the containers are empty and clean. If the container arrives in poor condition, is contaminated, or is not empty, it will be immediately rejected and documented. All 55-gallon drums used for IDW

storage must be new (that is, not reconditioned). Upon arrival of the containers, existing damage (for example, dings, significant paint scratches, or broken wheels), if not significant enough to result in rejection, will be documented using photos and written documentation. The FTL or designee will document and verify all containers arriving onsite in the field logbook as well as any damage observed.

Upon filling, the drums will be labeled with the site name, media (soil, PPE, purge water, etc.), date generated, generator contact information, and drum number. Drums will be inspected weekly, and information will be documented on the Waste Inventory Log (Attachment 2).

CH2M will be responsible for waste characterization sampling and analysis. IDW may be subject to land disposal restrictions. To determine disposal requirements, comprehensive waste characterization analysis will be performed as described in the following subsections.

5.1 Solid Waste

- Waste characterization samples (solid) will be collected at a rate of 1 sample per 10 drums of waste. Samples will be submitted for toxicity characteristic leaching procedure (TCLP) tests for TCLP VOCs, TCLP SVOCs, TCLP metals, TCLP pesticides, TCLP herbicides, PCBs, pH, and flashpoint. These samples will be analyzed on expedited turn by the analytical laboratory.
- If the TCLP analytical data indicate the waste for a given collection of drums is nonhazardous, the data will be transmitted to the waste transportation and disposal subcontractor, and the waste will be disposed of as nonhazardous waste.

5.2 Liquid Waste

- Waste characterization samples (liquid) will be collected at a rate of 1 sample per 10 drums of waste. These samples will be submitted for total VOCs, total SVOCs, total RCRA metals, total pesticides, total herbicides, PCBs, pH, and flashpoint. These samples will be analyzed on expedited turnaround time by the analytical laboratory.
- The analytical data will be used to complete waste characterization. If the analytical data for a given tank sample result in a hazardous waste characterization, the potential land disposal restrictions and the need for treatment will be evaluated by CH2M and the waste transportation and disposal subcontractor.

6. Field Equipment Decontamination

Nondisposable sampling equipment will be cleaned before mobilization to the site. Drill rigs, drill tools, and associated equipment will be steam cleaned before commencing intrusive activities at each boring location in accordance with the drilling subcontractor statement of work (SOW) (CH2M, 2021c). CH2M will provide access to a potable water source for drilling and decontamination activities at the site; however, no power source will be provided.

Decontamination of the drill rig, rods, bits, and tools will consist of high-pressure, low-volume steam cleaning. The subcontractor will provide a high-pressure, low-volume steam cleaning device. The subcontractor will also provide the detergents, solvents, buckets, and brushes necessary for decontamination of sampling equipment. Decontamination will be conducted at the FPS in an area designated by CH2M, and decontamination fluids will be handled and containerized as IDW.

Decontamination will be performed in accordance with the *Field Equipment Cleaning and Decontamination Procedures* FOP (Attachment 1).

7. Sample Handling and Analysis

The FTL or designee will be responsible for sample collection, sample packing, and coordination of sample shipment. The following subsections provide detail for sample handling, shipping, and analytes.

7.1 Analytical Laboratory—Contaminants

CH2M assumes that approximately 32 soil and 20 groundwater samples will be submitted for analysis. Soil samples will be collected from drilling activities, and groundwater samples will be collected from new and existing monitoring wells.

7.2 Analytical Laboratory—NAPL Physical Properties

CH2M assumes that up to four NAPL samples will be submitted to a subcontracted laboratory for physical property analysis. Samples may be prepared and shipped offsite daily (if applicable) for analysis.

7.3 Sample Nomenclature

Samples will be labeled in accordance with the QAPP (CH2M, 2021a). A sample ID system will be used to identify each sample, including duplicate and blank samples. Each sample will be logged in and assigned a unique laboratory number, and the number will be used by all laboratory personnel handling samples to ensure all sample information is captured. Analyses required will be specified by codes assigned to samples at login. Labels containing the laboratory sample number are generated and placed on sample bottles.

Field sample identification will vary slightly, based on media sampled.

7.3.1 Soil Samples

Soil samples will be identified as follows:

[Site]-[Operational Unit]-[Investigation Area]-[Media]-[Station Location]-[Depth Indicator]

Where:

[Site] = The site references the Velsicol Chemical Corporation Superfund Site, which will be identified as "VCS" (short for Velsicol Chemical Site).

[Operational Unit] = This references the OU where the investigation is being performed (that is, OU1, OU2, OU3, or OU4). This work will be performed within OU1.

[Investigation Area] = This references the area where the field investigation is occurring, or "MW19" for this investigation.

[Media] = This refences the media sampled, or "SO" for soil.

[Station Location] = This identifies the unique name of the sampling location. For example, a soil sample collected from soil core location 1 would be identified as "001."

[Depth Indicator] = This identifies the top and bottom depth intervals, separated by a slash. The depth will be represented in feet bgs. For example, "0/0.5" indicates a sample collected from an interval of 0.0 to 0.5 feet bgs.

Example:

VCS-OU1-MW19-SO-001-0.0/0.5 is a soil sample collected in the MW-19 investigation area from soil core location 1, collected from an interval of 0.0 to 0.5 feet bgs.

7.3.2 Groundwater Samples

Groundwater samples will be identified as follows:

[Site]-[Operational Unit]-[Investigation Area]-[Media]-[Station Location]-[Date]

Where:

[Site] = The site references the Velsicol Chemical Corporation Superfund Site, which will be identified as "VCS" (short for Velsicol Chemical Site).

[Operational Unit] = This references the OU where the investigation is being performed (that is, OU1, OU2, OU3, or OU4). This work will be performed within OU1.

[Investigation Area] = This references the area where the field investigation is occurring, or "MW19" for this investigation.

[Media] = This refences the media sampled, or "GW" for groundwater.

[Date] = This indicates the date the sample was collected. This is required for groundwater samples since several groundwater monitoring events will be performed for some of the investigations. The date will be identified using a MMDDYY format.

Example:

VCS-OU1-MW19-GW-CMW22-070122 is a groundwater sample collected in the MW-19 investigation area from monitoring well CMW-22 on July 1, 2022.

7.3.3 Nonaqueous Phase Liquid Samples

NAPL samples will be identified as follows:

[Site]-[Operational Unit]-[Investigation Area]-[Media]-[Station Location]-[Depth Indicator]

Where:

[Site] = The site references the Velsicol Chemical Corporation Superfund Site, which will be identified as "VCS" (short for Velsicol Chemical Site).

[Operational Unit] = This references the OU where the investigation is being performed (that is, OU1, OU2, OU3, or OU4). This work will be performed within OU1.

[Investigation Area] = This references the area where the field investigation is occurring, or "MW19" for this investigation.

[Media] = This refences the media sampled, or "NAPL" for NAPL.

[Station Location] = This identifies the unique name of the sampling location. For example, an NAPL sample collected from soil core location 1 would be identified as "001."

[Depth Indicator] = This identifies the top and bottom depth intervals, separated by a slash. The depth will be represented in feet bgs. For example, "10/10.5" indicates a sample collected from an interval of 10.0 to 10.5 feet bgs.

Example:

VCS-OU1-MW19-NAPL-001-10.0/10.5 is an NAPL sample collected in the MW-19 investigation area from soil core location 1, collected from an interval of 10.0 to 10.5 feet bgs.

7.3.3.1 Investigation-derived Waste Samples

IDW samples will be identified as follows:

[Site]-[Operational Unit]-[Investigation Area]-[IDW]-[Media]-[Date]

Where:

[Site] = The site references the Velsicol Chemical Corporation Superfund Site, which will be identified as "VCS" (short for Velsicol Chemical Site).

[Operational Unit] = This references the OU where the investigation is being performed (that is, OU1, OU2, OU3, or OU4). This work will be performed within OU1.

[Investigation Area] = This references the area where the field investigation is occurring, or "MW19" for this investigation.

[IDW] = This indicates the sample is an IDW sample.

[Media] = This refences the media sampled, or "SO" for soil and "W" for liquid.

[Date] = This indicates the date the sample was collected. This is required for IDW samples since multiple IDW samples may be collected in a day. The date will be identified using a MMDDYY format.

Example:

VCS-OU1-MW19-IDW-SO-070122 is a soil IDW sample collected on July 1, 2022.

VCS-OU1-MW19-IDW-W-070122 is a liquid IDW sample collected on July 1, 2022.

7.3.4 Quality Assurance/Quality Control Samples

QA/QC samples will be identified as described in the following subsections.

7.3.5 Examples

VCS-OU1-MW19-EB-001 is the first equipment blank collected during the MW-19 Area investigation.

VCS-OU1-MW19-TB-010 is the tenth trip blank collected and was collected during the MW-19 Area investigation.

VCS-OU1-MW19-GW-CMW22-070122-FD is an FD for the groundwater sample collected in the MW-19 Area investigation area from monitoring well CMW-22 on July 1, 2022.

7.3.6 Standardization of Sample Designation

During the daily course of sampling activities, each collected sample container will be labeled with its unique sample ID and date and time of collection. Collected sample information will be entered into the EPA sample management program, Scribe, to generate sample labels, which will be printed and affixed to each sample container. Waterproof labels will be used. Sample labels may be preprinted with static information, minimizing the amount of data that must be entered in the field. Any changes to label information by the sampler will require the accompaniment of the sampler's initials.

The following information will be included on the label:

- SAS Number – EPA unique number for sample tracking
- Sample ID
- Date of collection
- Time of collection (using 24-hour clock)
- Analytical parameters
- Preservative used (if any)

7.4 Sample Containerization, Preservation, and Analysis

Samples will be collected in certified, clean containers. Each sample will be identified and labeled after collection, then enclosed in a plastic cooler. The sample information will be entered into Scribe and used to generate chain-of-custody forms. The samples will be shipped to the appropriate laboratory by overnight delivery service or courier.

Samples will be packaged and shipped to the laboratory in accordance with the QAPP (CH2M, 2021a) and the *Superfund Sample Handling and Chain-of-Custody Procedures* and *Sample Handling, Packaging, and Shipping* FOPs (Attachment 1). Only plastic coolers will be used for shipping samples. Shipments to the laboratory will be properly padded to prevent breakage. Ice used in shipping coolers will be placed in heavy-duty resealable bags with minimum air content. The chain-of-custody record will be placed inside a resealable plastic bag and taped to the inside of the cooler top. The cooler will be closed and taped shut with strapping tape. A custody seal will be properly placed across two sides of the cooler lid and covered with clear packing tape.

The samples will be sent to the EPA Contract Laboratory Program, Analytical Services Branch, or subcontract laboratory via FedEx overnight. The laboratory sample custodian will acknowledge the sample receipts upon arrival. The laboratory is responsible for storing the samples in a secure location and following all chain-of-custody procedures detailed in the QAPP (CH2M, 2021a). The laboratory analytical technicians will prepare and analyze the field samples in accordance with the methods provided in Appendix C of the QAPP (CH2M, 2021a). The laboratory hazardous waste manager will be responsible for the final sample disposal.

7.5 Chain of Custody

Generation of chain-of-custody using the EPA Scribe software will be performed in accordance with the *Superfund Sample Handing and Chain-of-Custody Procedures* FOP (Attachment 1) and the QAPP (CH2M, 2021a).

Accurate records and control of sample and data custody are necessary to provide relevant and defensible data. Chain-of-custody is addressed during field sample collection, data analyses in the laboratory, and through proper handling of project files. Persons will be considered to have custody of samples when samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured to prevent tampering. In addition, when samples are secured in a restricted area accessible only to authorized personnel, samples will be deemed in the custody of such authorized personnel.

Chain-of-custody forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratory. The FTL or designee will generate the chain-of-custody forms at the end of each day of sampling. If samples are relinquished by the FTL or designee to other sampling or field personnel, chain-of-custody forms will be signed and dated by the appropriate personnel to document the custody transfer. Original chain-of-custody forms will accompany samples to the laboratory, and copies will be posted on the project's Teams site.

7.5.1 Field Custody Procedures

Chain-of-custody forms are required for all samples. The field team members will initiate chain-of-custody forms in the form of a sample list in the fieldbook. The sample list will contain the sample's unique ID, sample date and time, and any special notes or comments (FDs or MS/MSD volumes collected). The sample list will be photocopied and submitted to the FTL or designee for use in generating the chain-of-custody using the EPA Scribe software. A copy of the sample list will be retained with the field documentation.

Chain-of-custody forms or sample lists will remain with the samples at all times. Samples and signed chain-of-custody forms will remain in the sampling crew's possession until samples are delivered to the express carrier (for example, FedEx), hand-delivered to the laboratory, or placed in secure storage.

8. Surveying

A survey will be performed after the predesign investigation field activities are completed. The survey will consist of collecting geospatial data for soil borings and new monitoring wells (including well location, ground elevations, and top of casing elevations). Surveying will be completed by a subcontracted professional surveyor licensed in the State of Michigan in accordance with the survey subcontractor SOW (CH2M, 2021c).

9. Health and Safety

CH2M and its subcontractors will abide by U.S. Occupational Safety and Health Administration regulations and the site-specific HASP (CH2M, 2021b). The HASP will be kept onsite during all field activities and a copy will be maintained in the project files. Before onsite field activities, CH2M field personnel and subcontractor personnel will conduct a field-chartering meeting and review the scope of work, site-specific, and task-specific hazards.

9.1 Personal Protective Equipment

PPE must be worn by field personnel at all times when actual or potential hazards exist. All field personnel will refer to and follow procedures outlined in the HASP (CH2M, 2021b). Fieldwork for this investigation will be performed in Modified Level D as follows:

- Work clothes or cotton overalls
- Safety-toe, chemical-resistant boots, or safety-toe leatherwork boots with outer rubber boot covers

- Surgical-style nitrile gloves
- Hardhat
- Safety glasses with side shield protection
- Hearing protection

Since the MW-19 Area is outside of the DBCP control zone, Level B PPE is not required. However, engineering controls will be implemented to direct vapors away from workers during drilling activities as an additional safety precaution.

9.2 Air Monitoring

Air monitoring procedures will be completed in accordance with the HASP (CH2M, 2021b).
The potential presence of VOCs within the FPS requires air monitoring using a PID to monitor the breathing zone near the drill rig, near the soil sample processing and sample collection table, and at the exclusion zone boundary. Air monitoring activities will be documented in the fieldbook or field data sheets, or both. Documented information will include the following:

- Calibration information
- Weather conditions
- Drilling location
- Boring location
- Instrument reading
- Date and time of the reading

PIDs (MiniRAE unit, MultiRAE unit, or equivalent) will be calibrated daily using compressed gas cylinders per manufacturer instructions. Calibration results will be recorded in the field logbook or on equipment calibration forms as a record of equipment accuracy and consistency. If equipment calibration does not meet manufacturer specifications or if equipment is not operating correctly, it will not be used.

10. References

CH2M HILL, Inc. (CH2M). 2005. *Source Migration Investigation Report, Velsicol Chemical/Pine River Site, OU1, St. Louis, Michigan*.

CH2M HILL, Inc. (CH2M). 2021a. *Draft Uniform Federal Policy Quality Assurance Project Plan, Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan, Operable Unit 1—Remedial Design.* September.

CH2M HILL, Inc. (CH2M). 2021b. *Health and Safety Plan, Velsicol Chemical Corporation Superfund Site, Former Plant Site Remedial Design, St. Louis, Michigan.* September.

CH2M HILL, Inc. (CH2M). 2021c. *Drilling Services – Remedial Design Investigations, Velsicol Chemical/Pine River Superfund Site, St. Louis, Michigan.* September.

Jacobs. 2021. *Technical Proposal – Velsicol Chemical Superfund Site, St. Louis, Michigan, Remedial Design*. July.

Weston Solutions of Michigan, Inc. (Weston). 2006. *Remedial Investigation Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan*. November.

Weston Solutions of Michigan, Inc. (Weston). 2009. *Remedial Investigation Addendum Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan*. January.

Weston Solutions of Michigan, Inc. (Weston). 2011. *Feasibility Study Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan*. November.

Table

Table 1. MW-19 Area Sample Summary

MW-19 Area Investigation Work Plan, Velsicol Chemical Corporation Superfund Site

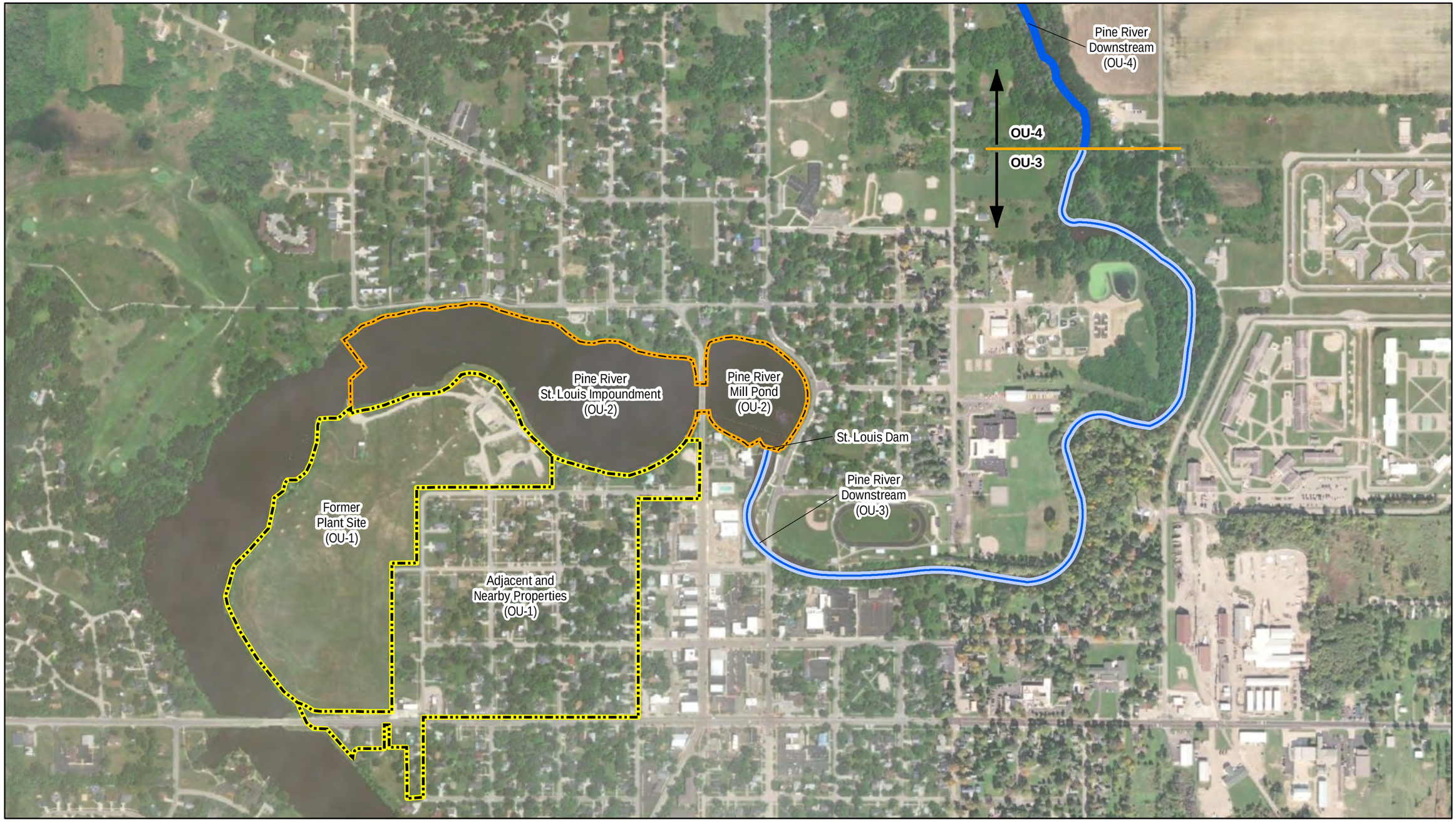
Sample Type	Sample Frequency	Sample Nomenclature	Sample Analysis	Containers/ Preservative	Analytical Laboratory	Notes
Soil	2 samples per soil boring (estimate 40 samples)	VCS-OU1-MW19-SO-[Station Location]-[Depth Indicator] Example: *VCS-OU1-MW19-SO-001-0.0/0.5*	VOCs (including DBCP) SVOCs Pesticides (including HBB, PBB and Total DDx) Total metals (including mercury)	TBD	VOCs, SVOCs, & metals will be analyzed by CLP. Address is TBD. Pesticides will be analyzed by CT: CT Laboratory 1230 Lange Court Baraboo, WI 53913 608-356-2760	
Groundwater	1 sample per MW; 10 MWs per event; 2 sample events (estimate 20 samples)	VCS-OU1-MW19-GW-[MW ID]-[Date] Example: *VCS-OU1-MW19-GW-CMW22-070122*	VOCs (including DBCP) SVOCs Pesticides (including HBB, PBB and Total DDx) Total metals (including mercury)	TBD	VOCs, SVOCs, & metals will be analyzed by CLP. Address is TBD. Pesticides will be analyzed by CT: CT Laboratory 1230 Lange Court Baraboo, WI 53913 608-356-2760	
NAPL	Up to 4. Collect wherever NAPL is encountered and can be collected	VCS-OU1-MW19-NAPL-[Station Location]-[Depth Indicator] Example: *VCS-OU1-MW19-NAPL-001-10.0/10.5*	VOCs (including DBCP) SVOCs PCBs Pesticides Herbicides RCRA metals pH Flashpoint Density	TBD	Texas Oil Tech: Texas Oil Tech Laboratory 10630 Fallstone Road Houston, TX 77099 281-495-2400	
IDW-Soil	1 sample for every 10 drums of soil IDW	VCS-OU1-MW19-IDW-SO-[Date] Example: *VCS-OU1-MW19-IDW-SO-070122*	TCLP VOCs TCLP SVOCs PCBs TCLP pesticides TCLP herbicides TCLP metals pH flashpoint	TBD	TCLP VOCs, TCLP SVOCs, PCBs, TCLP pesticides, and TCLP metals will be anlyazed by CLP. Address is TBD. pH and flashpoint will be analyzed by ASB: EPA Region 5 ASB 536 S. Clark Street Chicago, IL 60605 312-353-0375 TCLP herbicides will be analyzed by ALS Holland: ALS Environmental-Holland 3352 128th Avenue Holland, MI 49424 616-399-6070	5-day TAT

Table 1. MW-19 Area Sample Summary

MW-19 Area Investigation Work Plan, Velsicol Chemical Corporation Superfund Site

Sample Type	Sample Frequency	Sample Nomenclature	Sample Analysis	Containers/ Preservative	Analytical Laboratory	Notes
IDW-Liquid	2 sample for every 10 drums of liquid IDW	VCS-OU1-MW19-IDW-W-[Date] Example: *VCS-OU1-MW19-IDW-W-070122*	Total VOCs Total SVOCs PCBs Total pesticides Total herbicides Total RCRA metals pH flashpoint	TBD	Total VOCs, Total SVOCs, PCBs, Total pesticides, and Total RCRA metals will be anlyazed by CLP. Address is TBD. pH and flashpoint will be analyzed by ASB: EPA Region 5 ASB 536 S. Clark Street Chicago, IL 60605 312-353-0375 TCLP herbicides will be analyzed by ALS Holland: ALS Environmental-Holland 3352 128th Avenue Holland, MI 49424 616-399-6070	5-day TAT
QA/QC	EBs - once per week or once per event, whichever is more frequent FB - once per week or once per event, whichever is more frequent TBs - one for every cooler that contains liquid VOC samples FDs - one per every 10 samples collected MS/MSD - one per every 20 samples collected	Equipment blanks (EBs) will be numbered sequentially. Example: *VCS-OU1-MW19-EB-001* *Field blanks (FBs) will be numbered sequentially. Example: VCS-OU1-MW19-FB-001* Trip blanks (TBs) will be numbered sequentially. Example: *VCS-OU1-MW19-TB-010* Field duplicates (FDs) will be submitted in the same format as the normal sample, but with "-FD" at the end. Example: *VCS-OU1-MW19-GW-CMW22-070122-FD* MS samples are not identified in the station location identifier but on the chain-of-custody form.	Same as normal sample	Same as normal sample	Same as normal sample	

Figures



Legend

- FORMER PLANT SITE AND ADJACENT AND NEARBY PROPERTIES (OU1)
- PINE RIVER - ST LOUIS IMPOUNDMENT (OU2)
- PINE RIVER (OU3)
- PINE RIVER (OU4)

N

0 600 1,200

Feet

FIGURE 1
Study Areas and Operable Units
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

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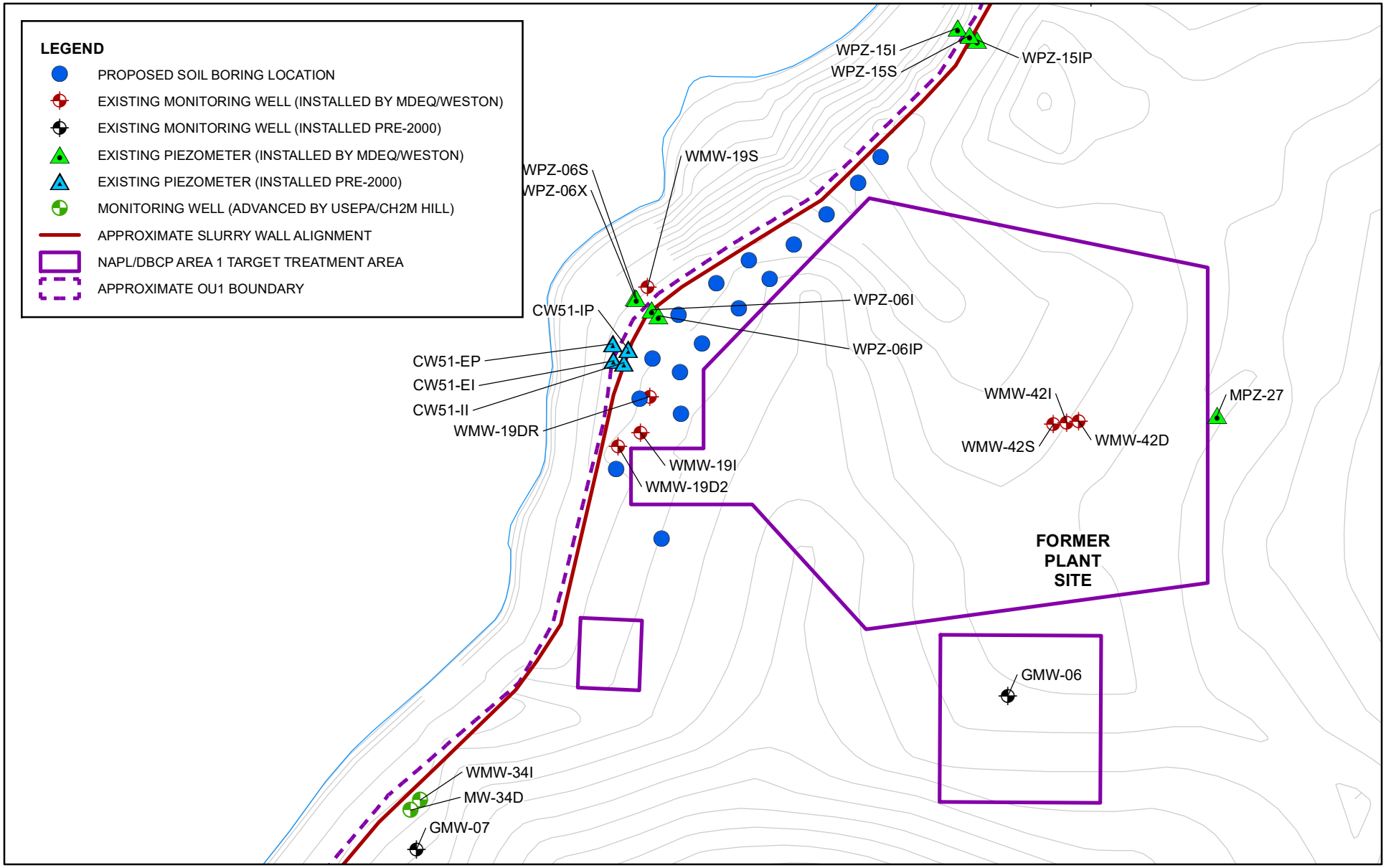


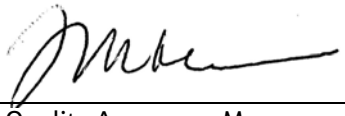
FIGURE 2
MW-19 Area
Field Investigation Boring Locations
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Attachment 1
Field Operating Procedures

Field Standard Operating Procedure-01
Direct-Push Technology Sampling Methods

Author: Sara Maihofer 02/10/2021

Approver: Theresa Himmer 02/10/2021



Quality Assurance Manager

Field Standard Operating Procedure-01
Direct-Push Technology Sampling Methods

1. Purpose

This field standard operating procedure (SOP) provides a general guideline for the collection of soil and sediment samples using direct-push technology (DPT) drilling methods.

2. Scope

The method described for DPT soil and sediment sampling is applicable for sampling soils, exposed sediments, and submerged sediments within a water body. Specific equipment and the responsibilities of DPT drilling subcontractors are described in the contracting documentation.

3. Equipment and Materials

- Drilling equipment and tools for hydraulic DPT rig using continuous samplers
- Equipment and supplies required for logging soil or sediment cores
- Analytical sample containers and sampling supplies
- Personal protective equipment (PPE)

4. Procedures and Guidelines

1. Position the DPT drill rig over the proposed sampling location. Record the Location ID, station positioning (X and Y coordinates) within 3 feet, weather conditions, personnel, and other relevant information.
2. If working from a barge over open water, measure the depth to the top of sediment from the DPT drill rig work platform surface or from the water surface. Record the distance from the working surface or water surface to the top of sampling surface to the nearest 0.01 foot and record the basis of the measurement.
3. Ensure that non-dedicated downhole equipment and sampling equipment are decontaminated in accordance with field SOP *Field Equipment Cleaning and Decontamination Procedures*.
4. Wear appropriate PPE, as required by the Health and Safety Plan. Change gloves between sampling locations.
5. Collect subsurface soil and sediment samples continuously to refusal or depth specified by the project work plan using a Macro-core sampler with an acetate liner. Between sediment or soil core locations, the Macro-core sampler and downhole tools will be decontaminated in accordance with the procedures outlined in field SOP *Decontamination of Drilling Rigs and Equipment*.
6. Ensure the drilling operators open the polycarbonate liner once removed from the Macro-core sampler and present it to the field staff for logging and sampling. Log the sediment sample according to visual methods outlined in ASTM International (ASTM) Method D-2487-98.

7. Fill all sample containers using decontaminated sampling equipment. Sediment or soil samples for inorganic and nonvolatile organic analyses will be separated and transferred into disposable aluminum pans, homogenized by mixing with a stainless-steel spoon, and transferred to the appropriate sample container.
8. Label, handle, and store the samples according to procedures outlined in the site-specific plans. Record sampling data such as depth, time, and date as specified in the site-specific plans. Discard unused sample according to the guidelines for IDW outlined in the Waste Management Plan.
9. Advance the DPT rig to the next sampling interval after a subsurface sediment or soil sample is collected.
10. Obtain accurate and representative sediment or soil samples. The drilling subcontractor will be responsible for obtaining accurate and representative sediment or soil samples, informing the geologist/field technician of changes in drilling conditions, and keeping a separate general log of the sampling locations.
11. Decontaminate all non-dedicated downhole equipment (e.g., rods, sampling tubes) in accordance with field SOP *Decontamination of Drilling Rigs and Equipment*.

5. References

None.

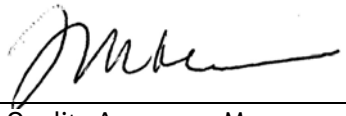
6. Key Checks and Items

- Verify that the DPT rig is clean and in proper working order.
- Monitor that the DPT operator thoroughly completes the decontamination process between sampling locations.
- Determine if a quality control (QC) sample will be required at a sampling location (refer to the SAP).

Field Standard Operating Procedure-06
Field Equipment Cleaning and Decontamination Procedures

Author: Sara Maihofer 01/19/2021

Approver: Theresa Himmer 01/19/2021



Quality Assurance Manager

Field Standard Operating Procedure-06 Field Equipment Cleaning and Decontamination Procedures

1. Purpose

This field standard operating procedure (SOP) provides a general guideline for decontamination of field sampling equipment.

2. Scope

The methods for decontaminating reusable field equipment are discussed in the following sections.

3. Materials

- Health and safety equipment (as required in the health and safety plan [HASP])
- Distilled water
- Non-phosphate soap (Only Liquinox)
- Appropriate cleaning solvent (for example, isopropyl alcohol)
- Rinse collection plastic containers
- Brushes
- Garbage bags
- Spray bottles

4. Procedures and Guidelines

1. Disposable sampling equipment (core liners, aluminum pans, sampling utensils, etc.) will be used when possible.

2. Follow the health and safety procedures specified in the health and safety plan.

3. All non-disposable sampling equipment will be decontaminated on arrival at the site and prior to each use.

4. For large equipment, such as the sediment grab samplers or metal, reusable outer core barrels the decontamination procedure is as follows:

    – Scrape or brush excess sediment off and return to the point of collection (that is, the sediment surface)

- Triple rinse equipment within the river at the location of sampling; this can be achieved by submerging the equipment in river water or using a hose connected to a pump drawing river water. The rinse water will be returned to the river.

- If site conditions are observed (oily, sheen, etc.), then non-disposable equipment will be rinsed by adding a surfactant (Liquinox) to the water, and the decontamination fluid will be containerized and managed as investigation derived waste.

5. The following decontamination procedures should be followed for small, non-disposable sampling devices:

   - Wash with non-phosphate detergent and potable water.

   - Rinse with distilled water.

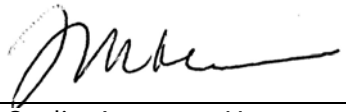
   - Rinse equipment with solvent (isopropyl alcohol).

   - Rinse with distilled water.

   - Dry with paper towel.

Field Standard Operating Procedure-07
Sample Handling, Packaging, and Shipping

Author: Sara Maihofer 02/10/2021 

Approver: Theresa Himmer 02/10/2021 

Quality Assurance Manager

Field Standard Operating Procedure-07
Sample Handling, Packaging, and Shipping

1. Purpose

This procedure delineates protocols for the packing and shipping of samples to the laboratory for analysis.

2. Scope

This procedure is applicable for all samples collected and prepared for analysis at an offsite laboratory. There are also additional procedures for analysis at an onsite laboratory.

3. Equipment and Materials

- Waterproof hard plastic coolers
- Plastic resealable bags
- Plastic garbage bags
- Absorbent packing material (not vermiculite)
- Inert cushioning material (not vermiculite)
- Ice
- Chain-of-custody forms
- custody seals
- Airbills and shipping pouches (for example, FedEx)
- Clear tape
- Strapping tape
- Mailing labels

4. Procedures and Guidelines

4.1 Prepare Bottles for Shipment

1) Arrange sample containers in groups by sample number.
2) Check that sample container lids are tight.
3) Arrange containers in front of assigned coolers.
4) Affix appropriate adhesive labels to each container. Protect label with clear tape.
5) Enclose each sample in a clear, resealable plastic bag and ensure sample labels are visible.

4.2 Prepare Coolers for Shipment

1) For samples that will be delivered to an onsite laboratory, these steps may be skipped. Sample bottles can be delivered to the onsite laboratory in a cardboard box or resealable plastic bag with the signed chain-of-custody form. They must then be transferred to the laboratory refrigerator.
2) Tape drains shut, inside and out.

3) Affix "This Side UP" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
4) Place mailing label with laboratory address on top of the coolers.
5) Place inert cushioning material (for example, bubble wrap, preformed poly-foam liner) in the bottom of the cooler. Do not use vermiculite.
6) Place appropriate chain-of-custody records with corresponding custody seals on top of each cooler.
7) Place the samples inside a garbage bag and tie the bag.
8) Double bag and seal loose ice in resealable plastic bags to prevent melting ice from leaking and soaking the packing material. Place the ice outside the garbage bags containing the samples. Place sufficient ice in cooler to maintain the internal temperature at 4 degrees Celsius (°C) (±2°C) during transport.
9) Fill cooler with enough absorbent material and packing material to prevent breakage of the sample bottles and to absorb the entire volume of the liquid being shipped.
10) Sign each chain-of-custody form (or obtain signature) and indicate the time and date the cooler was custody sealed.
11) Seal the laboratory copies of the chain-of-custody forms in a large resealable plastic bag and tape to the inside lid of the cooler. Retain the chain-of-custody forms. Each cooler must contain a chain-of-custody form (or forms) that correspond to the contents of the cooler.
12) Close lid and latch.
13) Peel custody seals carefully from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
14) Tape cooler shut on both ends, making several complete revolutions with strapping tape. **Do not** cover custody seals.
15) Relinquish to carrier (for example, FedEx). Place air bill receipt inside the mailing envelope and send copies of shipping documents to sample manager and project chemist, along with the other documentation.

4.3 High-concentration Samples or Nonaqueous Phase Liquid Samples

When shipping high-concentration samples or samples of nonaqueous phase liquid, the Jacobs dangerous goods shipping handbook must be consulted for reference. In addition, a Jacobs dangerous goods shipping coordinator should be contacted for assistance. Field staff must have the appropriate dangerous goods training. This does not apply for samples delivered to an onsite laboratory.

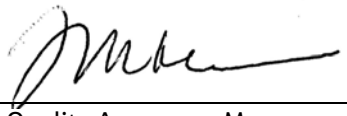
5. Key Checks and Items

None.

Field Standard Operating Procedure-09
Field Logbook

Author: Sara Maihofer 10/22/2020

Approver: Theresa Himmer 10/22/2020



Quality Assurance Manager

Field Standard Operating Procedure-09
Field Logbook

1. Purpose

The purpose of this field standard operating procedure (SOP) is to delineate protocols for recording field survey and sampling information in a field logbook.

2. Scope

Data generated from the use of this field SOP may be used to support all stages of site management.

3. Equipment and Materials

- Field logbook
- Indelible waterproof ink pen
- Project specific field forms defined in the site-specific project plans

4. Procedures and Guidelines

All information pertinent to a field survey or sampling effort will be recorded in a bound field logbook that will be initiated at the start of the first onsite activity. The field logbook will consist of a bound notebook with consecutively numbered pages that cannot be removed. The outside front cover of the logbook will contain the project (site) name and the specific activity (for example, remedial design sampling). The inside front cover will include the following:

- The name of the person to whom the logbook is assigned
- Contact information for “if found”
- Logbook number
- Project name
- Project start date
- Project end date

Each page will be consecutively numbered, dated, and initialed. All entries will be made in indelible ink, and all corrections will consist of line-out deletions that are initialed and dated. If only part of a page is used, the remainder of the page should have an “X” drawn across it. At a minimum, entries in the logbook will include the following:

- Time of arrival and departure of site personnel, site visitors, and equipment
- Instrument calibration information, including make, model, and serial number of the equipment calibrated

- Field observations (such as sample description, weather, unusual site conditions or observations, and sources of potential contamination)
- Detailed description of the sampling location, including a sketch or field map markup
- Details of the sample site (for example, coordinates [*x*, *y*], water elevation [*z*], casing diameter and depth, integrity of the casing)
- Sampling methodology and matrix, including distinction between grab and composite samples
- Names of samplers and crew members
- Start or completion time of sample collection activities
- Field measurements (such as water depths, sediment probe depths)
- Type of sample (such as sediment)
- Number, depth, and volume of sample collected
- Field sample number
- Requested analytical determinations
- Sample preservation
- Quality control samples
- Sample shipment information including chain-of-custody form number, carrier, date, and time
- Health and safety issues (including level of personal protective equipment)
- Signature and date by personnel responsible for observations

Sampling situations vary widely and site-specific project plans will contain further direction on the types of information that must be captured for a given project. No general rules can specify the extent of information that must be entered in a logbook. Records should, however, contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory. The field team leader will keep a master list of all field logbooks assigned to the sampling crew.

5. Attachments

None.

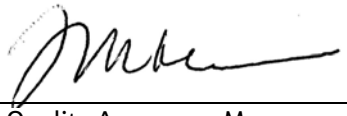
6. Key Checks and Items

None.

Field Standard Operating Procedure-10
Investigation-derived Waste Handling and Disposal

Author: Sara Maihofer 10/22/2020

Approver: Theresa Himmer 10/22/2020



Quality Assurance Manager

Field Standard Operating Procedure-10 Investigation-derived Waste Handling and Disposal

1. Purpose

The purpose of this field standard operating procedure (SOP) is to provide general guidelines for the handling and disposal of investigation-derived waste (IDW). Additional guidance will be provided in site specific project plans.

2. Scope

This SOP covers the handling and disposal of IDW, which are the waste materials generated during a field investigation. Some of the waste materials may be classified as hazardous waste. All IDW must be disposed of in accordance with local, state, and federal regulations.

Materials that may become IDW requiring proper treatment, storage, and disposal include the following:

- Personal protective equipment (PPE), such as disposable coveralls, gloves, booties, and respirator canisters.
- Disposable equipment, such as plastic ground and equipment covers, aluminum foil, Teflon tubing, broken or unused sample containers, sample container boxes, and tape.
- Excessive soil or sediment from sampling activities
- Groundwater obtained through well development, purging, or sampling.
- Decontamination fluids such as spent solvent and wash water.

3. Equipment and Materials

- Fluids
  - DOT-approved 55-gallon steel drums or frac tanks
  - Tools for securing drum lids
  - Funnel for transferring liquid into drum
  - Labels
  - Paint Pens
  - Marking pen for appropriate labels
  - Seals for 55-gallon steel drums

- Solids
  - DOT-approved 55-gallon steel drums or rolloffs
  - Tools for securing drum lids
  - Paint Pens
  - Plastic sheets
  - Labels
  - Marking pen for appropriate labels

4. Procedures and Guidelines

All IDW will be handled in accordance with federal and state regulations, as well as any site-specific requirements. If IDW is identified as potentially hazardous waste based on analytical data, it must be segregated from IDW that will be treated as nonhazardous for further characterization.

Clean, empty drums or roll-offs or frac tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes (fill drum ¾, not to top), capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will be labeled as they are filled in the field and labels indicating that the contents are pending analysis affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. Check with the Environmental Manager (EM) assigned to the project prior to sample collection for frequency and analysis. Unless otherwise specified by the EM, the drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums (check with disposal facility to determine sample frequency) containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. Additional analysis may be required by your EM.

If rolloffs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

The following IDW will be placed in 55-gallon drums approved by the U.S. Department of Transportation and transported to the staging area:

- Excess soil or sediment brought to the surface during sampling activities not used for laboratory analysis
- Used PPE **identified as potentially hazardous waste**
- Purge water

- Development water
- Decontamination fluids

All IDW **not identified as potentially hazardous waste** will be managed as follows:

- Used PPE will be placed in containers or trash bags and disposed of as a solid waste in an appropriate licensed landfill.

4.1 Labeling

All IDW containers will be labeled to identify their waste status. Labels shall be obtained from the field team leader. Containers being used to store/accumulate waste shall include one of the following labels:

- "Nonhazardous Waste"
- "Analysis Pending"
- "Hazardous Waste"
- Before affixing the label, prepare containers by wiping any residue from outer surfaces that may prevent legible and permanent labeling. Labels will include the following information:
- Type of waste
- Location from which the waste was generated
- Accumulation start date
- Any other information required (that is, point of contact with phone number)

4.2 Waste Accumulation Area Management

All IDW identified as potentially hazardous will be transferred as soon as practical to a temporary storage areaidentified by the field team leader. The following requirements apply to the waste storage areas:

- Hazardous wastes and waste awaiting designation will be stored separately in the waste accumulation area.
- All containers will be stored on wooden pallets.
- Store containers in rows based on the waste stream designators.

4.3 Offsite Disposal

Offsite IDW disposal will be coordinated by the Subcontractor following applicable state and federal regulations. Arrangements will be made immediately upon completion of drilling and sampling activities to have the contracted waste handling firm remove the waste from the site. The need for waste disposal analysis will be determined as discussed with the contract waste handler before the onset of field events.

5. Records Management

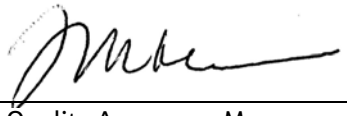
Document retention requirements are outlined in the prime contract number and require that all information be retained and available for 10 years following final payment on the contract. All information generated under this program is considered to be confidential and shall not be released to others without the written consent of the Contract Officer.

6. Key Checks

- Contact the project Environmental Manager prior to containerizing waste to determine containerization method and sampling frequency and analysis.
- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

Field Standard Operating Procedure-12
Soil Boring Logging

Author: Steve Chumney 8/27/2021 

Approver: Theresa Himmer 08/31/2021 

Quality Assurance Manager

Field Standard Operating Procedure-12
Soil Boring Logging

1. Purpose

This field operating procedure (FOP) document provides guidance for obtaining accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

2. Scope

The logging of soil samples will be conducted in general accordance with current ASTM International (ASTM) Designation D 2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). The ASTM procedure is available for internal use only on the Jacobs Technical Information Library. Neither the ASTM electronic file nor the hard copy print may be reproduced in any way.

3. Equipment and Materials

- Indelible Soil boring log forms
- Soil logging guide
- Field logbook
- Write-in-the-rain pen (for extreme weather conditions—cold/rain)
- Clean plastic sheeting
- Clean 55-gallon steel drum approved by the U.S. Department of Transportation and label
- Tape measure
- Pocket penetrometer (optional)
- Clean latex or nitrile gloves
- 12-inch ruler
- Hand lens
- Color Chart for Soil and Rock

4. Procedures and Guidelines

This section covers several aspects of the soil characterization: instructions for completing the soil boring log, field classification of soil, and standard penetration test procedures.

4.1 Instructions for Completing Soil Boring Logs

Soil boring logs will be completed on the soil boring log. The information collected in the field to perform the soil characterization is described below. Field personnel should review completed logs for accuracy,

clarity, and thoroughness of detail. Analytical samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets. Print all information on the field log form—do not write in cursive.

4.1.1 Heading Information

- **Boring Number**. Enter the boring number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each location.
- **Location**. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.
- **Elevation**. Elevation will be determined at the conclusion of field activities.
- **Contractor**. Enter name of the company and the city and state where it is based.
- **Drilling/Excavation Method and Equipment**. Identify the bit size and type and method of drilling (e.g., rotary, rotosonic, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted. For excavations enter type of equipment used (e.g., make/model of equipment).
- **Water Level and Date**. Enter the depth below ground surface to the apparent water level in the borehole/excavation. If free water is not encountered during drilling/excavation or cannot be detected because of the drilling method, this information should be noted. Record date and time of day of each water level measurement.
- **Date of Start and Finish**. Enter the date(s) and time(s) the boring/excavation was begun and completed.
- **Logger**. Enter the first initial and full last name of the person completing the form and describing the materials from the borehole.

4.1.2 Technical Data

- **Depth below Ground Surface**. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.
- **Sample Interval**. Note the depth at the top and bottom of the sample interval.

4.1.3 For Soil Borings:

- **Sample Type and Number.** Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.
- **Sample Recovery.** Enter the length to the nearest 0.1 foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material (e.g., slough) in the measurement. Record recovery in feet.
- **Soil Description**. The soil classification should follow the format described in the Field Classification of Soil subsection below.

- **Comments**. Include all pertinent observations (e.g., rod drops, rod bounce as in driving on a cobble, and equipment malfunctions). In addition, note if casing was used, the sizes, and depths installed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders). Such information should be attributed to the driller and recorded in this column.

4.2 Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils.

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1) Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example “Sandy CLAY”
2) Group symbol, in parentheses—for example, “(CL)”
3) Color, using Munsell color designation if appropriate
4) Moisture content
5) Relative density or consistency
6) Soil structure, mineralogy, or other descriptors

This order generally follows the format described in ASTM D 2488.

4.2.1 Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is Silty SAND with gravel, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is Sandy SILT. The gravel portion is not included in the soil name because the gravel

portion was estimated as less than 15 percent. The Group Symbol is (ML). However, the description of this sample should include the phrase "with some gravel" after the descriptive terminology of the primary soil group.

- The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as “Interlayered Sand and Silt,” should be used. In addition, the relative proportion of each soil type should be indicated.

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

4.2.2 Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group.

Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

4.2.3 Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

4.2.4 Moisture Content

The relative degree of moisture present in a soil sample should be defined as dry, moist, or wet.

4.2.5 Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586). If an auto-hammer is not used to collect samples, this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly determined using a pocket penetrometer. For purposes of environmental sampling, the ‘rule of thumb’ can be used, for example, very soft means the soil can be easily penetrated several inches by fist, soft is easily penetrated several inches by thumb, firm can be penetrated several inches by thumb with moderate effort, stiff is readily indented by thumb, but

penetrated only with great effort, very stiff is readily indented by thumbnail, and hard is indented with difficulty by thumbnail.

4.2.6 Soil Structure, Mineralogy, and Other Descriptions

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described. Man-made debris encountered in drilling (such as slag from mineral smelting activities) should be identified as such on the log and otherwise described similar to soils, considering aspects such as grain size, angularity, and moisture content.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product (for example, nonaqeous phase liquid, or NAPL).

4.2.7 Equipment and Calibration

No equipment needs to be calibrated if not sampling with the auto hammer.

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

The field notes and utility-locate drawings will be reviewed by the Field Quality Manager at the end of each work day performed.

7. Attachments

Soil boring log.

8. References

ASTM D2488. Standard Practice for Description and Identification of Soils (Visual-Manual Procedures. July 2017.

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

PROJECT NUMBER	BORING NUMBER SHEET 1 OF 2

SOIL BORING LOG

PROJECT : LOCATION :

ELEVATION : DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	PID READING (ppm)	CORE DESCRIPTION SOIL TYPE, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF SURFACE CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND START/STOP TIMES OF DAILY DRILLING RUNS.
5						
10						
15						
20						
25						
30						
35						
40						
45						

PROJECT NUMBER	BORING NUMBER SHEET 2 OF 2

SOIL BORING LOG

PROJECT : LOCATION :

ELEVATION : DRILLING CONTRACTOR :

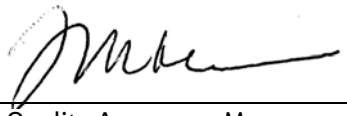
DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	PID READING (ppm)	CORE DESCRIPTION SOIL TYPE, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF SURFACE CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND START/STOP TIMES OF DAILY DRILLING RUNS.
50						
55						
60						
65						
70						
75						
80						
85						
90						

Field Standard Operating Procedure-13
Multi RAE Photoionization Detection Calibration and Operation

Author: Sara Maihofer 8/27/2021 

Approver: Theresa Himmer 08/31/2021 

Quality Assurance Manager

Field Standard Operating Procedure-13
Multi RAE Photoionization Detection Calibration and Operation

1. Purpose

This field operating procedure (FOP) provides general reference information for using the Multi RAE photoionization detector (PID) in the field. Calibration and operation, along with field maintenance, are included in this FOP.

2. Scope

This procedure provides information into the field operation and general maintenance of the Multi RAE PID. Review of the information contained herein will ensure this type of field monitoring equipment will be properly used. Review of the owner's instruction manuals is a necessity for more detailed descriptions.

3. Definitions

- Carbon monoxide sensor (CO): Expresses the carbon monoxide concentration in parts per million (ppm).
- Volatile organic compound (VOC): Expresses the VOC concentration in ppm.
- Lower explosive limit (LEL): Combustible gas is expressed as a percent of the LEL.
- Hydrogen sulfide sensor (H_2S): Expresses the hydrogen sulfide concentration in ppm.
- Oxygen sensor (OXY): Expresses the oxygen concentration as a percentage.
- Parts per million (ppm): Parts of vapor or gas per million parts of air by volume.

4. Responsibilities

- Project Manager: Responsible for ensuring project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The project manager is responsible for selecting qualified individuals for the monitoring activities.
- Health and Safety Coordinator: Responsible for developing a site-specific health and safety plan that specifies air monitoring requirements.
- Field Team Leader: Responsible for implementing these procedures in the field and ensuring the field team performing air monitoring activities have been briefed and trained to execute these procedures before the start of site operations.
- Safety Liaison (SL): Responsible for ensuring the specified air monitoring equipment is onsite, calibrated, and used correctly by the field personnel. The SL will coordinate these activities with the Field Team Leader if the SL is not the Field Team Leader as well.

- Field Team: Responsible for following these procedures or documented project-specific procedures as directed by the Field Team Leader/SL. The field personnel are responsible for documenting air monitoring results in the field logbook during each field investigation.

5. Equipment and Materials

- MultiRAE PID
- Calibration gas
- Calibration gauge

6. Procedures and Guidelines

The Multi RAE uses the principle of detecting sensors. The PID operates on the principle that most organic compounds and some inorganic compounds are be ionized when they are bombarded by high-energy ultraviolet (UV) light. These compounds absorb the energy of the light, which excites the molecule and results in a loss of electron and the formation of a positively charged ion. The number of ions formed and the ion current produced is directly proportional to mass and concentration. The amount of energy required to displace an electron is called ionization potential. The air sample is drawn into a UV lamp using a pump or a fan. The energy of the lamp determines whether a particular chemical will be ionized. Each chemical compound has a unique ionizing potential. When the UV light energy is greater than the ionization potential of the chemical, ionization will occur. When the sample is ionized, the electrical signal is displayed on an analog or digital output. Although the output does not distinguish between chemicals, it does detect an increase in the ion current. If only one chemical is present in the air, it is possible to use PIDs quantitatively.

Chemical structure and lamp intensity affects the sensitivity of the instrument to a given contaminant. All PID readings are relative to the calibration gas, usually isobutylene. It is important to calibrate the PID in the same temperature and elevation that the equipment will be used, and to determine the background concentrations in the field before taking measurements. For environments where background readings are high, factory zero calibration gas should be used.

The following subsections discuss Multi RAE calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

6.1 Calibration

The Multi RAE configured with O_2, LEL, H_2S, and CO sensors and a 10.6 electron volt (eV) PID Lamp or other lamp size specified in the project H&S plan.

Start up Instrument

- Press **Mode** button
- Observe displays:

On!……..

Multi RAE
Version X.XX

Model Number
SN XXXX

Date Time
Temp

Checking Sensor
Ids….

VOC Installed

CO Installed

H_2S Installed

OXY Installed

LEL Installed

H_2S VOC CO LEL OXY
Alarm Limits=
XX XX.X XX XX High XX.X
XX XX.X XX XX Low XX.X
XX XX.X XX STEL
XX XX.X XX TWA
Battery = X.XV Shut off at 4.2V
User Mode=
Alarm Mode=

Datalog Time Left

Datalog Mode

Datalog Period

Unit ready in….. 10 Seconds

- The pump will start, the seconds will count down to zero, and the instrument will be ready for use

6.2 Calibration Check and Adjustment

Allow instrument to warm up for 15 minutes.

- Depress the **[N/-]** key first, then while depressing the **[N/-]**, depress the **[Mode]** key also and depress both keys for 5 seconds.
- Display will read:

Calibrate Monitor?

- Press the **[Y/+]** key
- Display will read:

Fresh Air Calibration?

- If "Zero Air" is necessary, attach the calibration adapter over the inlet port of the Multi RAE Monitor and connect the other end of the tube to the gas regulator (HAZCO loaner regulator LREG.5, RAE Systems P/N 008-3011 or suitable .5 LPM regulator) on the Zero Air bottle (HAZCO P/N SGZA, RAE P/N 600-0024). If no Zero Air is available, perform the Fresh Air Calibration in an area free of any detectable vapor.
- Press the **[Y/+]** key
- Display will read:

Zero…. In progress…

CO Zeroed! Reading = X

VOC Zeroed! Reading = X

LEL Zeroed! Reading = X

OXY Zeroed! Reading = X

Zero Cal done!

H_2S Zeroed! Reading = X

In each of the above screens, "X" is equal to the reading of the sensor before it was zeroed.

- Display will then read:

Multiple Sensor Calibration?

- Press the **[Y/+]** key
- The display shows all of the pre-selected sensors and the "OK?" question:

CO H_2S LEL OK? OXY

- Apply calibration gas – use either HAZCO Services Part Number R-SGRAE4 or Rae Systems Part Number 008-3002 – using a .5 LPM regulator and direct tubing.
- Press the **[Y/+]** key. Display will read:

Apply Mixed gas

Calibration In progress …

- The display will count down showing the number of remaining seconds:

CO cal'ed Reading=50

H_2S cal'ed Reading=25

LEL cal'ed Reading=50

OXY cal'ed Reading=20.9

Calibration done Turn off gas!

- Display will read:

Single Sensor Calibration?

- Press the **[Y/+]**.
- Display will read:

CO VOC H_2S LEL pick? OXY

- Attach 100 ppm isobutylene (HAZCO P/N r-SGISO or Rae P/N 600-0002) using a 1.0 LPM regulator (HAZCO P/N LR10HS or Rae P/N 008-3021). Open regulator.
- Press the **[Mode]** key once, the V of VOC will be highlighted.
- Press the **[Y/+]**. The display will read:

Apply VOC Gas

Calibration In progress…

- The display will count down showing the number of remaining seconds, then display:

VOC cal'd
Reading=100

Calibration done
Turn off gas!

Single Sensor
Calibration?

- Press **[Mode]** key twice to return to main screen.
- **CALIBRATION IS COMPLETE!**

6.3 Operation

Because the Multi RAE has many operational functions, it is recommended that you follow the operational procedures as outlined in the instruction manual.

6.4 Maintenance

After each use, the meter should be recharged. and the outside of the instruments should be wiped clean with a soft cloth.

Scheduled Maintenance

Function	Frequency
Check alarm and settings	Monthly/before each use
Clean screens and gaskets around sensors	Monthly
Replace sensors	Biannually or when calibration is unsuccessful

7. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

8. Quality Control and Quality Assurance

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the field logbook.

- Identification: Site name, date, location, activity monitored, (surface water sampling, soil sampling, etc), serial number, time, resulting concentration, comments and identity of air monitoring personnel
- Field observations: Appearance of sampled media (if definable)
- Additional remarks (e.g., Multi RAE had wide range fluctuations during air monitoring activities.)

9. Attachments

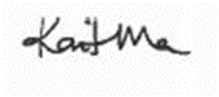
None.

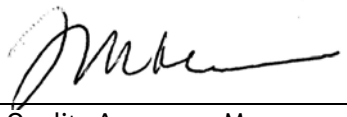
10. References

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

RAE Systems. 2003. Multi RAE Plus Multiple Gas Monitor User Manual, Revision B1. November.

Field Standard Operating Procedure-14
Water Level and Total Depth Measurements

Author: Kaitlin Ma 8/27/2021 

Approver: Theresa Himmer 08/31/2021 

Quality Assurance Manager

Field Standard Operating Procedure-14
Water Level and Total Depth Measurements

1. Purpose

This field operating procedure (FOP) provides guidelines for measuring depths to groundwater and total depth in soil borings, piezometers, and monitoring wells.

2. Scope

This FOP also covers the topic of measuring light nonaqueous phase liquid (LNAPL) that may be present. It includes only guidelines for discrete measurements of static water levels.

3. Equipment and Materials

- Field logbook and water proof pen
- Equipment/instrument decontamination materials (see *Field Equipment Cleaning and Decontamination Procedures*)
- Well keys and wrenches/T-bar
- Clean latex or nitrile gloves
- Electronic water level meter or oil/water interface probe (Solinst® or equivalent) with a minimum 100-foot tape with graduations in increments of 0.01 foot or less

4. Procedures and Guidelines

- Decontaminate equipment/instruments in accordance with the *Field Equipment Cleaning and Decontamination Procedures*.
- Open the protective cover on well.
- Unlock and remove all monitoring well caps. The well caps will be removed from all monitoring wells prior to beginning depth to groundwater measurements. A minimum time of 30 minutes shall be allotted between the removal of a well cap and measuring the depth to groundwater in the same monitoring well unless the well casing has a hole in it to allow barometric pressures to constantly equilibrate. This will allow the groundwater surface within the riser to stabilize with atmospheric pressure prior to taking a depth to water measurement.
- Lower the probe slowly into the monitoring well or soil boring until the probe just contacts the groundwater surface; the unit will respond with a tone or light signal. Make sure that the top of the riser pipe does not have a sharp edge that may damage the protective coating around the wires in the tape.

- Note the depth to groundwater relative to a reference point indicated on the monitoring well riser pipe. If no reference is clearly visible, reference the northern edge of the riser pipe or soil boring. Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the field logbook.
- Measure water levels to the nearest 0.01 foot.
- Record the condition of the concrete pad, padlock, well cap, protective cover, and bollards (if present) in the field logbook, along with the depth to the groundwater surface.
- Compare the newly measured depth to water in each well to the historical depth to water in that and adjacent wells and re-measure if the new data are outside the historic range for an individual well or if the new data are inconsistent with general patterns of water table rise and fall, considering all wells being monitored. [For example, if most wells measured are generally a few feet higher than the past monitoring event but one well is measured as being several feet lower than past data indicate, re-measure and verify the depth.]
- The total depth of the monitoring well or soil boring should be measured and recorded in the field logbook every time the well is monitored. The total well depth shall be measured in the same general manner as the depth to groundwater except that no indication [light or buzzer] will be produced by the instrument when bottom is reached. Instead, the field personnel will have to monitor the relative weight of the tape and probe as it is lowered into the well and use feel to determine when bottom is reached. The feel of the bottom of the well should also be recorded, this would be soft if the bottom appears to be covered in silt, or firm if the bottom feels clean.
- Decontaminate the probe and tape as it is removed from the well or boring in accordance with the *Personnel and Equipment Decontamination Procedures*.

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

Verify that the battery of the water level meter or oil/water interface probe is charged before each use by pressing the test button on the side of the unit.

- Verify that the unit is operating correctly by testing the probe in tap water (not distilled or deionized water) and verifying that the light and buzzer are activated at the same depth. If one measures higher or lower than the other, continue testing in tap water and determine which indicator is more accurate, and use that indicator for the field measurements.
- Inspect the tape for abrasions that may have been exposed to the wires. The unit will not function properly if there is a short in the wiring.
- It is recommended that a map of all wells to be monitored be carried into the field when monitoring occurs.

- Prior to mobilizing to the site, use historical data to determine which wells to be monitored are cleanest and which are dirtiest/most contaminated and start monitoring with the clean wells first and moving to more contaminated wells last.

7. Attachments

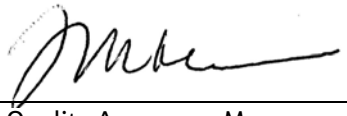
None.

8. References

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

Field Standard Operating Procedure-15
Identification of NAPL in Environmental Media

Author: Steve Chumney 8/27/2021 

Approver: Theresa Himmer 08/31/2021 

Quality Assurance Manager

Field Standard Operating Procedure-15 Identification of NAPL in Environmental Media

1. Purpose

This field operating procedure (FOP) describes the procedures for identifying nonaqueous phase liquids (NAPLs) in environmental media during subsurface sampling activities.

2. Scope

This procedure provides field personnel with techniques to identify a "positive" NAPL hit, which will trigger sample collection activities.

3. Equipment and Materials

- Clear jars or bottles
- Oil Red O, Sudan IV, or similar hydrophobic dye NAPL test kit
- Distilled water
- Stirring rods
- Field notebook
- Portable centrifuge
- Photoionization detector (PID) and/or flame ionization detector
- Electronic oil-water interface probe
- Digital camera

4. Procedures and Guidelines

4.1 Testing for the Presence of NAPL in Soil Samples

4.1.1 Visual Inspection

- Collect grab samples from the soil core in 2-foot intervals.
- Inspect sample for any discoloration (green, amber, brown, or black), coating, staining, presence of sheens in the saturated zone, NAPL-saturated soils, and staining on drilling equipment.

4.1.2 Instrument Inspection

- Use a PID to scan soil core to identify intervals that have elevated levels of volatile organic compounds. Record all readings in field notebook and on soil boring log following FOP *Note Taking and Field Logbook and Soil Boring Logging*.
- Take photographs of all positive NAPL hits in 2-foot intervals. Record the boring ID, depth interval, date, and time in the field notebook and photo log.

4.1.3 Hydrophobic Dye Test Kit

- The hydrophobic dye test is a field screening procedure**. It will be used to qualitatively determine the presence of NAPL in soil and groundwater in 2-foot depth intervals across the soil column**.
- Collect soil sample from selected interval and place soil into the test kit in accordance with the manufacturer's directions. Add distilled water into the test kit in accordance with the manufacturer's directions and cap the test kit. Shake the test kit by hand for approximately 10 to 30 seconds. Color development indicates the presence of NAPL in the soil-water mixture.
- Sample duplicates should be performed in the field to document method repeatability at the rate of at least 1 for every 20 samples
- **Disregard above instructions and follow specific instruction manuals if NAPL field screening kit has a dedicated procedure that differs.**
- Once NAPL testing is complete, use the following soil classifications to document the absence or presence of NAPL:
  - **No evidence of NAPL** –No visual evidence of NAPL and negative NAPL soil test kit result.
  - **Evidence of NAPL** –Soils exhibit signs of being coated or stained, drilling and/or sampling equipment stained, or sheens noted. Positive NAPL soil test kit result.
  - **Zone of potentially mobile NAPL** – Soils are either saturated with NAPL or exhibit signs of NAPL ganglia. Soils are discolored and readily stain sampling and drilling equipment. Generally, NAPL is not observed to readily flow out of soil unless agitated. Positive NAPL soil test kit result.
  - **Zone of mobile NAPL –** NAPL is present as free-phase liquid, or soils are visibly saturated with NAPL. NAPL readily flows from soil with little or no agitation. In these cases, an NAPL soil test kit result is not required.
- Document field screening results and soil classifications in the field notebook and boring log following procedures outlined in FOP *Note Taking and Field Logbook and Soil Boring Logging*.

4.2 Testing for the Presence of NAPL in Groundwater Samples

4.2.1 Visual Inspection

- Collect water samples and look for iridescent sheen. Inspect the water sample for phase separations. If present, light nonaqueous phase liquids (LNAPLs) will occur at the top of the container and dense nonaqueous phase liquids (DNAPLs) will occur at the bottom of the container.
- Look for irregular blobs of free product if a floating layer of NAPL was intercepted. In which case, determine the thickness of the free product (see Section V).
- Look for small black particles that sink to the bottom of the water sample, this may indicate the following:
  - The presence of DNAPL
  - Weathered LNAPL - One of the weathering processes of LNAPLs is sedimentation, caused by the evaporation of the lighter NAPL fraction. The remaining heavier fractions can adhere to particulate matter, such as sand or clay, and sink.
- Collect a sample of water and seal the container. Place container in the sun and let it sit undisturbed. Check to see if there are phase separations in the sample.
- Take photographs of positive NAPL hits in 2-foot intervals. Record the boring ID, depth interval, date, and time in the field notebook and photo log.

4.2.2 Hydrophobic Dye Test Kit

- Place approximately 40 milliliters of groundwater sample in a clear jar or bottle. Add about 2 milligrams of Oil Red O dye to water and shake.
- Color development indicates the presence of an NAPL.
- If a portable centrifuge is available, the sample can be placed in centrifuge tube and centrifuged to determine if the NAPL is a DNAPL or LNAPL.

4.3 Measuring Thickness of Free Product

- If a layer of free product is intercepted during drilling, stop drilling.
- Measure thickness of the free product using an oil-water interface probe in the borehole. Note: The thickness measured in the borehole will not be the actual thickness of the free product in the formation.
- Record results in the field logbook and follow procedures below.

4.4 Reporting

- The following information should be recorded in the field logbook for each sample analyzed: date, time, matrix description (i.e., soil type or groundwater description), temperature, location, depth, field sampler's name, and observations of solid and liquid phases (see FOP *Field Logbook*).

- Record results on the boring log for the appropriate depth where the sample was collected (see FOP *Soil Boring Logging*).

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

- The Refer to the Health and Safety Plan for appropriate health and safety precautions.
- A safety data sheet (SDS) for the hydrophobic dye should be made available to all personnel involved in the chemical analysis.

7. Attachments

None.

8. References

Cohen, R. M., A.P. Bryda, S. T. Shaw, and C. P. Spalding. 1992. "Evaluation of Visual Methods to Detect NAPL in Soil and Water." *GWMR*. pp. 132-139.

Cohen, R. M., and J.W. Mercer. 1993. "DNAPL Site Evaluation." EPA/600/R-93/022. February. pp. 7.6, 9.31 and 9.38 - 9.46.

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

New Jersey Department of Environmental Protection. 1992. *Field Sampling Procedures Manual*.

Field Standard Operating Procedure-16
Non-aqueous Phase Liquids Collection

Author: Scott Pratt 8/27/2021

Approver: Theresa Himmer 08/31/2021

Quality Assurance Manager

Field Standard Operating Procedure-16
Non-aqueous Phase Liquids Collection

1. Purpose

This field operating procedure (FOP) provides several procedures for the collection of non-aqueous phase liquid (NAPL) samples for laboratory analysis from borings and test pits. The Field Geologist will be responsible for choosing the best procedure to be used for NAPL collection.

2. Scope

This FOP also covers the topic of collecting NAPL.

3. Equipment and Materials

- Oil-water interface probe (such as Solinst® Model 122 Interface Meter or equivalent)
- Peristaltic pump or similar pump
- Disposable plastic tubing
- Clear disposable bailer(s)
- Nylon cord or rope
- Scissors
- Deionized water spray bottles
- Alconox solution in spray bottles
- Paper towels
- Container(s) for collecting decontamination water and purge water (if applicable)
- Appropriate sample container(s) for collecting NAPL
- Sample Cooler
- Personal protective equipment (PPE) as required by the health and safety plan

4. Procedures and Guidelines

NAPL may be collected using several procedures as noted below. For rotosonic drilling it is assumed that a temporary well will be installed through the rotosonic casing. For test pits, it is assumed that sufficient NAPL exists in the backhoe bucket or the trench itself.

4.1 Identify NAPL Presence and Thickness

Once NAPL has been identified (FOP *Identification of NAPL in Environmental Media*), the Field Geologist will instruct the Subcontractor to halt all drilling/excavation activities.

4.1.1 Temporary Well Only

- Verify that the oil-water interface probe is turned on and functioning properly.
- Slowly lower the probe toward the base of the well. Note a change in probe sound or indicator light that denotes dense NAPL (DNAPL). If DNAPL is identified, then slowly repeat the measurement for verification.
- If the oil-water interface probe yields erratic readings then switch to a different probe or NAPL measurement method.
- Identify the base of the well.
- Proceed to lower a clear bailer down the well to collect NAPL. The clear bailer will be used to verify the approximate thickness and consistency of the DNAPL. If pure product is observed in bailer, this may be used for collection. However, if bailer disturbs sample, then purging may be required, as described below.
- If the temporary well screen inhibits the flow of NAPL, then bailer and purging techniques should be attempted without the well in the boring.

4.2 NAPL Purging

If the NAPL thickness is sufficient for pumping, a peristaltic pump or similar pump may be used to collect a sample.

- Attach appropriate disposable clear tubing to the pump and lower slowly into the well or excavation (if possible), below the DNAPL surface.
- Turn the pump on and adjust the flow rate, starting slowly until the NAPL is observed in the tubing.
- Adjust the flow rate so that NAPL is flowing evenly from the tubing and not splashing.
- Make certain the tubing remains below the DNAPL surface so that air does not get introduced, which may hinder flow.
- Place the end of the disposable clear tubing into the appropriate clean bottles and fill to the recommended level.
- Continue pumping until all bottles are filled or the DNAPL supply is drained, whichever occurs first.
- Clean exterior of bottles and place in cooler for temporary storage until being shipped to lab following FOP *Packing and Shipping of Environmental Samples*. **NOTE THAT NAPL MUST BE SHIPPED AS DANGEROUS GOODS.**
- Record all observations in the field notebook and boring log following FOPs *Field Logbook* and *Soil Boring Logging*.

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

- NAPL cross-contamination must be avoided. Therefore, use disposable equipment where possible and be prepared to use vigorous decontamination techniques where NAPL is encountered.
- Before each use, verify that the battery is charged by pressing the test button on the interface probe.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.
- Thoroughly decontaminate equipment and tooling that has come in contact with NAPL.
- Properly dispose of PPE and disposal sampling equipment that contacted NAPL in accordance with project-specific plans.

7. Attachments

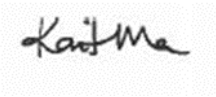
None.

8. References

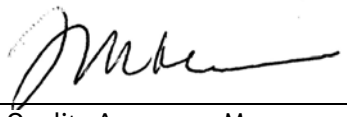
Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

Field Standard Operating Procedure-17
Field Water Quality Measurements and Calibration

Author: Kaitlin Ma 8/27/2021



Approver: Theresa Himmer 08/31/2021



Quality Assurance Manager

Field Standard Operating Procedure-17
Field Water Quality Measurements and Calibration

1. Purpose

This field operating procedure (FOP) provides a general guideline for using the YSI 600XLM or similar device for field water quality measurements such as pH, specific conductance, dissolved oxygen, ORP, and temperature and using a HACH turbidity meter or similar device for measuring turbidity. The operator's manual should be consulted for detailed calibration and operating procedures.

2. Scope

All water quality measurements will be taken in accordance with this FOP. Record keeping to document calibration activities and environmental sample results will be documented in the field log book in accordance with FOP *Note Taking and Field Logbook*.

3. Equipment and Materials

- Nitrile gloves
- Field Notebook
- YSI 600XLM Water Quality Meter, or similar device
- Distilled or deionized water in spray bottle
- Alconox, of equivalent, in spray bottle
- Calibration standard solution for pH (4, 7, and 10), conductivity, and ORP
- HACH turbidity meter, or similar device

4. Procedures and Guidelines

4.1 Calibration

Prior to each day's use, clean the YSI probe according to the manufacturer's direction and calibrate using specified solutions. Follow the instructions provided with the water quality meter. If there is a problem with calibration, the meter will return an error. In this case, the cause of the error must be researched in the manual or with the supplier of the equipment before using. Calibrate temperature probe with a laboratory grade thermometer using hot and cold tap water to establish accuracy over a range of temperatures.

Prior to each day's use, confirm calibration of the HACH turbidity meter according to the manufacturer's direction. Turbidity will be measured in NTUs.

4.2 Sample Measurement

As the water passes through the probe, allow readings to stabilize and record in the field notebook or on proper documentation sheets

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

- Verify meters are calibrated
- Clean probe with Alconox, or equivalent, and rinse with deionized or distilled water before calibrating, between calibration fluids, and when done
- Refer to operations manual for recommended maintenance
- Check batteries, and have a replacement set on hand
- Store the YSI probe must be stored in non-deionized water when not in use to prevent damage to the DO membrane. If the membrane is damaged, the replacement method can be found in the manual.
- The field notes will be reviewed by the Field Quality Manager at the end of each workday performed.

7. Attachments

None.

8. References

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

Monitoring Well

Field Data Sheet

Well Number: Field Crew: Purpose of Sampling:

Site: Field Conditions:

WELL CONDITION

Well Pad	Acceptable	Not Acceptable	Explain:
Protective Casing	Acceptable	Not Acceptable	Explain:
Well Casing	Acceptable	Not Acceptable	Explain:
Locking Cap	Acceptable	Not Acceptable	Explain:
Well Label	Acceptable	Not Acceptable	Explain:

PURGE METHOD

Date: Time: Method:

Total Well Depth (ft) =

Depth to Water (ft): =

Water Column (ft): =

1 volume

Comments:

OBSERVATIONS

Odor: None , Low , High , H_2S , Fuel Like , Other:

Comments:

FIELD PARAMETERS

Time	Volume (gal) --	Rate (mL/min) --	pH (s.u.) +/- 0.1 s,u,	DO (mg/L) +/- 10%	ORP (mV) +/- 10 mV	Specific Conductance (mS/cmc) +/- 3%	Temp (^oC) +/- 3%	Turbidity (NTU) <10 NTU	Depth to water (feet) --

SAMPLING

Date: Time:

Sample ID: Method of Sample Collection:

Analytical Parameters:

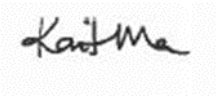
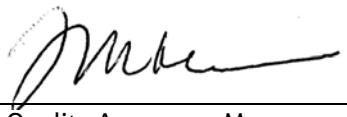
Q.C. Sample Type: MS/MSD Duplicate Duplicate Sample ID:

Q.C. Parameters:

Trash picked up? Well locked?

SIGNED/SAMPLER:

Field Standard Operating Procedure-18
Groundwater Sampling Procedures

Author: Kaitlin Ma	8/30/2021	
Approver: Theresa Himmer	08/31/2021	 Quality Assurance Manager

Field Standard Operating Procedure-18 Groundwater Sampling Procedures

1. Purpose

This field operating procedure (FOP) presents general guidelines for collecting groundwater or groundwater grab samples from monitoring wells using low-flow sampling techniques. *FOP-14 Water Level and Total Depth Measurements* should be consulted in conjunction with this FOP.

2. Scope

This FOP is applicable to low-flow sampling techniques. This FOP does not cover purging and sampling of monitoring wells by bailing or other high-flow methods.

3. Equipment and Materials

- Nitrile gloves
- Field Notebook
- Water Level Meter
- YSI 600XLM Water Quality Meter, or similar device
- Groundwater pump
    - Adjustable rate, submersibile pumps are preferred (centrifugal or bladder pump)
    - Peristaltic pump with portable battery may be used with caution. EPA guidance states that "suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds."
- Calibration standard solution for pH (4, 7, and 10), conductivity, and ORP
- HACH turbidity meter, or similar device
- Distilled or deionized water in spray bottle
- Alconox, of equivalent, in spray bottle
- Environmental Manager-approved container such as United Nations drum
- T connector
- Disposable Teflon tubing
- Disposable silicon tubing (for peristaltic)
- Measuring cup to assess flow rate

- 1-micron filter for dissolved phase target analyte list (TAL) metals sample collection
- Stopwatch
- Laboratory-supplied analytical sample containers

4. Water Quality Indicator Parameters Defined

The six field indicator parameters to be monitored include dissolved oxygen, turbidity, ORP, specific conductance, pH, and temperature. Of the parameters, dissolved oxygen, ORP, specific conductance, pH, and temperature are moderately to extremely sensitive to contact with atmospheric oxygen and will be measured in-line using a flow-through cell. Turbidity also will be measured separately to reduce the influence of suspended solids that are retained in the flow-through cell. Indicator parameters will be monitored continuously during purging and values recorded every 5 minutes or whenever at least 1 system volume has cycled through the flow cell.

4.1.1.1 Dissolved Oxygen, ORP, Specific Conductance, pH, and Temperature

The stabilization criteria for dissolved oxygen, ORP, specific conductance, pH, and temperature are three successive readings separated by a time interval sufficient to pump at least one sampling tubing volume plus flow-through cell volume of water through the system at a flow rate equal to or greater than 100 milliliters per minute (mL/min) but less than 500 mL/min while not lowering the water level in the well more than 0.3 foot, within the following ranges:

- Dissolved oxygen: ±10 percent for values greater than 0.5 mg/L
- Eh (ORP): ±10 millivolts (mV)
- Conductivity: ±3 percent (micromhos per centimeter (µmho/cm))
- pH: ±0.1 unit
- Temperature: ±3 percent (degrees Celsius,°C)

Note: A minimum of three system volumes must be purged before evaluating whether stabilization criteria are met and purging is complete before sampling.

4.1.1.2 Turbidity

It should be noted that natural turbidity levels in ground water may exceed 5 nephelometric turbidity units (NTU). If the other parameters stabilize but turbidity remains greater than 5 NTUs, field personnel should continue purging at the determined sustainable flow rate until turbidity readings are ±10 percent NTUs. If turbidity does not stabilize, the project manager should be notified. It should be noted that turbidity measurements may not stabilize within the aforementioned criteria before collecting a sample in accordance with the procedures for purging a low-recovery well.

5. Procedures and Guidelines

5.1 Water Quality Indicator Parameters

1. Set up and calibrate instruments in accordance with manufacturer's instructions.

2. Decontaminate sampling equipment and other instruments to be placed in the monitoring well riser before sampling in accordance with the FOP-06 Personnel and Equipment Decontamination Procedures.

3. Measure the depth to groundwater before performing low-flow sampling, as described in the FOP-02 Water Level and Total Depth Measurements. **Do not measure the depth to the bottom of the well at this time in order to reduce the possibility that accumulated sediment in the well will be disturbed.** Obtain total well depth from the monitoring well development log, or acquire total depth during water level measurements, but the well should not be sampled the same day as depth to bottom is measured.

4. Place field equipment and supplies on clean plastic sheeting to minimize contamination.

5. Determine the system volume, which is the volume of water that will pass through the tubing in the well, pump, and flow-through cell. A minimum of three system volumes must be purged before evaluating whether stabilization criteria are met and purging is complete before sampling.

6. Follow these procedures if using a peristaltic pump:

a. Connect the silicone tubing to the peristaltic pump.

b. Lower the Teflon tubing slowly to the top of the water column. The field team should use a tape measure to measure out the tubing.

c. Place the tubing intake at the depth where the highest contaminant concentrations are present. If this depth is unknown, place the tubing intake in the middle of the well screen if the entire length of the well screen is below the potentiometric surface. If the potentiometric surface is within the well screen, the intake should be set approximately 2 feet off the bottom of the well to minimize the intake of fines accumulated on the bottom of the well and maximize the length of water column above the tubing intake.

d. Cut the Teflon tubing, secure to the top of the well riser with a clamp, and connect to the silicone tubing in the peristaltic pump. Allow extra polyethylene tubing in case the water does not recharge as fast as the pumping rate, so the tubing can be lowered farther into the well.

e. Ensure that the pump flow direction is correct on the peristaltic pump. It is best to verify the flow direction before connecting the polyethylene tubing by inserting the silicone tubing in a cup of distilled water.

f. Connect silicone tubing to the water quality meter flow through cell (bottom connector). Run the outlet tubing (upper connector) to the 5-gallon bucket.

7. Follow these procedures if using a centrifugal pump:

a. Connect Teflon tubing to pump.

b. Lower the pump slowly to the required depth, and use a tape measure to measure the tubing.

c. Place the pump intake at the depth where the highest contaminant concentrations are present. If this depth is unknown, place the pump intake in the middle of the well screen if the entire length of the well screen is below the potentiometric surface. If the potentiometric surface is within the well screen, the intake should be set approximately 2 feet off the bottom of the well to minimize the intake of fines accumulated on the bottom of the well and maximize the length of water column above the tubing intake.

d. Connect the Teflon tubing to the bottom of the flow through cell. Run the outlet tubing from the upper connector to the 5-gallon bucket.

8. Start pumping. Purge rate should be less than 500 mL/min. Monitor the water level carefully after beginning the pumping process.

9. Turn on the groundwater parameter field instrument and let the readings stabilize. Once temperature has stabilized for 30 seconds, record initial groundwater parameters and depth to groundwater on a groundwater purging and sampling form.

10. Containerize purged groundwater initially in a plastic 5-gallon bucket and subsequently transfer to a clean 55-gallon steel drum, other labeled storage container, or handle as directed in the site waste management plan.

11. Purge to stability with a total water surface drop of 0.3 foot or less if water level is stable or only slowly dropping, to ensure stagnant water stored in the well casing is not being sampled and that only fresh groundwater is sampled.

12. Monitor carefully if water level has dropped more than 0.3 foot. Consider lowering the purge rate to keep the water level drop to less than 0.3 foot.

13. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

14. Disconnect the Teflon tubing from the flow-through cell if the well was purged. **Groundwater samples must never be collected from the outlet of the flow-through cell.** When collecting samples, ensure that the flow rate of the pump is equal to or less than the flow rate used to purge the monitoring well. Collect groundwater samples directly from the outlet of the polyethylene tubing starting with volatile organic compound (VOC) samples first.

15. Dissolved phase TAL metals are to be collected by attaching a 0.45-micron filter to the tubing and purging the water through the filter and into the sample jar.

16. Label the sample containers following the collection of groundwater samples, and place the samples in an ice bearing cooler away from sources of cross-contamination.

17. Remove the tubing from monitoring well and discard. Secure the well cap and lid on the well immediately after removing the tubing to prevent objects from being dropped in the well.

18. Decontaminate all equipment and instruments in accordance with the FOP-06 Personnel and Equipment Decontamination Procedures.

19. Store instruments in accordance with the manufacturer's instructions.

20. Purged groundwater will be handled in accordance with the project-specific plans.

6. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

7. Quality Control and Quality Assurance

- Ensure that the water quality meters are calibrated and cared for in accordance with manufacturer's instructions.

- Keep sampling system and monitoring probes out of direct sunlight.

- Verify dissolved oxygen readings by checking reported dissolved oxygen against a chart and correlating theoretical readings at actual site temperatures. Do not record any dissolved oxygen readings that are outside theoretical limits or that do not make sense, such as negative concentrations.

- Check that the flow direction switch on the peristaltic pump is in the correct direction. Flow in the wrong direction may create bubbles in the well riser, thus affecting dissolved oxygen readings.

- Charge battery to peristaltic pump and water quality meter when not in use. Low battery on the water quality meter may not allow unit to connect properly with sonde.

8. Attachments

Groundwater Purging and Sampling Form.

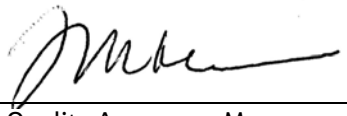
9. References

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

EPA. *Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.* September 19, 2017.

Field Standard Operating Procedure-19
General Soil Sample Collection

Author: Steve Chumney 8/30/2021 

Approver: Theresa Himmer 08/31/2021 

Quality Assurance Manager

Field Standard Operating Procedure-19
General Soil Sample Collection

1. Purpose

This procedure provides general guidelines for the collection of soil samples using rotosonic drilling and test pit sampling methods.

2. Scope

The method described for soil sampling is applicable for soil sampling at and below ground surface. Specific equipment and responsibilities of subcontractors are described in the contracting documentation.

3. Equipment and Materials

- Rotosonic drill rig
- 4-inch sonic sampling barrel
- Barrel liners
- Backhoe with decontaminated shovel
- Plastic sheeting
- Photoionization detector and/or flame ionization detector
- Safety knife or other tool for opening liners
- Clean latex or surgical gloves as specified in the health and safety plan (HASP)
- Pre-cleaned sample containers, stainless-steel sampling equipment, and other sampling supplies as referred to in the project-specific plan(s)

4. Procedures and Guidelines

1. Before staging at the sampling location, ensure rotosonic sampling barrel, casing, other non-dedicated downhole equipment, backhoe, and sampling equipment are decontaminated in accordance with field operating procedure FOP *Equipment Decontamination Procedures*.

2. Wear appropriate personal protective equipment, as required by the HASP. Change gloves between sampling locations.

3. Drive sampling barrel to the desired sampling depth using the selected drilling equipment. Be cognizant of compaction of the soil within the sample barrel, which will likely be less than the length of the drive depth. Arrange soil in representative depths as defined by the field sampling plan or quality assurance project plan to prepare for nonaqueous phase liquid (NAPL) screening and possible sampling.

4. Subcontractor will remove sampling barrel from the borehole and extrude the soil into a plastic liner, before handing off to the field Geologist for logging and NAPL field screening. Using the safety knife or other tool, carefully split the liner to allow access to the sample.

5. For test pit samples, have subcontractor lower backhoe shovel into trench to retrieve desired sample. Place the sample on clean plastic to allow for field NAPL screening and logging.

6. Conduct NAPL field screening procedures as outlined in FOP *Identification of NAPL in Environmental Media*. Log the soil sample according to visual methods outlined in ASTM Method D 2488 and outlined in FOP *Soil Boring Logging*.

7. Soil samples that represent a moderate to high range of contaminant concentrations encountered throughout the field investigation activities will be collected based on field screening results as outlined in the FOP *Identification of NAPL in Environmental Media*.

8. Fill all sample containers using decontaminated sampling equipment, beginning with the containers for volatile organic compound (VOC) analysis following FOP *VOC Soil Sample Collection*. Soil samples for inorganic and nonvolatile organic analyses will be separated and transferred into stainless steel bowls, homogenized by mixing with a stainless-steel spoon, and transferred to the appropriate sample container. Remove large pebbles and cobbles from sample before placing in jars.

9. Label, handle, and store the sample according to procedures outlined in the QAPP. Record sampling data such as depth, time, and date as specified in the QAPP. Discard unused sample according to the guidelines for investigation-derived waste outlined in the Transportation & Disposal Plan.

10. Decontaminate all non-dedicated downhole equipment (such as barrels or casing) and backhoe shovel in accordance with FOP *Equipment Decontamination Procedures*.

11. Backfill borehole at each sampling location with grout or bentonite slurry and repair the surface with like material (such as bentonite, asphalt patch, or concrete), as required.

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

- Verify that the rotosonic drill rig and backhoe are clean and in proper working order.
- Ensure that the subcontractors thoroughly complete the decontamination process between sampling locations.
- Determine if a quality control sample will be required at a sampling location (refer to the QAPP).
- Collect rinse water investigation-derived waste according to the procedures outlined in the FOP on *Investigation Derived Waste Handling and Disposal*.
- Verify that the borehole made during sampling activities has been properly abandoned according to relevant state and local requirements.

7. Attachments

None.

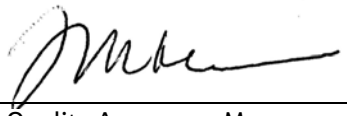
8. References

ASTM Method D 2487-98. 2017. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System. December.

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

Field Standard Operating Procedure-20
VOC Soil Sample Collection

Author: Steve Chumney 8/30/2021 

Approver: Theresa Himmer 08/31/2021 

Quality Assurance Manager

Field Standard Operating Procedure-20
VOC Soil Sample Collection

1. Purpose

This field operating procedure (FOP) presents general guidelines for collecting and handling soil samples for volatile organic compound (VOC) analysis using TerraCore™ sampling techniques.

2. Scope

The method described for TerraCore™ sampling is applicable for collecting soil samples for VOC analysis following U.S. Environmental Protection Agency SW-846 Method 5035B (Closed-System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples). The TerraCore™ sampler is a disposable volumetric sampling device developed to assist in collecting soil and sediment samples for VOC analysis with minimal handling. The TerraCore™ sampler has three components: the TerraCore™ sample plunger, a set of pre-preserved 40-milliliter (mL) vials, and the dry-weight soil container. Alternative sample plungers can be used, as applicable.

3. Equipment and Materials

- TerraCore™ soil sample kit consisting of the pre-weighed and pre-preserved 40-mL sample collection vials, the dry-weight container (used to determine soil moisture), and the TerraCore™ sample plunger, or similar. The 40-mL vials are preserved with methanol and sodium bisulfate and /or organic free water. The sampling kit typically comes in a foam holder, which has space for each vial and the sampler.
- Wipes to remove excess soil from the TerraCore™ sampler and/or the treads of the 40-mL sample collection vials
- Spatula to transfer soil to the dry weight container
- Sample cooler with ice (SW-846 Method 5035 samples need to be transported on ice at 4 degrees Celsius [°C]).
- Field logbook
- Latex or nitrile gloves
- Safety goggles
- 1-gallon resealable plastic bags for the TerraCore™ sample kit

- Decontamination solutions and equipment
- Air monitoring devices, such as photoionization detectors (PIDs)

4. Procedures and Guidelines

The following procedures and guidelines refer to the soil core or soil from which the VOC soil sample will be collected as a "soil sample." "VOC sample" or "VOC soil" refers to the sample extracted from the macro sample by the TerraCore™ sampler or similar core sampling device.

4.1 Acquire the Soil Sample

The collection of soil samples will vary slightly depending on the method of collection. Follow the directions specified in this FOP for the specific sampling methodology.

1. Have the drilling subcontractor/sample technician position the sampling equipment over the surveyed and flagged sample location.
2. The driller/sampler will collect the desired soil sample using the rotosonic 4-inch barrel sampler and cleaned backhoe bucket.
3. Soil samples that represent a low and high range of contaminant concentrations encountered throughout the remedial design investigation will be collected based on field screening results as outlined in the FOP *Identification of NAPL in Environmental Media*. Collect the VOC sample using the TerraCore™ system from the impacted interval. Each TerraCore™ kit will typically contain one dry-weight container, two low-detection-level sodium bisulfate-preserved vials, and one high-detection-level methanol-preserved vial. The kit also will include a sampler/plunger to collect 5 to 10 grams of soil (depending on the laboratory requirements).

    a. Have ready a 40-mL glass volatile organic analysis (VOA) vial containing the appropriate preservative. With the plunger seated in the handle, push the TerraCore™ into freshly exposed soil until the sample chamber is filled. A filled chamber will deliver approximately 5 to 10 grams of soil.

b. Wipe all soil or debris from the outside of the TerraCore™ sampler. The soil plug should be flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.

c. Rotate the plunger that was seated in the handle 90 degrees until it is aligned with the slots in the body. Place the mouth of the sampler into the 40-mL VOA vial containing the appropriate preservative, and extrude the sample by pushing the plunger down. Quickly place the lid back on the 40-mL VOA vial. **Note:** When capping the 40-mL VOA vial, be sure to remove any soil or debris from the top and/or threads of the vial.

4. Soil containing carbonate will effervesce when placed in the sodium bisulfate solution. Effervescence could result in loss of VOCs from the soil sample and/or the explosion of the VOA vial. If the soil effervesces in the sodium bisulfate, then the VOC sample must be taken with two 40-mL vials that contain 5-mL of organic free water and a stir bar. These vials can be purchased separately (Chemisphere, Inc., 888-411-0757).
5. Fill the dry-weight container half full of soil. This sample will be used to determine soil moisture.
6. Log the core/sample and record the data on a standard log sheet or field logbook. Conduct PID readings and record the data on the core sampling log. Photograph the soil sample, if appropriate.

4.2 Prepare the TerraCore™ Sampler for Shipment

- Label each container with the boring location sample identification number following the sample-naming protocol in the FOP *Sample Handling and Chain of Custody Procedures*.
- Seal the sample vials in the foam holder provided and place in a 1-gallon resealable container. If a foam holder is not provided, ensure that the sample vials are wrapped in bubble wrap and then placed in the resealable container.
- Put the TerraCore™ sample in a cooler with ice.
- Fill out the chain-of-custody form and process the sample for delivery to the laboratory.
- Decontaminate the sample barrel, pan or bowl, and media transfer tools before using to collect another sample.

- Collect rinse water from decontamination activities and dispose appropriately.

Note that TerraCore™ soil samples preserved with organic free water have a very limited holding time (generally 48 hours or less). Contact the laboratory to coordinate sample shipment and receipt by the laboratory.

4.3 Quality Control Samples

Quality control (QC) samples that are collected with soil samples include duplicates and matrix spike/matrix spike duplicate (MS/MSD) samples. If a duplicate sample is required, a second sample aliquot shall be collected. If an MS/MSD sample is required, two additional sample aliquots are generally required. Contact the laboratory to determine how much extra volume is required for MS/MSD soil samples. The MS/MSD sample will be submitted to the laboratory with the original sample. Duplicates will be submitted to the laboratory as separate samples.

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

- Make sure the samples are kept at a temperature of 4°C before and after they are processed for delivery to the laboratory.
- Have 40-mL vials with organic-free water available in case the soil samples effervesce in the sodium bisulfate solution.
- Determine if a QC sample will be required at a sampling location. If an MS/MSD or duplicate soil sample will be needed, then additional sample volume will be required. Additional sample volume may be acquired by collecting additional samples using the procedures outlined in this FOP.
- Ensure that all tools that may come in contact with the sample are properly decontaminated.
- Never composite a soil sample that will be analyzed for VOCs.
- The VOC sample must be collected as quickly as possible to minimize the loss of volatiles. Do not let the soil sample “cook” in the sun.

7. Attachments

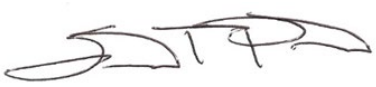
None.

8. References

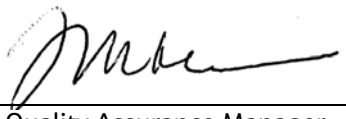
Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

Field Standard Operating Procedure-21
Field Quality Assurance/Quality Control Sample Collection

Author: Scott Pratt 8/30/2021



Approver: Theresa Himmer 08/31/2021



Quality Assurance Manager

Field Standard Operating Procedure-21 Field Quality Assurance/Quality Control Sample Collection

1. Purpose

The purpose of this field operating procedure (FOP) is to describe the methods for collecting quality assurance (QA)/quality control (QC) samples for soil, water, and air matrices.

2. Scope

The general protocols for preparing QA/QC samples are outlined. These standard procedures may be changed as required, dependent upon site conditions, equipment, or project-specific requirements.

3. Equipment and Materials

Generally, the equipment/apparatus required to collect QA/QC samples is the same as the equipment/apparatus required to collect the environmental samples. Refer to the specific FOP for sample matrix-specific information (i.e., sampling procedures, reagents/preservative, and equipment required). QA/QC samples will require some or all of the following equipment:

- Blank liquid (use ASTM International [ASTM] Type II or laboratory-grade water)
- Millipore (or similar) deionized water
- Laboratory-provided performance evaluation (PE) sample
- Sample bottles or canisters as appropriate
- Gloves
- Preservatives as appropriate

4. Procedures and Guidelines

The following subsections discuss QA/QC samples for soil, water, and air matrices.

4.1 Field Duplicate and Split Samples

Field duplicate and split samples are field samples obtained from one location, homogenized, and divided into separate containers. They are treated as separate samples throughout the sample handling and analytical process. The samples are used to assess precision by comparing analytical results for two parts of the sample from the same location.

Requests from clients, regulatory agencies, or primary responsible parties for split samples should be honored. Split samples are collected following the sample procedures for field duplicate samples using sample containers, blank samples, preservatives, sample courier, chain-of-custody forms, etc. provided by the requesting agency or party.

Field duplicate and split samples must be prepared and analyzed for the same parameters by the same methods to demonstrate the reproducibility of the sampling and analytical techniques. It is recommended that field duplicate and split samples be collected at a frequency 10 percent of the samples.

- **Aqueous Sample Matrix:** Alternatively fill sample containers from the same sampling device for duplicate and split samples of aqueous matrices. Volatile organic compound (VOC) samples should be collected first into two 40-milliter vials until there is a positive meniscus, then seal the vials. Fill containers by alternating between the two sample container sets during filling.

- **Nonaqueous Volatiles Sample Matrix:** Volatile duplicate samples must be taken before mixing the sample and before collecting any samples for nonvolatile organic analyses. For VOC samples of soil, isolate the depth stratum from which the sample is taken, fill the VOC sample container, and seal the container as quickly as possible.

- **Nonaqueous Nonvolatile Sample Matrix:** Homogenize (mix) the sample by filling a decontaminated stainless-steel bowl with the collected sample and mixing with a decontaminated stainless-steel instrument. Once mixed, the sample should be divided in half, and the sample containers should be filled by scooping sample material alternatively from each half.

- **Air Sample Matrix:** Place two identical samplers next to each other, pull air from one source, and split into two canisters with a manifold.

Document and ship samples in accordance with the procedures for other samples.

4.2 Equipment Blank Samples

Equipment blanks (also referred to as rinsate blanks) are used to assess the effectiveness of decontamination procedures using laboratory-grade water. Equipment blank samples are collected after decontaminating sampling equipment that has contacted the sample.

To collect an equipment blank for VOC analysis from the surface of sampling equipment other than pumps, pour blank water over one piece of equipment and into two 40-milliter vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook, as well as the type and lot number of the water used.

For nonvolatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces that contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles. Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a Grundfos Redi-Flo2 pump with disposable tubing is used, remove the disposable tubing after sampling but before decontamination. When decontamination is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.

Document and ship samples in accordance with the procedures for other samples.

4.3 Collocated Samples

Collocated samples are collected adjacent to the primary field sample to determine variability of the soil and contaminant(s) within a small area. Analytical results are used to assess site variation in the immediate sample area. Typically, collocated samples are collected between 1 to 3 feet away from the primary sample location.

Collocated air samples are collected by placing two identical samplers next to each other, and either: (1) air is drawn from one source and split with a manifold, or (2) two pumps are set adjacent to each other and each collect a sample at the same flow rate. Depending upon the methods used to collect and analyze the samples, collocated samples can determine the variation due to both sampling error and precision in the analyses (e.g., using thermally desorbed adsorbent tubes), or to isolate the variation due to sampling error only (e.g., using solvent-extracted tubes and Summa canisters).

Collocated samples are collected from the same sample interval, using the same method, and for the same parameters as the primary sample. When required, the minimum frequency of collocated samples is 5 percent or one per sampling event.

4.4 PE Samples

PE samples are used to assess the overall accuracy of the analytical laboratory and detect any bias in the analytical method used. These samples are usually prepared by a third party, using a quantity of analyte(s) that is known to the preparer but unknown to the laboratory. The analyte(s) used to prepare the PE sample is the same as the analyte(s) of concern. Laboratory accuracy is evaluated by comparing the percentage of analyte identified in the PE sample (percent recovery) with the analytical results of the site samples. When analyzed, the minimum frequency of PE samples is one per analyte of interest per matrix.

4.5 Field Blank Samples

Field blanks are collected for aqueous and air sample matrixes. Field blanks are used to assess potential sources of contamination resulting from exposure to the ambient air. Field blanks are samples that undergo the full handling and shipping process of an actual sample. Field blanks are designed to detect potential sample contamination that may occur during field operations or during shipment. An aqueous sample field blank consists of two identical sets of laboratory-cleaned sample containers. One set of containers is filled at the laboratory with deionized water and the other set is taken to the site empty. At the most contaminated area of the site, pour Millipore or deionized water directly in the empty sample containers.

An air sample field blank is opened with the other sampling media, resealed, and carried through the sampling process. The field blank must be associated with an actual sampling period.

Field blanks are analyzed for the same parameters as site samples. When required, field blanks should be collected at a frequency of 5 percent. Document and ship field blank samples in accordance with the procedures for other samples.

4.6 Trip Blank Samples

Trip blanks (also referred to as travel blanks) are only required for volatile organics analysis and are prepared by the laboratory and shipped with the empty sample containers. Trip blanks are handled, transported, and analyzed in the same manner as the other volatile organic samples. The trip blank shall be placed in the container at the beginning of the day. Trip blanks are used to evaluate contamination error associated with sample handling and shipment, or laboratory handling and analysis. Trip blank contamination indicates the blank water itself was of questionable quality or contamination occurred during transport and/or storage of the samples. The minimum frequency of trip blanks is one per container used to transport volatile organic samples.

The air matrix trip blank is prepared and added to the site samples after sampling has been completed, just prior to shipping samples for analysis. If the absorbent tubes were sealed from the manufacturer, their seals should be broken at this point. For absorbent tubes that have been recycled and resealed by the laboratory, there is no need to break these temporary seals prior to shipping. Canister trip blanks are evacuated containers that are shipped to and from the site with the canisters used for air sampling. A trip blank for an impinger-based sampling method consists of an aliquot of impinger reagent that is shipped back to the laboratory with the samples. Submit trip blanks at a rate of 5 percent of the total samples or a minimum of one per sampling event.

4.7 Matrix Spike/Matrix Spike Duplicate Samples

Matrix spike (MS)/matrix spike duplicate (MSD) samples are used to assess proficiency on analyte recovery as a function of analyte loss during transport and storage of the collected samples and as a function of the analytical procedures and equipment. MS/MSD samples shall be collected following the same procedure as a field duplicate but at triple volume and should be collected at a frequency of 5 percent.

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

- Verify sampling procedures with project-specific modifications.
- Verify documentation of sufficient volume to collect QA/QC samples.
- Verify QA/QC samples are collected at the requested frequency.
- Do not use non-decontaminated equipment to prepare blank(s).
- Use ASTM-Type II or laboratory-grade water to prepare blank(s).

7. Attachments

None.

8. References

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

ERT

USER MANUAL for

SCRIBE CLP SAMPLING

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Modification Date: June 11, 2010

INTRODUCTION

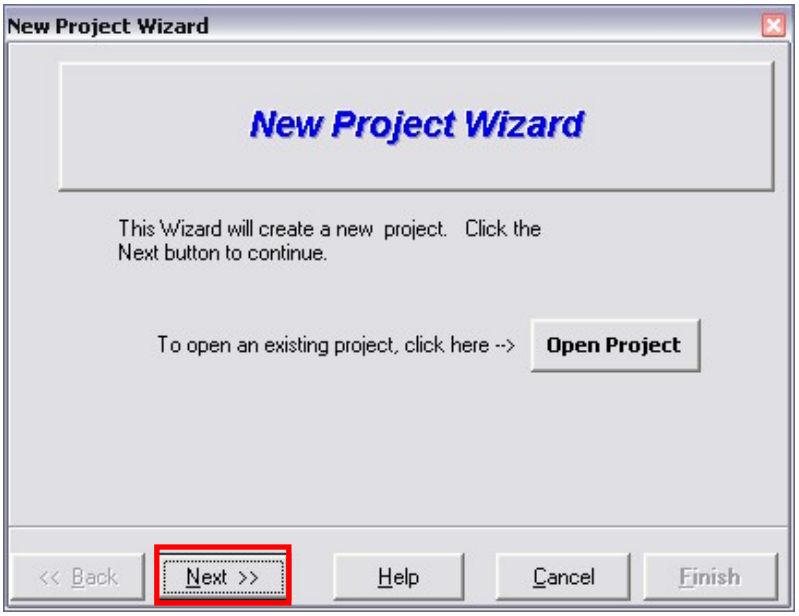
The intent of this User Guide is to provide a basic overview of how to use Scribe to create a new sampling project and manage samples collected for the EPA's Contract Lab Program (CLP). Scribe provides support for CLP sample documentation including the CLP Chain of Custody (COC) reports and the CLP XML format.Query. This document also assumes that the user is already familiar with the Scribe application for sampling. Otherwise, please refer to the Scribe User guides for detailed Scribe application instructions.

Create a New Project

New Project Wizard

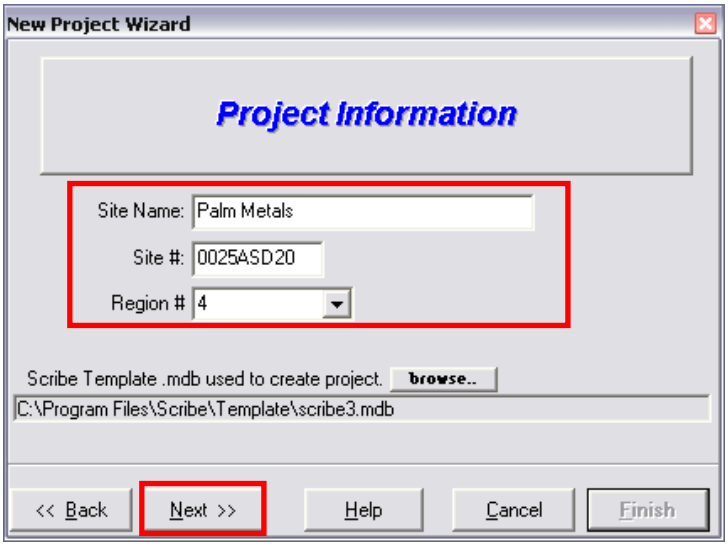
If you are starting Scribe for the first time after installation, the New Project Wizard will run automatically. Otherwise, to create a new project in Scribe:

1. Click on '**File'**.
2. Select '**New Project'**.
3. A New Project Wizard window is displayed.



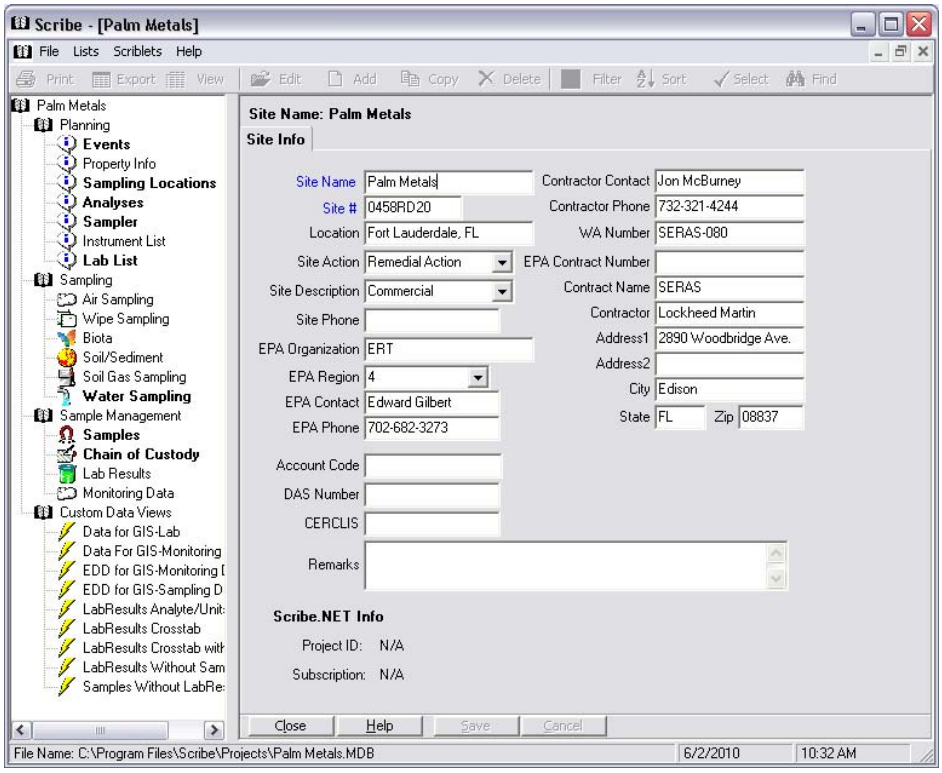
4. Click '**Next'** to continue.

5. Enter the Project Information.



6. Enter the **Site Name**, **Site #** and **EPA Region #**.

7. Click '**Next**' and then click '**Finish**' to create the new project.



The New Project Wizard closes and the "**Site Info**" screen displays. ONLY the field names in **BLUE** are required but we recommend completing as many fields as possible.

CLP SAMPLING IN SCRIBE

CLP Samples

CLP Analyses

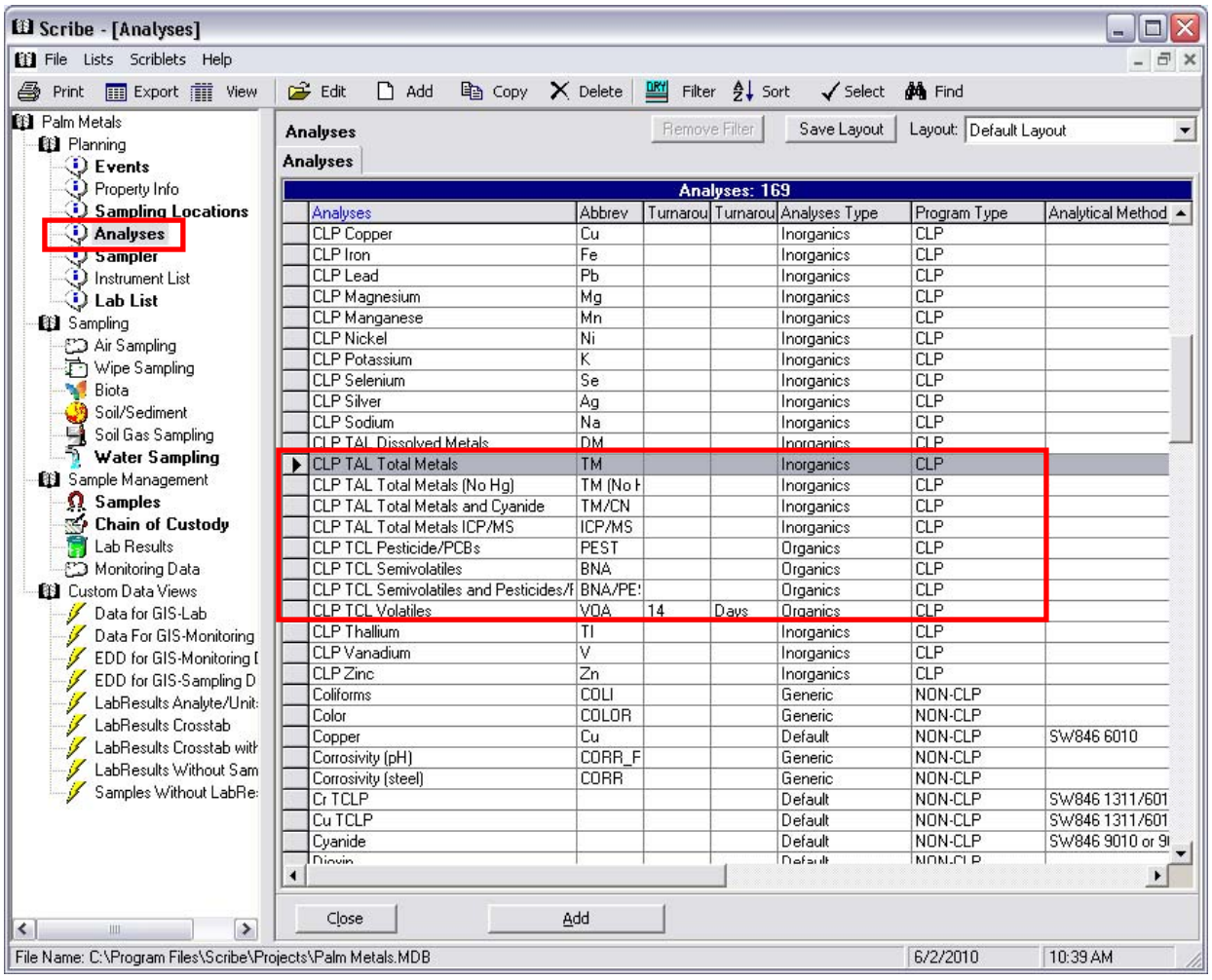
The Scribe Analyses List now includes CLP Analyses. To view or modify the list:

1. Click on "**Analyses**" in the left Navigation Pane. This section is used to manage a list of Analyses including the Program Type and Analysis Type. For example:

   Analysis: CLP TAL Total Metals

   Program Type: CLP

   Analyses Type: Inorganics



CLP/Tag Settings

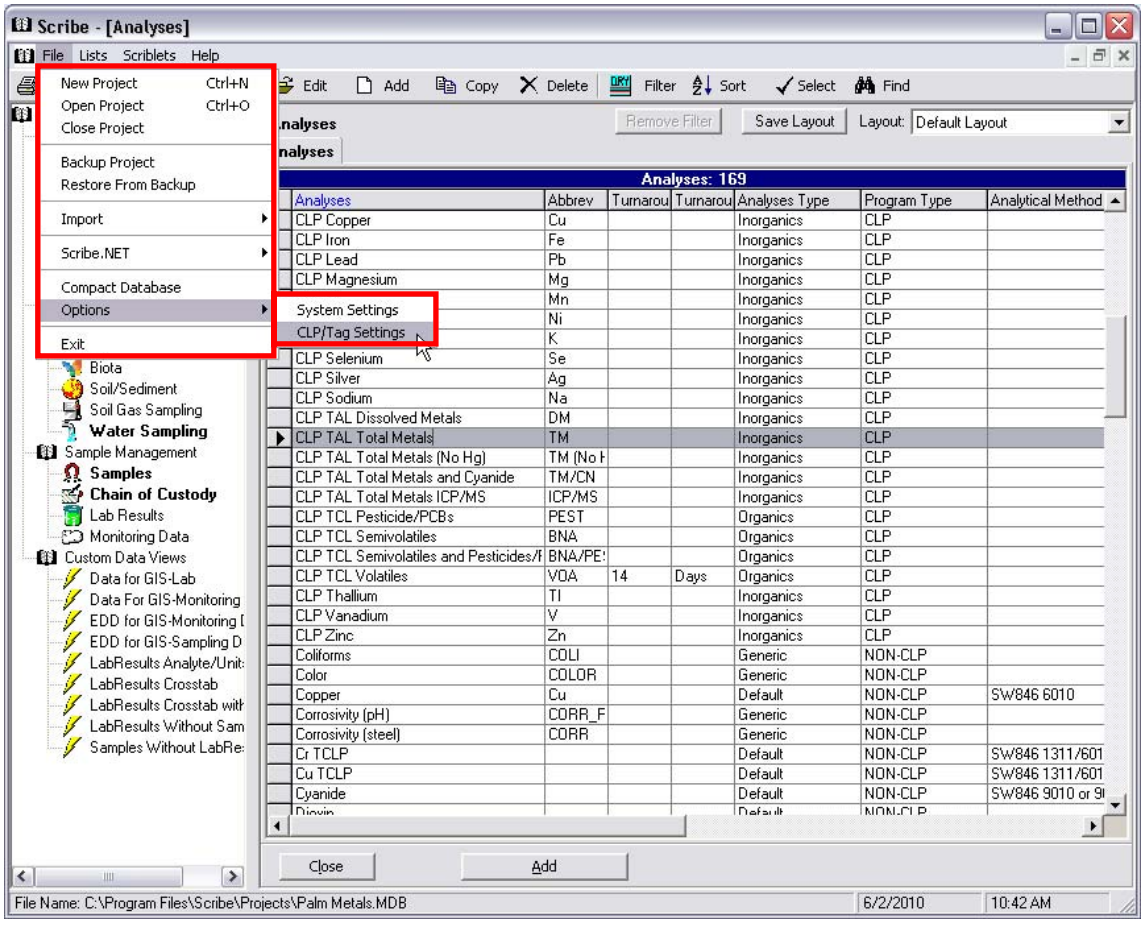
A new feature included with CLP Analyses is the ability to set defaults for the CLP Tags. When a CLP Analysis is selected for a sample, Scribe will assign a CLP Sample number. You can set the **Next CLP Sample number** and **Next Tag number** similar to a sample mask but not exactly.

The CLP Sample # and the Tag # is a field that will update as Samples are added to Scribe. This number is a DISPLAY of the Next number to be assigned. It is editable so that you may customize the next CLP Sample Number that you would like Scribe to assign to your samples.

The numbers auto-increment as samples are added using the CLP business rules.

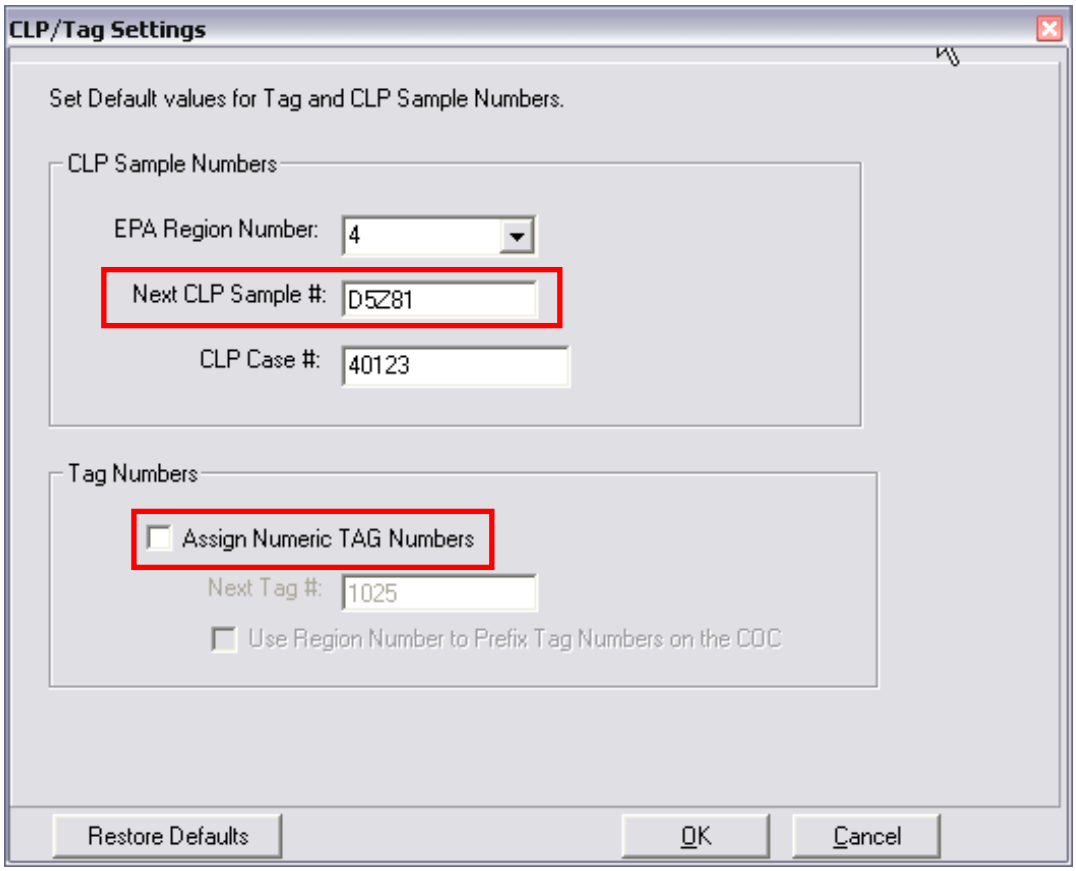
To modify the default settings:

1. Click on **File**.
2. Select **Options**.
3. Select **CLP/Tag Settings**.



4. The window for CLP/Tag Settings is displayed.

5. Input the appropriate information and click the '**OK**' button to Save and Close.



Adding CLP Samples and Assigning Analyses

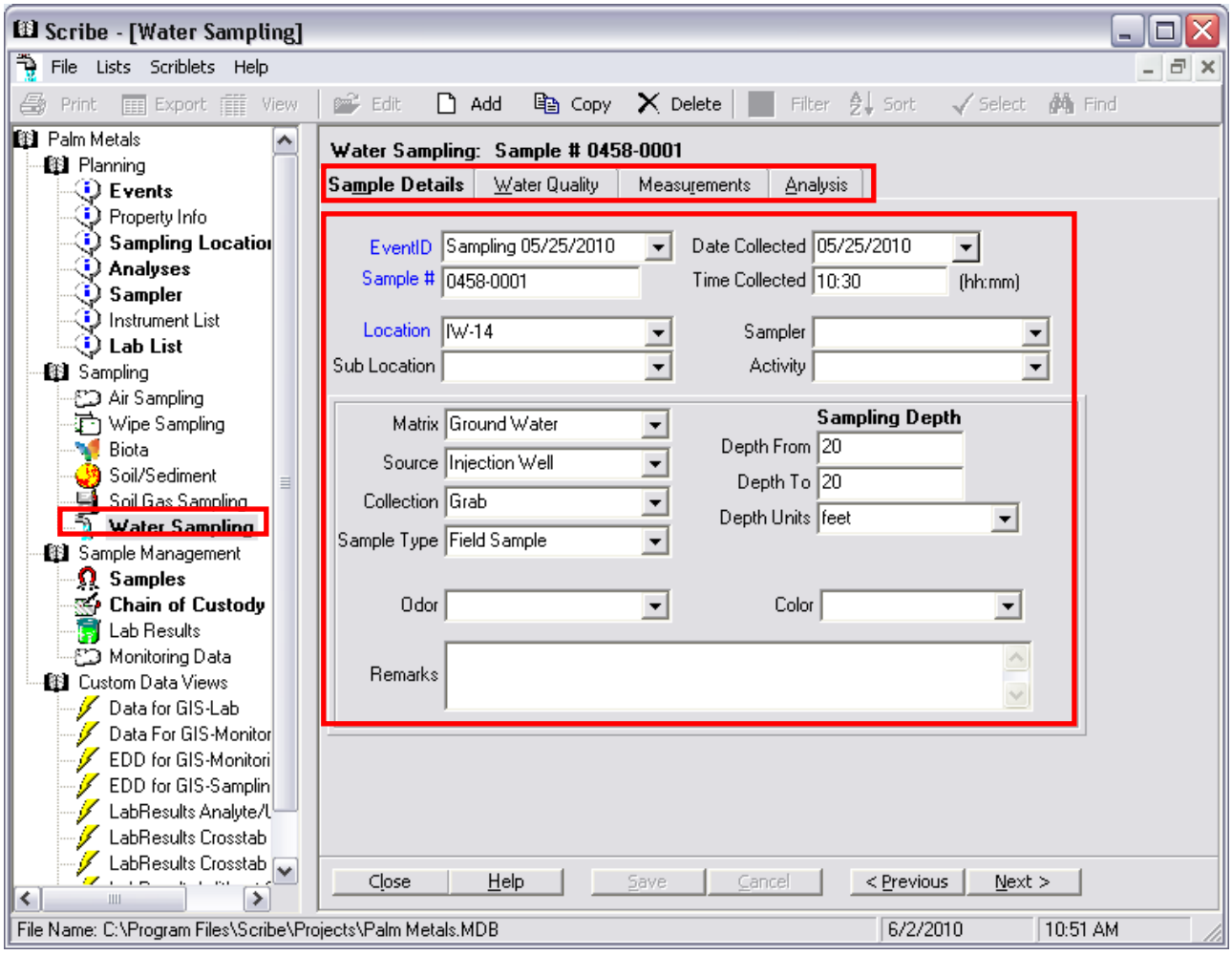
Depending on the type of sampling, click on the appropriate sampling task under Sampling in the left Navigation Pane. For example,

1. Click on '**Water Sampling'** in the left Navigation bar.

2. To add a Water Sample, click the '**Add**' button on the top menu.

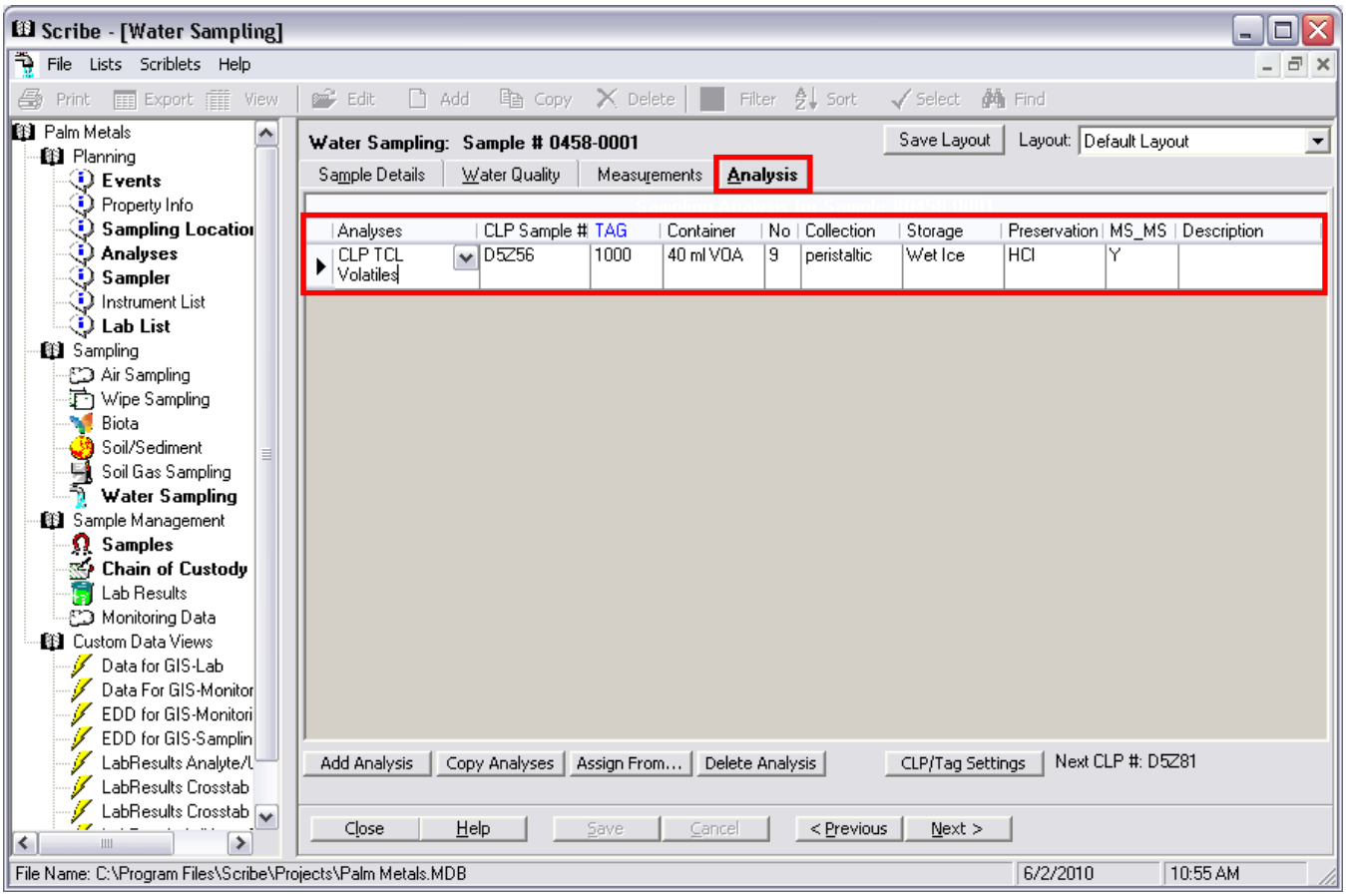
3. Enter sample information into the "**Sample Details"** screen.

Note: There are additional detail screens on the Water Quality and Measurements tabs. These tabs vary by sampling task. The details on the **Analysis** tab must be completed to assign an analysis to your sample.



Enter Analysis information for the Sample and assign CLP Sample and Tag numbers.

4. Click on the **Analysis** tab.
5. Click in the **Analyses field**.
6. Click on the **down arrow** for a list of the CLP Analyses that we referred to earlier.
7. Select an Analysis.



8. For a CLP Analysis, a Tag number and a CLP Sample number is assigned based on the CLP/Tag Settings.
9. To assign additional Analyses to sample containers, click the '**Add Analysis'** button.
10. When all analyses have been added, click the '**Close**' button on the bottom of the window to save and close.

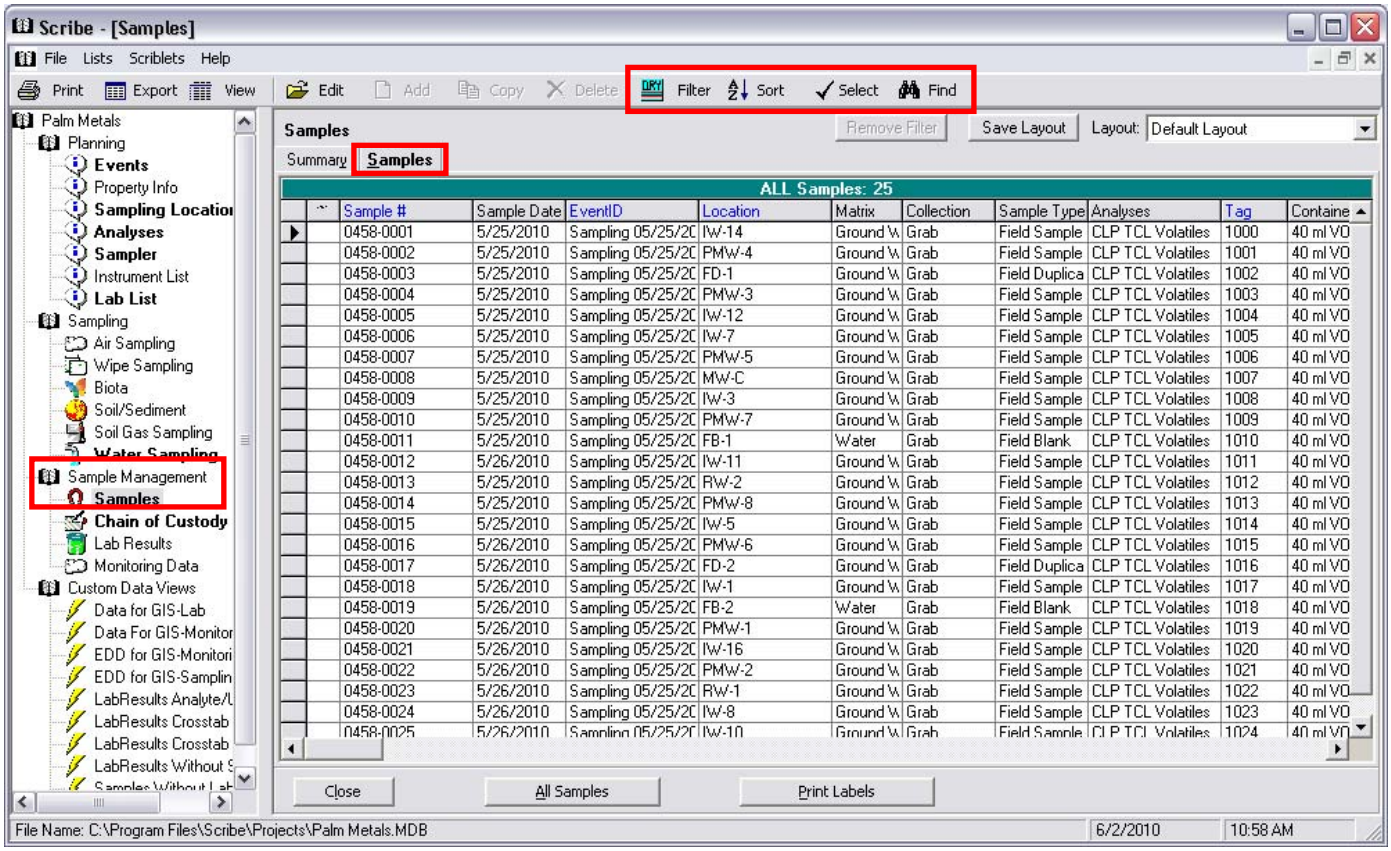
View Samples

Sample Management

Under Sample Management in the left Navigation Pane, you can view and manage all samples using Find, Filter and Sort. The options to Print labels and Chains of Custody are also available.

To view samples:

1. Click on '**Samples**' under Sample Management in the left Navigation Pane.

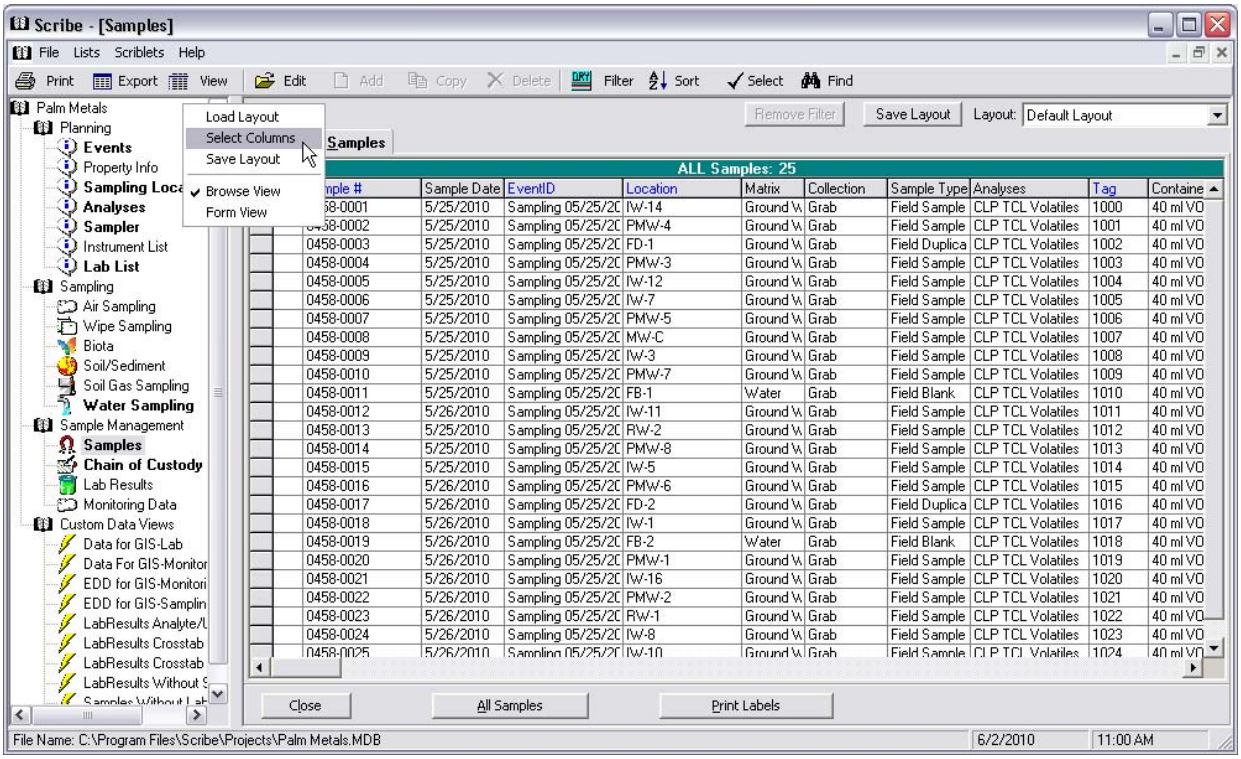


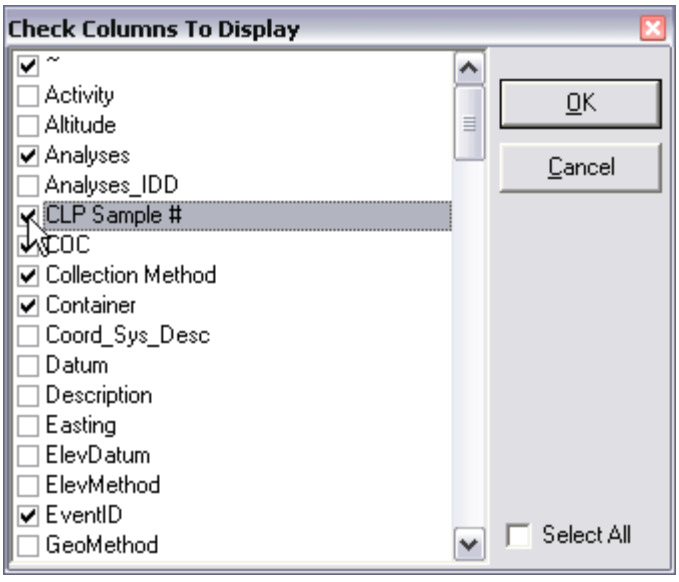
2. To filter your view of samples, RT-click on the field to filter on and select the '**Filter for…**' option. For multi-level filters, click the '**Filter**' button on the top menu bar.

3. To sort your view of samples, RT-click on the column heading and select a sort option. For advanced sort options, click on the '**Sort**' button on the top menu bar.

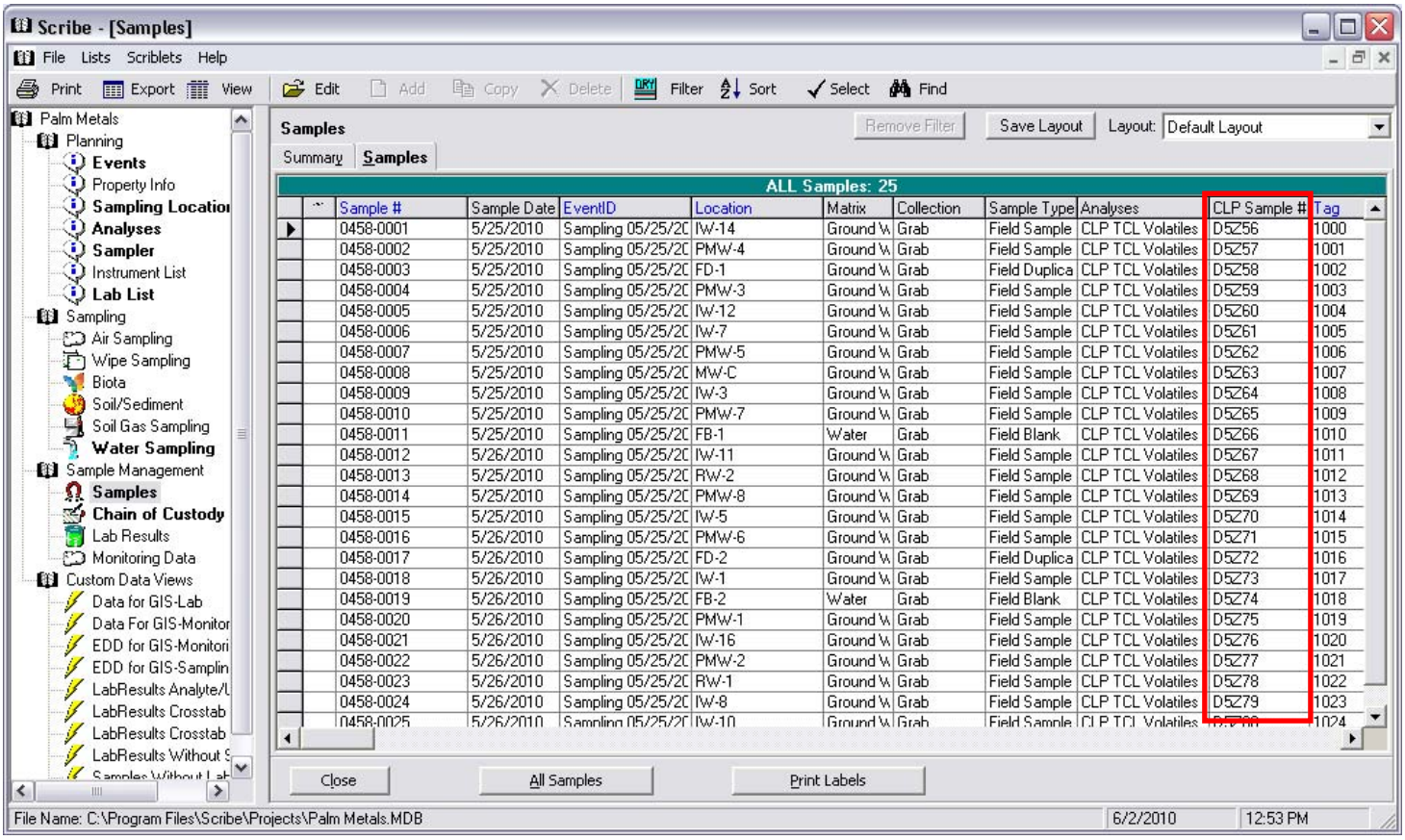
4. To find a particular sample(s), RT-click on the field and select the appropriate option. For multi-level finds, click the '**Find'** button on the top menu bar.

5. To see CLP Sample information including the **CLP Sample #,** click the drop-down menu for the Layout field on the top right corner of the window and select the '**CLP Layout**'.





6. The **CLP Sample #** column is now exposed.



LABELS AND CHAIN OF CUSTODY

CLP Sample Labels

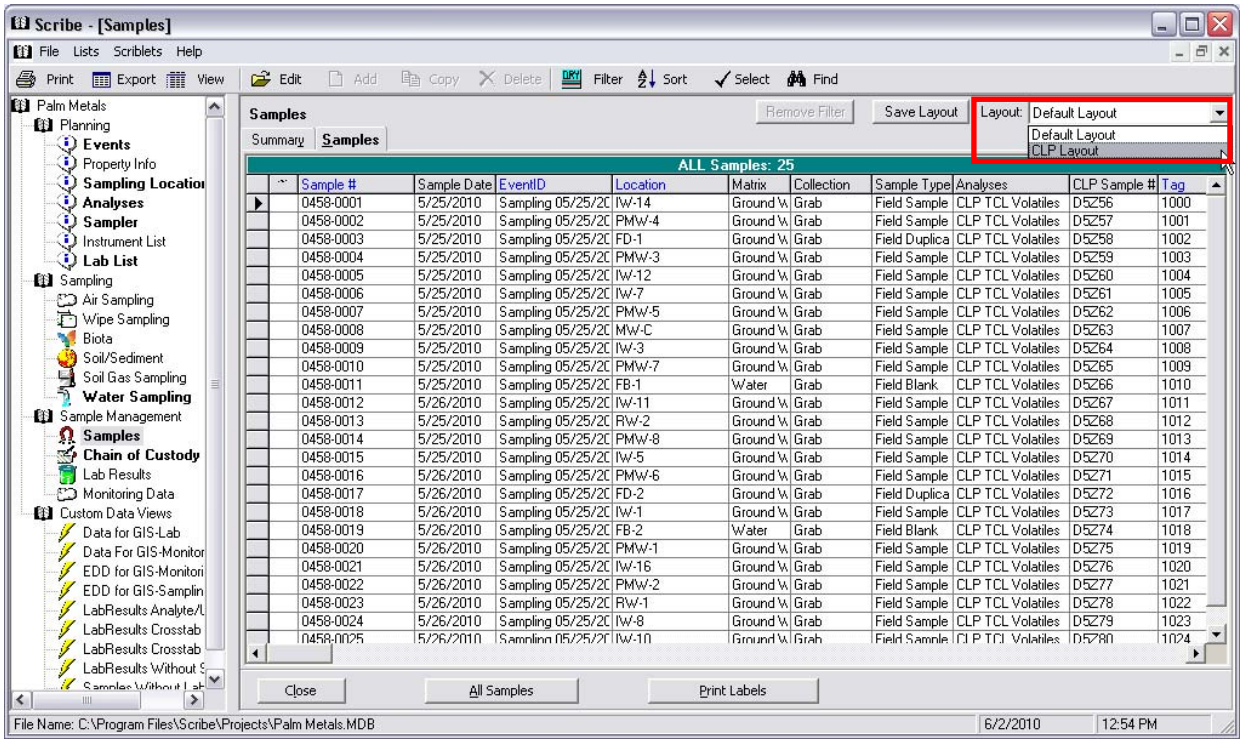
Print Sample Labels

Label options are available through the Samples View. Click on '**Samples**' under Sample Management in the left Navigation Pane. All samples shown on the screen are available to be printed on labels. You can apply Filters, Finds and Sorts to limit the display to the Samples you wish to see.

To configure your labels and print:

1. Click on **drop-down menu** for the Layout field on the top right corner.

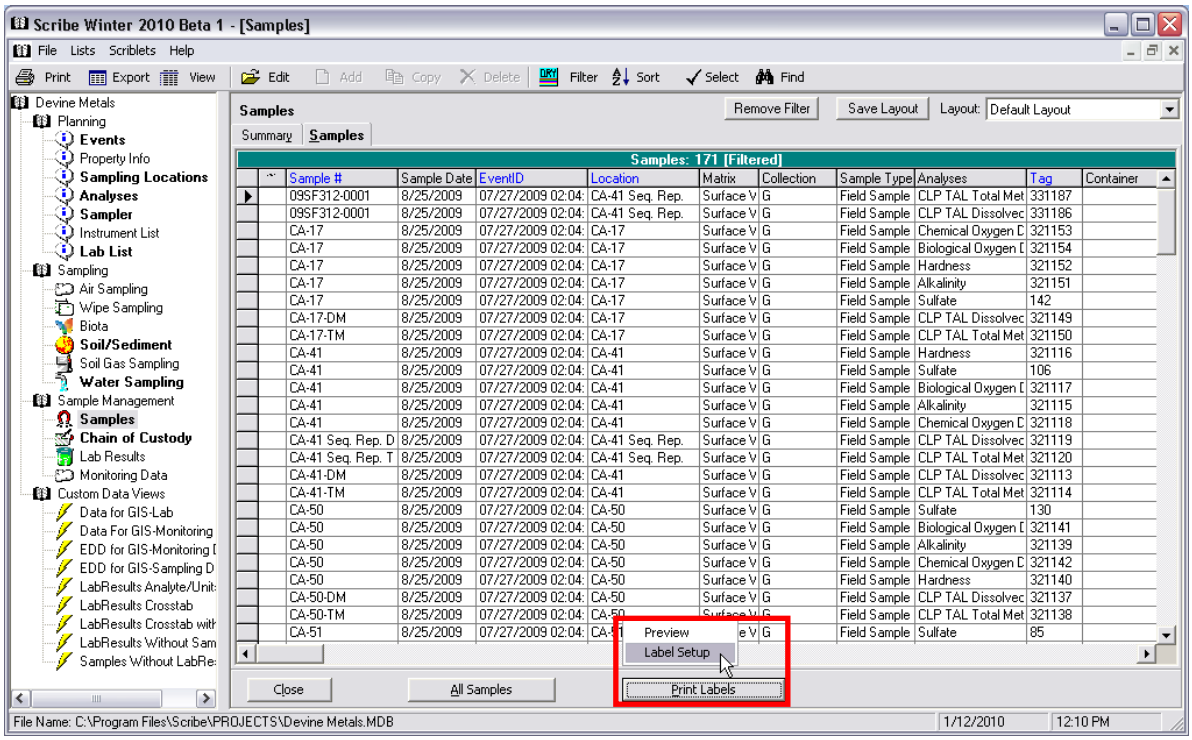
2. Select '**CLP Layout'**. This layout will replace the default Scribe Sample # with the CLP Sample # on the default label layout.

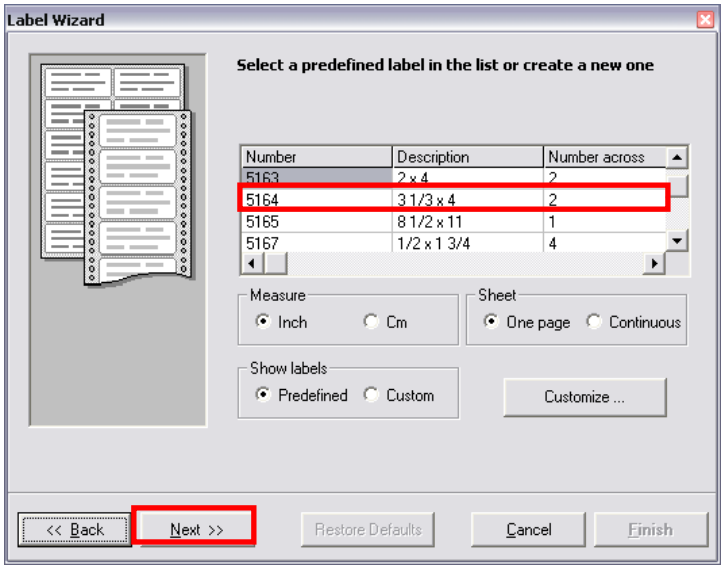


3. Click the '**Print Labels'** button on the bottom of the window.

4. Select '**Label Setup'** if it's the first time you are setting up a label.

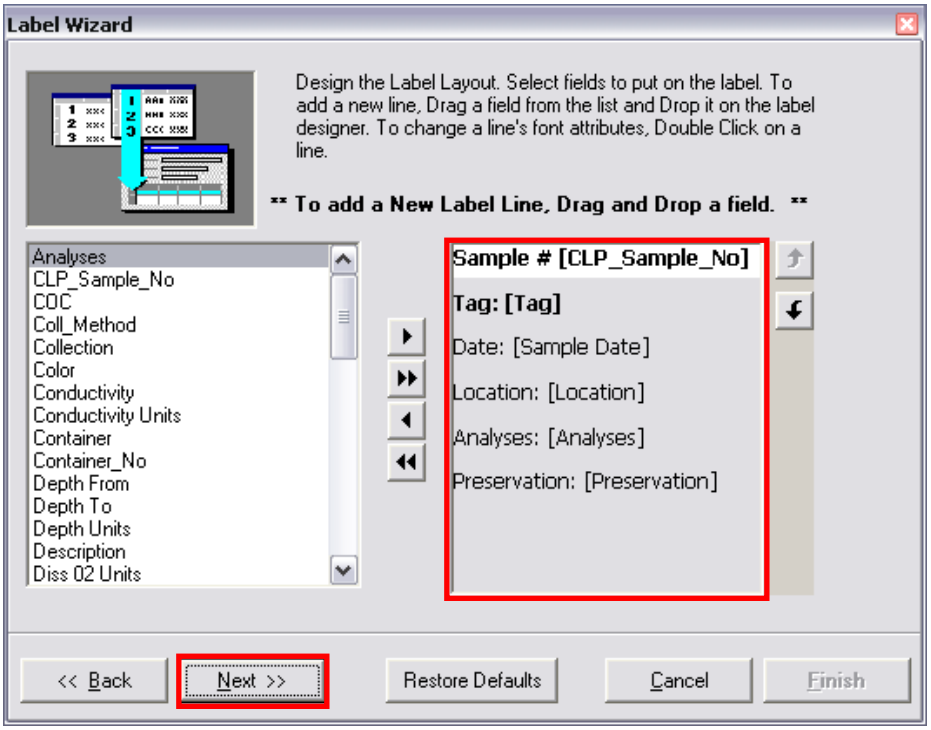
5. Select a pre-defined label format that matches your labels.





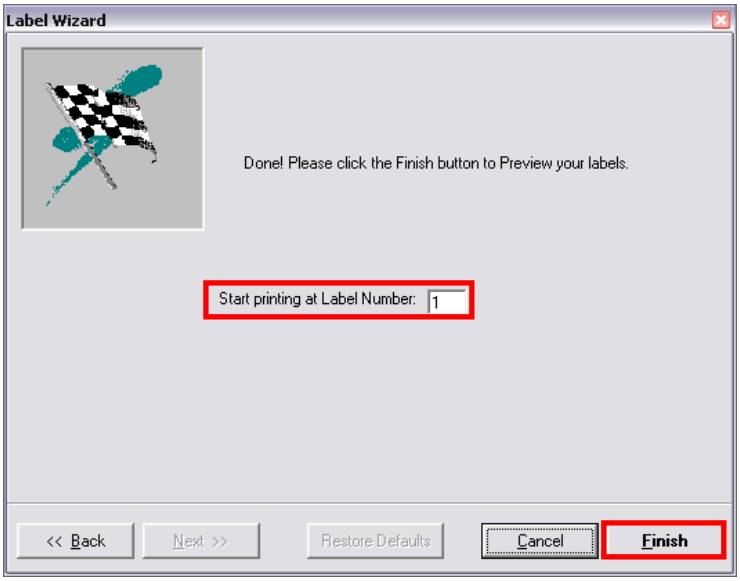
6. Click '**Next**' to continue.

7. Design your label by adding/removing fields to or use the default design. **Note:** The CLP Sample number instead of the Scribe Sample number will be printed on the label.

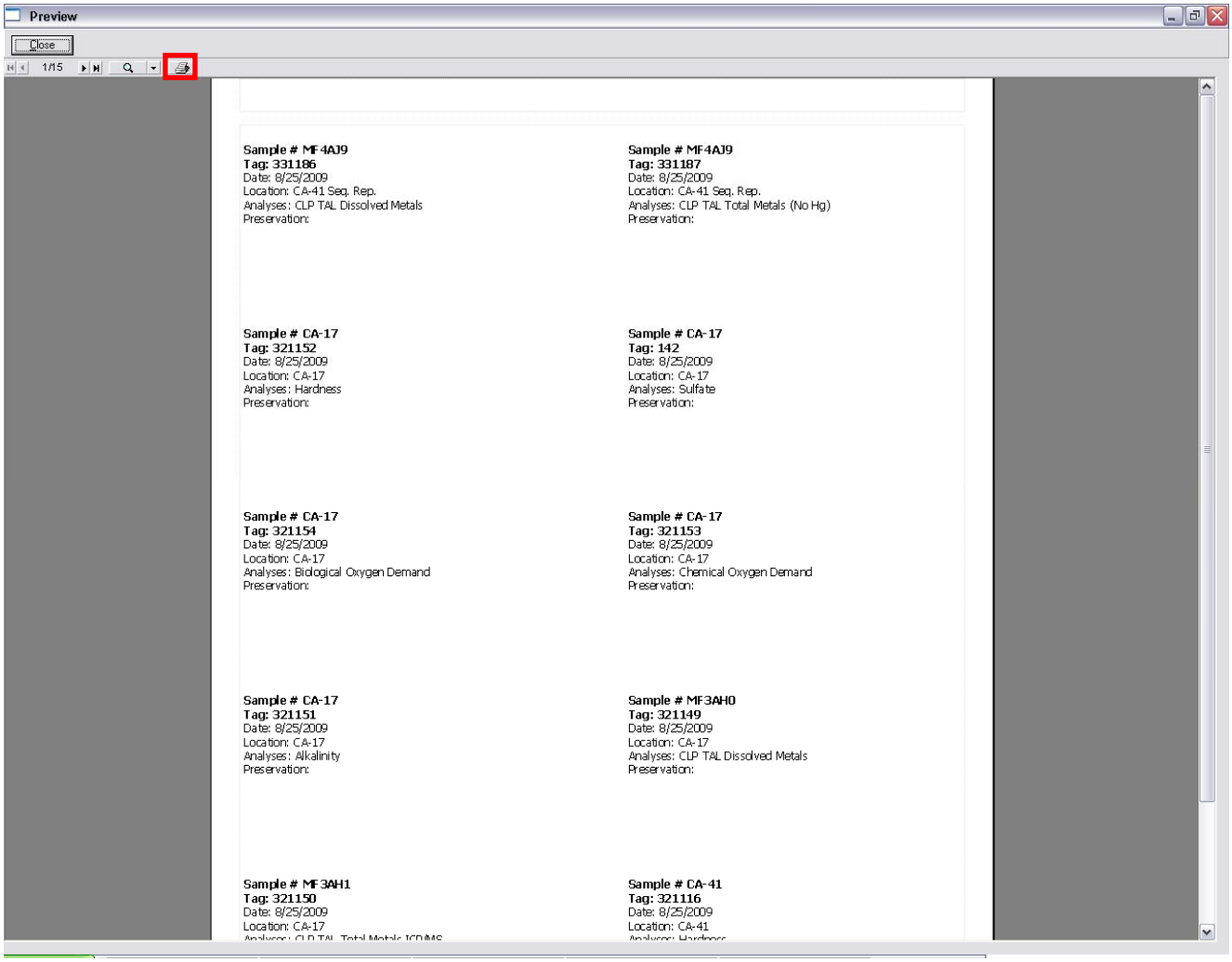


8. Click '**Next**' to continue.

9. If you need to print on half a sheet of labels, use this option to select which label to print on first. Otherwise, click '**Finish**' to continue.



10. A preview of the labels to be printed is displayed.



11. Click on the Printer icon on the top menu bar to print the labels.

Chain of Custody

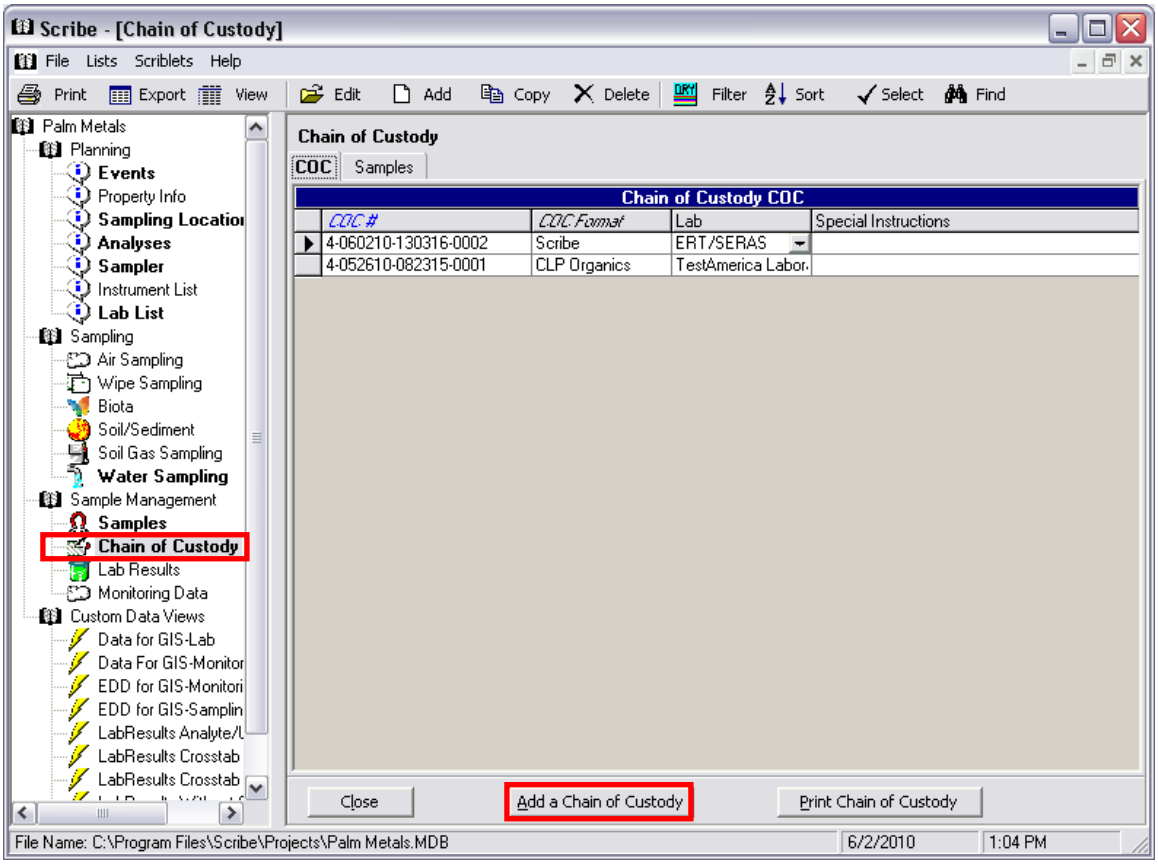
A new feature in Scribe to support CLP sampling is the COC Format for the Chain of Custody. The COC Format option modifies the COC form to adhere to COC standards and requirements. It also controls what samples can be assigned to the COC. For example, Samples with Inorganics analyses can only be assigned to the CLP Inorganics format on the COC.

Note: After submitting samples to the CLP labs, it is recommended that users request the labs to return lab results in electronic format i.e. a spreadsheet (.xls) or a comma-separated text (.csv). Scribe has a Custom Import feature that will import lab result data and marry them up with the sampling data. This effectively eliminates transcription errors and reduces data processing time. See the "Scribe Manual Advanced Part III" for importing details.

Create COC and Assign Samples

To manage and print a Chain of Custody (COC), a COC needs to be created and then samples have to be assigned to the COC:

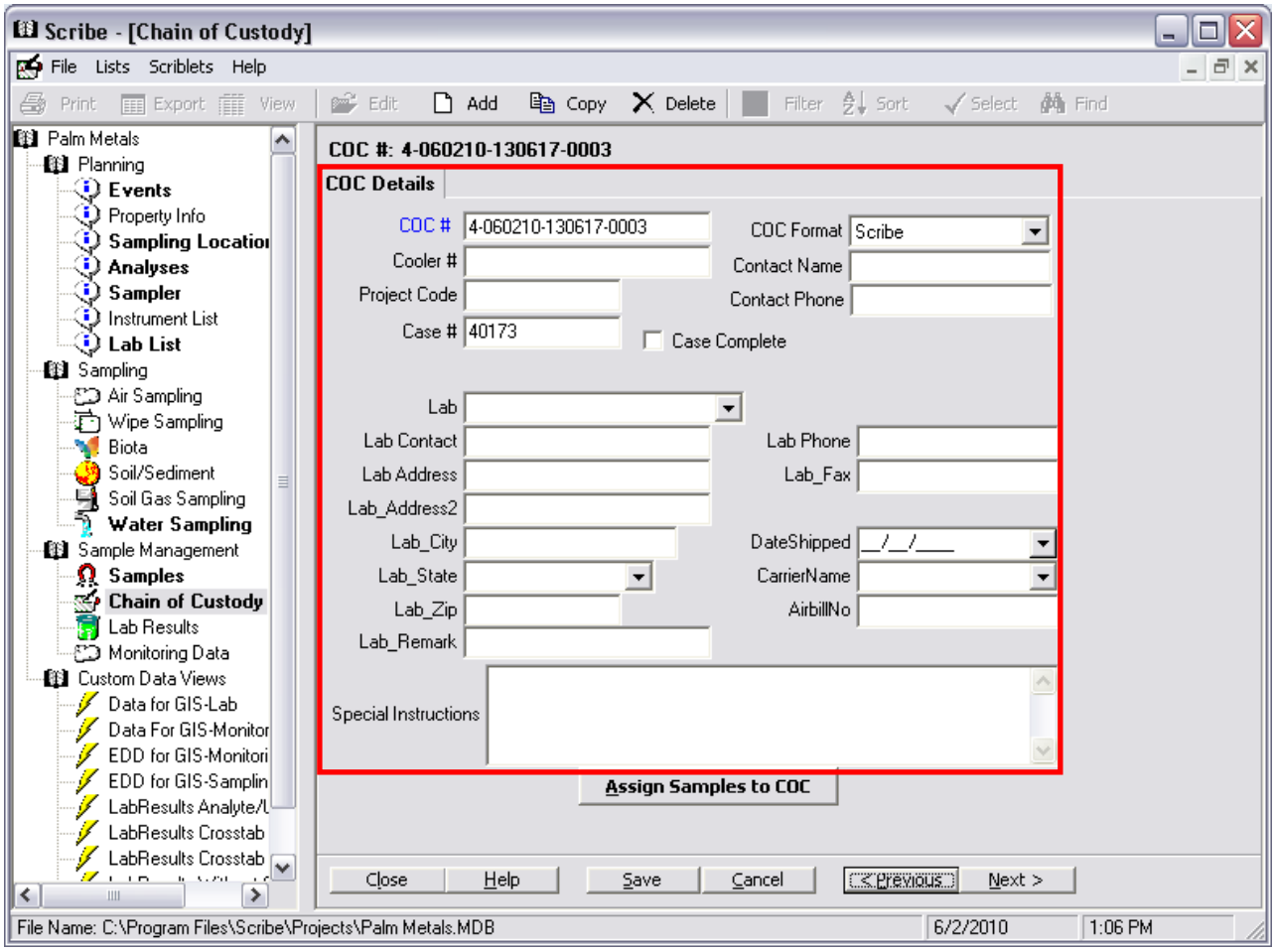
1. Select '**Chain of Custody**' under Sample Management in the left Navigation Pane.



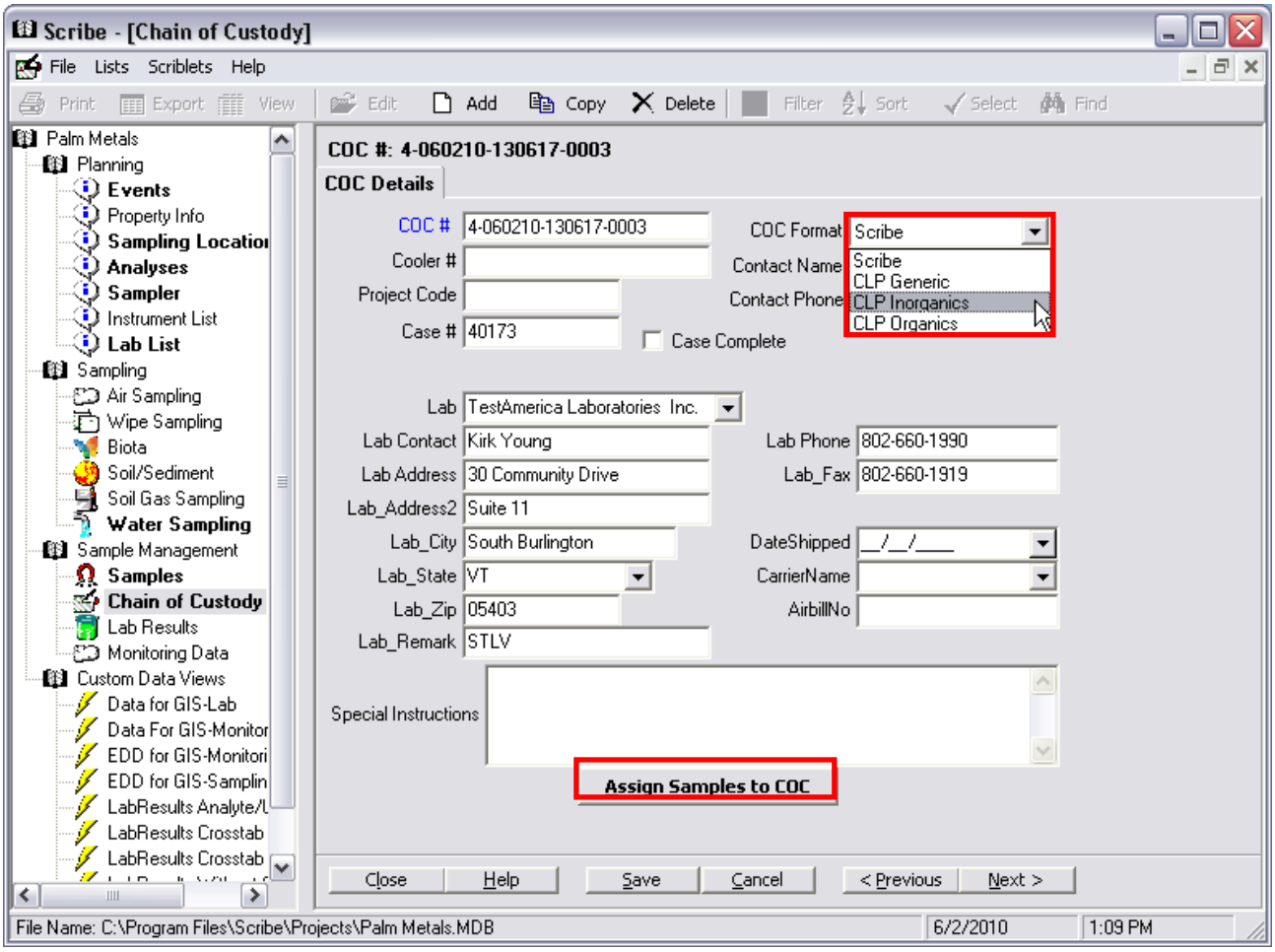
2. Click the '**Add a Chain of Custody**' button on the bottom of the window.

3. The "**COC Details**" screen is displayed.

4. Complete the form by entering other fields such as the **Case #, Cooler #, Lab, and Lab Phone**.

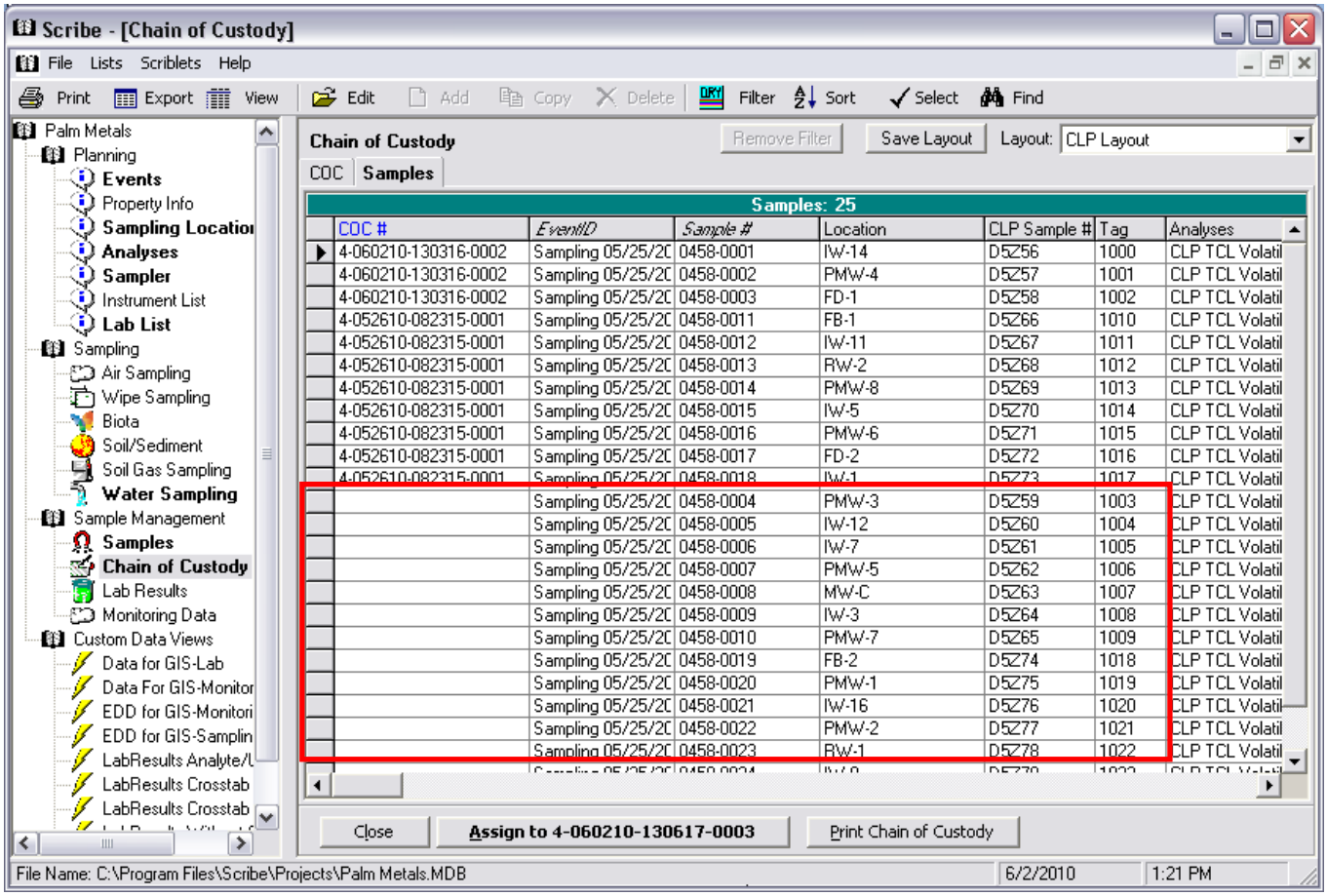


5. Select the appropriate **COC Format** based on the type of COC Samples you are packing. For example, if you are creating a COC for Inorganics, select COC Inorganics. The CLP Generic COC option should be used if you are submitting samples to a program other than CLP but one that requires a CLP/F2L type COC for generating CLP type XML files. Based on the format setting you select, the system will filter for only those types of samples that can be added to this COC.



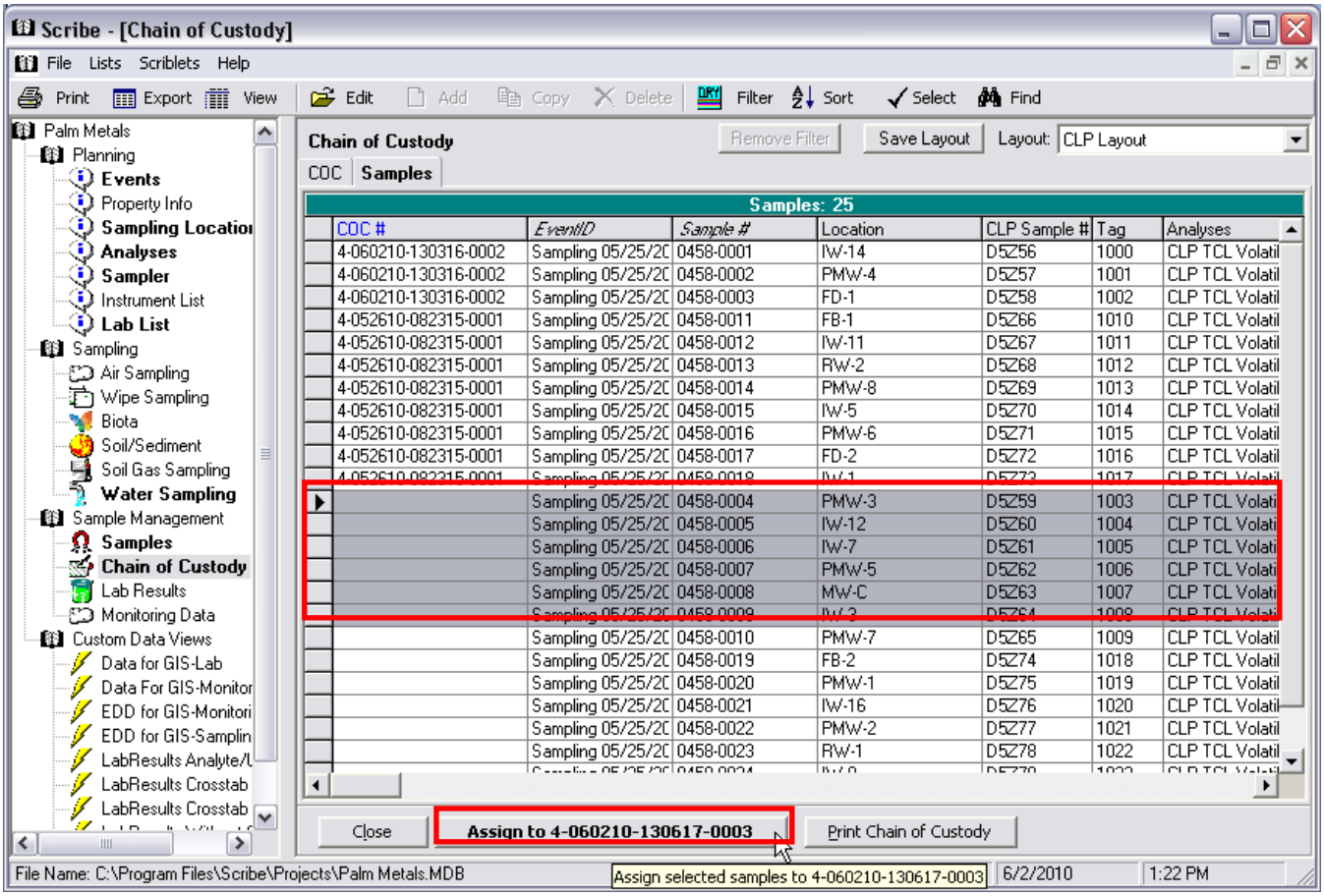
6. Click '**Assign Samples to the COC'** to continue.

7. The "**Chain of Custody Samples**" screen appears. Samples that have not been assigned to a chain are displayed at the bottom of the list.

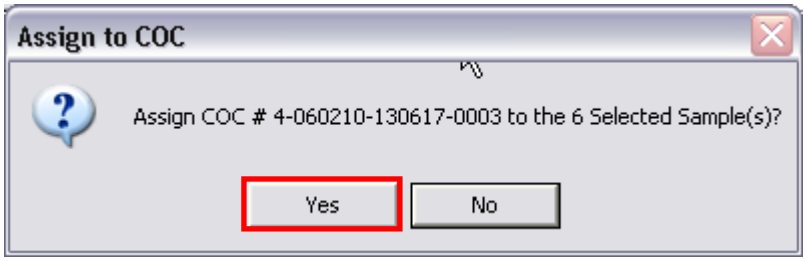


8. Highlight the samples to assign to the new Chain of Custody. Highlight multiple samples by holding down the Shift key or Ctrl key while clicking on the first column before COC# of the samples you wish to assign to the COC.

9. Click the '**Assign to...**' button on the bottom of the window to assign the samples to the Chain of Custody.



10. You will be prompted to confirm. Click '**Yes**' to assign the selected samples to the COC.

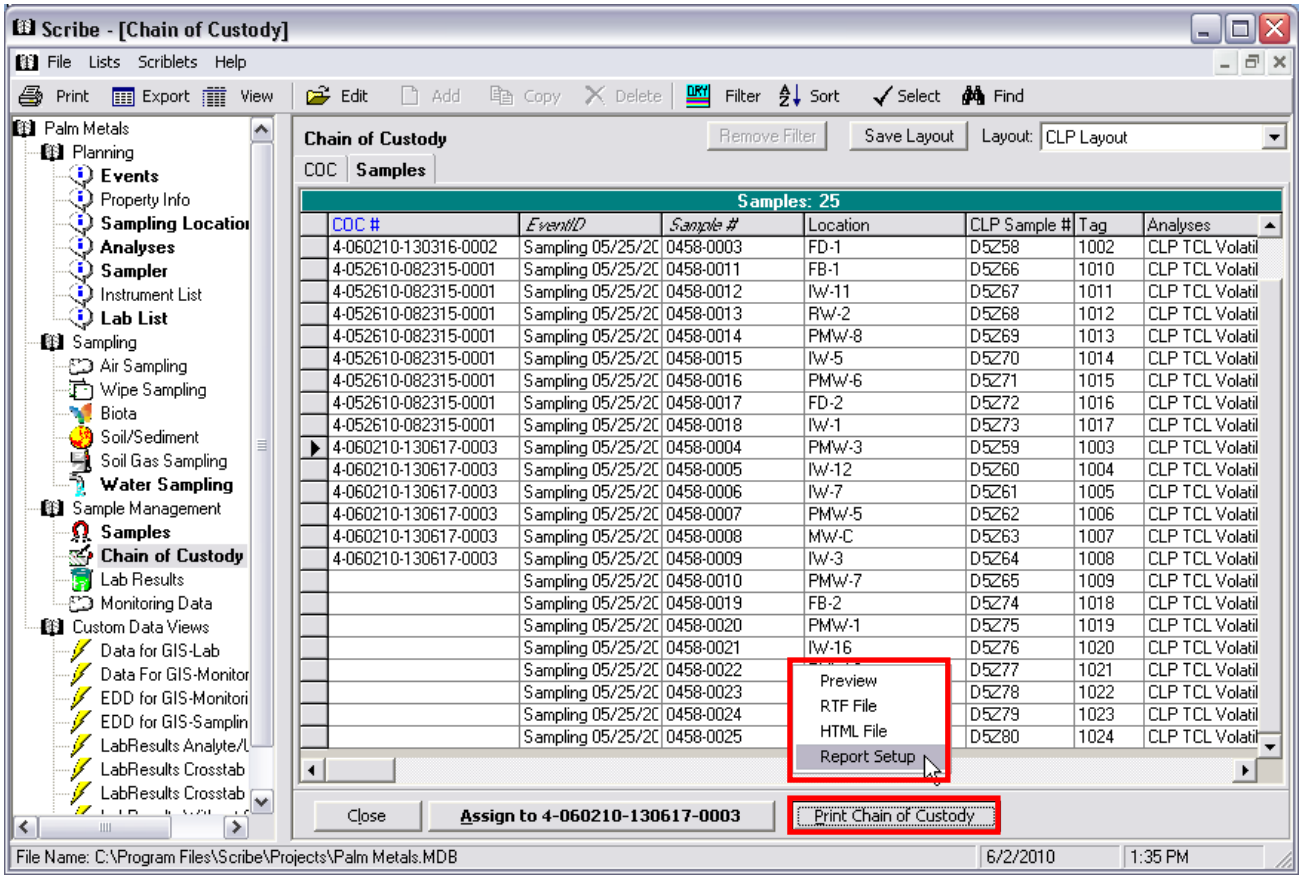


11. You are now ready to configure and print your COC.

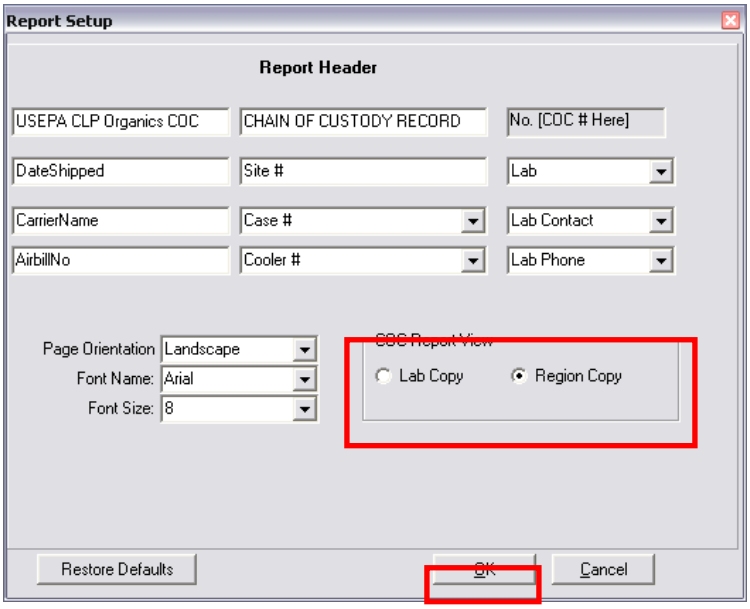
Configure and Print COC

To configure and print a COC:

1. Click the '**Print Chain of Custody**' button.
2. Then select '**Report Setup**'.

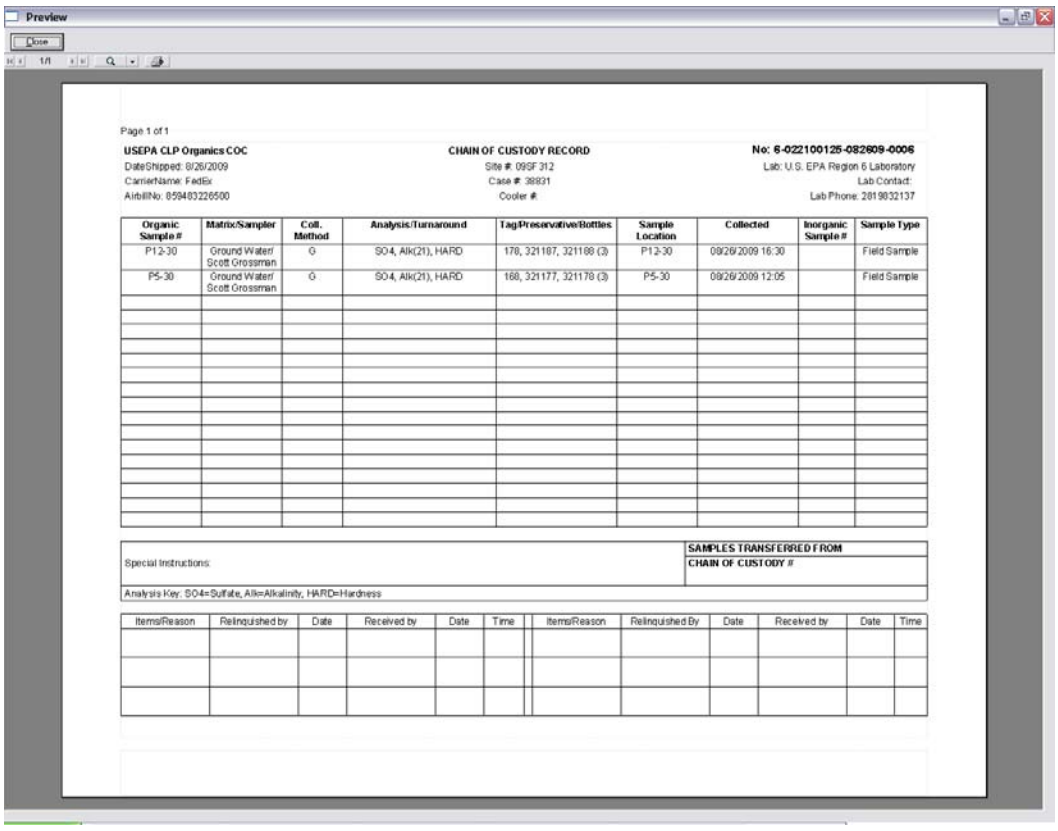


3. The Report Header settings are displayed.



4. The COC Report View (Lab or Region Copy) can also be selected.

5. Click '**OK**' to preview and print the Chain of Custody.

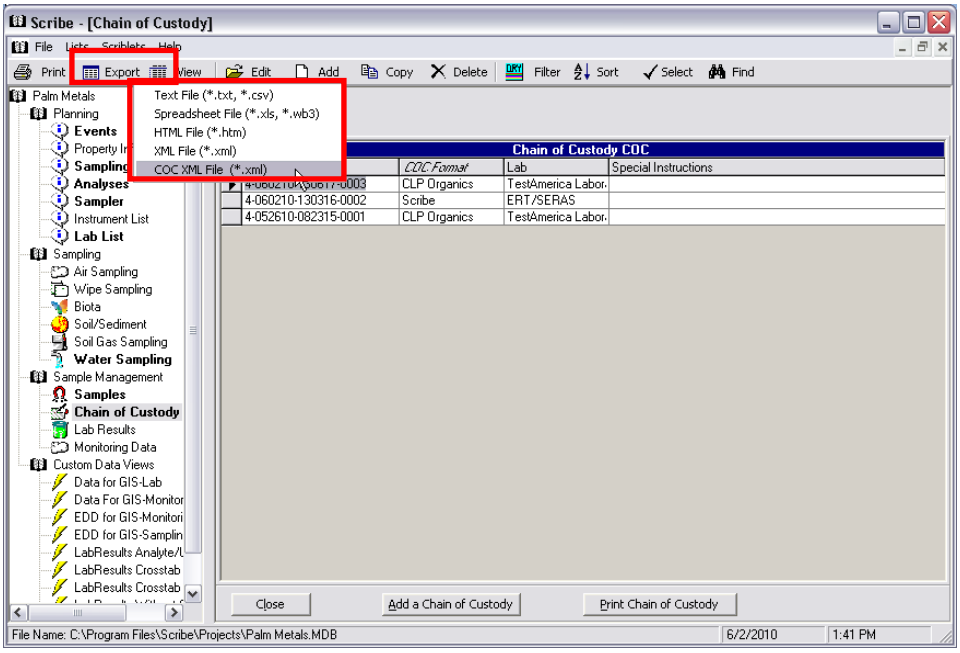


Export to XML File

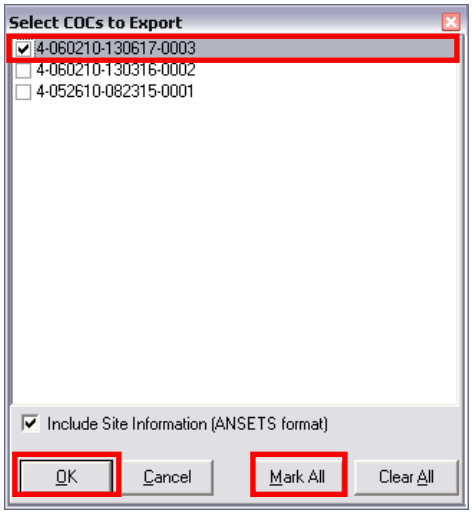
Export COC to XML

A new feature in Scribe is the ability to export the CLP COCs to an XML file. To export:

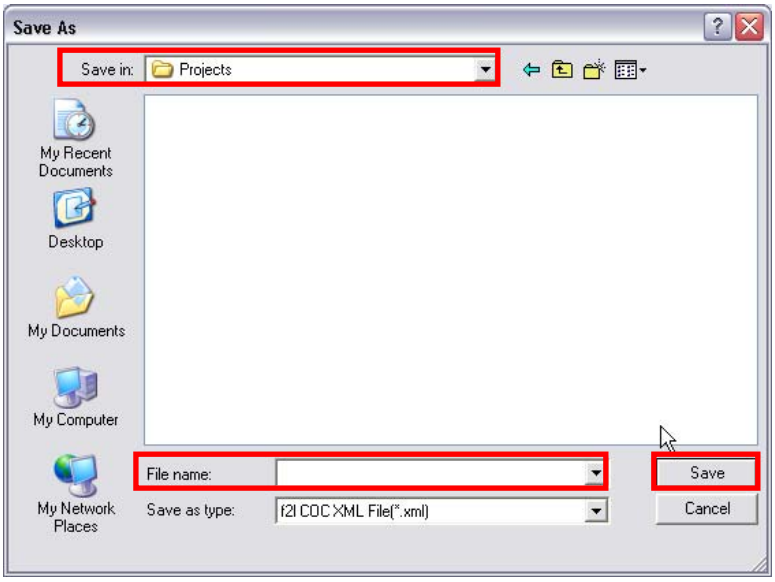
1. Click the '**Export'** button on the top menu bar.
2. Select '**COC XML File (*.xml)**' option.



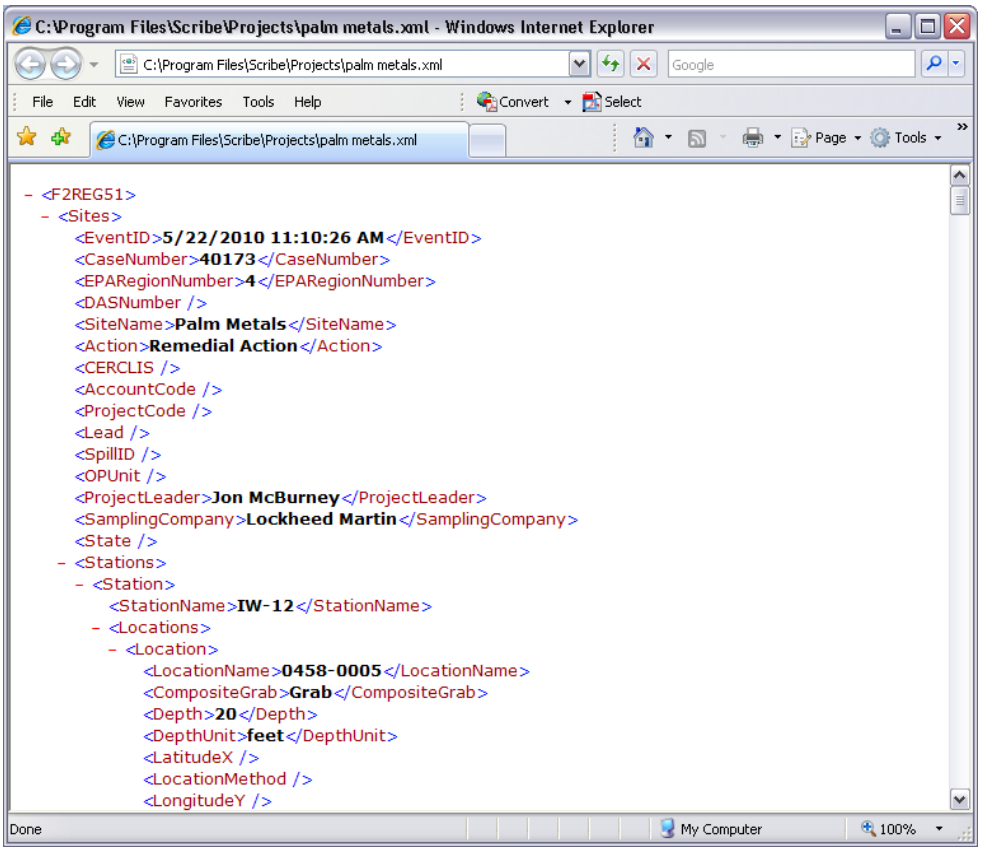
3. Select the Chain of Custody records to export by checking the individual records or click **'Mark All'** to select all COCs.



4. Select your location and provide a filename and click '**Save**'.



5. The XML file will open in Windows Internet Explorer while the file is created and saved.



REPORTING

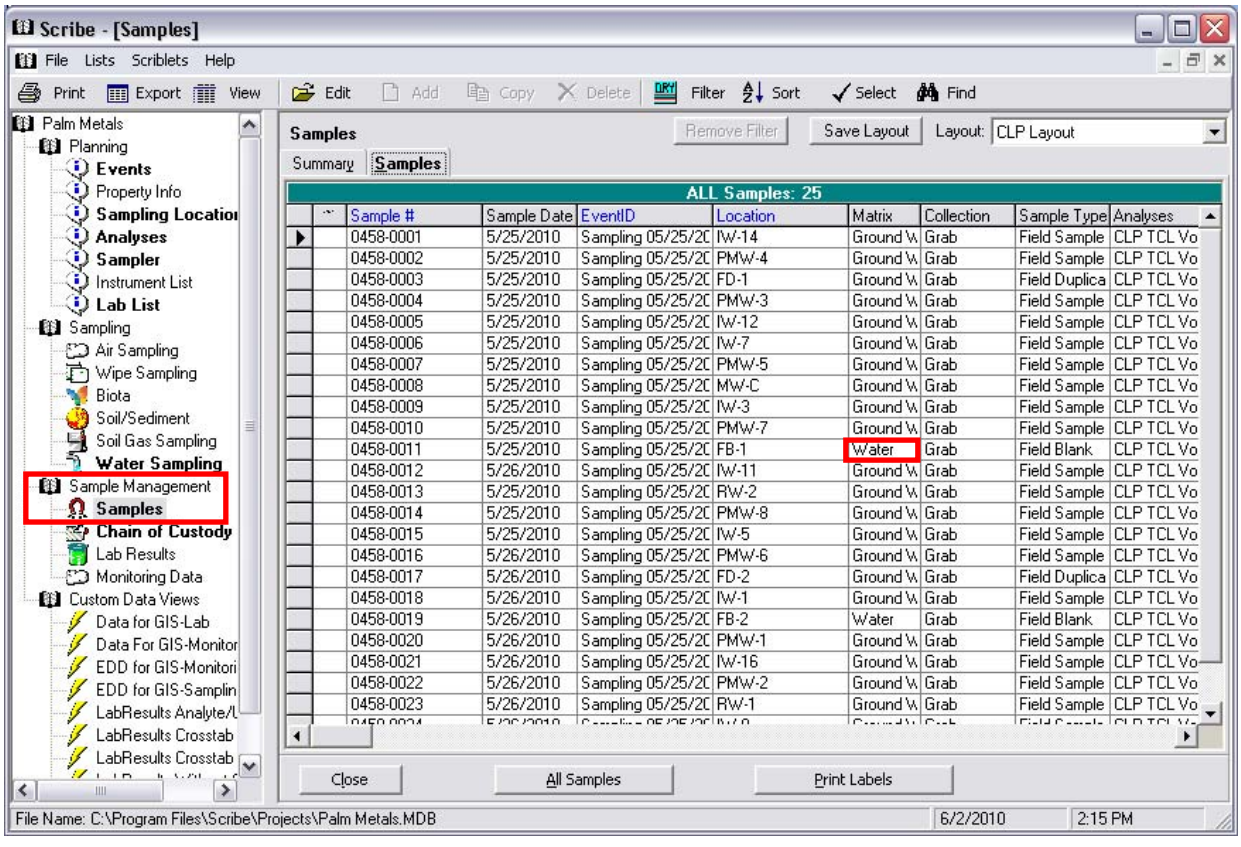
Scribe has flexible reporting options. The most popular way to report out from Scribe is to manipulate the grid view in the All Samples screen to display the data you wish to report. Then export the grid data to an file type that fits your reporting needs. File types include .txt, .csv, .xls, .htm, .xml, .kml, and .kmz.

Find, Filter and Sort

Scribe has built-in user-friendly querying functions such as Find, Filter and Sort. These functions are most useful when you are searching for a particular subset of data that meets one or more criteria.

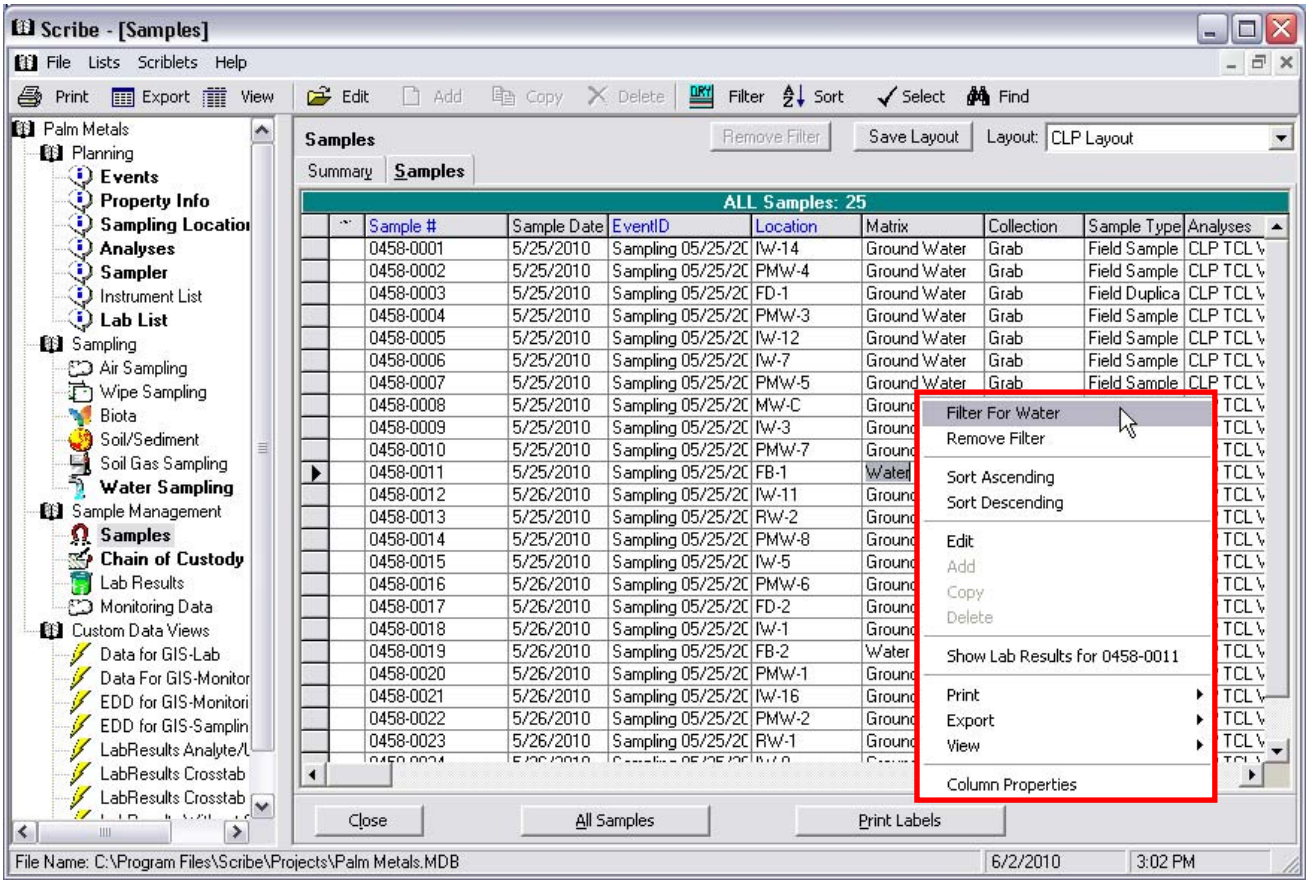
For example, to find and filter for all samples with a Water matrix or Sort ascending/descending:

1. Click on **'Samples'** under Sample Management in the left Navigation bar.



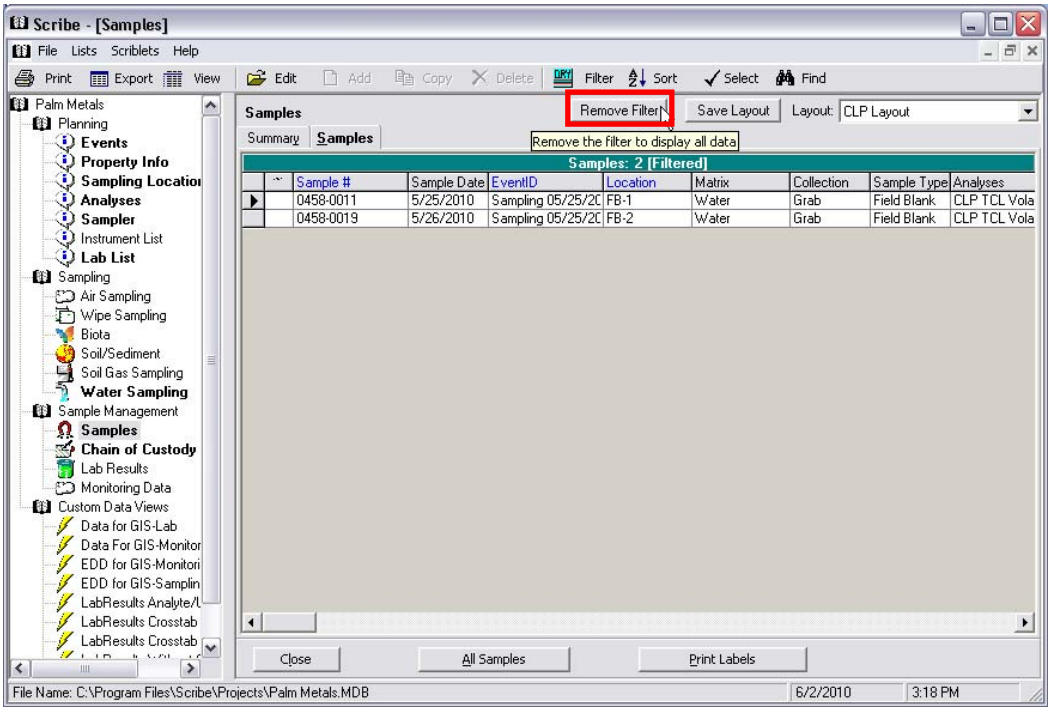
2. To filter or sort on ONE criteria, RT-click on Water value in the Matrix column.

3. Select '**Filter for Water'** in the pop-up menu or select Sort.

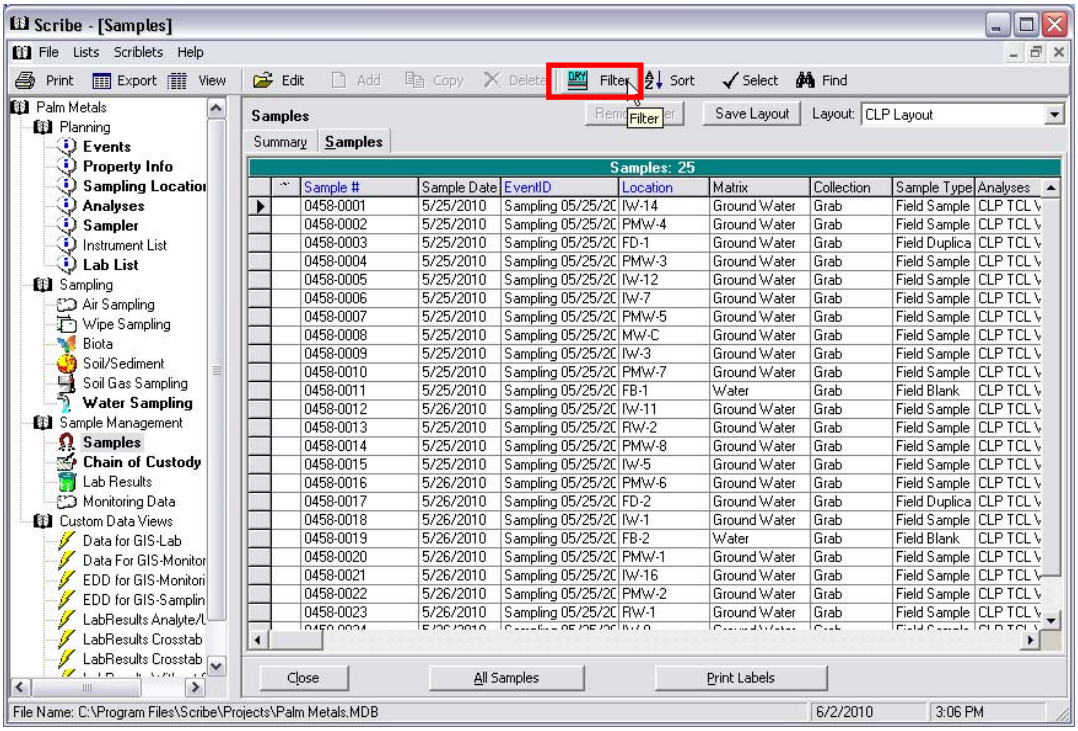


All records that have Water in the Matrix field are displayed.

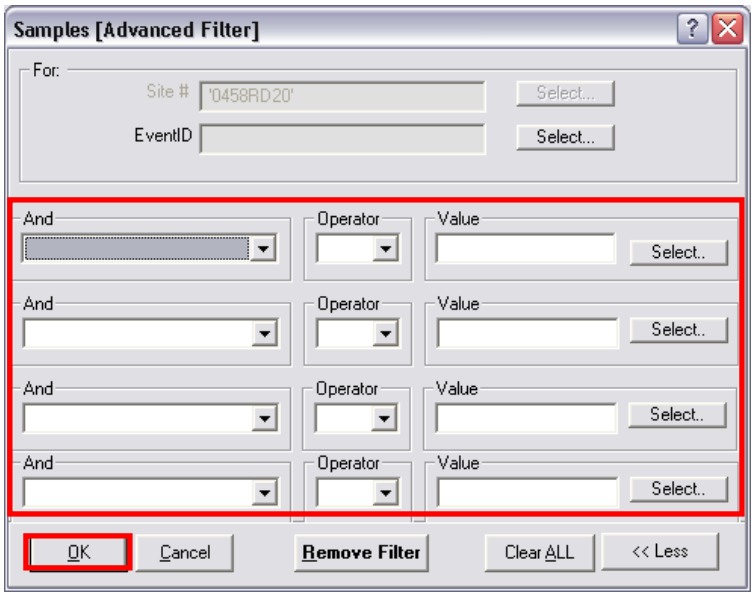
4. To remove the applied filter, click the **'Remove Filter'** button at the top of the screen.



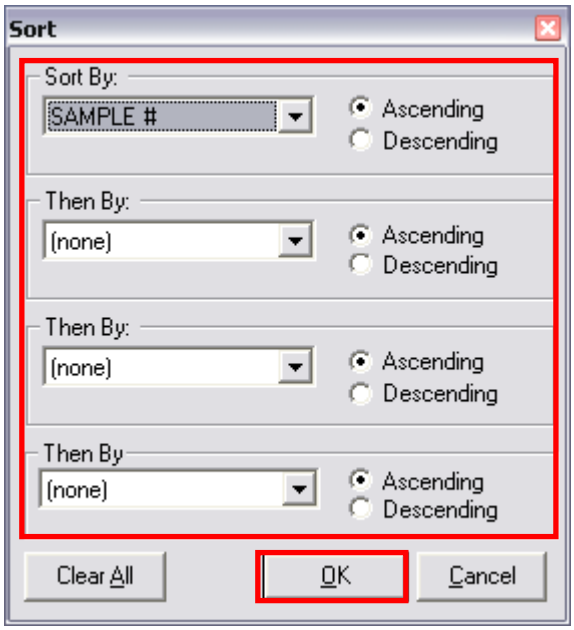
5. To filter on multiple criteria, select the **'Filter'** button on the top menu bar.



6. The Advanced Filter window is displayed. Input the criteria that for your search and click **'OK'** to apply the filter.



7. The Advanced **Sort** button also provides multi-tiered sorting options for sorting on more than one criteria.



Export

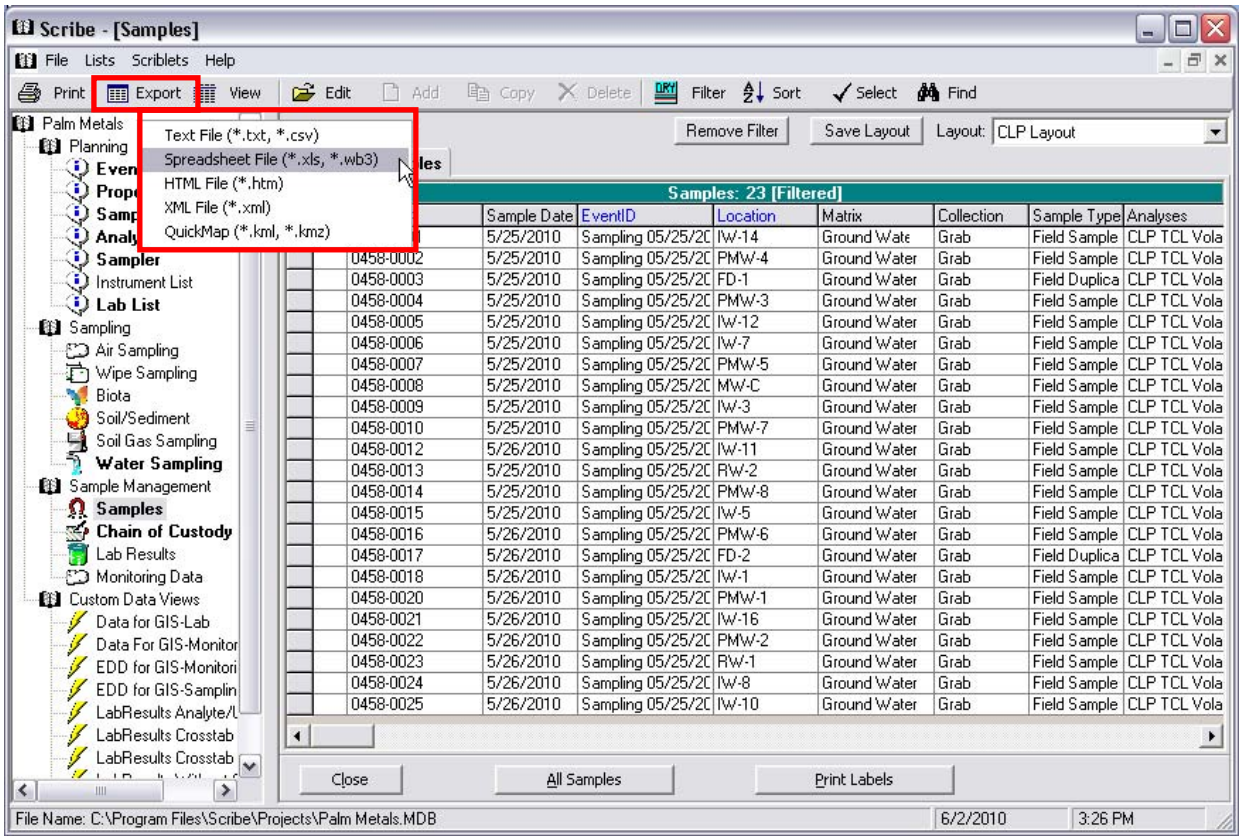
The Scribe grid view does not display every field in Scribe. Select fields are displayed by default and the user can turn on/off the columns. Turn on/off columns as described in the Sample Management section of this document to manipulate the data that is displayed.

After your grid view contains the data necessary for reporting purposes, the user can export the grid view to a third-party file type.

To export the grid view:

1. Click on **'Export'** button on the top menu bar.

2. Select the file type to which you wish to save the data. For example, Spreadsheet (.xls).



3. You will be prompted to select the destination and name the file.

4. The file will open in the external application if it is installed on your computer. For example, if you selected Spreadsheet, Excel will open with the grid data.

Worksheet Reports

Scribe provides a generic worksheet report that allows the user to customize the Header of the report to suit their needs. This option can be used to customize a Samples Report that could be used as a Receipt for Samples on residential sampling tasks.

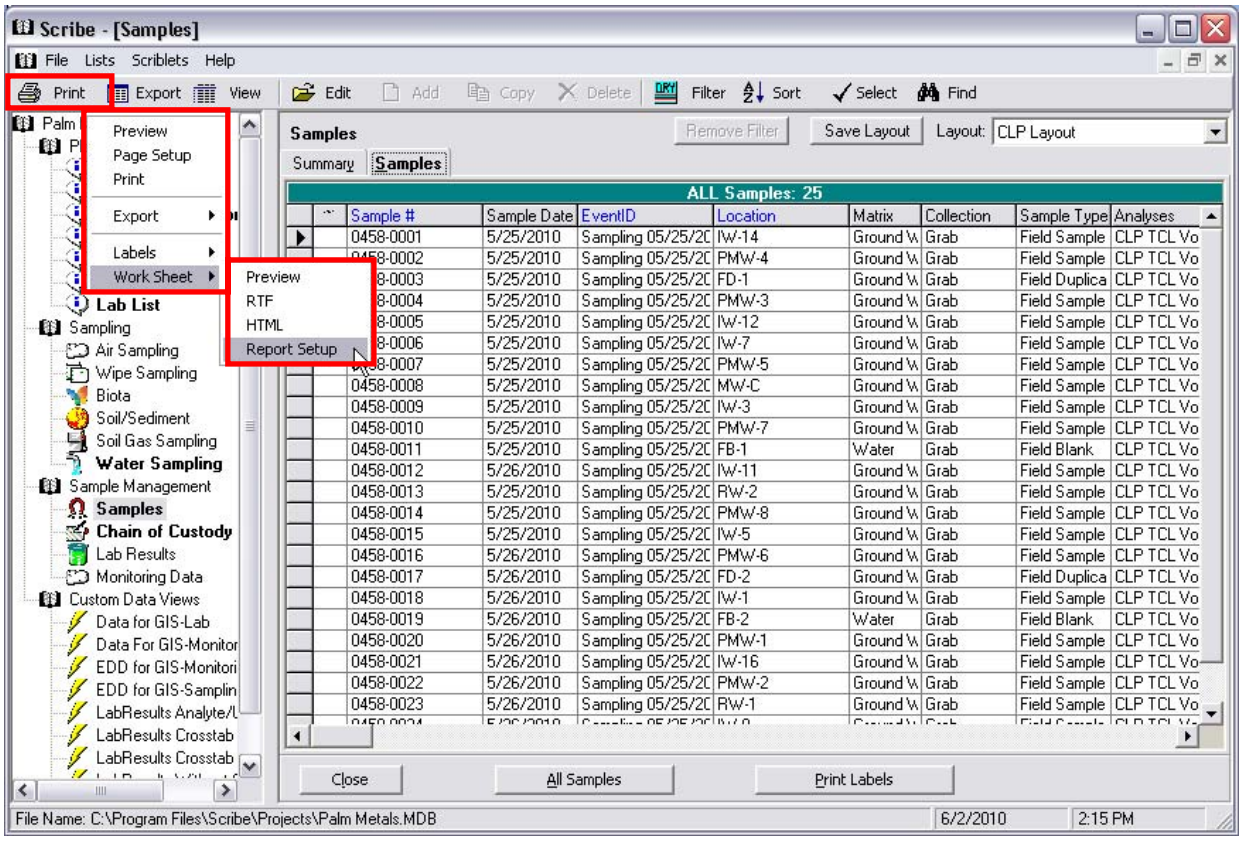
To generate the worksheet report:

1. Use the Find, Filter and Sort options and Column Views to display the data you want to report.

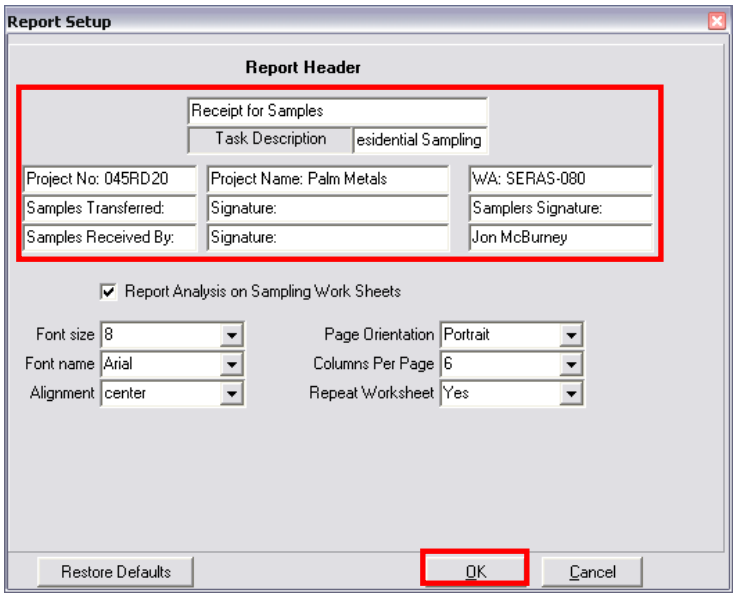
2. Click on the **'Print'** button on the top menu bar.

3. Select the **'Worksheet'** option.

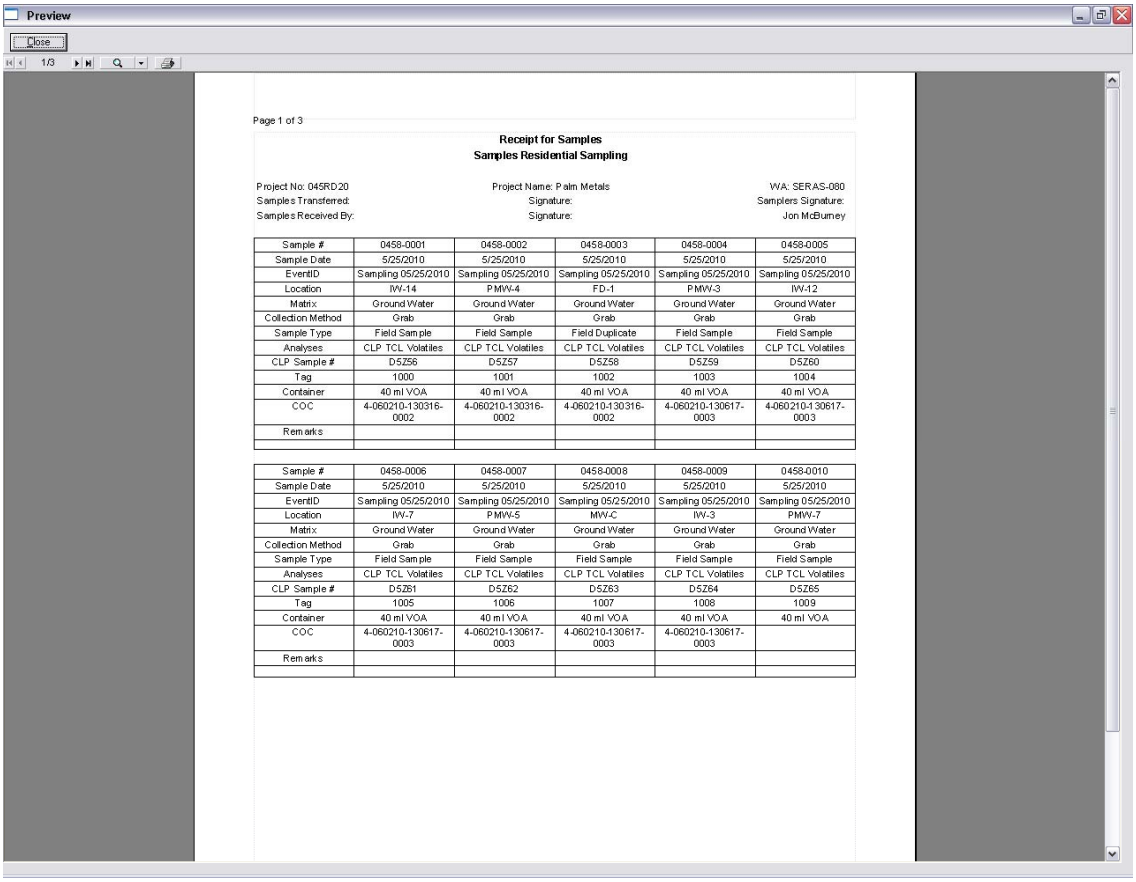
4. Select the **'Report Setup'** option to customize the Header. RTF and HTML will print the worksheet data to the selected format.



5. Configure the Report Header fields to reflect the information that will be displayed at the top of the report.



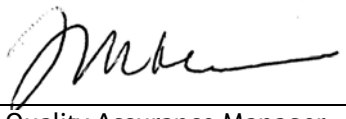
6. Click **'OK'** and the report is generated.



Sample #	0458-0001	0458-0002	0458-0003	0458-0004	0458-0005
Sample Date	5/25/2010	5/25/2010	5/25/2010	5/25/2010	5/25/2010
EventID	Sampling 05/25/2010	Sampling 05/25/2010	Sampling 05/25/2010	Sampling 05/25/2010	Sampling 05/25/2010
Location	IW-14	PMW-4	FD-1	PMW-3	IW-12
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Collection Method	Grab	Grab	Grab	Grab	Grab
Sample Type	Field Sample	Field Sample	Field Duplicate	Field Sample	Field Sample
Analyses	CLP TCL Volatiles	CLP TCL Volatiles	CLP TCL Volatiles	CLP TCL Volatiles	CLP TCL Volatiles
CLP Sample #	D5Z56	D5Z57	D5Z58	D5Z59	D5Z60
Tag	1000	1001	1002	1003	1004
Container	40 ml VOA	40 ml VOA	40 ml VOA	40 ml VOA	40 ml VOA
COC	4-060210-130316-0002	4-060210-130316-0002	4-060210-130316-0002	4-060210-130617-0003	4-060210-130617-0003
Remarks					

Sample #	0458-0006	0458-0007	0458-0008	0458-0009	0458-0010
Sample Date	5/25/2010	5/25/2010	5/25/2010	5/25/2010	5/25/2010
EventID	Sampling 05/25/2010	Sampling 05/25/2010	Sampling 05/25/2010	Sampling 05/25/2010	Sampling 05/25/2010
Location	IW-7	PMW-5	MW-C	IW-3	PMW-7
Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Collection Method	Grab	Grab	Grab	Grab	Grab
Sample Type	Field Sample	Field Sample	Field Sample	Field Sample	Field Sample
Analyses	CLP TCL Volatiles	CLP TCL Volatiles	CLP TCL Volatiles	CLP TCL Volatiles	CLP TCL Volatiles
CLP Sample #	D5Z61	D5Z62	D5Z63	D5Z64	D5Z65
Tag	1005	1006	1007	1008	1009
Container	40 ml VOA	40 ml VOA	40 ml VOA	40 ml VOA	40 ml VOA
COC	4-060210-130617-0003	4-060210-130617-0003	4-060210-130617-0003	4-060210-130617-0003	
Remarks					

Field Standard Operating Procedure-22 Superfund Sample Handling and Chain-of-Custody Procedures

Author: Kaitlin Ma	8/30/2021	
Approver: Theresa Himmer	08/31/2021	 Quality Assurance Manager

Field Standard Operating Procedure-22 Superfund Sample Handling and Chain-of-Custody Procedures

1. Purpose

This Field Operating Procedure (FOP) defines "custody" and describe protocols for documenting the transfer of custody from one party to the next (for example, from the site to the laboratory). A documented custody trail is established using a U.S. Environmental Protection Agency (EPA) chain-of-custody form that uniquely identifies each sample container, and who has possession of it from the sample's origin to its destination. The chain-of-custody form also describes the sampling point, date, time, and analysis parameters. This procedure is applicable to Superfund projects executed under the Great Lakes Architect-Engineer Services II (GLAES II) Contract.

2. Scope

This is a general description of how to document the transfer of custody of samples from one party to the next. Sample personnel should be aware that a sample is considered in a person's custody if the sample meets the following conditions:

- It is in a person's actual possession
- It is in view after being in a person's possession
- It is locked up so that no one can tamper with it after it has been in physical custody

When samples leave the custody of the sampler, possession must be documented and the cooler must be custody-sealed, if shipped. Data generated from the use of this FOP may be used to support the following activities: site characterization, risk assessment, and evaluation of remedial alternatives.

3. Equipment and Materials

- Computer with Scribe software loaded
- Laser printer with paper (8.5 × 11 inch) and ink cartridge (black)
- Scribe generated label (adhesive labels)

- Indelible black ink pen
- Bubble wrap
- 2-gallon resealable plastic bags for ice
- Packing/strapping tape
- Custody seals

4. Procedures and Guidelines

4.1 Chain-of-Custody Forms

The Superfund chain-of-custody form (see Attachment 1 for example) must contain the following information:

- Case Number/Client Number: If a Contract Laboratory Program (CLP) laboratory is used, enter the case number provided by EPA's Regional Sample Control Center Coordinator. If the CLP is not used, enter the SAS number provided by the sample and analytical coordinator.
- EPA Region: Enter Region "5", for example.
- Site Name/State: Enter the site name and state.
- Project Leader: Enter the project manager's name.
- Action: "Remedial Investigation" or "Site Characterization", for example
- Sampling Co.: "CH2M"
- Sample No.: This is the unique number that will be used for sample tracking. For CLP, this number is taken from a block of numbers assigned by the EPA Regional Sample Control Center Coordinator. For non-CLP, the CH2M sample and analytical coordinator will assign the number.
- Matrix: Describes the sample media (for example, "Soil").
- Sampler Name: The name of the sampler or sample team leader.
- Concentration: Low (L), Low/Medium (M) or High (H).

- Sample type: "Grab" or "Composite."
- Analysis: This indicates the analyses required for each sample.
- Preservative: Document what preservative has been added to the sample (for example, "HCl," "Ice Only," "None").
- Station Location: This is the CH2M Station Location Identifier.
- Sample Collect Date/Time: Use military time.
- QC Type: This is for field quality control (QC) only, and includes field duplicates.
- Date shipped: The date that samples are relinquished to the shipping carrier.
- Carrier Name: (for example, "FedEx").
- Airbill: Air bill number used for shipping.
- Shipped to: This is the laboratory name and full address, including the laboratory contact. If the contact is not known, use "Sample Custodian".
- Chain-of-Custody Record fields: The sampler's signature must appear in the "Relinquished By" field. The date and time (military time) must also be included.
- Although the samples are "relinquished" to the shipping carrier, the shipping carrier does not have access to the samples if the shipping cooler is custody sealed. Consequently, the shipping carrier does not sign the chain-of-custody form.
- Sample(s) to be used for laboratory QC: This identifies which samples are to be used for matrix spike/matrix spike duplicate analyses.
- Indicate if shipment for case is complete: Use "Y" or "N".
- Chain-of-Custody Seal Number: Record the custody seal numbers that appear on the Regional custody seals, as applicable, that can be found on the shipping container. There is usually a minimum of two per shipping container during shipment.

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

- All sample containers must be properly labeled.
- Each cooler/box (canisters only) must have a chain-of-custody form, and the samples in the cooler/box (summa canisters only) must match what is on the chain-of-custody form (as identified by the laboratory-provided sample tags for the summa canisters).
- Each chain-of-custody form must be properly relinquished (signature, date, time).
- If shipped, the custody seal numbers must be written on each chain-of-custody form.
- The shipping cooler/box (canisters only) must be custody sealed in two places: front and back; coolers/boxes (canisters only) transported by laboratory courier do not require custody seals.
- Chain-of-custody forms will be completed with required sampling information.
- If the designated sampler relinquishes samples to other sampling or field crew members for packing or other purposes, the sampler will complete the chain-of-custody form prior to this transfer.
- Appropriate personnel will sign and date chain-of-custody forms to document the sample custody transfer.
- Original chain-of-custody forms will be placed in resealable plastic bags and will accompany the shipment; copies will be retained by the sampler for sampling records.
- If samples are sent by common carrier, bills of lading will be used. Receipts or bills of lading will be retained as part of the permanent project documentation.
- Commercial carriers will not be required to sign off on chain-of-custody forms if the forms are sealed inside the sample cooler and the custody seals remain intact.
- Packaging, marking, labeling, and shipping of samples will comply with the regulations promulgated by the U.S. Department of Transportation in the Code of Federal Regulations (49 CFR 171 177).

7. Attachments

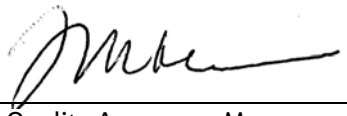
Attachment 1. Quick Guide to Using Scribe.

8. References

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

Field Standard Operating Procedure-24
Monitoring Well Installation

Author: Steve Chumney 8/30/2021 

Approver: Theresa Himmer 08/31/2021 

Quality Assurance Manager

Field Standard Operating Procedure-24 Monitoring Well Installation

1. Purpose

The purpose of this field operating procedure (FOP) is to define the requirements for the installation of shallow (overburden) monitoring wells.

2. Scope

This is a general description of how to install shallow monitoring wells for the collection of groundwater samples and water levels.

3. Equipment and Materials

- Drill rig (hollow-stem auger, sonic, air hammer, air rotary, or mud rotary)
- Well-construction materials (i.e., surface casing, screens, riser, casing, end caps, vented well caps, 8 to 12-inch diameter steel isolation casing, centering guides for deep wells, sand, powdered bentonite grout, and surface-finish materials)
- Mud scales for weighing the bentonite grout (if required)
- Well development materials (surge block, pump, calibrated meters to measure pH, temperature, specific conductance, Eh, and dissolved oxygen of development water, containerization for development water)

4. Procedures and Guidelines

4.1 General

A monitoring well is a device designed for obtaining groundwater samples that represent the chemical quality of the aquifer adjacent to the screened interval, unbiased by the well materials and installation process, and that provides access to measure the potentiometric surface for the screened interval. The screened interval is that part of the device that is directly open (horizontally adjacent) to the host aquifer by way of openings in the well casing (hereafter called the “screen”) and indirectly open (vertically adjacent) to the aquifer by way of the filter pack (or other permeable material) extending below or above the screen. The maximum length of the screened interval is fixed for a given well (by the length of the

filter pack), but the effective or functional length may vary with water table fluctuations or sampling techniques. ASTM D 5092 contains additional guidance on monitoring well installation.

4.2 Well Clusters

Each monitoring well is a mechanism through which to obtain a representative sample of groundwater and, to measure the potentiometric surface in that well. To help ensure this representation in the case of well clusters, each well of a cluster should be installed in a separate boring. Multiple well placements in a single boring are too difficult for effective execution and evaluation to warrant single-hole usage.

4.3 Well Screen Usage

Each shallow monitoring well should have a screen, per attached Typical Monitoring Well Detail (or of a technically equivalent construction as in ASTM D 5092).

4.4 Beginning Well Installation

1. The installation of the monitoring well should begin within 12 hours of completing the boring for holes uncased or partially cased with temporary drill casing. Installation should begin within 48 hours in holes fully cased with temporary drill casing. Once installation has begun, there should be no breaks in the installation process until the well has been grouted and the drill casing removed. Anticipated exceptions should be requested in writing before drilling. Data to include in such a request are:
   - Wells in question
   - Circumstances
   - Recommendations and alternatives
2. In cases of unscheduled delay, such as personal injury, equipment breakdowns, or sudden inclement weather or scheduled delays such as borehole geophysics, no advance approval of delayed well installation should be needed. In those cases, resume installation as soon as practicable. Partially completed borings should be properly secured during periods of inactivity to preclude the entry of foreign materials or unauthorized personnel to the boring.
3. Temporary drill casing may be withdrawn from the before well installation if cross-contamination is unlikely and if the borehole walls will not slough during the time required for well installation. This procedure usually is successful in firm clays and in bedrock that is not intensely fractured or highly weathered.
4. If the borehole will not remain stable long enough to complete placement of all necessary well materials in the proper position, it may be necessary to install some or all well materials before removing the casing. In this situation, the rotary sonic casing should have an inside diameter sufficient to allow installation of the prescribed diameter screen and casing plus annular space for a pipe through which to place the filter pack and grout.
5. Once begun, well installation should not be interrupted by the end of the driller's work shift, darkness, weekend, or holiday.

All materials and equipment for drilling and installing a well should be available and onsite before drilling the well. The equipment and materials should be onsite before drilling and installing a well if the total

drilling and installation effort is scheduled to take 14 days or less. For longer schedules, the materials needed for at least 14 days of operation should be onsite before well drilling. The balance of materials should be in transit before well drilling. Site-specific factors that preclude the availability of needed secure storage areas should be identified and resolved in the drilling plan.

4.5 Screening Casings and Fittings

1. Well screens and well casings should be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and washed with approved water before use. Prewashing may not be necessary if the materials have been packaged by the manufacturer and have their packaging intact up to the time of installation. Pipe nomenclature stamped or stenciled directly on the well screen or blank casing within and below the bentonite seal should be removed by means of sanding, unless removable in approved water. Solvents, except approved water, should not be used to remove markings. Washed screens and casings should be stored in plastic sheeting until immediately before insertion into the borehole.
2. Bottoms of well screens should be placed no more than 1 meter (3 feet) above the bottom of the drilled borehole. If significant overdrilling is required (as for determining stratigraphy), a pilot boring should be used. The intent is to narrow the interval of aquifer being sampled, to limit the potential for stagnant or no-flow areas near the screen, and to preclude unwanted backfill materials (e.g., grout or bentonite) from entering or passing through the interval to be screened and sampled. The casing/screen should be suspended from the surface and should not rest on the bottom of the borehole during installation of the filter pack and annular seal.
3. All screen bottoms should be securely fitted with a threaded cap or plug of the same composition as the screen. The cap/plug should be within 150 millimeters (0.5 foot) of the open part of the screen. No solvents or glues should be permitted for attachment.
4. Silt or sediment traps (also called cellars, tail pipes, or sumps) should not be used. A silt trap is a blank length of casing attached to and below the screen. Trap usage fosters a stagnant, turbid environment that could influence analytical results for trace concentrations.
5. The top of each well should be level such that the difference in elevation between the highest and lowest points on the top of the well casing or riser should be less than or equal to 6 millimeters (0.02 foot).
6. The borehole should be of sufficient diameter to permit at least 50 millimeters (2 inches) of annular space between the borehole wall and all sides of the well (centered riser and screen). When telescoping casings (one casing within another), the full 50-millimeter (2-inch) annulus may not be practical or functional. In that case, a smaller spacing may be acceptable, depending on specific site conditions.
7. Well screen lengths may be a function of hydrostratigraphy, temporal considerations, environmental setting, analytes of concern, or regulatory mandate. Screen lengths should be specified in the drilling plan.
8. The actual inside diameter of a nominally sized well is a function of screen construction and the wall thickness/schedule of both the screen and casing. In the case of continuously wound screens, their interior supporting rods may reduce the full inside diameter. This consideration is critical when planning the sizes for pumps, bailers, surge devices, and so on.
9. When physical or biological screen clogging is anticipated, the larger open area per unit length of continuously wound screens has an advantage over the slotted variety.

4.6 Granular Filter Pack

1. When artificial filter packs are used, a tremie pipe should be used to place the filter pack, especially when the boring contains drilling fluid or mud. A record should be maintained of the amount of water used to place the filter pack, which should be added to the volume of water to be removed during well development.
2. The filter pack should extend from the bottom of the boring to 1 to 1.5 meters (3 to 5 feet) above the top of the screen unless otherwise specified in the drilling plan. This extra filter allows for settlement (from infiltration and compaction) of the filter pack during development and repeated sampling events. The additional filter helps to maintain a separation between the bentonite seal and well screen.
3. Depending on the gradation of the primary filter pack and the potential for grout intrusion into the primary filter pack, a secondary filter pack may be installed above the primary filter pack to prevent the intrusion of the bentonite grout seal into the primary filter pack. To be effective, the secondary filter should extend 0.3 to 0.6 meter (1 to 2 feet) above the primary filter pack.
4. The final depth to the top of the granular filter should be directly measured (by tape or rod) and recorded. Final depths should not be estimated, for example, as based on volumetric measurements of placed filter.

4.7 Bentonite Seals

1. Bentonite seals, especially those set in water, should be composed of commercially available pellets. Pellet seals should be 1 to 1.5 meters (3 to 5 feet) thick, as measured immediately after placement without allowance for swelling. Granular bentonite may be an alternate if the seal is set in a dry condition. Tremie pipes are not recommended.
2. Slurry seals can be used when the seal location is too far below water to allow for pellet or containerized bentonite placement or within a narrow well-borehole annulus. Typically, the specific gravity of cement grout placed atop the slurry seal will be greater than that of the slurry. Therefore, use a slurry seal should be detailed in the drilling plan, and details should discussi how the grout will be precluded from migrating through the slurry. Slurry seals should have a thick, batter-like (high viscosity) consistency with a placement thickness of 1 to 1.5 meters (3 to 5 feet). Typically, only high-solids bentonite grouts are used that consist of a blend of powdered bentonite and fresh water mixed to a minimum 20 percent solids by weight of pumpable slurry with a density of 9.4 pounds per gallon or greater.
3. The final depth to the top of the bentonite seal should be directly measured (by tape or rod) and recorded. Final depths should not be estimated, as, for example, based on volumetric measurements of placed bentonite.

Numerous opinions have been expressed regarding bentonite hydration time, bentonite placement procedures under water versus in a dry condition, and the potential installation delays and other consequences caused by these factors. By not allowing sufficient time for the bentonite seal to hydrate and form a low permeable seal, grout material could infiltrate into the bentonite seal and possibly into the filter pack. It is recommended waiting at least 3 to 4 hours for hydration of bentonite pellets, or tablets when cement grout is used above the bentonite seal. If bentonite chips are used, the minimum hydration time could be twice as long. Normally chips should be used only if it is necessary to install a seal in a deep water column. Because of their high moisture content and slow swelling tendencies, chips can be dropped

through a water column more readily than a material with a low moisture content, such as pellets or tablets. Bentonite chips should not be placed in the vadose zone. A 1-meter (3-foot) minimum bentonite pellet seal must be constructed to protect the screen and filter pack from downhole grout migration. When installing a bentonite seal in the vadose zone (the zone above the water table), water should be added to the bentonite for it to hydrate properly. The amount of water required depends on the formation. It is recommended that the bentonite seal be placed in 0.15- to 0.3-meter (6- to 12-inch) lifts, with each lift hydrated for a period of 30 minutes. This method will assure that the bentonite seal is well hydrated and accomplish its intended purpose. A 0.15- to 0.3-meter (6- to 12-inch) layer of fine to medium sand (secondary filter pack) placed atop the bentonite seal may further enhance barrier resistance to downward grout migration.

4.8 Grouting

All prescribed portions of grout material should be combined in an aboveground rigid container and mechanically (not manually) blended to produce a thick, lump-free mixture throughout the mixing vessel. The mixed grout should be placed around the monitoring well as follows:

1. The grout should be placed from within a rigid side discharge grout pipe located just over the top of the seal. The grout or tremie pipe should be decontaminated before use.
2. Before exposing any part of the borehole above the seal by removal of drill casing, the annulus between the drill casing and well casing should be filled with sufficient grout to allow planned removal of the drill casing. The grout should not penetrate the well screen or granular filter pack. Disturbance of the bentonite seal should be minimal.
   - If all drill casing is to be removed in one operation, the grout should be pumped through the grout pipe until undiluted grout flows from the annulus at ground surface, forming a continuous grout column from the seal to ground surface. The drill casing should then be removed, making certain that exposure of the borehole to the atmosphere is minimal. During removal of hollow-stem augers (if used), the grout pipe may have to be reinserted occasionally for additional grouting to compensate for the larger annular space created by the augers' helical coil.
   - If drill casing is to be incrementally removed with intermittent grout addition, the grout should be pumped through the grout pipe until it reaches a level that will permit at least 3 meters (10 feet) of grout to remain in the well/drill casing annulus after removing the selected length of drill casing.
3. If the ungrouted part of the hole is less than 4.5 meters (15 feet) deep and without fluids after casing removal, the ungrouted part may be filled by pouring grout from the surface without a pipe.
4. If drill casing was not used, grouting should proceed to surface in one continuous operation. Care should be taken, however, in deep wells when using cement grout around PVC casing. Extreme heat, commonly known as heat of hydration, can be generated by the cement during hydration and curing. The heat generated can be sufficient enough to soften or weaken PVC casing, resulting in collapse of the casing. Grouting in multiple lifts may be necessary in this situation.
5. Once begun, the grouting process should be continuous until the drill casing has been removed and all annular spaces are grouted to the ground surface.
6. Protective casing should be installed the same day that grouting begins.

7. The site should be checked for grout settlement and more grout added that day to fill any depression. Repeat the process until firm grout remains at ground surface. This process should be completed within 24 hours of the initial grout placement. Incremental quantities of grout added in this manner should be recorded on the attached well completion diagram.
8. For grout placement in a dry and open hole less than 4.5 meters (15 feet) deep, the grout may be manually mixed and poured in from the surface as long as seal integrity is maintained.

No grout should be placed or allowed to migrate below the bentonite seal and into the well screen.

4.9 Well Protection

1. Protective casing should be installed around each monitoring well the day the grout is placed. The annulus formed between the outside of the protective casing and borehole should be filled to the ground surface with grout. The annulus should be filled to at least 150 millimeters (0.5 foot) above the ground surface with cement or bentonite as part of the overall grouting procedure.
2. Protective casing should be cleaned by steam or hot-water pressure before placement; free of extraneous openings; and devoid of asphaltic, bituminous, encrusting, and coating materials, except the black paint or primer applied by the manufacturer.
3. An example of a flush-to-ground completion is shown in attached Typical Monitoring Well Detail. Additional guidance on monitoring well protection may be found in ASTM Standard Practice D 5787. Recommended minimum elements of protection design include the following list:
   - All manhole covers should be lockable.
   - If practical, have all padlocks at a given site keyed the same.
   - There should be no more than 60 millimeters (0.2 foot) from the top of the protective casing to the top of the well casing. This, or a smaller spacing, is needed for subsequent water-level determinations by some acoustical equipment which must rest upon the well casing in order to function.
   - Each well should be identified by a number.
   - The erection of protective posts should be considered when physical damage resulting from construction equipment or vehicles is likely. When necessary, steel posts should be erected with a minimum diameter of 80 millimeters (3 inches). Each post should be radially located at least 1 meter (3 feet) from the well and placed 0.6 to 1 meters (2 to 3 feet) below ground, having 1 meter (3 feet) minimally above ground surface. Posts typically are filled with concrete and set in post holes that are backfilled with concrete. The post should be painted orange using a brush. Installation should be completed before sampling the well. Flags or barrier markers in areas of high vegetation may be helpful.
   - When posts are used in conjunction with concrete pads, the posts should be located outside the pads. Posts inside a pad (especially near a comer or edge) may cause the pad to crack, either by normal stress relief or if severely struck, as by a vehicle.
   - Place a 6-millimeter (¼-inch) diameter hole (drainage port) in the protective casing centered, no more than 3 millimeters (⅛ inch) above the grout-filled annulus between the riser and the protective casing.

- Apply at least a 150-millimeter (0.5-foot) thick coarse gravel 19- to 75-millimeters (¾- to 3-inch) particle size pad extending 1 meter (3 feet) radially from the protective casing. Prior to placement of the gravel pad, any depression around the well should be filled to slightly above the level of the surrounding ground surface with uncontaminated cohesive soil. This will prevent a "bathtub" effect of water collecting in the gravel pad around the well casing. The gravel pad should be constructed before developing the well. Some long-term, heavy traffic, or high visibility locations may warrant a concrete pad specially designed for site conditions. Concrete pads, especially in cold climates, should be designed to withstand frost heave. Frost uplift may adversely affect well and pad integrity. A concrete pad should be at least 100 millimeters (4 inches) thick and 1 meter (3 feet) square. Round concrete pads are acceptable.

All elements of well protection should be detailed in the drilling plan. Unique well protection requirements for floodplains, frost heaving, heavy traffic areas, parking lots, and wells finished at or below grade, and other special circumstances should also be covered on a case-by-case basis in the drilling plan.

4.10 Drilling Fluid Removal

When a borehole, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid that would preclude or hinder the specified well installation, the borehole fluid should be removed or displaced with approved water. This is intended to remove or dilute the thick fluid and thus facilitate proper placement of casing, screen, granular filter, and seal. Fluid loss in this operation should be recorded on the well diagram or boring log and later on the well development record. Fluid removal before well placement should be contingent upon the driller's and the geologist's evaluation of hole stability; that is, long enough for the desired well and seal placement.

4.11 Well Construction Diagrams

Each installed well should be depicted in a well completion diagram (see attached example). The diagram should be attached to the original boring log for that installation and graphically denote depth from ground surface. The following information, if applicable, should be described on the well completion diagram:

- Actual quantity and composition of the grout, bentonite seals, and granular filter pack used for each well
- Screen slot size in millimeters (inches), slot configuration, total open area per meter (foot) of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer
- Material between the bottom of the boring and the bottom of the screen
- Outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing
- Joint design and composition

- Centralizer design and composition
- Depth and description of any permanent pump or sampling device. For pumps include the voltage, phase requirements, and electrical plug configuration
- Composition of the protective casing and nominal inside diameter
- Special problems and their resolutions; for example, grout in well, lost casing or screen, bridging, casing repairs or adjustments, and so on
- Dates and times for the start and completion of well installation

Special abbreviations used on the attached well completion diagram should be defined on the diagram.

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

Field quality manager should review well construction diagrams for accuracy and completeness.

7. Attachments

Well completion diagram.

8. References

ASTM D5092, 2004 Edition, January 1, 2004 - Standard Practice for Design and Installation of Ground Water Monitoring Wells.

ASTM D5787-20, Standard Practice for Monitoring Well Protection At or Near Land Surface, ASTM International, West Conshohocken, PA, 2020, www.astm.org

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

PROJECT NUMBER	WELL NUMBER
	SHEET 1 OF 1

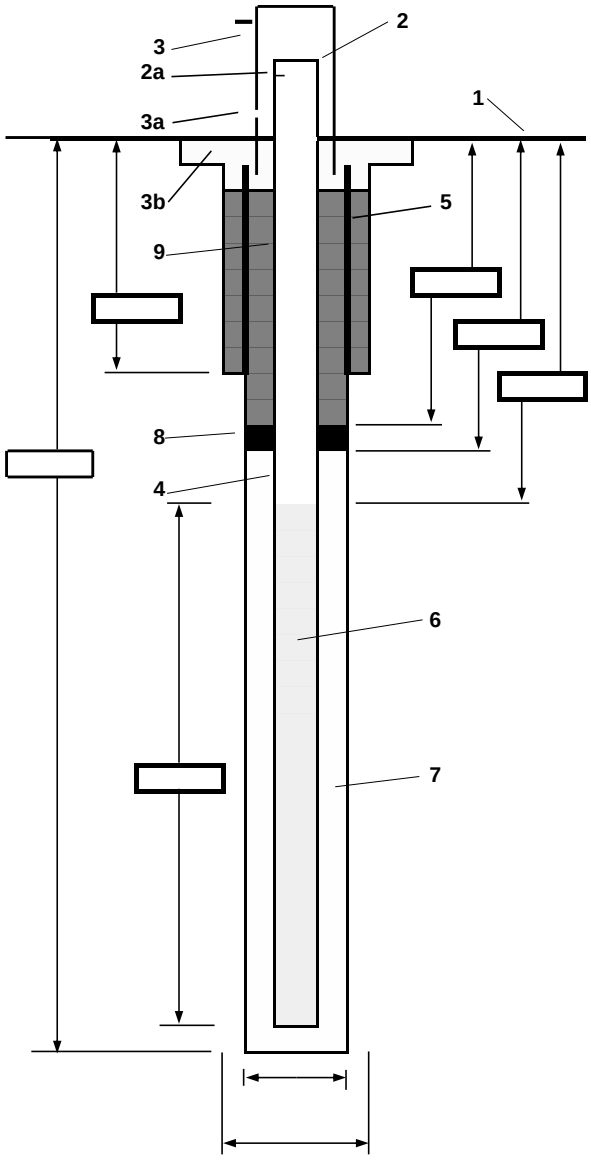
WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well _____

2- Top of casing elevation _____
   a) vent hole? _____

3- Wellhead protection cover type _____
   a) weep hole? _____
   b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Dia./type of surface casing _____

6- Type/slot size of screen _____

7- Type screen filter _____
   a) Quantity used _____

8- Type of seal _____
   a) Quantity used _____

9- Grout
   a) Grout mix used _____
   b) Method of placement _____
   c) Vol. of surface casing grout _____
   d) Vol. of well casing grout _____

Development method _____

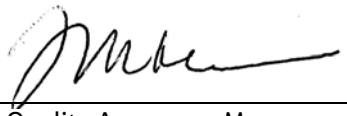
Development time _____

Estimated purge volume _____

Comments _____

Field Standard Operating Procedure-25
Monitoring Well Development

Author: Steve Chumney 8/30/2021 

Approver: Theresa Himmer 08/31/2021 

Quality Assurance Manager

Field Standard Operating Procedure-25 Monitoring Well Development

1. Purpose

This procedure defines the requirements for the development of shallow groundwater monitoring wells.

2. Scope

These guidelines are for the development of shallow groundwater monitoring wells.

3. Equipment and Materials

- Potable water
- Decontamination supplies (5-gallon buckets, wash tubs, Alconox, latex gloves, etc.)
- Submersible pump/controller or peristaltic pump
- Tubing
- Disposable bailers
- Surge block for a 2-inch-diameter well
- Portable generator (minimum 3,500 W)
- Water level indicator
- YSI Multi-meter (or equivalent)

4. Procedures and Guidelines

After the installation of the monitoring well, development of the well should occur after the grout has set, at least 48 hours following placement of the grout. Overpumping is the most desirable method for well

development. Procedures for developing monitoring wells also apply to re-developing existing monitoring wells. Monitoring wells will be developed using the following guidelines:

- All non-dedicated down well equipment (tubing, water level indicator, etc.) will be decontaminated prior to each well being developed. Dedicated tubing will be used for each well developed.
- After the well is opened, depth to water and total depth of well will be measured with a water level indicator and recorded in the site specific field logbook. Casing volumes (for a 2-inch diameter well) can be calculated using the following equation: Total depth of monitoring well (TD) – Depth to water (DTW) = height of water in monitoring well (h); therefore 1 casing volume = h × 0.16 for 2-inch-diameter wells.
- If there are indications of silt or fines at the bottom of the well (e.g. "spongy or soft feeling" when total depth of well is measured or shallower total depth measurement compared to historical data) a bailer or other applicable means may be used to collect sediment at the bottom of the well before installing the submersible pump.
- After fines have been removed from the well, a submersible pump (or a peristaltic pump) with dedicated tubing will be lowered into the well and set at the top of the well screen. The pump will be plugged into the controller and generator. The outflow end of the tubing will be secured in a 55-gallon drum used to containerize the development water.
- Turn pump on with a beginning flow rate of 100 mL/minute and begin developing the well. Measure the initial pH, temperature, specific conductance, and turbidity and enter measurements in the field logbook. Record initial color, odor, and clarity of the groundwater.
- Incrementally lower the intake down the well screen. Repeat the process going up the well screen.
- As the well is being developed, adjustments may have to be made to the flow rate of the pump. If the pumping rate does not produce significant drawdown (0.5 foot or more) than the pumping rate should be increased. The pumping rate should be increased incrementally until significant drawdown is produced. For submersible pumps, care should be taken to prevent the water level from falling below the pump intake.
- If necessary, gentle surging the well with a surge block can be initiated to further development. After surging, fines that have settled in the bottom of the well should be removed. This technique is not recommended for low-yield wells.
- At a minimum, the volume of water injected during the well development and three well purge volumes of water will be removed from the well with water quality measurements (pH, temperature, specific conductance, and turbidity) being recorded for every purge volume of water removed. Introducing of water from another source should only be used if stated in the approved work plan and with the project manager's approval.
- Well development will be considered complete when pH, temperature and specific conductivity measurements have stabilized (three consecutive readings where pH is within ± 0.1 unit, and temperature and specific conductivity are within 3 percent) or turbidity is less than 50 NTUs, or a maximum of 12 casing volumes of water has been removed from the monitoring well.
- Well development will cease if the well goes dry within one purge volume under a pumping rate of 100 mL/minute.
- The following data should be recorded in the field logbook for each monitoring well developed:
  - Well ID

- Date of well installation or redevelopment
- Time of well development
- Water levels before, during, and after development
- Water quality stabilization parameters (pH, temperature, specific conductance, and turbidity) initially, during and at the end of developing the well
- Quantity of water removed
- Type of equipment used (e.g., submersible pump, peristaltic pump, bailer)

Description of well development techniques (e.g., over pumping, surging).

5. Records Management

Project records will be managed in accordance with the Quality Management Plan Great Lakes Architect-Engineer Services II Contract (Jacobs, 2021). Project documents and records will be retained for10 years after the closing date of the prime contract. All information generated under this program is considered confidential and shall not be released to others without the written consent of the Contract Officer.

6. Quality Control and Quality Assurance

Field quality manager should review well development logs for accuracy and completeness and conformance to stabilization criteria outlined in the project plans.

7. Attachments

Well development log.

8. References

Jacobs Engineering Group, Inc. 2021. *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract (Jacobs, 2021)*. March.

WELL DEVELOPMENT LOG

WELL ID:

Project Name:
Project Number:
Installation Date:
Development Team:

Log Book ID/Page:
Well Depth: ft btoc
Well Diameter: in
Screened Interval: ft btoc
Static Water Level: ft btoc
Well Materials:

Development Information
Start Date:
Start Time:
End Date:
End Time:

Contractor Information
Development:
Equipment:

Development Method:

Purging Equipment:

WELL STABILIZATION DATA

Time	Volume Removed	Water level (ft btoc)	Turbidity (NTU)	Clarity/Color	Temp. (°C)	pH	Sp. Cond. (mS/cm)	Remarks

STABILIZATION SUMMARY

Range or Average Pump Rate: gpm
Maxium Drawdown during pumping: ft
Total quantity of material bailed: gal
Total quantity of water discharged by pumping: gal

Purge Water Description:
Comments:

Attachment 2
Field Forms

Air Monitoring Record

Project Name & Number:	
Action Levels:	
Safety Coordinator Name & Signature	

Date:		Sensor/Channel				
Time	Monitored Location	LEL	O2	PID/FID	Other:	Other:
	☐BZ ☐Other (describe):					
	☐BZ ☐Other (describe):					
	☐BZ ☐Other (describe):					
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	☐BZ ☐Other (describe):					
	☐BZ ☐Other (describe):					

BZ = Breathing Zone

ch2m

PHOTOGRAPH RECORD FILE INDEX

ROLL NO: _____

PERIOD FROM: _____ TO _____ 20 ___

PROJECT: Velsicol - NAPL/DBCP Areas 1 and 2 PROJECT NO: 478783

PREPARED BY: _____

Picture Number	Photograph Description/Location	Date	Daily Log Number

PID Calibration Log

Project Name/Number:

Field Personnel:

Make, Model and Serial Number of Unit:

Date:

Time	Gas	Concentration of Gas	Calibration Gas Lot Number	Instrument Reading	Comments	Initial
	Methane					
	Isobutylene					
	Oxygen					
	Hydrogen Sulfide					
	Carbon Monoxide					

Make, Model and Serial Number of Unit:

Date:

Time	Gas	Concentration of Gas	Calibration Gas Lot Number	Instrument Reading	Comments	Initial
	Methane					
	Isobutylene					
	Oxygen					
	Hydrogen Sulfide					
	Carbon Monoxide					

Make, Model and Serial Number of Unit:

Date:

Time	Gas	Concentration of Gas	Calibration Gas Lot Number	Instrument Reading	Comments	Initial
	Methane					
	Isobutylene					
	Oxygen					
	Hydrogen Sulfide					
	Carbon Monoxide					

MW-19 Area Predesign Investigative Derived Waste Inventory Log

Quantity	CH2M HILL Container NUMBERS	Characterization Sample Name	Characterization ID (SAS Number)	Analytes Received	Contents	Empty/Full/Part Full	Area	Location	Project	Condition	Labeling	Accumulation Start Date	90 Day Date	Waste >60 day old	Scheduled for pickup	Container Filled by	Point of Contact	COMMENTS

Orange: Hazardous waste

Red: Pending analysis

Green: Non Hazardous

Pink: EDD Data Received
Blue: Signed Report Received