

Quality Assurance Project Plan (QAPP) for Remedial Investigation Activities

*Sonwil Distribution Center
Buffalo Lakeside Commerce Park Site*

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Prepared For:



SONWIL DISTRIBUTION CENTER
Buffalo, New York

Prepared By:



QUALITY ASSURANCE PROJECT PLAN (QAPP)

Sonwil Distribution Center

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1.0 INTRODUCTION

This Quality Assurance Project Plan, or QAPP, presents the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the proposed scope of work for the investigation described in the Remediation Investigation (RI), Alternatives Analysis Report (AAR), Interim Remedial Measures (IRM) Work Plan to be implemented at the Sonwil Distribution Site located in Buffalo, New York (Figures 1 and 2). A Sampling, Analysis and Monitoring Plan (SAMP) describing specific protocols for sample collection, sample handling and storage, chain-of-custody, and laboratory and field analyses to be performed as part of the RI is provided as Section 4.0 of this QAPP.

1.1 Background

The RI/AAR/IRM Work Plan was prepared to accompany the Brownfield Cleanup Program (BCP) Application for the approximately 45-acre Sonwil Distribution Site. The RI will further assess potential environmental conditions related to historical Site activities.

1.2 QAPP Preparation Guidelines

All QA/QC procedures described herein are structured in accordance with applicable technical standards, and NYSDEC's requirements, regulations, guidance, and technical standards. Specifically, this QAPP has been prepared in accordance with:

- USEPA *Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA QA/R-5) (Ref. 1).
- *Region II CERCLA Quality Assurance Manual*, Revision I, EPA Region II, dated October 1989 (Ref. 2).
- NYSDEC Technical Assistance and Guidance Memorandum (TAGM) 3014 – *Quality Assurance Project Plan*, dated 1991 (Ref. 3).
- NYSDEC *DER-10 Technical Guidance for Site Investigation and Remediation*, dated December 2006 (Ref. 4).

1.3 Scope of the QAPP

This QAPP was prepared to provide quality assurance (QA) guidelines to be implemented during the RI activities. This document may be modified for subsequent phases of investigative work, as necessary. The QAPP provides:

- A means to communicate to the persons executing the various activities exactly what is to be done, by whom, and when.
- A culmination to the planning process that ensures that the program includes provisions for obtaining quality data (e.g., suitable methods of field operations).
- A historical record that documents the investigation in terms of the methods used, calibration standards and frequencies planned, and auditing planned.
- A document that can be used by the Prime Consultant Project Manager and QA Officer to assess if the activities planned are being implemented and their importance for accomplishing the goal of quality data.
- A plan to document and track project data and results.
- Detailed descriptions of the data documentation materials and procedures, project files, and tabular and graphical reports.

The QAPP is primarily concerned with the quality assurance and quality control aspects of the procedures involved in the collection, preservation, packaging, and transportation of samples; field testing; record keeping; data management; chain-of-custody procedures; laboratory analyses; and other necessary matters to assure that the investigation activities, once completed, will yield data whose integrity can be defended.

QA refers to the conduct of all planned and systematic actions necessary to perform satisfactorily all task-specific activities and to provide information and data confidence as a result of such activities. The QA for task-specific activities includes the development of procedures, auditing, monitoring and surveillance of the performance.

QC refers to the activity performed to determine if the work activities conform to the requirements. This includes activities such as inspections of the work activities in the field (e.g., verification that the items and materials installed conform to applicable codes and

design specifications). QA is an overview monitoring of the performance of QC activities through audits rather than first time inspections.

1.4 Project Description

1.4.1 Project Objectives

The RI will incorporate on-site investigation data, as necessary, to better assess anticipated site impacts, thereby allowing assessment of the need for either further study, corrective action or no further action. Objectives to be achieved by the RI are:

- To delineate the presence and extent of on-site impacts.
- To provide the data necessary to evaluate potential remedial measures.
- To determine appropriate subsequent action based on potential risk (i.e., no action, additional remediation).

1.4.2 Project Overview

The RI is being performed to delineate on-site surface and subsurface soil/fill and groundwater impacts at the Site. The scope of work for the RI is presented in the RI/AAR/IRM Work Plan and, in general, includes:

- The collection and analysis of 11 surface and 46 subsurface soil samples from soil borings to evaluate the nature of impacts within five Areas of Assessment (AOAs).
- The installation of a minimum of eight permanent, two-inch diameter groundwater monitoring wells via hollow stem auger with:
 - The collection and analysis of surface soil samples from each of the eight monitoring well locations.
 - The collection and analysis of groundwater samples from each of the eight newly installed monitoring wells via low-flow (minimal drawdown) techniques.
- The measurement of groundwater elevations within all monitoring wells (new and existing) before implementing sampling activities.

Field team personnel will collect environmental samples in accordance with the rationale and protocols described in Section 4.0 and Appendix A – Field Operating Procedures (FOPs). NYSDEC-approved sample collection and handling techniques will be used. Samples for chemical analysis will be analyzed in accordance with methods specified in the most recent version of USEPA SW-846 to meet the definitive-level data requirements. Laboratory-analyzed water quality parameters will be performed by a laboratory using USEPA-approved standard methods as identified in USEPA Methods for Chemical Analysis of Water and Wastes (Ref. 5). Analytical results will be evaluated by a qualified third-party data validator. All proposed sample locations are presented on Figure 2.

1.5 Project Schedule

The anticipated project schedule is provided in Section 7.4 of the RI/AAR/IRM Work Plan.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The principal organizations involved in verifying achievement of data collection goals for the Sonwil Distribution Site include: the New York State Department of Environmental Conservation (NYSDEC), Sonwil Distribution (Volunteer), TurnKey Environmental Restoration, LLC (Volunteer's Consultant), the drilling/test pit subcontractor(s), the independent environmental laboratory, and the independent third party data validator. Roles, responsibilities and required qualifications of these organizations are discussed in the following subsections. Resumes for key management and QA personnel are included in Appendix C.

2.1 Management Responsibilities

2.1.1 *NYSDEC and NYSDOH*

It is the responsibility of the New York State Department of Environmental Conservation (NYSDEC), in conjunction with the New York State Department of Health, to review the RI Work Plan and supporting documents, including this QAPP, for completeness and conformance with the site-specific cleanup objectives and to make a decision to accept or reject these documents based on this review. The NYSDEC also has the responsibility and authority to review and approve all QA documentation collected during brownfield cleanup construction and to confirm that the QA Plan was followed.

- NYSDEC Representative: *Martin Doster, Project Manager*
- NYSDOH Representative: *Cameron O'Connor, Project Manager*

2.1.2 *Sonwil Distribution Center*

Sonwil Distribution Center ("Volunteer") will be responsible for complying with the QA requirements as specified herein and for monitoring and controlling the quality of the brownfield cleanup construction either directly or through their designated environmental consultant and/or legal counsel. The Volunteer will also have the authority to select Remedial Action Contractor(s) to assist them in fulfilling these responsibilities. The designated Project Coordinator is responsible for implementing the project, and has the

authority to commit the resources necessary to meet project objectives and requirements. The Project Coordinator will provide the major point of contact and control for all matters concerning the project.

- Sonwil Project Coordinator: *Randy Anderson, Construction Manager*

2.1.3 TurnKey Environmental Restoration, LLC

TurnKey Environmental Restoration, LLC (TurnKey) is the prime consultant on this project and is responsible for the performance of all services required to implement each phase of the RI Work Plan (hereafter referred to as the Work Plan), including, but not limited to, field operations, laboratory testing, data management, data analysis and reporting. Any one member of TurnKey's staff may fill more than one of the identified project positions (e.g., field team leader and site safety and health officer). The various quality assurance, field, laboratory and management responsibilities of key project personnel are defined below.

- TurnKey Project Manager (PM): *Michael Lesakowski*

The TurnKey PM has the responsibility for ensuring that the project meets the Work Plan objectives. The PM will report directly to the Sonwil Project Coordinator and the NYSDEC/NYSDOH Project Coordinators and is responsible for technical and project oversight. The PM will:

- o Define project objectives and develop a detailed work plan schedule.
- o Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task.
- o Acquire and apply technical and corporate resources as needed to assure performance within budget and schedule constraints.
- o Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.
- o Review the work performed on each task to assure its quality, responsiveness, and timeliness.
- o Review and analyze overall task performance with respect to planned requirements and authorizations.

- o Review and approve all deliverables before their submission to NYSDEC.
- o Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.
- o Ultimately be responsible for the preparation and quality of interim and final reports.
- o Represent the project team at meetings.

- TurnKey FTL/SSHO:

Bryan C. Hamm

The Field Team Leader (FTL) has the responsibility for implementation of specific project tasks identified at the Site, and is responsible for the supervision of project field personnel, subconsultants, and subcontractors. The FTL reports directly to the Project Manager. The FTL will:

- o Define daily develop work activities.
- o Orient field staff concerning the project's special considerations.
- o Monitor and direct subcontractor personnel.
- o Review the work performed on each task to ensure its quality, responsiveness, and timeliness.
- o Assure that field activities, including sample collection and handling, are carried out in accordance with this QAPP.

For this project the FTL will also serve as the Site Safety and Health Officer (SSHO). As such, he is responsible for implementing the procedures and required components of the Site Health and Safety Plan (HASP), determining levels of protection needed during field tasks, controlling site entry/exit, briefing the field team and subcontractors on site-specific health and safety issues, and all other responsibilities as identified in the HASP (see Attachment 2 of the Work Plan).

2.2 Quality Assurance (QA) Responsibilities

The QA Officer will have direct access to corporate executive staff as necessary, to resolve any QA dispute. He/she is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations and TurnKey policies, and NYSDEC requirements. The QA Officer has sufficient authority to stop work on the investigation as deemed necessary in the event of serious QA issues.

- Project QA Officer:

Lori E. Riker

Specific function and duties include:

- o Performing QA audits on various phases of the field operations (see Section 10).
- o Reviewing and approving QA plans and procedures.
- o Providing QA technical assistance to project staff.
- o Reporting on the adequacy, status, and effectiveness of the QA program on a regular basis to the Project Manager for technical operations.
- o Responsible for assuring third party data review of all sample results from the analytical laboratory.

2.3 Field Responsibilities

TurnKey field staff for this project is drawn from a pool of qualified resources. The Project Manager will utilize the staff to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

2.4 Laboratory Responsibilities

TestAmerica Analytical Testing Corporation (TestAmerica, formerly Severn Trent Laboratories, Inc. of Buffalo), the environmental laboratory retained by Benchmark, is located at 10 Hazelwood Drive, Amherst, New York 14228, and is an independent, NY State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified facility approved to perform the analyses prescribed herein. TestAmerica also has NYSDOH Contract Laboratory Program (CLP) certification while maintaining ASP accreditation. Results of recent CLP proficiency test data are provided in Appendix B. TestAmerica will report directly to the QA Officer, and will be responsible for immediately notifying the QA Officer of any problems with sample receipt, analysis or quality control.

- TestAmerica Client Services Manager: *C. James Stellrecht*

The client services manager is responsible for the Client Services Department and will report directly to the Project Manager. The client services manager provides a complete interface with clients from initial project specification to final deliverables.

- TestAmerica Laboratory Director: *Chris Spencer*

The Laboratory Director is a technical advisor and is responsible for summarizing and reporting overall unit performance. Responsibilities of the Laboratory Director include:

- o Provide technical, operational, and administrative leadership.
- o Allocation and management of personnel and equipment resources.
- o Quality performance of the facility.
- o Certification and accreditation activities.
- o Blind and reference sample analysis.

- TestAmerica Quality Assurance Manager (QA Manager): *Verl Preston*

The QA Director has the overall responsibility for data after it leaves the laboratory. The QA Director will be independent of the laboratory but will communicate data issues through the Laboratory Director. In addition, the QA Director will:

- o Oversee laboratory QA.
- o Oversee QA/QC documentation.
- o Conduct detailed data review.
- o Determine whether to implement laboratory corrective actions, if required.
- o Define appropriate laboratory QA procedures.
- o Prepare laboratory SOPs.

Independent QA review will be provided by the TestAmerica Laboratory Director and QA Director prior to release of all data to TurnKey.

- TestAmerica Sample Management Office *Ken Kinecki*

The Sample Management Office will report to the Laboratory Director. Responsibilities of the Sample Management Office will include:

- o Receiving and inspecting the incoming sample containers.
- o Recording the condition of the incoming sample containers.
- o Signing appropriate documents.
- o Verifying chain-of-custody.
- o Notifying laboratory manager and laboratory supervisor of sample receipt and inspection.
- o Assigning a unique identification number and customer number, and entering each into the sample-receiving log.
- o With the help of the laboratory manager, initiating transfer of the samples to appropriate lab sections.
- o Controlling and monitoring access/storage of samples and extracts.

- TestAmerica Technical Staff (TS):

The TS will be responsible for sample analyses and identification of corrective actions. The staff will report directly to the Laboratory Director.

2.5 Other Subcontractor Personnel

2.5.1 Independent Third Party Data Validator

Data Validation Services, Inc., the third party data validator retained by TurnKey, will perform an independent data usability evaluation as recommended under NYSDEC Division of Environmental Remediation's Draft DER-10 Technical Guidance for Site Investigation and Remediation for Quality Assurance Plans at Brownfield Cleanup Sites (Ref. 4). The data usability evaluation will involve review of pertinent internal and external QC data as reported by the laboratory. QC parameters that will be evaluated in reference to compliance with the analytical methods, protocols and deliverables requirements will include those items necessary to satisfy NYSDEC's requirements for preparation of a Data Usability

Summary Report (DUSR). The specific data usability evaluation performed by the following key project personnel is defined below:

- Data Usability *Judy Harry*

The data validator has the responsibility for evaluating the data usability by examining the following:

- o Completeness of the data package as defined under the requirements of with Equivalent Category B deliverables.
- o Compliance with required holding times.
- o Sample chain-of-custody forms
- o QC analysis data, including blanks, instrument tunings, calibrations, spikes, surrogate recoveries, duplicates, laboratory controls and sample data.
- o Agreement between laboratory raw data and data summary sheets, with verification that correct data qualifiers were used where appropriate.

The DUSR will present the review findings with a discussion of any data deficiencies, analytical protocol deviations, and quality control problems encountered. Data deficiencies, analytical method protocol deviations and quality control problems will be described and their effect on the data presented. Recommendations for resampling/reanalysis will be made where deemed necessary. Data qualifications will be documented for each parameter following the USEPA SW-846 Methodology.

2.5.2 Drilling Subcontractor

TREC Environmental, Inc., retained by TurnKey, will be responsible for assisting in performing investigation activities as directed by TurnKey.

- Drilling Project Coordinator: *Keith Hambley, Owner*
- Drilling Project Manager: *Keith Hambley, Project Manager*

2.6 Special Training Requirements and Certifications

The purpose of this section is to address any specialized or non-routine training requirements necessary for completion of the subject investigation. Sufficient information shall be provided to ensure that special training skills can be verified, documented and updated as necessary.

2.6.1 Training

Requirements for specialized training for non-routine field sampling techniques, field analyses, laboratory analyses, and data validation are specified below.

Non-routine field sampling techniques: Currently there are no non-routine field sampling techniques that require specialized training.

Non-routine field analyses: Currently there are no non-routine field analysis that require specialized training.

Non-routine laboratory analyses: Currently there are no non-routine laboratory analyses techniques that require specialized training.

Data validation: Selected analyses to be validated for all matrices sampled will be validated by Ms. Judy Harry of Data Validation Services. Data validation will be performed using the most current methods and quality control criteria from SW-846 and the USEPA's Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review. The CLP Data review guidance will be used only to the extent that it is applicable to the SW-846 methods; SW-846 methodologies will be followed primarily and given preference over CLP when differences occur.

2.6.2 Certification

Ms. Harry has already attained certifications required for implementing this plan for Data Validation Services.

2.7 Contacts

The names, addresses, and telephone numbers of key project personnel are as follows:

Randy Anderson:
Tecumseh Project Coordinator

Sonwil Distribution
100 Sonwil Drive
Buffalo, NY 14225
(716) 684-0555

Michael Lesakowski:
Project Manager

TurnKey Environmental Restoration, LLC
726 Exchange Street
Buffalo, New York 14210
Office: (716) 856-0635
Mobile: (716) 818-3954

Bryan C. Hann:
*Field Team Leader/
Site Health and Safety Officer*

TurnKey Environmental Restoration, LLC
726 Exchange Street
Buffalo, New York 14210
Office: (716) 856-0635
Mobile: (716) 870-1165

Jim Stellrecht:
Laboratory Client Services Manager

TestAmerica Analytical Testing Services
10 Hazelwood Drive, Suite 106
Amherst, New York 14228
(716) 691-2600

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall objectives and criteria for assuring quality for this effort are discussed below. This QAPP addresses how the acquisition and handling of samples and the review and reporting of data will be documented. The objectives of this QAPP are to address the following:

- The procedures to be used to collect, preserve, package, and transport groundwater samples.
- Field data collection.
- Record keeping.
- Data management.
- Chain-of-custody procedures.
- Precision, accuracy, completeness, representativeness, decision rules, comparability and level of quality control effort conformance for sample analysis and data management by TestAmerica under EPA analytical methods.

Analytical methods and detection/reporting limits for chemical parameters to be analyzed during the RI are listed in Tables 1 and 2. In addition, water levels and select water quality parameters (i.e., pH, turbidity, specific conductance, and temperature) will be measured in the field as described in the FOPs located in Appendix A.

The goals for precision, accuracy, and completeness intended for use on this project are discussed in Sections 3.1 through 3.3 of this QAPP. Laboratory quality assurance objectives are presented in the analytical laboratory's QA/QC Plan, which is located in Appendix B. Severn Trent Laboratories, Inc. (TestAmerica) is the analytical laboratory selected to analyze environmental samples for this RI.

All data will be reported completely. No data will be omitted unless an error occurred in the analyses or the run was invalidated because of QC sample recovery or poor precision.

3.1 Precision

Precision is a measurement of the degree to which two or more measurements are in agreement, which is quantitatively assessed based on the standard deviation. Precision in the laboratory is assessed through the calculation of relative percent difference (RPD) and relative calculation of relative standard deviations (RSD) for three or more replicate samples. The equations to be used to verify precision for this investigation are found in Section 12.1 of this QAPP. General precision goals are provided in Table 3.

Laboratory precision will be assessed through the analysis of matrix spike/matrix spike duplicate (MS/MSD) and field duplicate samples for organic parameters. For inorganic parameters, precision will be assessed through the analysis of matrix spike/duplicates field duplicate pairs. Precision for field parameters, including pH, turbidity, specific conductance, and temperature will be determined through duplicate analysis of 1 in every 20 samples. Precision control limits for field-measured parameters are provided in Table 4.

3.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference of true value. Accuracy in the field is assessed through the use of field blanks and trip blanks and through the adherence to all sample handling, preservation and holding times. One trip blank will accompany each batch of water matrix sample containers shipped to the laboratory for volatile organic chemical analysis. Laboratory accuracy is assessed through the analysis of a matrix spike/matrix spike duplicate (MS/MSD) (1 per 20 samples), standard reference materials (SRM), laboratory control samples (LCS), and surrogate compounds, and the determination of percent recoveries. The equation to be used for accuracy for this investigation is found in Section 12.1 of this QAPP. Accuracy control limits for the laboratory are given in Table 3.

Accuracy for field measured parameters including pH, turbidity, specific conductance, and temperature will be assessed through instrument calibration standards discussed in instrument calibration and maintenance FOPs (see Section 4.0). Accuracy control limits are provided in Table 4.

3.3 Completeness

Data completeness is a measure of the amount of valid data obtained from a prescribed measurement system as compared with that expected and required to meet the project goals. Laboratory and field completeness will be addressed by applying data quality checks and assessments described in Section 3.1 and 3.2 and Section 9.0 to ensure that the data collected are valid and significant.

As shown on Table 3, the laboratory completeness objectives for the RI will be 90 percent or greater. A third party data validator will follow procedures described in Section 9.2 to assess the completeness and validity of laboratory data deliverables. For this investigation, 100 percent of all laboratory analytical results will undergo third party data review. The completeness of an analysis will be documented by including in the report sufficient information to allow the data validator to assess the quality of the results.

Raw data such as chromatograms, spectra, calibration data, laboratory worksheets and notes, etc will not be produced with the analytical data reporting package but will be stored with the sample results in the laboratory and made available upon request, if necessary, to substantiate analytical results. The raw data will be archived for at least two years by the laboratory. The laboratory will retain all analytical information; regardless of whether TurnKey requests the substantiation of results.

3.4 Data Representativeness

Data representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary. All proposed field-testing and measurement procedures were selected to maximize the degree to which the field data will represent the conditions at the Site, and the matrix being sampled or analyzed.

As described in Section 10.0, Performance System Audits and the proper execution of field activities are the main mechanism for ensuring data representativeness. Representativeness in the laboratory is ensured through the use of the proper analytical procedures, appropriate methods, meeting sample holding times, and analyzing and assessing field duplicate samples.

3.5 Comparability

Data comparability expresses the confidence with which one data set can be compared to another data set. Procedures for field measurements, contained in Appendix A, will assure that tests performed at various locations across the Site are conducted using accepted procedures, in a consistent manner between locations and over time, and including appropriate QA/QC procedures to ensure the validity of the data. Sampling procedures for environmental matrices are provided in Section 4.0 to ensure that samples are collected using accepted field techniques.

Environmental samples will be analyzed by TestAmerica using consistent protocols for sample preservation, holding times, sample preparation, analytical methodology, and QC as described in USEPA SW-846.

Analytical data will be comparable when similar sampling and analytical methods are used as documented in the QAPP. Comparability is also dependent on similar QA objectives. The parameter units to be used for this investigation are listed in Table 5.

3.6 Level of QC Effort for Sample Parameters

Field blank, method blank, trip blank, field duplicate, laboratory duplicate, laboratory control, standard reference materials (SRM) and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. QC samples are discussed below and summarized in Table 6.

- Field and trip blanks consisting of distilled water will be submitted to the analytical laboratories to provide the means to assess the quality of the data resulting from the field-sampling program. Field (equipment) blank samples are analyzed to check for procedural chemical constituents at the facility that may cause sample contamination. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage.
- Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures.
- Duplicate samples are analyzed to check for sampling and analytical reproducibility.

- MS/MSD and MS/Duplicate samples provide information about the effect of the sample matrix on the digestion and measurement methodology. Depending on site-specific circumstances, one MS/MSD or MS/Duplicate should be collected for every 20 or fewer investigative samples to be analyzed for organic and inorganic chemicals of a given matrix.

The general level of QC effort will be one field (blind) duplicate and one field blank (when non-dedicated equipment is used) for every 20 or fewer investigative samples of a given matrix. Additional sample volume will also be provided to the laboratory to allow one site-specific MS/MSD or MS/Duplicate for every 20 or fewer investigative samples of a given matrix. One trip blank consisting of distilled, deionized water will be included along with each sample delivery group of aqueous VOC samples.

4.0 SAMPLING AND ANALYSIS PLAN

The selection and rationale for the RI sampling program is discussed in the RI/AAR/IRM Work Plan. Methods and protocol to be used to collect environmental samples (i.e., soil and groundwater) for this investigation are described in the TurnKey Field Operating Procedures (FOPs) presented in Appendix A of this QAPP. A summary of the FOPs to be used during this investigation is presented in Table 7.

The number and types of environmental samples to be collected, parameter lists, required detection limits, and sample container requirements for each matrix are summarized in Tables 1, 2, and 8. The sampling program and related site activities are discussed below. To the extent allowed by existing physical conditions at the facility, sample collection efforts will adhere to the specific methods presented herein. If alternative sampling locations or procedures are implemented in response to facility specific constraints, each will be selected on the basis of meeting data objectives. Such alternatives will be approved by NYSDEC before implementation and subsequently documented for inclusion in the project file.

4.1 Soil/Fill Investigation

4.1.1 Underground Utility Clearance

Prior to any intrusive activity (e.g., Geoprobe®, drill rig), TurnKey will request a utility clearance from the Underground Facilities Protective Organization (or approved other), and underground utilities will be identified and clearly marked. TurnKey will also review historic plant engineering drawings (if available) for on-site utility locations prior to initiating fieldwork.

4.1.2 Boring Advancement

Forty-six soil borings are planned at the Site. Approximately 19 borings will be advanced across the Site to allow for visual/olfactory/PID assessment of subsurface (AOC 1) and surface (AOC 2) conditions. A total of 15 soil borings will be advanced within the former PCB area (AOC 4) and an additional 12 soil borings will be advanced within the former groundwater infiltration area (AOC 5). Both AOC 4 and AOC 5 are located within the former Shenango Mold site. Eight groundwater monitoring wells will be completed from soil borings, as described in Section 4.2.1.

In general, borings will be advanced using direct-push technology via a Geoprobe® drill rig to a depth of approximately 8 to 12 feet below ground surface (fbgs). Borehole depths may vary depending on the vertical and horizontal extents of the soil/fill horizon, depth to groundwater, or encountered impacts (i.e., free-product, elevated PID readings etc.). Each boring will be advanced using a 1.5-inch diameter, 4-foot core sampler with dedicated PVC sleeve. Recovered samples will be described in the field by qualified TurnKey personnel in accordance with ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)," scanned for total volatile organic vapors with a calibrated MiniRae 2000 PID equipped with a 10.6 eV lamp (or equivalent), and characterized for impacts via visual and/or olfactory observations. Excavated soil/fill and the breathing zone atmosphere will be field screened for the presence of VOCs using the field PID as a procedure for ensuring the health and safety of personnel at the Site and to identify potentially impacted soil/fill samples for laboratory analysis of VOCs.

4.1.3 Surface Soil/Fill Sampling

As summarized on Table 6, a minimum of 11 surface (0.0 to 0.5 fbgs) soil/fill samples will be collected from the location of the soil borings for analysis of TCL SVOCs and TAL metals. At two soil boring locations, the surface soil/fill sample will also be analyzed for TCL PCBs and pesticides/herbicides for chemical characterization. The samples will be collected using a dedicated stainless steel hand trowel or stainless steel spoon, and transferred to laboratory supplied, precleaned sample containers.

4.1.4 Subsurface Soil/Fill Sampling

Nineteen Representative subsurface soil/fill samples from each boring location will be collected using dedicated sampling equipment. Samples will be transferred to laboratory supplied, precleaned sample containers for analysis of the parameters listed in Table 6 using USEPA SW-846 methodology.

Within AOC 1 and AOC 5, a second representative aliquot from each subsurface soil/fill location will be transferred to a sealable plastic bag for discrete headspace determination. In general, representative subsurface soil/fill samples will be collected, placed in a sealable plastic bag, and kept at or near room temperature (approximately 65-70°F) for a minimum of 15 minutes prior to PID measurement. Headspace determinations will be recorded on the appropriate field forms and Project Field Book. PID scan and/or

headspace determination values greater than 20 parts per million (ppm) will require the collection of an additional sample for TCL VOCs + STARS analysis via USEPA SW-846 methodology. The chosen soil/fill samples will be transferred directly into a laboratory supplied, precleaned sample container for analysis of TCL VOCs.

Following sample collection, the Geoprobe boreholes will be backfilled with the remaining soil cuttings and supplemented, as necessary, with bentonite powder. Decontamination of non-disposable and non-dedicated sampling equipment as well as handling of investigative-derived waste (IDW) is discussed in Section 4.3.

4.2 Groundwater Investigation

Groundwater elevation maps completed during previous investigations indicate that groundwater flows west and south toward the Union Ship Canal. Groundwater gauging also indicates that the wetland areas on the former Darling site influence groundwater flow toward the northwest.

Historical groundwater elevation measurements taken from monitoring wells on the Site indicate that the first water bearing zone (i.e., water table) ranges from approximately 1.0 to 4.0 fbg within the soil/fill unit. In order to supplement existing historic groundwater quality data, groundwater at the BCP Site will be sampled. No permanent monitoring wells currently exist on the Sonwil Site; however, if temporary useable wells are discovered during the RI, groundwater elevations will be measured during the sampling program. Monitoring wells located outside the BCP Site will only be incorporated as necessary to provide sufficient groundwater elevation information at the Site.

4.2.1 *Monitoring Well Installation*

Eight new monitoring wells, identified as MW-1 through MW-8, will be installed to further assess groundwater quality at the Site. The location of the new wells will be based on field observations recorded during the soil/fill investigation, but will be generally located as shown on Figure 5 of the RI/AAR/IRM Work Plan. It is anticipated that seven wells will be installed along the upgradient and downgradient perimeter of the Site, while one well will be installed at the approximate center of the Site.

Each boring location will be advanced into the unconsolidated overburden soil/fill to a depth of approximately 8 to 12 fbg. Shallow overburden well borings will be advanced using a Geoprobe 6620DT drill rig equipped with 4.25-inch I.D. hollow stem augers (HSA)

(or approved other). A 1.5-inch diameter, 4-foot core sampler with dedicated PVC sleeve will be advanced ahead of the auger string. Recovered samples will be described in the field by qualified TurnKey personnel in accordance with ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)," scanned for total volatile organic vapors with a calibrated MiniRae 2000 PID equipped with a 10.6 eV lamp (or equivalent), and characterized for impacts via visual and/or olfactory observations. In addition, PID scans will be supplemented with headspace determinations as previously described. All non-dedicated drilling tools and equipment will be decontaminated between boring locations using potable tap water and a phosphate-free detergent (i.e., Alconox).

Subsequent to boring completion, each monitoring well will be constructed of 2-inch I.D. flush-joint Schedule 40 PVC solid riser and machine slotted screen (0.010-inch slot size). The monitoring well screen will be approximately 5 feet in length. The well screen and attached riser will be placed within the borehole and the remainder of the sand pack will be installed within the borehole annulus to approximately 0.5 feet above the top of the well screen. A bentonite seal, approximately 2.0 feet thick, will be installed immediately above the filter sand layer. The bentonite seal will be constructed with 3/8-inch bentonite pellets or medium bentonite chips and allowed to hydrate sufficiently.

The top of the well riser pipe will extend approximately 3 feet above grade and will be fitted with a lockable J-plug and protected by a vented, 4-inch diameter protective steel casing. While taking care to not breach the bentonite chip seal, the steel casing will be installed to a depth of approximately 2 fbs and anchored in a 2-foot by 2-foot concrete surface pad. Each steel protective casing will be fitted with a locking cap, keyed alike lock, and labeled with permanent markings for identification. The concrete surface pad will be placed around the protective steel casing to allow surface water to drain away from the well. Installation procedures, including field forms for monitoring well installation and drill rig decontamination requirements, are presented in Appendix A.

4.2.2 Well Development

Upon installation, but not within 24 hours, the newly installed monitoring wells will be developed in accordance with NYSDEC and TurnKey protocols. Prior to development, the static water level and well depth will be measured and recorded. Development will be accomplished using a bottom-discharging bailer (either polyethylene or PVC) via purge and surge methodologies. Development will be recorded on field forms and considered

completed when the pH, specific conductivity and temperature have stabilized; and when the turbidity is below 50 Nephelometric Turbidity Units (NTU), or has stabilized above 50 NTU and a minimum of 3 well volumes have been removed. Stability is defined as variation between measurements of 10 percent or less and no overall upward or downward trend in the measurements. A minimum of three well volumes will be evacuated from each monitoring well. Development water will be passed through a mobile granular-carbon treatment vessel, and discharged to ground no closer than 50 feet in any radial direction from the monitoring well.

All data collected during well development will be recorded on TurnKey's Groundwater Well Development and Purge Logs. Well development procedures, including the field forms, and calibration and maintenance of field instruments used to measure stability parameters will be performed and/or completed in accordance with TurnKey's Field Operating Procedures (FOPs) included in Appendix A.

4.2.3 Groundwater Elevation Measurements

Following installation, the locations and elevations of the newly installed monitoring wells will be surveyed against a fixed benchmark and located on the site plan. The top of the PVC casings will be referenced to existing site vertical datum to provide a reference point for groundwater elevation measurements. Approximately 72 hours or more following completion of Site well development activities, depth to groundwater will be measured in all newly installed monitoring wells from the top of each riser using an electric water level indicator to the nearest 0.01 feet. Depth to water measurements will be used to calculate the groundwater elevations for each location. Groundwater elevations will be used to prepare an isopotential map of the Site. This site-specific isopotential map will be used to determine the groundwater flow direction and hydraulic gradient at the Site.

4.2.4 Groundwater Sample Collection and Analysis

Prior to sampling the monitoring wells, static water levels will be measured and recorded as described in Section 4.2.3. Following water level measurement, TurnKey personnel will purge and sample each monitoring well in accordance with low-flow/minimal drawdown purge and sample collection procedures. Prior to sample collection, groundwater will be evacuated from each well at a low-flow rate (typically less than 0.1 L/min). Field measurements for pH, specific conductance, temperature, turbidity, and water level as well as

visual and olfactory field observations will be periodically recorded and monitored for stabilization. Purging will be considered complete when pH, specific conductivity and temperature stabilize and when turbidity measurements fall below 50 NTU, or become stable above 50 NTU. Stability is defined as variation between field measurements of 10 percent or less and no overall upward or downward trend in the measurements. Once the field parameters have stabilized, groundwater samples will be collected and analyzed for the parameters presented in Table 6. In the event that low-flow purging and sampling techniques cannot be accomplished, standard purging and sampling techniques will be implemented via a dedicated polyethylene disposable bailer.

Groundwater samples collected for VOC analysis will not be sampled directly through the peristaltic pump due to potential degassing (i.e., loss of VOCs) of the groundwater sample. Instead, upon collection of VOC samples, the pump will be turned off and the pressure on the flexible walled tubing within the pump head will be maintained in order to prevent water within the tubing from escaping. The tubing will be removed from the well and coiled as to prevent any contact with the ground surface. Upon removal of the tubing and prior to re-activating the pump, the pump flow direction will be reversed. Upon pump re-activation, the pumping rate will be slowly increased; positively displacing groundwater within the tubing allowing it to flow, without disturbance and degassing, into the appropriate VOC sample jars.

All collected groundwater samples will be placed in pre-cleaned, pre-preserved laboratory provided sample bottles, cooled to 4°C in the field, and transported under chain-of-custody command to TestAmerica for analysis.

4.3 Decontamination & Investigation-Derived Waste (IDW)

Every attempt will be made to use dedicated sampling equipment; however, if non-dedicated equipment is required, the equipment will be decontaminated, at a minimum, with a non-phosphate detergent (i.e., Alconox®) and potable water mixture, rinsed with distilled water, and air-dried before each use in accordance with TurnKey's field operating procedures (included as an appendix to the QAPP). All decontaminated sampling equipment will be kept in a clean environment prior to sample collection. Heavy equipment, such as an excavator and drilling tools, will be decontaminated via high-pressure steam cleaning on a

temporary decontamination pad between grab sample locations and composite groups (i.e., borings, monitoring wells, etc.), as necessary.

During installation of the monitoring wells, excess soil cuttings will be stockpiled on-Site and covered with plastic, or containerized in 55-gallon drums and sampled to determine if they can be used on-site or require treatment or off-site disposal. Drums, if used, will be labeled with regard to contents, origin, and date of generation using a paint stick marker on two sides and the top of each drum. The drums will be staged on-site pending soil analyses and remedial measures assessment. Groundwater from well development and purging will be stored in drums or a portable tank.

Discarded personal protective equipment (PPE) (i.e., latex gloves, Tyvek, paper towels, etc.) and disposable sampling equipment (i.e., stainless steel spoons) will be placed in sealed plastic garbage bags and disposed of as municipal solid waste. If necessary, TurnKey field personnel will coordinate the on-site handling and temporary storage of IDW, including transportation and off-site disposal. The FOP for management of IDW is included in Appendix A.

4.4 Site Mapping & Survey

A Site map will be developed during the field investigation. All sample points and relevant Site features will be located on the map. TurnKey will employ a Trimble GeoXT handheld GPS unit to identify the locations of all soil borings and newly installed monitoring wells relative to State planar grid coordinates. Monitoring well elevations will be measured by TurnKey's surveyor. An isopotential map showing the general direction of groundwater flow will be prepared based on water level measurements relative to USGS vertical datum. Maps will be provided with the RI report.

4.5 Documentation

All investigation field activities will be documented in the Project Field Book. This logbook will provide a record of activities conducted at the Site. All entries will be signed and dated at the end of each day of fieldwork by the Field Team Leader. The field logbook will include, at a minimum, the following: date and time of all entries, names of all personnel on site, weather conditions (temperature, precipitation, etc.), location of activity, and description of activity. All test pits will be logged and photographed to indicate the

stratigraphic profile of each hole. TurnKey personnel will complete the following standard field forms:

- Chain of Custody Form
- Daily Drilling Report
- Drilling Safety Checklist
- Equipment Calibration Log
- Field Activity Daily Log (FADLs)
- Field Borehole/Monitoring Well Installation Log
- Field Geoprobe Borehole Log (as necessary)
- Groundwater Well Development Log
- Groundwater Well Inspection Form
- Groundwater Purge & Sample Collection Log – Low Flow
- Investigative-Derived Waste Container Log
- Photographic Log
- Real-Time Air Monitoring Log
- Sample Summary Collection Logs (groundwater and soil/fill)
- Tailgate Safety Meeting Form
- Underground/Overhead Utility Checklist for Sampling
- Variance Log (as necessary)
- Water Level Monitoring Record
- Well Completion Detail: Stick-up (Monitoring Well/Piezometer)

Examples of the field forms are provided in the appropriate FOPs presented in Appendix A.

5.0 CUSTODY PROCEDURES

Sample custody is controlled and maintained through the chain-of-custody procedures. Chain of custody is the means by which the possession and handling of samples will be tracked from the source (field) to their final disposition, the laboratory. A sample is considered to be in a person's custody if it is in the person's possession or it is in the person's view after being in his or her possession or it was in that person's possession and that person has locked it in a vehicle or room. Sample containers will be cleaned and preserved at the laboratory before shipment to the Site. The following section and FOPs for Sampling, Labeling, Storage, and Shipment, located in Appendix A, describe procedures for maintaining sample custody from the time samples are collected to the time they are received by the analytical laboratory. TestAmerica's laboratory chain-of-custody procedures are discussed in the TestAmerica Quality Assurance Manual located in Appendix B.

5.1 Field Custody Procedures

Field logbooks and appropriate field forms will provide the means of recording data collection activities performed during the investigation. As such, entries will be described in as much detail as possible so that persons going to the facility could reconstruct a particular situation without reliance on memory. Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in the document control center at TurnKey's main office located at 726 Exchange Street, Buffalo, New York, when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- Person to whom the logbook is assigned.
- Logbook number.
- Project name.
- Project start date.
- End date

Entries into the logbook or appropriate field form (see Section 4.6) will contain a variety of information. At the beginning of each logbook entry, the date, start time, weather, names of all sampling team members present, level of personal protection equipment being used, and the signature of the person making the entry will be entered. The names of visitors to the Site, field sampling or investigation team personnel and the purpose of their

visit will also be recorded in the field logbook. Measurements made and samples collected will be recorded in the logbook and appropriate field form. All entries will be made in permanent ink, signed, and dated and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark that is signed and dated by the sampler. Whenever a sample location is surveyed, which includes compass and distance measurements or, latitude and longitude information (e.g., obtained by using a global positioning system) the location information shall be recorded. In the event that photographs are taken to document field activities, the number and brief description of the photographs taken will also be recorded. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in Section 4.0 of this QAPP. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume and number of containers. Sample identification numbers will be assigned prior to sample collection. Field duplicate samples, which will receive a separate sample identification number, will be noted under sample description.

The sample packaging and shipment procedures summarized below will ensure that the samples will arrive at the laboratory with the chain-of-custody intact. The protocol for specific sample numbering and other sample designations are included in an FOP provided in Appendix A of this QAPP. Examples of field custody documents and instructions for completion are also presented in Appendix A of this QAPP.

- The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. Field procedures have been designed such that as few people as possible will handle the samples.
- All bottles will be identified by the use of sample tags with sample numbers, sampling locations, date/time of collection, and type of analysis. The sample numbering system is presented in the FOP.
- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample label because the ballpoint pen would not function in freezing weather.

- Samples will be accompanied by a properly completed chain-of-custody form (see FOP in Appendix A). The sample numbers and locations will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

Samples will be properly packaged and cooled to 4°C for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be locked and secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the front right and back left of the cooler and covered with clear plastic tape after being signed by the field team leader. The cooler will be strapped shut with strapping tape in at least two locations.

5.2 Laboratory Custody Procedures

Laboratory custody procedures for sample receiving and log-in; sample storage and numbering; tracking during sample preparation and analysis; and storage of data are described in Appendix B, the Laboratory QA Manual.

5.2.1 *Sample Receipt*

A sample custodian is responsible for receiving samples, completing chain-of-custody records, determining and documenting the condition of samples received through the Cooler Receipt and Preservation Form (CRPF, see laboratory QA Manual, Appendix B), logging samples into the LIMS system based upon the order of log-in, and storing samples in appropriate limited-access storage areas. Chain-of-custody documentation is also maintained for the transfer of samples between TestAmerica, and for shipment of samples to subcontracted laboratories.

Upon sample receipt, an inventory of shipment contents is compared with the chain-of-custody record, and any discrepancies, including broken containers, inappropriate container materials or preservatives, headspace in volatile organic samples, and incorrect or

unclear sample identification, are documented and communicated to the appropriate project manager.

Each sample is given a unique laboratory code and an analytical request form is generated. The analytical request contains pertinent information for each sample, including:

- Client name
- Project number
- Task number
- Purchase order number
- Air bill number
- Chain-of-custody number
- Number of samples
- Sample descriptions
- Sample matrix type
- Date and time of sampling
- Analysis due dates
- Date and time of receipt by lab
- Client sample identification
- Any comments regarding special instructions or discrepancies

5.2.2 Sample Storage

Samples are stored in secure limited-access areas. Walk-in coolers or refrigerators are maintained at 4°C, \pm 2°C, or as required by the applicable regulatory program. The temperatures of all refrigerated storage areas are monitored and recorded a minimum of once per day. Deviations of temperature from the applicable range require corrective action, including moving samples to another storage location if necessary.

5.2.3 Sample Custody

Sample custody is defined by this document as when any of the following occur:

- It is in someone's actual possession.
- It is in someone's view after being in his or her physical possession.
- It was in someone's possession and then locked, sealed, or secured in a manner that prevents unsuspected tampering.

- It is placed in a designated and secured area.

Samples are removed from storage areas by the sample custodian or analysts and transported to secure laboratory areas for analysis. Access to the laboratory and sample storage areas is restricted to laboratory personnel and escorted visitors only; all areas of the laboratory are therefore considered secure. If required by the applicable regulatory program, internal chain-of-custody is documented in a log by the person moving the samples between laboratory and storage areas.

Laboratory documentation used to establish COC and sample identification may include the following:

- Field COC forms or other paperwork that arrives with the sample.
- The laboratory COC.
- Sample labels or tags are attached to each sample container.
- Sample custody seals.
- Sample preparation logs (i.e., extraction and digestion information) recorded in hardbound laboratory books that are filled out in legible handwriting, and signed and dated by the chemist.
- Sample analysis logs (e.g., metals, GC/MS, etc.) information recorded in hardbound laboratory books that are filled out in legible handwriting, and signed and dated by the chemist.
- Sample storage log (same as the laboratory COC).
- Sample disposition log, which documents sample disposal by a contracted waste disposal company.

5.2.4 Sample Tracking

All samples are maintained in the appropriate coolers prior to and after analysis. The analysts remove and return their samples as needed. Samples that require internal COC are relinquished to the analysts by the sample custodians. The analyst and sample custodian must sign the original COC relinquishing custody of the samples from the sample custodian

to the analyst. When the samples are returned, the analyst will sign the original COC returning sample custody to the sample custodian. Sample extracts are relinquished to the instrumentation analysts by the preparatory analysts. Each preparation department tracks internal COC through their logbooks/spreadsheets.

Any change in the sample during the time of custody will be noted on the COC (e.g., sample breakage or depletion).

5.2.5 Sample Disposal

A minimum of 30 days following completion of the project, or after a period of time specified by any applicable project requirements, sample disposal is performed in compliance with federal, state, and local regulations. Alternatively, samples may be returned to the client by mutual agreement. All available data for each sample, including laboratory analysis results and any information provided by the client, are reviewed before sample disposal.

All samples are characterized according to hazardous/non-hazardous waste criteria and are segregated accordingly. All hazardous waste samples are disposed of according to formal procedures outlined in TestAmerica's Standard Operating Procedure (SOP). It should be noted that all waste produced at the laboratory, including the laboratory's own various hazardous waste streams, is treated in accordance with all applicable local and Federal laws.

Complete Internal Chain of Custody documentation is maintained for some samples from initial receipt through final disposal. This ensures that an accurate history of the sample from "cradle to grave" is generated. Internal Chain Documentation through disposal is in place at TestAmerica.

5.3 Project File

The project file will be the central repository for all documents, which constitute evidence relevant to sampling and analysis activities as described in this QAPP. TurnKey is the custodian of the evidence file and maintains the contents of evidence files for the investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports and data reviews in a secured, limited access area and under custody of the TurnKey project manager. Information generated during this study by will be retained by TurnKey in the project file. The project file will include at a minimum:

- Field logbooks
- Appropriate Field Forms (see Section 4.6)
- Field data and data deliverables
- Photographs
- Drawings
- Soil boring logs
- Laboratory data deliverables
- Data validation reports
- Data Assessment reports
- Progress reports, QA reports, interim project reports, etc.
- All custody documentation (tags, forms, air bills, etc.).

6.0 CALIBRATION PROCEDURES AND FREQUENCY

This section describes the calibration procedures and the frequency at which these procedures will be performed for both field and laboratory instruments.

6.1 Field Instrument Calibration

Quantitative field data to be obtained during groundwater sampling include pH, turbidity, specific conductance, temperature, and depth to groundwater. Quantitative water level measurements will be obtained with an electronic sounder or steel tape, which require no calibration. Quantitative field data to be obtained during soil sampling include screening for the presence of volatile organic constituents using a photoionization detector (PID).

FOPs located in Appendix A describe the field instruments used to monitor for these parameters and the calibration methods, standards, and frequency requirements for each instrument. Calibration results will be recorded on the appropriate field forms and in the Project Field Book.

6.2 Laboratory Instrument Calibration

All equipment and instruments used at TestAmerica are operated, maintained and calibrated according to the manufacturer's guidelines and recommendations, as well as to criteria set forth in the applicable analytical methodology. Operation and calibration are performed by personnel who have been properly trained in these procedures. Documentation of calibration information is maintained in appropriate reference files. The frequency of calibration and concentration of calibration standards are determined by the manufacturer's guidelines, the analytical method, or the requirements of special contracts. Generally, purchased standards have a shelf life of 12-36 months and prepared standards have a shelf life of 1-12 months. Recalibration is required at anytime the instrument is not operating correctly or functioning at the proper sensitivity. Brief descriptions of the calibration procedures for major laboratory equipment and instruments are described in TestAmerica's QA Manual (Appendix B).

7.0 ANALYTICAL PROCEDURES

Groundwater and soil samples collected during this investigation field sampling activities will be analyzed by TestAmerica Analytical Testing Corporation (TestAmerica), 10 Hazelwood Drive, Amherst, New York 14228, (716) 691-2600.

7.1 Field Analytical Procedures

Field procedures for collecting and preserving groundwater and soil samples are described in FOPs located in Appendix A.

7.2 Laboratory Analytical Procedures

This section describes the analytical procedures to be followed in the laboratory. Laboratory analytical procedures will follow USEPA methods contained in SW-846. Analytical methods, method detection limits, and reporting limits selected for use in this investigation are listed in Tables 1 and 2 for soil and groundwater, respectively. Sample container, preservation and holding time requirements are presented in Table 8. TestAmerica will provide analytical services; however, other laboratories may be used if necessary depending on project requirements. If a subcontract laboratory is required, the subcontracted laboratory's QA manual and copies of the State or Federal Certifications will be submitted to the NYSDEC prior to sample analysis for this project. General laboratory analytical procedures and sample handling procedures are presented in TestAmerica's QA Manual in Appendix B.

7.2.1 Sample Preparation and Analytical Methods

The laboratory named above will implement the method SOPs. The laboratory SOPs for sample preparation, cleanup and analysis are based on SW-846 Update III, and USEPA procedures. These SOPs provide sufficient details specific to the methods identified for this project.

7.2.2 Confirmation Analysis Methods

The laboratory SOPs presented in Appendix B identify the confirmatory analysis appropriate for this project. The basis for these SOPs is SW-846 Update III and USEPA

procedures. These protocols include second column confirmation for the gas chromatography methods.

In addition, confirmatory analysis may be performed by the evaluation of field duplicates and or analytical results for split samples with the agency. Although analyte concentrations between duplicate analyses and split samples may vary, the target analytes present should be the same. This can be considered confirmation analysis.

7.2.3 Method Validation

In order to demonstrate that the laboratory is capable of detecting and quantifying analytes at specific levels required by regulatory agencies or clients, each laboratory establishes method detection limits (MDLs), instrument detection limits (IDLs), and practical quantitation limits (PQLs), as required by the specific method protocols. These limits, along with other related detection or quantitation limits, are defined as follows:

- Method Detection Limit (MDL) - the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDL is a theoretical, statistically-derived value determined by preparing at least seven replicates of a low-level spiked matrix, which are taken through the entire sample preparation and analysis procedure; the standard deviation of the results is multiplied by the appropriate student's t value at the 99% confidence level to obtain the MDL. TestAmerica analytical laboratories perform MDL studies using the procedure defined in 40 CFR Part 136, Appendix B, *Definition and Procedure for the Determination of the Method Detection Limit* - Revision 1.11. MDLs are determined for each method and instrument annually, at a minimum, or when significant modifications to the procedure or instrumentation have been made, as determined by laboratory manager.
- Instrument Detection Limit (IDL) - an estimate of the lowest concentration of a substance that can be reliably detected above background noise on an instrument. The IDL is a theoretical, statistically derived value, which is determined by analyzing seven replicates of a low-level standard on each of three non-consecutive days; the standard deviation of the results is multiplied by three to obtain the IDL.
- Practical or Estimated Quantitation Limit (PQL or EQL) - an estimate of the lowest concentration of a substance that can be reliably achieved within specified limits

of precision and accuracy during routine laboratory operations. Typically, the PQL (EQL) is a nominal value selected at a level between 3 and 10 times the MDL.

- Contract Required Quantitation Limit (CRQL) - an estimate of the lowest concentration of a substance that can be reliably achieved as specified in the method. Typically, the CRQL is higher than PQL.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 Field Quality Control Checks

The QC criteria for each field measurement are provided in Table 4 of this QAPP. Assessment of field sampling precision and bias will be made by collecting field duplicates and field blanks for laboratory analysis. Collection of the samples will be in accordance with the applicable FOPs described in Section 4.0 of this QAPP at the frequency indicated in Section 3.0 of this QAPP.

Blind Duplicate groundwater samples will be collected to allow determination of analytical precision. One duplicate groundwater sample will be collected for every 20 samples or per sampling event if less than 20 samples are collected. Duplicate sample aliquots for groundwater will be collected sequentially as grab samples after collection of the initial sample aliquot. The sample location will not be disclosed to the analytical laboratory.

One equipment blank will be collected for each day of sampling activity when non-dedicated sampling equipment is used. These equipment blank samples will be used as a QC check of the decontamination procedures for sampling equipment. A VOC travel blank ("trip blank") will be included in each cooler containing water matrix samples to be analyzed for VOCs and sent to the laboratory for analysis.

8.2 Laboratory Quality Control Checks

The internal QC checks for laboratory analyses of groundwater samples that will be collected during this investigation are covered in the laboratory's QA Manual located in Appendix B. Laboratory analytical internal QA/QC will be conducted in accordance with USEPA SW-846. The checks include internal QC methods covering surrogate spikes, duplicates, preparation blanks, calibration, lab quality control samples and reagent checks. A site-specific MS/MSD sample will be analyzed as a further QC check. The matrix spike samples will be analyzed at the same frequency as the duplicate samples. The matrix spike samples will allow accuracy to be determined by using the percent recovery of the spiked compounds. The purpose of the MS/MSD samples is to monitor any possible matrix effects specific to samples collected from the Site. Acceptable QC limits for the MS/MSD

samples are found in USEPA SW-846. The specific sample location that will be used for matrix spikes may be chosen by the Project Manager or Project QA Officer.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

All data generated through field activities, or by the laboratory operation shall be reduced and validated prior to reporting. The laboratory shall disseminate no data until it has been subjected to the procedures summarized below.

9.1 Data Reduction

9.1.1 Field Data Reduction Procedures

Field measurements of pH, turbidity, temperature, specific conductance, water level and volatile organic vapor content (via the PID) are read directly in the units of final use, as discussed in Section 3.0 of this QAPP and listed in Table 5. Field personnel are responsible for monitoring the collection and reporting of field data. Field personnel will review field measurements at the time of measurement and will re-measure a parameter as necessary to assure quality and accuracy are maintained.

Field data will be recorded on appropriate field data record forms or the Project Field Book as they are collected and will be maintained in TurnKey's office project file. The Project QA Officer will review field procedures and compare field data to previous measurements to assess comparability and accuracy of the field data measurements.

9.1.2 Laboratory Data Reduction Procedures

Results of laboratory analyses will be reported in units of final use, as discussed in Section 3.0 and listed in Table 5. Laboratory calculations will be performed as prescribed for a given analytical method or in conformance with acceptable laboratory standards at the time the calculation is performed.

The laboratory will retain quality assurance/quality control records for at least five years. Original laboratory reports will be stored in the TurnKey project files. Copies of raw data will be available for review at the laboratory. Copies of raw data also may be requested as part of the QA/QC review. For this project, TurnKey has requested a Data Usability Summary Report (DUSR), which follows NYSDEC's September 1997 DUSR guidelines and will be developed from complete USEPA SW-846 Equivalent Category B deliverable. Specifically, the DUSR will examine:

- Completeness of the data package as defined under the requirements of USEPA SW-846 Equivalent Category B.
- Compliance with required holding times.
- Sample chain-of-custody forms.
- QC analysis data, including blanks, instrument tunings, calibrations, spikes, surrogate recoveries, duplicates, laboratory controls and sample data.
- Agreement between laboratory raw data and data summary sheets, with verification that correct data qualifiers were used where appropriate.

The Project Manager, Project QA Officer, or appropriate personnel assigned by the Project Manager will review the laboratory data. Section 12.0 outlines the procedures for evaluating the accuracy and precision of data. If comparison of data to previous measurements or known conditions at the Site indicates anomalies, the laboratory will be instructed to review the submitted data while TurnKey reviews the methods used to obtain the data. If anomalies remain, the laboratory may be asked to re-analyze selected samples provided that holding times have not been exceeded.

9.2 Data Usability Evaluation

Data usability evaluation procedures shall be performed for both field and laboratory operations as described below.

9.2.1 *Procedures Used to Evaluate Field Data Usability*

Procedures to validate field data for this project will be facilitated by adherence to the FOPs identified in Appendix A. The performance of all field activities, calibration checks on all field instruments at the beginning of each day of use, manual checks of field calculations, checking for transcription errors and review of field log books is the responsibility of the Field Team Leader.

9.2.2 Procedures Used to Evaluate Laboratory Data Usability

Data evaluation will be performed by the third party data validator using the most current methods and quality control criteria from the USEPA's Contract Laboratory Program (CLP) *National Functional Guidelines for Organic Data Review* (Ref. 6), and Contract Laboratory Program, *National Functional Guidelines for Inorganic Data Review* (Ref. 7). The data review guidance will be used only to the extent that it is applicable to the SW-846 methods; SW-846 methodologies will be followed primarily and given preference over CLP when differences occur. The role of the data validator, who will be independent of the laboratory, is indicated in Section 2.0 of this QAPP. Also, results of blanks, surrogate spikes, MS/MSDs, and laboratory control samples will be reviewed/evaluated by the data validator. All sample analytical data for each sample matrix shall be evaluated. The third party data validation expert will also evaluate the overall completeness of the data package. Completeness checks will be administered on all data to determine whether deliverables specified in Section 9.1.2 of this QAPP are present. The reviewer will determine whether all required items are present and request copies of missing deliverables.

9.3 Data Reporting

Data reporting procedures shall be carried out for field and laboratory operations as indicated below.

9.3.1 Field Data Reporting

All investigation field documents will be accounted for when they are completed. Accountable documents include items such as field notebooks, sample logs, field data records, photographs, data packages, computer disks, and reports.

9.3.2 Laboratory Data Reporting

Analytical data will be summarized in tabular format with such information as sample identification, sample matrix description, parameters analyzed and their corresponding detected concentrations, and the detection limit. Analytical results will be incorporated into reports as data tables, maps showing sampling locations and analytical results, and supporting text.

10.0 PERFORMANCE SYSTEM AUDITS AND FREQUENCY

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the FOPs and this QAPP. The audits of field and laboratory activities include two independent parts, internal and external.

10.1 Field Performance and System Audits

10.1.1 Internal Field Audits

The QA Officer will conduct internal audits of field activities including sampling and field measurements. These audits will verify that all established procedures are being followed. Internal field audits will be conducted at least once at the beginning of the Site sample collection activities. Project duration may warrant subsequent audits on a monthly basis.

The audit program consists of the following:

- Observation of field activities to confirm that procedures are performed in accordance with project protocols and standard accepted methods, as detailed in the FOPs located in Appendix A.
- Review daily field records, monitoring well sampling records, and any other data collection sheets during and after field measurements.

10.1.2 External Field Audits

The NYSDEC Site Project Coordinator may conduct external field audits. External field audits may be conducted any time during the field operations. These audits may or may not be announced and are at the discretion of the NYSDEC. External field audits will be conducted according to the field activity information presented in this QAPP.

10.2 Laboratory System Audits

The adequacy and implementation of TestAmerica's quality assurance plan are assessed on a continual basis through systems and performance audits. Systems audits evaluate practice against established quality system objectives and requirements.

Performance audits measure the comparability and accuracy of laboratory data through the analysis of reference materials for which the true value is unknown to the analyst. Audits may be performed by TestAmerica (internal), or by clients, regulatory agencies, or accreditation bodies (external).

10.2.1 Internal Laboratory Audits

The TestAmerica Quality Assurance (QA) Coordinator schedules internal systems audits such that the laboratory's quality system and range of test capabilities are audited annually. The audits are conducted to determine the following:

- Whether the procedures defined in the quality system are being followed;
- Whether the objectives defined in the quality system are being achieved; and
- Identify opportunities for improvement.

The TestAmerica Quality Assurance Coordinator will conduct the laboratory audit. The QA Coordinator prepares an audit plan for each audit, which defines the scope of the audit, requirements that the audit will be conducted against, and the audit technique(s) to be used (observation, record review, interview). The internal system audits are scheduled as two auditing events and follow the audit plan.

The results of each audit are reported to the Laboratory Director and Supervisors for review and comment. Any deficiencies noted by the auditor are summarized in an audit report and corrective action is taken within a specified length of time to correct each deficiency. Should problems impacting data quality be found during an internal audit, any client whose data is adversely impacted will be given written notification if not already provided.

10.2.2 External Laboratory Audits

Upon client, regulatory agency, or accreditation body notification of intent to audit, the quality assurance officer notifies laboratory personnel and corporate quality assurance. During the audit, the quality assurance coordinator, or a designee, provides escort for the auditors, and participates in the pre-audit and post-audit conferences. Additional laboratory personnel are called upon as necessary during the course of the audit. An external audit will

be conducted upon request by appropriate NYSDEC QA staff. These audits may or may not be announced and are at the discretion of the NYSDEC.

External audits may include any or all of the following:

- Review of laboratory analytical procedures.
- Laboratory on-site visits (see below).
- Submission of performance evaluation samples to the laboratory for analysis.

Failure of any or all audit procedures chosen can lead to laboratory disqualification, and the requirement that another suitable laboratory be chosen.

An external on-site review may consist of:

- Sample receipt procedures
- Custody and sample security and log in procedures,
- Calibration records
- Instrument logs and statistics (number and type)
- Review of QA procedures
- Review of logbooks
- Review of sample preparation procedures
- Sample analytical SOP review
- Instrument (normal or extends quantitation report) reviews
- Personnel interviews
- Review of deadlines and glassware prep
- A close out to offer potential corrective action

It is common practice when conducting an external laboratory audit to review one or more data packages from sample lots recently analyzed by the laboratory. This review will most likely include but not be limited to:

- Comparison of resulting data to the laboratory SOP or method, including coding for deviations.
- Verification of initial and continuing calibrations within control limits.
- Verification of surrogate recoveries and instrument tuning results where applicable.

- Review of extended quantitation reports for comparisons of library spectra to instrument spectra, where applicable.
- Recoveries on control standard runs.
- Review of run logs with run times, ensuring proper order of runs,
- Review of spike recoveries/QC sample data.
- Review of suspected manually integrated GC data and its cause (where applicable).
- Assurance that samples are run within holding times.

All data will be reviewed while on the premises of TestAmerica, so that any questionable data can be discussed with the staff.

Following the audit, the quality assurance officer provides a written summary of the audit to the laboratory manager, department supervisors, and corporate quality assurance. The summary includes the areas reviewed, and strengths and deficiencies identified during the audit.

The quality assurance coordinator initiates the corrective action process for each finding and is responsible for ensuring timely corrective action. The quality assurance coordinator prepares the audit report response, and prepares any follow-up responses as corrective actions are completed. The audit report and laboratory responses are copied to corporate quality assurance.

10.3 Laboratory Performance Audits

10.3.1 Internal Performance Audit

Internal performance audit samples are submitted at the discretion of the local quality assurance director as a supplement to the quality control checks run on a daily basis. The quality assurance director maintains a log of blind sample preparation in which the reference material used, preparation, and true value(s) are documented. The reference materials submitted should be independent of the laboratory's initial calibration standards.

Acceptance criteria for internal performance audit sample results are those provided with the reference material. If no criteria are provided, performance criteria listed in the reference method are used. Internal performance audit results are scored and corrective action is initiated in the same manner as external samples. The laboratory director is responsible for ensuring timely corrective action.

10.3.2 External Performance Audit

External performance audit samples are run at the frequency required to obtain and maintain desired certifications, accreditations, and approvals. Additional studies may be run at the discretion of corporate quality assurance or the local laboratory manager.

The quality assurance director initiates the corrective action process for each performance audit result scored as “fail.” The laboratory director is responsible for ensuring timely corrective action. The audit report and laboratory responses are copied to corporate quality assurance.

11.0 PREVENTATIVE MAINTENANCE

11.1 Field Instrument Preventative Maintenance

Each piece of field equipment is checked according to its routine maintenance schedule and before field activities begin. Field equipment planned for use during this investigation includes:

- Photoionization detector (PID)
- Water quality meters (includes pH, turbidity, temperature, Eh, and specific conductance)
- Electric water level indicator

Field personnel will report all equipment maintenance and/or replacement needs to the Project QA Officer and will record the information on the daily field record. Calibration and Maintenance FOPs are provided in Appendix A.

11.2 Laboratory Instrument Preventative Maintenance

As part of the QA Program Plan, a routine preventative maintenance program is conducted by TestAmerica to minimize the occurrence of instrument failure and other system malfunctions. The analysts regularly perform routine instrument maintenance tasks (or coordinate with the vendor). All maintenance that is performed is in accordance with the manufacturer's specifications and is documented in the laboratory's maintenance logbooks. The maintenance logbooks used at TestAmerica contain extensive information about the instruments used at the laboratory.

Preventative maintenance procedures, frequencies, and other pertinent information are available for each instrument used at TestAmerica through SOPs for routine and in the operating or maintenance manuals provided with the equipment. Responsibility for ensuring that routine maintenance is performed lies with the section supervisors. Each laboratory section maintains a critical parts inventory. The parts inventories include the items needed to perform the preventative maintenance procedures presented in TestAmerica's QA Manual provided in Appendix B of this QAPP.

11.3 Inspection/Acceptance Requirements for Supplies and Consumables

11.3.1 Field Supplies and Consumables

For this investigation, TurnKey will track critical supplies in the following manner.

Item	Date Received	Condition	Responsible Individual
Tyvek suits			
Disposable bailers			
Pump tubing			
Latex gloves			
Respirator cartridges			
Sample containers			
Decon materials			
Alconox detergent			
pH buffer solutions			
Calibration gases			

Labels indicating the following information on receipt and testing are to be used for critical supplies and consumables.

- Unique identification number (if not clearly shown).
- Date received.
- Date opened.
- Date tested (if performed).
- Date to be retested (if applicable).
- Expiration date.

11.3.2 Laboratory Supplies and Consumables

Supplies and consumables used in the analytical process shall have traceable documentation (e.g., labels or logbooks) for date received, date opened, and date expired. Inspection, testing and acceptance criteria for critical supplies and consumables are identified below.

Critical Supplies & Consumables	Inspection/ Acceptance Testing Requirements	Acceptance Criteria	Testing Method	Frequency	Responsible Individual	Handling/ Storage Conditions
Standards	Refer to the Manufacturer's Certificate of Analysis.					
Acids	<RL's for common lab contaminants	<RL's all elements	SW-846	Each Lot	Receiving / Laboratory Personnel	Vented Acid Cabinets
Solvents	<RL's for common lab contaminants	<RL's for common lab contaminants	SW-846	Each Lot	Receiving / Laboratory Personnel	Vented Solvent Cabinets

12.0 DATA PRECISION, ACCURACY, AND COMPLETENESS EVALUATION

The purpose of this section is to indicate the methods by which it will be assured that the data collected for this investigation is in accordance with the data quality objectives (DQOs) for the Site. Factors considered during this investigation include:

- The chemical constituents known and/or suspected to be of concern, as they relate to the data quality level parameters chosen.
- The types and frequency of samples necessary to determine/confirm the list of constituents of concern (COCs).
- The choice of analytical and sample preparation methods with method detection limits that meet the data quality level concentrations for chemical constituents of concern.

Once these goals and objectives are evaluated and chosen, analytical data quality will be assessed to determine if the objectives have been met. In addition, the data will be reviewed for indications of interferences to results caused by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies (i.e. samples holding time or analytical instrument problems).

As discussed in Section 3.0 of this QAPP, the validity of data will be evaluated in terms of precision, accuracy, and completeness. Described below are ways in which these three parameters will be evaluated. Evaluations will be performed upon completion of investigation field activities.

12.1 Accuracy Assessment

Data accuracy, which is assessed for laboratory data only, is based on recoveries, expressed as the percentage of the true (known) concentration, from laboratory spiked samples and QA/QC samples generated by the analytical laboratory.

Percent recovery (%R) for MS/MSD results is determined according to the following equation:

$$R\% = \frac{(A - B) \times 100}{T}$$

Where A = measured concentration after spiking
 B = background concentration
 T = known true value of spike

Percent recovery (%R) for LCS and surrogate compound results is determined according to the following equation:

$$R\% = \frac{\text{Experimental Concentration}}{\text{Known amount added}} \times 100$$

This information is reviewed periodically by the Project Manager or Project QA Officer. The goals for the recovery of any constituent in a spiked or QA/QC sample are presented in Table 3. For data generated in the field, the accuracy goals are summarized in Table 4.

12.2 Precision Assessment

For data generated by the laboratory, data precision is estimated by comparing analytical results from duplicate samples. The comparison is made by calculating the relative percent difference (RPD) given by:

$$RPD\% = \frac{2(S_1 - S_2)}{S_1 + S_2} \times 100$$

Where S₁ = sample result
 S₂ = duplicate result

This information is calculated and reviewed periodically by the Project Manager and/or Project QA Officer. The goals for data precision for duplicate samples are presented in Table 3. For data generated in the field, the precision goals are summarized in Table 4.

12.3 Completeness Assessment

Data completeness will be evaluated by comparing the objectives of investigation efforts with the data obtained and determining whether there are any shortcomings in required information. A series of protocols, described below, will be used to evaluate data completeness. The purpose is to accomplish the following:

- Rigorously assess the quality and adequacy of data collected during the investigation.
- Review data collected during the investigation to evaluate if the study's objectives are being addressed and met.
- Ensure that the data collected are valid by applying the quality checks described in this and other sections of the QAPP.

Data generated during groundwater assessment and monitoring programs will be evaluated for completeness; that is, the amount of data meeting project QA/QC goals. If data generated during field operations or during analytical procedures appear to deviate significantly from previous trends, the Project Manager or Project QA Officer will review field or laboratory procedures with the appropriate personnel to evaluate the cause of such deviations. Where data anomalies cannot be explained, resampling may be performed. Completeness is defined as the percentage of valid results according to the equation below:

$$\% \text{ completeness} = \frac{A}{B} \times 100$$

Where: A = number of valid results;
B = total number of possible results

The goals for data completeness for laboratory measurements were presented previously in Table 3. For data generated in the field, the completeness goals are summarized in Table 4.

12.4 Assessment of Data

To assess the integrity of the data generated during this investigation, the Project Manager and QA Officer will review the laboratory analytical data and field data in accordance with procedures and protocols outlined in this QAPP. An assessment will be made to determine if the project objectives described in Section 1.0 have been achieved. Corrective Action described in Section 13.0 will be implemented, if necessary, to meet objectives for data integrity.

13.0 CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out of quality control performance that can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and data assessment. All corrective action proposed and implemented should be documented in the regular quality assurance reports to management. Corrective action should be implemented only after approval by the Project Manager, or his/her designee. If immediate corrective action is required, approvals secured by telephone from the Project Manager should be documented in an additional memorandum.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. In the field, the person who identifies the problem is responsible for notifying the Field Team Leader, who will notify the Project Manager, who in turn will notify the Tecumseh Project Coordinator and the NYSDEC Project Coordinator. If the problem is analytical in nature, information will be promptly communicated to the NYSDEC Project Coordinator via fax or telephone during that same day or the next business day. Implementation of corrective action will be confirmed in writing through the same channels. If noncompliance is observed in the laboratory or during data validation, the analyst or data validator will notify the Project Manager and communication will continue in the same manner as described above.

13.1 Field Corrective Action

If errors in field procedures are discovered during the observation or review of field activities by the Project QA Officer or his/her designee, corrective action will be initiated. Nonconformance to the QA/QC requirements of the field operating procedures (FOPs) will be identified by field audits or immediately by project staff who know or suspect that a procedure is not being performed in accordance with the requirements. The Project QA Officer or his designee will be informed immediately upon discovery of all deficiencies. Timely action will be taken if corrective action is necessary.

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the Work Plan, etc.) or when sampling procedures and/or field analytical procedures require modification due to unexpected conditions. In general, the Project Manager and QA Officer may identify the

need for corrective action. The Project Manager will approve the corrective measure that will be implemented by the field team. It will be the responsibility of the Project Manager to ensure that corrective action has been implemented.

If the corrective action will supplement the existing sampling plan (e.g., additional soil borings) using existing and approved procedures in the QAPP, corrective action approved by the Project Manager will be documented. If the corrective actions result in less samples (or analytical fractions), alternate locations, etc., which may result in non-achievement of project QA objectives, it will be necessary that all levels of project management, including the NYSDEC Project Coordinator, concur with the proposed action.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The QA Officer will identify deficiencies and recommend corrective action to the Project Manager. The Project Manager and field team will implement corrective actions. Corrective action will be documented in QA reports to the entire project management.

Corrective actions will be implemented and documented in the project field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by the NYSDEC Project Coordinator.

If at any time a corrective action issue is identified which directly impacts project DQOs, the NYSDEC Project Coordinator will be notified immediately.

13.2 Laboratory Corrective Action

Corrective actions may be initiated if the quality assurance goals are not achieved. The initial step in a corrective action is to instruct the analytical laboratory to examine its procedures to assess whether analytical or computational errors caused the anomalous result. If no error in laboratory procedures or sample collection and handling procedures can be identified, then the Project Manager will assess whether reanalysis or resampling is required or whether any protocol should be modified for future sampling events.

13.3 Data Validation & Assessment Corrective Action

The need for corrective action may be identified during the data validation or assessment processes. Potential types of corrective action may include resampling by the field team, or reinjection/reanalysis of samples by the laboratory.

These actions are dependent upon the ability to mobilize the field team, whether the data to be collected is necessary to meet the QA objectives (e.g., the holding time for samples is not exceeded, etc.). If the data validator identifies a corrective action situation, the Project Manager will be responsible for approving the corrective action implementation. All required corrective actions will be documented by the laboratory Quality Assurance Coordinator.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The deliverables associated with the tasks identified in the Work Plan and monthly progress reports will contain separate QA sections in which data quality information collected during the reporting period is summarized. Those reports will be the responsibility of the Project Manager and will include the QA Officers input on the accuracy, precision, and completeness of the data, as well as the results of the performance and system audits, and any corrective action needed or taken during the project.

14.1 Contents of Project QA Reports

The progress reports will contain, on a routine basis, a QA section describing all results of field and laboratory audits, all information generated during the past month reflecting on the achievement of specific DQOs, and a summary of corrective action that was implemented, and its immediate results on the project. The status of the project with respect to the Project Schedule included in this QAPP will be determined. Whenever necessary, updates on training provided, changes in key personnel, anticipated problems in the field or laboratory for the coming month that could bear on data quality along with proposed solutions, will be reported. Detailed references to QAPP modifications will also be highlighted. All QA reports will be prepared in written, final format by the project manager or his designee. To the extent possible, assessment of the project should also be performed on the basis of available QC data and overall results in relation to originally targeted objectives.

In the event of an emergency, or in case it is essential to implement corrective action immediately, QA reports can be made by telephone to the appropriate individuals, as identified in the Project Organization and Corrective Action sections of this QAPP. However, these events, and their resolution will be addressed thoroughly in the next monthly progress report.

14.2 Frequency and Distribution of QA Reports

The QA reports will be completed for all months during which sample collection and/or analysis occurs and will be presented as part of the monthly progress report.

14.3 Individuals Receiving/Reviewing QA Reports

The QA reports will be delivered to all progress report recipients, which shall include all individuals identified in the Project Organization chart and other individuals identified by NYSDEC.

15.0 REFERENCES

1. U.S. Environmental Protection Agency. *Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA QA/R-5), October 1998.
2. U.S. Environmental Protection Agency, Region II, *CERCLA Quality Assurance Manual, Revision I*, October 1989.
3. U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. SW-846, Third Edition (Updates I, II and III). 1991.
4. New York State Department of Environmental Restoration, Division of Environmental Restoration, *DER-10 Technical Guidance for Site Investigation and Remediation*, December 2006.
5. U.S. Environmental Protection Agency, *Methods for Chemical Analysis of Water and Wastes*, EPA 600/4-70-020. 1983b.
6. U.S. Environmental Protection Agency. National Functional Guidelines for Organic Data Review (EPA-540/R-94-012), 1994a.
7. U.S. Environmental Protection Agency. National Functional Guidelines for Inorganic Data Review (EPA-540/R-94-013), 1994b.

TABLES



TABLE 1

CONSTITUENTS OF PRIMARY CONCERN (COPCs)
FOR SOIL

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
<i>STARS Volatile Organic Compounds: (15 compounds) (ug/kg)</i>				
Benzene	71-43-2	8021B	1	0.11
n-Butylbenzene	104-51-8	8021B	1	1.00
sec-Butylbenzene	135-98-8	8021B	1	0.08
tert-Butylbenzene	98-06-6	8021B	1	0.12
p-Cymene	99-87-6	8021B	1	0.41
Ethylbenzene	100-41-4	8021B	1	0.07
Isopropylbenzene	98-82-8	8021B	1	0.08
Methyl tert butyl ether	1634-04-4	8021B	1	0.06
n-Propylbenzene	103-65-1	8021B	1	0.11
Toluene	108-88-3	8021B	1	0.04
1,2,4-Trimethylbenzene	95-63-6	8021B	1	0.40
1,3,5-Trimethylbenzene	108-67-8	8021B	1	0.84
o-Xylene	95-47-6	8021B	1	0.01
p-Xylene	106-42-3	8021B	1	0.04
m-Xylene	108-38-3	8021B	1	0.04
<i>TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L)</i> <i>[includes STARS VOCs in blue]</i>				
Acetone	67-64-1	8260B	25	22.57
Benzene	71-43-2	8260B	5	0.81
Bromoform	75-25-2	8260B	5	1.13
Bromodichloromethane	75-27-4	8260B	5	0.72
Bromomethane (Methyl bromide)	74-83-9	8260B	5	1.47
2-Butanone (MEK)	78-93-3	8260B	25	3.49
n-Butylbenzene	104-51-8	8260B	5	1.95
sec-Butylbenzene	135-98-8	8260B	5	0.99
tert-Butylbenzene	98-06-6	8260B	5	1.03
Carbon disulfide	75-15-0	8260B	5	1.24
Carbon tetrachloride	56-23-5	8260B	5	0.84
Chlorobenzene	108-90-7	8260B	5	0.60
Chloroethane	75-00-3	8260B	5	0.84
Chloroform	67-66-3	8260B	5	1.26
Chloromethane (Methyl chloride)	74-87-3	8260B	5	0.73
Cyclohexane	110-82-7	8260B	5	0.23
p-Cymene (p-isopropyltoluene)	99-87-6	8260B	5	1.05
1,2-Dibromo-3-chloropropane	96-12-8	8260B	5	1.03



TABLE 1

CONSTITUENTS OF PRIMARY CONCERN (COPCs)
FOR SOIL

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
<i>TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L)</i> <i>[includes STARS VOCs in blue]</i>				
1,2-Dibromoethane (EDB)	106-93-4	8260B	5	0.78
Dibromochloromethane	124-48-1	8260B	5	0.91
Dichlorodifluoromethane (Freon-12)	75-71-8	8260B	5	1.15
1,2-Dichlorobenzene	95-50-1	8260B	5	0.57
1,3-Dichlorobenzene	541-73-1	8260B	5	0.57
1,4-Dichlorobenzene	106-46-7	8260B	5	0.57
1,1-Dichloroethane	75-34-3	8260B	5	1.02
1,2-Dichloroethane (EDC)	107-06-2	8260B	5	0.88
1,1-Dichloroethylene (1,1-DCE)	75-35-4	8260B	5	0.61
trans-1,2-Dichloroethylene	156-60-5	8260B	5	1.43
cis-1,2-Dichloroethylene	156-59-2	8260B	5	1.19
cis-1,3-Dichloropropene	10061-01-5	8260B	5	0.79
trans-1,3-Dichloropropene	10061-02-6	8260B	5	0.96
1,2-Dichloropropane	78-87-5	8260B	5	0.95
Ethylbenzene	100-41-4	8260B	5	0.62
2-Hexanone	591-78-6	8260B	25	4.72
Isopropylbenzene (Cumene)	98-82-8	8260B	5	0.57
Methyl acetate	79-20-9	8260B	5	1.95
Methylene chloride	75-09-2	8260B	5	4.42
Methylcyclohexane	108-87-2	8260B	5	0.92
4-methyl-2-pentanone (MIBK)	108-10-1	8260B	25	4.21
Methyl tert butyl ether (MTBE)	1634-04-4	8260B	5	0.55
n-Propylbenzene	103-65-1	8260B	5	0.89
Styrene	100-42-5	8260B	5	1.20
1,1,1,2-Tetrachloroethane	630-20-6	8260B	5	1.12
Tetrachloroethylene (PCE)	127-18-4	8260B	5	0.80
Toluene	108-88-3	8260B	5	1.62
1,2,4-Trichlorobenzene	120-82-1	8260B	5	0.93
1,1,1-Trichloroethane	71-55-6	8260B	5	0.69
1,1,2-Trichloroethane	79-00-5	8260B	5	0.92
Trichloroethylene (TCE)	79-01-6	8260B	5	0.64
Trichlorofluoromethane (Freon-11)	75-69-4	8260B	5	0.77
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon)	76-13-1	8260B	5	0.53
1,2,4-Trimethylbenzene	95-63-6	8260B	5	0.74



TABLE 1

CONSTITUENTS OF PRIMARY CONCERN (COPCs)
FOR SOIL

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
<i>TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L)</i> <i>[includes STARS VOCs in blue]</i>				
1,3,5-Trimethylbenzene	108-67-8	8260B	5	0.65
Vinyl chloride	75-01-4	8260B	10	0.78
o-Xylene	95-47-6	8260B	5	1.12
p-Xylene	106-42-3	8260B	5	0.93
m-Xylene	108-38-3	8260B	5	0.93
<i>TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/kg)</i> <i>[includes Base-Neutrals (black) and Acid Extractables (blue)]</i>				
Acenaphthene	83-32-9	8270C	330	11.00
Acenaphthylene	208-96-8	8270C	330	10.00
Anthracene	120-12-7	8270C	330	9.00
Benzo(a)anthracene	56-55-3	8270C	330	13.00
Benzo(a)pyrene	50-32-8	8270C	330	11.00
Benzo(b)fluoranthene	205-99-2	8270C	330	15.00
Benzo(g,h,i)perylene	191-24-2	8270C	330	10.00
Benzo(k)fluoranthene	207-08-9	8270C	330	17.00
Benzyl alcohol	100-51-6	8270C	330	14.00
bis(2-Chloroethoxy)methane	111-91-1	8270C	330	14.00
bis(2-Chloroethyl)ether	111-44-4	8270C	330	14.00
2,2'-oxybis(1-chloropropane); bis(2-chloroisopropyl)ether	108-60-1	8270C	330	14.00
bis(2-Ethylhexyl)phthalate	117-81-7	8270C	330	19.00
Butyl benzyl phthalate	85-68-7	8270C	330	17.00
4-Bromophenyl phenyl ether	101-55-3	8270C	330	11.00
4-Chloroaniline	106-47-8	8270C	330	18.00
4-Chloro-3-methylphenol	59-50-7	8270C	330	12.00
2-Chloronaphthalene	91-58-7	8270C	330	13.00
2-Chlorophenol	95-57-8	8270C	330	12.00
4-Chlorophenyl-phenylether	7005-72-3	8270C	330	12.00
Chrysene	218-01-9	8270C	330	10.00
Dibenzo(a,h)anthracene	53-70-3	8270C	330	13.00
Dibenzofuran	132-64-9	8270C	330	10.00
3,3'-Dichlorobenzidine	91-94-1	8270C	330	148.00
2,4-Dichlorophenol	120-83-2	8270C	330	15.00
1,2-Dichlorobenzene	95-50-1	8270C	330	15.00



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CONSTITUENTS OF PRIMARY CONCERN (COPCs)
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Sonwil BCP Site
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Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
<i>TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/kg) [includes Base-Neutrals (black) and Acid Extractables (blue)]</i>				
1,3-Dichlorobenzene	541-73-1	8270C	330	14.00
1,4-Dichlorobenzene	106-46-7	8270C	330	13.00
Diethyl phthalate	84-66-2	8270C	330	9.00
2,4-Dimethylphenol	105-67-9	8270C	330	33.00
Dimethyl phthalate	131-11-3	8270C	330	10.00
Di-n-butyl phthalate	84-74-2	8270C	330	11.00
Di-n-octyl phthalate	117-84-0	8270C	330	31.00
4,6-Dinitro-2-methylphenol	534-52-1	8270C	1600	66.00
2,4-Dinitrophenol	51-28-5	8270C	1600	120.00
2,4-Dinitrotoluene	121-14-2	8270C	330	33.00
2,6-Dinitrotoluene	606-20-2	8270C	330	66.00
Fluoranthene	206-44-0	8270C	330	12.00
Fluorene	86-73-7	8270C	330	10.00
Hexachlorobenzene	118-74-1	8270C	330	11.00
Hexachlorobutadiene	87-68-3	8270C	330	13.00
Hexachlorocyclopentadiene	77-47-4	8270C	330	12.00
Hexachloroethane	67-72-1	8270C	330	14.00
Indeno(1,2,3-cd)pyrene	193-39-5	8270C	330	11.00
Isophorone	78-59-1	8270C	330	13.00
2-Methylnaphthalene	91-57-6	8270C	330	14.00
2-Methylphenol (o-Cresol)	95-48-7	8270C	330	33.00
4-Methylphenol (p-Cresol)	106-44-5	8270C	330	14.00
Naphthalene	91-20-3	8270C	330	14.00
2-Nitroaniline	88-74-4	8270C	1600	12.00
3-Nitroaniline	99-09-2	8270C	1600	17.00
4-Nitroaniline	100-01-6	8270C	1600	66.00
Nitrobenzene	98-95-3	8270C	330	12.00
2-Nitrophenol	88-75-5	8270C	330	66.00
4-Nitrophenol	100-02-7	8270C	1600	66.00
N-Nitrosodiphenylamine	86-30-6	8270C	330	29.00
N-Nitroso-di-n-propylamine	621-64-7	8270C	330	13.00
Pentachlorophenol	87-86-5	8270C	1600	50.00
Phenanthrene	85-01-8	8270C	330	11.00
Phenol	108-95-2	8270C	330	11.00



TABLE 1

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FOR SOIL

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/kg) <i>[includes Base-Neutrals (black) and Acid Extractables (blue)]</i>				
Pyrene	129-00-0	8270C	330	11.00
1,2,4-Trichlorobenzene	120-82-1	8270C	330	18.00
2,4,5-Trichlorophenol	95-95-4	8270C	800	14.00
2,4,6-Trichlorophenol	88-06-2	8270C	330	13.00
TAL Metals (modified): (12 compounds) (mg/L) <i>[site specific metals in blue]</i>				
Antimony	7440-38-2	6010B	15	0.69
Arsenic	7440-38-2	6010B	2	0.37
Barium	7440-39-3	6010B	0.5	0.05
Cadmium	7440-43-9	6010B	0.2	0.06
Chromium	7440-47-3	6010B	0.5	0.14
Lead	7439-92-1	6010B	1	0.19
Mercury	7439-97-6	7471A	0.02	0.0071
Nickel	7440-02-0	6010B	0.5	0.12
Potassium	7440-09-7	6010B	30	8.4
Selenium	7782-49-2	6010B	4	0.48
Silver	7440-22-4	6010B	0.5	0.15
Thallium	7440-28-0	6010B	6	0.66
Wet Chemistry: (1 compound) (mg/kg)				
Cyanide (total)	57-12-5	9012.0	1.0	0.35
PCBs: (7 compounds) (mg/kg)				
Aroclor 1016	12674-11-2	8082	16.66	3.26118
Aroclor 1221	11104-28-2	8082	16.66	6.95672
Aroclor 1232	11141-16-5	8082	16.66	3.12131
Aroclor 1242	53469-21-9	8082	16.66	2.90256
Aroclor 1248	12672-29-6	8082	16.66	3.98752
Aroclor 1254	11097-69-1	8082	16.66	8.66085
Aroclor 1260	11096-82-5	8082	16.66	6.57138
TCL Pesticides: (21 parameters) (ug/kg)				
4,4'-DDD	72-54-8	8081	1.67	0.31
4,4'-DDE	72-55-9	8081	1.67	0.21
4,4'-DDT	50-29-3	8081	1.67	0.38
Aldrin	309-00-2	8081	1.67	0.4
alpha-BHC	319-84-6	8081	1.67	0.4
alpha-Chlordane	5103-71-9	8081	1.67	0.83



TABLE 1

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Sonwil BCP Site
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Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
<i>TCL Pesticides: (21 parameters) (ug/kg)</i>				
beta-BHC	319-85-7	8081	1.67	0.5
delta-BHC	319-86-8	8081	1.67	0.4
Dieldrin	60-57-1	8081	1.67	0.4
Endosulfan I	959-98-8	8081	1.67	0.3
Endosulfan II	33213-65-9	8081	1.67	0.3
Endosulfan Sulfate	1031-07-8	8081	1.67	0.311
Endrin	72-20-8	8081	1.67	0.54
Endrin aldehyde	7421-93-4	8081	1.67	0.68
Endrin ketone	53494-70-5	8081	1.67	0.41
gamma-BHC	58-89-9	8081	1.67	0.4
gamma-Chlordane	5103-74-2	8081	1.67	0.4
Heptachlor	76-44-8	8081	1.67	0.83
Heptachlor epoxide	1024-57-3	8081	1.67	0.43
Methoxychor	72-43-5	8081	1.67	0.38
Toxaphene	8001-35-2	8081	33.00	9.7
<i>Herbicides: (19 compounds) (mg/kg)</i>				
2,4-D	94-75-7	8151A	17	1.958
Dalapon	75-99-0	8151A	17	2.425
Dichloroprop	120-36-5	8151A	17	2.293
Dinoseb	88-85-7	8151A	17	1.808
4-Nitrophenol	100-02-7	8270	330	40.92
Pentachlorophenol	87-86-5	8151A	17	2.328
Picloram	1918-02-1	8151A	17	7.180
2,4,5-T	93-76-5	8151A	17	2.155
2,4,5-TP	93-72-1	8151A	17	1.852

Notes:

1. Analytes as per NYSDEC and USEPA list of parameters.
2. Analytical methods per USEPA publication, SW-846, "Test Methods for Evaluating Solid Waste", Third Edition.

Acronyms/Abbreviations:

CAS = Chemical Abstracts Service registry number.
MDL = Method Detection Limit provided by STL
PQL = Practical Quantitation Limit
STARS = Spill Technology And Remediation Series; NYSDEC
TCL = Target Compound List
TAL = Target Analyte List

mg/kg = milligrams per kilogram
ug/kg = micrograms per kilogram



TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs)
FOR GROUNDWATER

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
<i>STARS Volatile Organic Compounds: (15 compounds) (ug/L)</i>				
Benzene	71-43-2	8021B	0.2	0.02
n-Butylbenzene	104-51-8	8021B	0.4	0.03
sec-Butylbenzene	135-98-8	8021B	0.4	0.02
tert-Butylbenzene	98-06-6	8021B	0.4	0.03
p-Cymene	99-87-6	8021B	0.4	0.28
Ethylbenzene	100-41-4	8021B	0.2	0.03
Isopropylbenzene	98-82-8	8021B	0.2	0.03
Methyl tert butyl ether	1634-04-4	8021B	0.4	0.23
n-Propylbenzene	103-65-1	8021B	0.2	0.03
Toluene	108-88-3	8021B	0.2	0.04
1,2,4-Trimethylbenzene	95-63-6	8021B	0.2	0.03
1,3,5-Trimethylbenzene	108-67-8	8021B	0.2	0.17
o-Xylene	95-47-6	8021B	0.2	0.09
p-Xylene	106-42-3	8021B	0.4	0.25
m-Xylene	108-38-3	8021B	0.4	0.25
<i>TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L)</i> <i>[includes STARS VOCs in blue]</i>				
Acetone	67-64-1	8260B	5	2.48
Benzene	71-43-2	8260B	1	0.35
Bromoform	75-25-2	8260B	1	0.26
Bromodichloromethane	75-27-4	8260B	1	0.39
Bromomethane (Methyl bromide)	74-83-9	8260B	1	0.28
2-Butanone (MEK)	78-93-3	8260B	5	2.49
n-Butylbenzene	104-51-8	8260B	1	0.28
sec-Butylbenzene	135-98-8	8260B	1	0.30
tert-Butylbenzene	98-06-6	8260B	1	0.30
Carbon disulfide	75-15-0	8260B	1	0.48
Carbon tetrachloride	56-23-5	8260B	1	0.27
Chlorobenzene	108-90-7	8260B	1	0.32
Chloroethane	75-00-3	8260B	1	0.32
Chloroform	67-66-3	8260B	1	0.34
Chloromethane (Methyl chloride)	74-87-3	8260B	1	0.35
Cyclohexane	110-82-7	8260B	1	0.53
p-Cymene (p-isopropyltoluene)	99-87-6	8260B	1	0.31
1,2-Dibromo-3-chloropropane	96-12-8	8260B	1	0.47
1,2-Dibromoethane (EDB)	106-93-4	8260B	1	0.42
Dibromochloromethane	124-48-1	8260B	1	0.32
Dichlorodifluoromethane (Freon-12)	75-71-8	8260B	1	0.29



TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs)
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RI/AAR/IRM Work Plan
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Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
<i>TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L)</i> <i>[includes STARS VOCs in blue]</i>				
1,2-Dichlorobenzene	95-50-1	8260B	1	0.40
1,3-Dichlorobenzene	541-73-1	8260B	1	0.33
1,4-Dichlorobenzene	106-46-7	8260B	1	0.37
1,1-Dichloroethane	75-34-3	8260B	1	0.27
1,2-Dichloroethane (EDC)	107-06-2	8260B	1	0.46
1,1-Dichloroethylene (1,1-DCE)	75-35-4	8260B	1	0.29
trans-1,2-Dichloroethylene	156-60-5	8260B	1	0.33
cis-1,2-Dichloroethylene	156-59-2	8260B	1	0.37
cis-1,3-Dichloropropene	10061-01-5	8260B	1	0.36
trans-1,3-Dichloropropene	10061-02-6	8260B	1	0.37
1,2-Dichloropropane	78-87-5	8260B	1	0.33
Ethylbenzene	100-41-4	8260B	1	0.34
2-Hexanone	591-78-6	8260B	5	2.39
Isopropylbenzene (Cumene)	98-82-8	8260B	1	0.32
Methyl acetate	79-20-9	8260B	1	0.45
Methylene chloride	75-09-2	8260B	1	0.44
Methylcyclohexane	108-87-2	8260B	1	0.50
4-methyl-2-pentanone (MIBK)	108-10-1	8260B	5	2.34
Methyl tert butyl ether (MTBE)	1634-04-4	8260B	1	0.48
n-Propylbenzene	103-65-1	8260B	1	0.35
Styrene	100-42-5	8260B	1	0.31
1,1,1,2-Tetrachloroethane	630-20-6	8260B	1	0.35
Tetrachloroethylene (PCE)	127-18-4	8260B	1	0.36
Toluene	108-88-3	8260B	1	0.35
1,2,4-Trichlorobenzene	120-82-1	8260B	1	0.41
1,1,1-Trichloroethane	71-55-6	8260B	1	0.26
1,1,2-Trichloroethane	79-00-5	8260B	1	0.42
Trichloroethylene (TCE)	79-01-6	8260B	1	0.32
Trichlorofluoromethane (Freon-11)	75-69-4	8260B	1	0.36
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon)	76-13-1	8260B	1	0.55
1,2,4-Trimethylbenzene	95-63-6	8260B	1	0.33
1,3,5-Trimethylbenzene	108-67-8	8260B	1	0.36
Vinyl chloride	75-01-4	8260B	1	0.24
o-Xylene	95-47-6	8260B	1	0.27
p-Xylene	106-42-3	8260B	1	0.66
m-Xylene	108-38-3	8260B	1	0.66



TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs)
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RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
<i>TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/L)</i> <i>[includes Base-Neutrals (black) and Acid Extractables (blue)]</i>				
Acenaphthene	83-32-9	8270C	10	0.15
Acenaphthylene	208-96-8	8270C	10	0.09
Anthracene	120-12-7	8270C	10	0.10
Benzo(a)anthracene	56-55-3	8270C	10	0.16
Benzo(a)pyrene	50-32-8	8270C	10	0.09
Benzo(b)fluoranthene	205-99-2	8270C	10	0.17
Benzo(g,h,i)perylene	191-24-2	8270C	10	0.12
Benzo(k)fluoranthene	207-08-9	8270C	10	0.12
Benzyl alcohol	100-51-6	8270C	20	1.79
bis(2-Chloroethoxy)methane	111-91-1	8270C	10	2.10
bis(2-Chloroethyl)ether	111-44-4	8270C	10	2.44
2,2'-oxybis(1-chloropropane); bis(2-chloroisopropyl)ether	108-60-1	8270C	10	1.77
bis(2-Ethylhexyl)phthalate	117-81-7	8270C	10	2.80
Butyl benzyl phthalate	85-68-7	8270C	10	7.47
4-Bromophenyl phenyl ether	101-55-3	8270C	10	2.50
4-Chloroaniline	106-47-8	8270C	10	1.05
4-Chloro-3-methylphenol	59-50-7	8270C	10	2.73
2-Chloronaphthalene	91-58-7	8270C	10	1.94
2-Chlorophenol	95-57-8	8270C	10	1.00
4-Chlorophenyl-phenylether	7005-72-3	8270C	10	2.42
Chrysene	218-01-9	8270C	10	0.17
Dibenzo(a,h)anthracene	53-70-3	8270C	10	0.12
Dibenzofuran	132-64-9	8270C	10	0.12
3,3'-Dichlorobenzidine	91-94-1	8270C	20	7.43
2,4-Dichlorophenol	120-83-2	8270C	10	2.13
1,2-Dichlorobenzene	95-50-1	8270C	10	2.50
1,3-Dichlorobenzene	541-73-1	8270C	10	2.43
1,4-Dichlorobenzene	106-46-7	8270C	10	2.45
Diethyl phthalate	84-66-2	8270C	10	2.99
2,4-Dimethylphenol	105-67-9	8270C	10	1.60
Dimethyl phthalate	131-11-3	8270C	10	2.53
Di-n-butyl phthalate	84-74-2	8270C	10	6.64
Di-n-octyl phthalate	117-84-0	8270C	10	6.95
4,6-Dinitro-2-methylphenol	534-52-1	8270C	50	7.62
2,4-Dinitrophenol	51-28-5	8270C	50	10.51
2,4-Dinitrotoluene	121-14-2	8270C	10	3.52
2,6-Dinitrotoluene	606-20-2	8270C	10	2.67



TABLE 2

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Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/L) <i>[includes Base-Neutrals (black) and Acid Extractables (blue)]</i>				
Fluoranthene	206-44-0	8270C	10	0.14
Fluorene	86-73-7	8270C	10	0.10
Hexachlorobenzene	118-74-1	8270C	10	1.14
Hexachlorobutadiene	87-68-3	8270C	10	3.50
Hexachlorocyclopentadiene	77-47-4	8270C	45	23.67
Hexachloroethane	67-72-1	8270C	10	3.47
Indeno(1,2,3-cd)pyrene	193-39-5	8270C	10	0.13
Isophorone	78-59-1	8270C	10	2.51
2-Methylnaphthalene	91-57-6	8270C	10	0.09
2-Methylphenol (o-Cresol)	95-48-7	8270C	10	2.07
4-Methylphenol (p-Cresol)	106-44-5	8270C	10	1.09
Naphthalene	91-20-3	8270C	10	0.11
2-Nitroaniline	88-74-4	8270C	50	4.50
3-Nitroaniline	99-09-2	8270C	50	3.50
4-Nitroaniline	100-01-6	8270C	50	3.14
Nitrobenzene	98-95-3	8270C	10	2.27
2-Nitrophenol	88-75-5	8270C	10	2.00
4-Nitrophenol	100-02-7	8270C	50	15.00
N-Nitrosodiphenylamine	86-30-6	8270C	10	2.29
N-Nitroso-di-n-propylamine	621-64-7	8270C	10	1.66
Pentachlorophenol	87-86-5	8270C	50	9.54
Phenanthrene	85-01-8	8270C	10	0.14
Phenol	108-95-2	8270C	10	1.10
Pyrene	129-00-0	8270C	10	0.17
1,2,4-Trichlorobenzene	120-82-1	8270C	10	2.45
2,4,5-Trichlorophenol	95-95-4	8270C	10	3.21
2,4,6-Trichlorophenol	88-06-2	8270C	10	1.92
TAL Metals (modified): (12 compounds) (mg/L) <i>[site specific metals in blue]</i>				
Antimony	7440-38-2	6010B	0.02	0.0055
Arsenic	7440-38-2	6010B	0.01	0.00338
Barium	7440-39-3	6010B	0.002	0.00017
Cadmium	7440-43-9	6010B	0.001	0.00034
Chromium	7440-47-3	6010B	0.004	0.0009
Lead	7439-92-1	6010B	0.005	0.0016
Mercury	7439-97-6	7470A	0.0002	0.00015
Nickel	7440-02-0	6010B	0.01	0.0011
Potassium	7440-09-7	6010B	0.5	0.039



TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs)
FOR GROUNDWATER

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Analyte ¹	CAS Number	Analytical Method ²	PQL	MDL
TAL Metals (modified): (12 compounds) (mg/L) <i>[site specific metals in blue]</i>				
Selenium	7782-49-2	6010B	0.015	0.0061
Silver	7440-22-4	6010B	0.003	0.0009
Thallium	7440-28-0	6010B	0.02	0.0066
Wet Chemistry: (1 compound) (mg/L)				
Cyanide (total)	57-12-5	9012.0	1.0	0.005
Field Parameters: (5 compounds) (units as identified below)				
pH (units)	NA	field	NA	NA
Temperature (°C)	NA	field	NA	NA
Specific Conductance (uS/mS)	NA	field	NA	NA
Turbidity (NTU)	NA	field	NA	NA
Dissolved Oxygen	NA	field	NA	NA

Notes:

1. Analytes as per NYSDEC and USEPA list of parameters.
2. Analytical methods per USEPA publication, SW-846, "Test Methods for Evaluating Solid Waste", Third Edition.

Acronyms/Abbreviations:

CAS = Chemical Abstracts Service registry number.
MDL = Method Detection Limit provided by STL
mg/L = milligrams per liter
mS = milli-Siemans
ug/L = micrograms per liter
uS = micro-Siemans

TCL = Target Compound List
TAL = Target Analyte List
STARS = Spill Technology And Remediation Series; NYSDEC
NA = not applicable
NTU = nephelometric turbidity unit
PQL = Practical Quantitation Limit



TABLE 3

PROJECT GOALS FOR PRECISION, ACCURACY & COMPLETENESS
FOR LABORATORY MEASUREMENTS

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Analytical Method	Precision Goal ¹ (RPD) ²	Accuracy Goal (% R) ³		Completeness Goal (%)
	Soil & Water	Soil	Water	
STARS 8021B or EPA 8260B	± 30	± 50	± 30	90
EPA 8270C	± 30	± 50	± 30	90
EPA 6010B and EPA 7470A/7471A	± 30	± 50	± 30	90
EPA 8082	± 30	± 50	± 30	90
Water Quality Parameters	± 30	NA	± 30	90

Notes:

1. Precision goals vary depending on the compound being analyzed; precision goals presented are general in nature.
2. RPD = Relative Percent Difference
3. %R = Percent Recovery



TABLE 4

PROJECT GOALS FOR PRECISION, ACCURACY & COMPLETENESS
FOR FIELD MEASUREMENTS

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Measurement	Units	Precision Goal	Accuracy Goal	Completeness Goal
pH	pH units	± 0.2 unit	± 0.2 unit	90%
Eh	milli-volts (mV)	± 1.0 mV	± 1.0 mV	90%
Temperature	degrees Celsius ($^{\circ}\text{C}$)	± 0.2 deg. C	± 0.4 deg. C	90%
Turbidity	NTU	± 0.05 NTU	± 0.05 NTU	90%
Specific Conductance	mS/cm at 25°C mS/cm at 25°C	± 100 uS/cm ± 0.1 mS/cm	± 100 uS/cm ± 0.1 mS/cm	90%
Dissolved Oxygen	ppm	± 0.3 ppm	± 0.3 ppm	90%
Water Level	fbTOR	± 0.01 unit	± 0.01 unit	90%

Acronyms/ Abbreviations:

fbTOR = feet below top of riser

mS = milli-Siemans

NTU = nephelometric turbidity unit

ug/L = micrograms per liter



TABLE 5

DATA MEASUREMENT UNITS FOR
FIELD & LABORATORY PARAMETERS

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Parameter	Units
Water Level	feet below top of riser (fbTOR)
pH	pH units
Eh	milli-volts (mV)
Temperature	degrees Celsius (°C)
Turbidity	Nephelometric Turbidity Unit (NTU)
Specific Conductance	microsiemens per centimeter at 25°C (mS/cm) millisiemens per centimeter at 25°C (mS/cm)
Dissolved Oxygen (DO)	parts per million (ppm)
Concentration of parameter in soil sample	micrograms per kilogram (mg/kg) organic milligrams per kilogram (mg/kg) inorganic
Concentration of parameter in groundwater sample	micrograms per liter (mg/L) organic milligrams per liter (mg/L) inorganic
Hydraulic Conductivity	centimeters per second (cm/sec)
Photoionization Detector (PID)	parts per million by volume (ppmv)



TABLE 6

ANALYTICAL PROGRAM QUALITY ASSURANCE/
QUALITY CONTROL SUMMARY

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Area of Concern	Matrix, Parameter ¹ & Minimum No. of Samples							
	Soil					Groundwater		
	TCL VOCs+ STARS ²	TCL SVOCs ³	TAL Metals	TCL PCBs ⁴	Pesticides/Herbicides	TCL VOCs+ STARS ⁵	TCL SVOCs ⁶	TAL Metals
AOC 1 <i>Site Subsurface Soil/Fill</i>	19	19	19	3	3			
AOC 2 <i>Site Surface Soil/Fill</i>	0	11	11	3	3			
AOC 3 <i>Site Groundwater</i>						8	8	8
AOC 4 <i>Former PCB Area (Shenango Mold)</i>	0	0	0	15	0			
AOC 5 <i>Former Groundwater Infiltration Area (Shenango Mold)</i>	12	12	12	12	0			
TOTALS:	31	42	42	33	6	8	8	8

QA/QC Sample	Estimated Number of QA/QC Samples							
	Soil					Groundwater		
Blind Duplicate ⁶	2	3	3	2	1	1	1	1
Matrix Spike (MS) ⁶	2	3	3	2	1	1	1	1
Matrix Spike Duplicate (MSD) ⁶	2	3	3	2	1	1	1	1
Trip Blank ⁷	0	0	0	0	0	1	0	0
Equipment Blank ⁸	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

- All analyses will be performed via SW-846 methodologies with Category B equivalent deliverables package.
- If necessary based on PID readings, full TCL list of VOCs via Method 8260B, plus the STARS List VOCs via Method 8021.
- Full TCL list of SVOCs via Method 8270C, including base-neutrals and acid extractables.
- Target Analyte List (TAL) Metals.
- PCBs include the full TCL list of PCBs via Method 8082.
- Blind duplicate and MS/MSD samples will be collected at a frequency of 1 per 20 samples collected.
- Trip blanks will be submitted to the laboratory each day groundwater volatile organic samples are collected.
- Equipment blanks collected daily if non-dedicated equipment is used; Work Plan calls for dedicated sampling equipment to be used.

Acronyms:

MS = matrix spike
MSD = matrix spike duplicate
NA = Not Applicable
STARS = Spill Technology And Remediation Series; NYSDEC
TCL = Target Compound List



TABLE 7

SUMMARY OF FIELD OPERATING PROCEDURES

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Benchmark FOP No.	Procedure
001.0	Abandonment of Borehole Procedures
007.0	Calibration and Maintenance of Portable Dissolved Oxygen Meter
008.0	Calibration and Maintenance of Portable Field pH/Eh Meter
009.0	Calibration and Maintenance of Portable Field Turbidity Meter
011.0	Calibration and Maintenance of Portable Photoionization Detector
012.0	Calibration and Maintenance of Portable Specific Conductance Meter
015.0	Documentation Requirements for Drilling and Well Installation
017.0	Drill Site Selection Procedure
018.0	Drilling and Excavation Equipment Decontamination Procedures
021.0	Establishing Horizontal and Vertical Control
022.0	Groundwater Level Measurement
024.0	Groundwater Sample Collection Procedures
026.0	Hollow Stem Auger (HSA) Drilling Procedures
031.0	Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedure
032.0	Management of Investigation-Derived Waste (IDW)
033.0	Monitoring Well Construction for Hollow Stem Auger Boreholes
036.0	Monitoring Well Development Procedures
039.0	NAPL Detection and Sample Collection Procedure
046.0	Sample Labeling, Storage and Shipment Procedures
047.0	Screening of Soil Samples for Organic Vapors During Drilling Activities
054.0	Soil Description Procedures Using The USCS
063.1	Surface and Subsurface Soil Sampling Procedures
073.0	Real-Time Air Monitoring During Intrusive Activities
076.0	"Before Going Into the Field" Procedure

TABLE 8

**SAMPLE CONTAINER, VOLUME, PRESERVATION &
HOLDING TIME REQUIREMENTS**

RI/AAR/IRM Work Plan
Sonvil BCP Site
Buffalo, New York

Matrix	Parameter ¹	Method ¹	Container Type	Minimum Volume	Preservation (Cool to 2-4 °C for all samples)	Holding Time from Sample Date
Soil	TCL VOCs + STARS	8260B	WMG	16 oz.	Cool to 2-4 °C, Zero Headspace	14 days
	TCL SVOCs	8270C	WMG	16 oz.	Cool to 2-4 °C	14 days extrac./40 days
	TAL Metals	6010B	WMG	4 oz.	Cool to 2-4 °C	6 months/Hg 28 days
	Pesticides	8081	WMG	8oz	Cool to 2-4 °C	14 days extrac./40 days
	Herbicides	8151	WMG	8oz	Cool to 2-4 °C	14 days extrac./40 days
	PCBs	8082	WMG	4 oz.	Cool to 2-4 °C	14 days extrac./40 days
Groundwater	TCL VOCs + STARS	8260B	glass vial	3 - 4 oz.	Cool to 2-4 °C, HCl to pH<2, Zero Headspace	14 days
	TCL SVOCs	8270C	amber glass	1000 ml	Cool to 2-4 °C	7 days extrac./40 days
	TAL Metals	6010B	plastic	600 ml	HNO ₃ to pH<2, Cool to 2-4 °C	6 months/Hg 28 days

References:

1. Test Methods for Evaluating Solid Wastes, USEPA SW-846, Update III, 1991.

Notes:

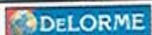
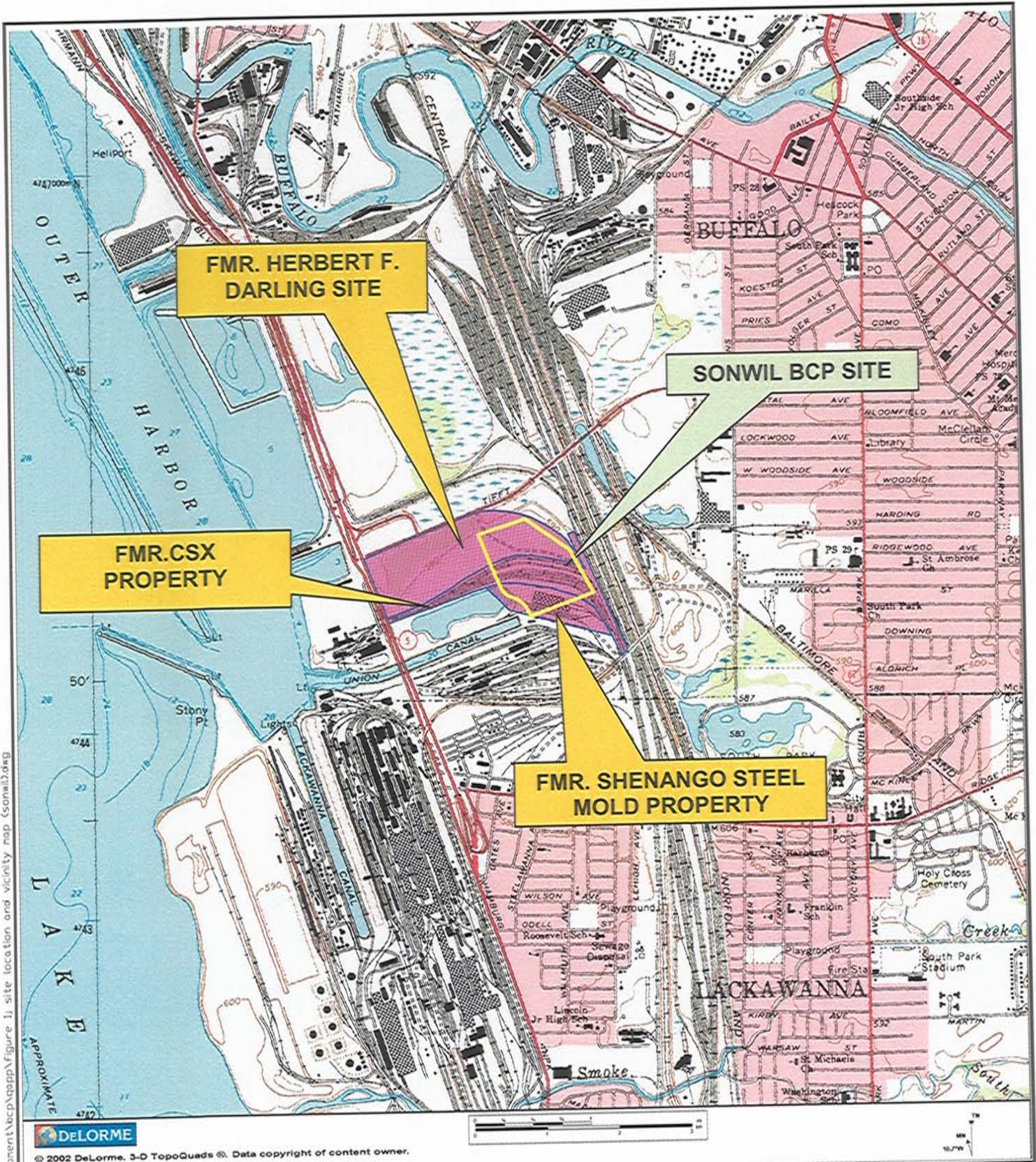
1. EPA approved methods published in Reference 1 above may be used. The list of analytes, laboratory method and the method detection limit for each parameter are included in Tables 1 and 2 of the QAPP.

Acronyms:

VOCs = Volatile Organic Compounds
SVOCs = Semi-Volatile Organic Compounds
TCL = Target Compound List
TAL = Target Analyte List
WMG = Wide Mouth Glass

FIGURES

FIGURE 1



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726 EXCHANGE STREET
SUITE 624
BUFFALO, NEW YORK 14210
(716) 856-635

SITE LOCATION AND VICINITY MAP

QAPP

BUFFALO LAKESIDE COMMERCE PARK
BUFFALO, NEW YORK

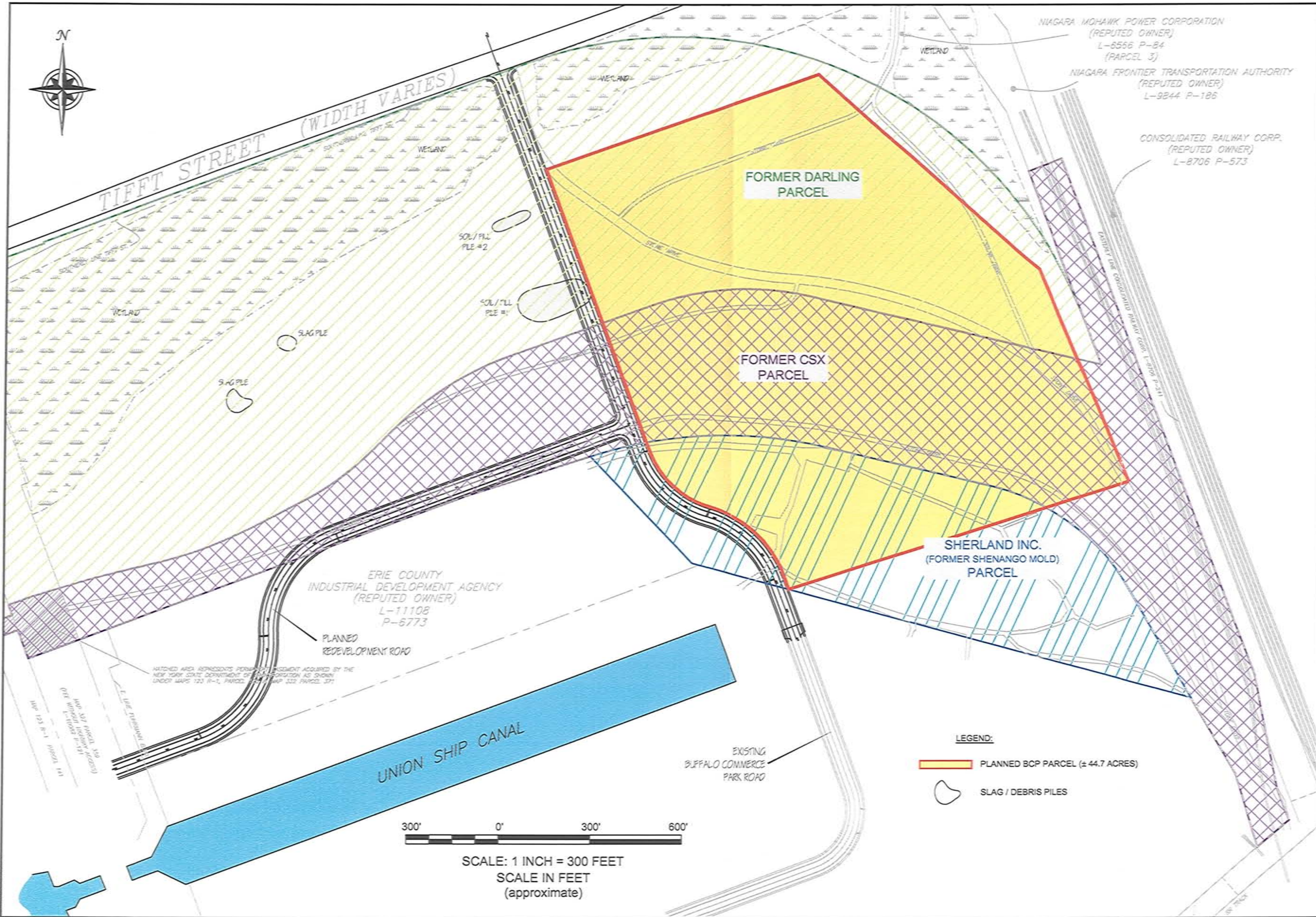
PREPARED FOR
SONWIL DISTRIBUTION

PROJECT NO.: 0131-001-100

DATE: AUGUST 2007

DRAFTED BY: RCH

DATE: AUGUST 2008
PROJECT: Development of BCP/QAPP Figure 2: Site Plan (SONWIL).dwg
DRAFTED BY: BCI



SITE PLAN
QAPP
BUFFALO LAKESIDE COMMERCE PARK
BUFFALO, NEW YORK

PREPARED FOR
SONWIL DISTRIBUTION

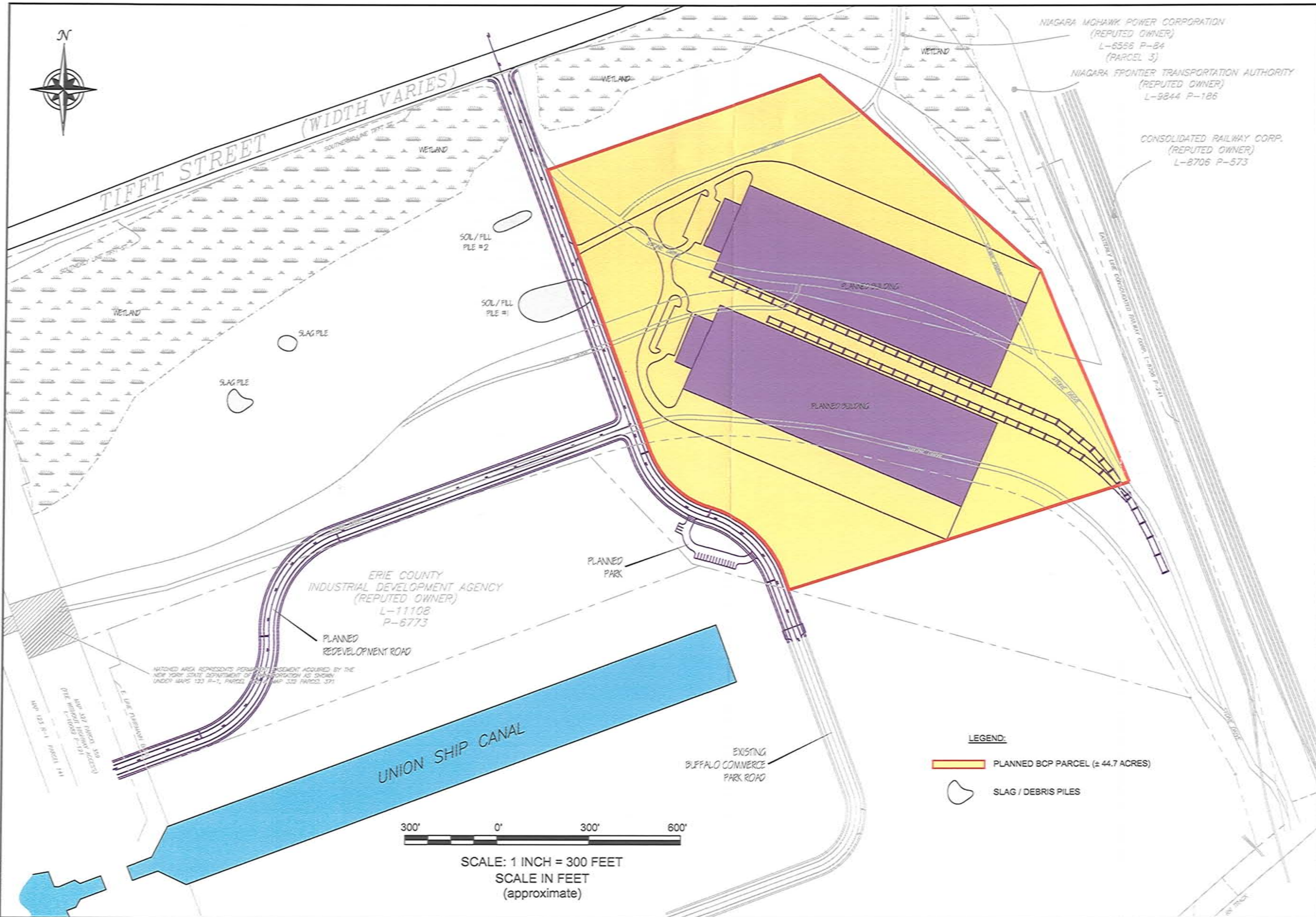


726 EXCHANGE STREET
SUITE 624
BUFFALO, NEW YORK 14210
(716) 856-0835

JOB NO.: 0131-001-100

FIGURE 2

\\NYC\GIS\2007\Development\BCP\QAPP\Figure 3 Redevelopment Plan.dwg
DATE: AUGUST 2007
DRAFTED BY: BCI



REDEVELOPMENT PLAN
QAPP

BUFFALO LAKESIDE COMMERCE PARK
BUFFALO, NEW YORK

PREPARED FOR
SONWIL DISTRIBUTION



726 EXCHANGE STREET
SUITE 624
BUFFALO, NEW YORK 14210
(716) 856-0835

JOB NO.: 0131-001-100

FIGURE 3

APPENDIX A

FIELD OPERATING PROCEDURES (FOPS)



APPENDIX A

SUMMARY OF FIELD OPERATING PROCEDURES

RI/AAR/IRM Work Plan
Sonwil BCP Site
Buffalo, New York

Benchmark FOP No.	Procedure
001.0	Abandonment of Borehole Procedures
007.0	Calibration and Maintenance of Portable Dissolved Oxygen Meter
008.0	Calibration and Maintenance of Portable Field pH/Eh Meter
009.0	Calibration and Maintenance of Portable Field Turbidity Meter
011.0	Calibration and Maintenance of Portable Photoionization Detector
012.0	Calibration and Maintenance of Portable Specific Conductance Meter
015.0	Documentation Requirements for Drilling and Well Installation
017.0	Drill Site Selection Procedure
018.0	Drilling and Excavation Equipment Decontamination Procedures
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031.0	Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedure
032.0	Management of Investigation-Derived Waste (IDW)
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036.0	Monitoring Well Development Procedures
039.0	NAPL Detection and Sample Collection Procedure
046.0	Sample Labeling, Storage and Shipment Procedures
047.0	Screening of Soil Samples for Organic Vapors During Drilling Activities
054.0	Soil Description Procedures Using The USCS
063.1	Surface and Subsurface Soil Sampling Procedures
073.0	Real-Time Air Monitoring During Intrusive Activities
076.0	"Before Going Into the Field" Procedure



FIELD OPERATING PROCEDURES

Abandonment of Borehole Procedures

ABANDONMENT OF BOREHOLE PROCEDURE

PURPOSE

Soil borings that are not completed as monitoring wells will be plugged by filling the holes with a cement/bentonite grout. Field staff will calculate the borehole volume and compare it to the final installed volume of grout to evaluate whether bridging or loss to the formation has occurred. These calculations and the actual volume placed will be noted on the Boring Log.

PROCEDURE

1. Determine most suitable seal materials. Grout specifications generally have mixture ratios as follows:

Grout Slurry Composition (% Weight)

1.5 to 3.0%	-	Bentonite (Quick Gel)
40 to 60 %	-	Cement (Portland Type I)
40 to 60 %	-	Potable Water

2. Calculate the volume of the borehole base on the bit or auger head diameter plus 10% and determine the volume of grout to be emplaced. Generally, the total mixed volume is the borehole volume plus 20%.
3. Identify the equipment to be used for the preparation and mixing of the grout. Ensure the volume of the tanks to be used for mixing has been measured adequately. Document these volumes on the **Field Borehole Log** (sample attached).
4. Identify the source of the water to be used for the grout and determine its suitability for use. In particular, water with high sulfate, or chloride levels or heated water should not be used. These types of waters can cause operational difficulties or modify the set-up for the grout.
5. Identify the equipment to be used for emplacing the grout. Ensure that the pump to be used has adequate pressure to enable complete return to surface.

FOP 001.0

ABANDONMENT OF BOREHOLE PROCEDURE

6. Identify the volumes to be pumped at each stage or in total if only one stage is to be used.
7. Prepare the borehole abandonment plan and discuss the plan and activities with the drilling contractor prior to beginning any mixing activities.
8. Begin mixing the grout to be emplaced.
9. Record the type and amount of materials used during the mixing operation. Ensure the ratios are within specifications tolerance.
10. Begin pumping the grout through the return line bypass system to confirm all pump and surface fittings are secure.
11. Initiate downhole pumping from the bottom of the borehole. Record the times and volumes emplaced on the Field Borehole Log (sample attached).
12. Document the return circulation of grout. This may be facilitated by using a colored dye or other tagging method if a mudded borehole condition exists prior to grout injection.
13. Identify what procedures will be used for grouting in the upper 3 feet. When casing exists in the borehole, decisions are required as to the timing for removal and final disposition of the casing. Generally, it will not be removed prior to grouting because of the potential for difficult access and loss of circulation in the upper soil or rock layers. Accordingly, when cement return is achieved at surface, the casing is commonly removed and the borehole is topped off with grout or soils. If casing removal is not possible or not desired, the casing left in place should be cut off at a depth of 5 feet or greater below ground surface. If casing is not present during grouting, the grout level in the borehole is topped off after the rods or tremie pipe is removed.
14. Clear and clean the surface near the borehole. Level the ground to above the pre-existing grade. Add grout or cement as necessary to the area near the borehole. (Note: On occasion, the grout may settle over several days. If settling occurs, the



FOP 001.0

ABANDONMENT OF BOREHOLE PROCEDURE

natural soils from the immediate vicinity can be used to level to settled area to match the existing grade.

15. A follow-up check at each site should be made within one week to 10 days of completion. Document the visit and describe any action taken on a Field Activity Daily Log.

ATTACHMENTS

Field Borehole Log (sample)

REFERENCES

New York State Department of Environmental Conservation, July 1988, Drilling and Monitoring Well Installation Guidance Manual.

Driscoll, F.G., 1987, Groundwater and Wells, Johnson Division, St. Paul, Minnesota, 1089 p.



ABANDONMENT OF BOREHOLE PROCEDURE



TURNKEY
ENVIRONMENTAL
RESTORATION, LLC



FIELD OPERATING PROCEDURES

Calibration & Maintenance of Portable Dissolved Oxygen Meter

FOP 007.0

CALIBRATION AND MAINTENANCE OF PORTABLE DISSOLVED OXYGEN METER

PURPOSE

This guideline describes a method for calibration of a portable dissolved oxygen meter. This meter measures the concentration of dissolved oxygen within a water sample. This parameter is of interest both as a general indicator of water quality, and because of its pertinence to fate and transport of organics and inorganics. This guideline presents a method for calibration of this meter, which is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the dissolved oxygen meter will be within $\pm 1\%$ of full-scale over the temperature range of 23° to 113° F (-5° to +45° C).

PROCEDURE

1. Calibrate the dissolved oxygen meter to ambient air based on probe temperature and true local atmospheric pressure conditions (or feet above sea level). Because procedures vary with different brands and models of meters, refer to the manufacturer's recommended calibration procedures.
2. In the event of a failure to adequately calibrate, follow the corrective action directed by the manufacturer.
3. If calibration cannot be achieved or maintained, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.



FOP 007.0

CALIBRATION AND MAINTENANCE OF PORTABLE DISSOLVED OXYGEN METER

4. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
 - Time, date, and initials of the field team member performing the calibration
 - The unique identifier for the meter, including manufacturer, model, and serial number
 - The brand and expiration dates of calibration solutions
 - The calibration readings
 - The instrument settings (if applicable)
 - The approximate response time
 - The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above
 - Corrective action taken (see Step 5 above) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use or between measurements, the dissolved oxygen probe will be kept immersed in or moist with deionized water.
- The meter batteries will be checked prior to each meter's use and will be replaced when the meter cannot be redline adjusted.
- The meter response time and stability will be tracked to determine the need for instrument maintenance. When response time becomes greater than two minutes, probe service is indicated.

ATTACHMENTS

Equipment Calibration Log (sample)



FOP 007.0

CALIBRATION AND MAINTENANCE OF PORTABLE DISSOLVED OXYGEN METER



EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: _____

Date: _____

Project No.: _____

Client: _____

Instrument Source: ☐ TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL BY	STANDARD	READING	SETTL
<input type="checkbox"/> pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00 7.00 10.01 < 0.4 20 100 800		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		uS @ 25 °C		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		open air zero		MIBK re factor
<input type="checkbox"/> PID	ppm		Photovac 2020 PID	215 276 303		ppm Iso. Gas		
<input type="checkbox"/> Particulate meter	mg/m ³					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/hr					background area		
<input type="checkbox"/>								

ADDITIONAL REMARKS:

PREPARED BY: _____

DATE: _____





FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Field pH/Eh Meter

FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

PURPOSE

This guideline describes a method for calibration of a portable pH/Eh meter. The pH/Eh meter measures the hydrogen ion concentration or acidity of a water sample (pH function), and the oxidation/reduction potential of a water sample (Eh function). Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the pH/Eh meter will be:

pH ± 0.2 pH unit, over the temperature range of ± 0.2 C.

Eh ± 0.2 millivolts (mV) over the range of ± 399.9 mV, otherwise ± 2 mV.

PROCEDURE

Note: Meters produced by different manufacturers may have different calibration procedures. These instructions will take precedence over the procedure provided herein. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

1. Obtain and active the meter to be used. As stated above, initial calibrations will be performed at the beginning of each sampling day.



FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

2. Immerse the sensing probe in a container of certified pH 7.0 buffer solution traceable to the National Bureau of Standards.
3. Measure the temperature of the buffer solution, and adjust the temperature setting accordingly.
4. Compare the meter reading to the known value of the buffer solution while stirring. If the reading obtained by the meter does not agree with the known value of the buffer solution, recalibrate the meter according to the manufacturer's instructions until the desired reading is obtained. This typically involves accessing and turning a dial or adjustment screw while measuring the pH of the buffer solution. The meter is adjusted until the output agrees with the known solution pH.
5. Repeat Steps 2 through 5 with a pH 4.0 and 10.0 buffer solution to provide a three-point calibration. Standards used to calibrate the pH meter will be of concentrations that bracket the expected values of the samples to be analyzed, especially for two-point calibrations (see note below).

Note: Some pH meters only allow two-point calibrations. Two-point calibrations should be within the suspected range of the groundwater to be analyzed. For example, if the groundwater pH is expected to be approximately 8, the two-point calibration should bracket that value. Buffer solutions of 7 and 10 should then be used for the two-point calibration.

6. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
 - Time, date, and initials of the field team member performing the calibration
 - The unique identifier for the meter, including manufacturer, model, and serial number
 - The brand and expiration dates of buffer solutions
 - The instrument readings
 - The instrument settings (if applicable)



FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use, or between measurements, keep the pH/Eh probe immersed in or moist with buffer solutions.
- Check the meter batteries at the end of each day and recharge or replace as needed.
- Replace the pH/Eh probe any time that the meter response time becomes greater than two minutes or the meter consistently fails to retain its calibrated accuracy for a minimum of ten sample measurements.
- If a replacement of the pH/Eh probe fails to resolve instrument response time and stability problems, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.

ATTACHMENTS

Equipment Calibration Log (sample)



FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER



EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: _____
 Project No.: _____
 Client: _____

Date: _____

Instrument Source: ☐ TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETUP
<input type="checkbox"/> pH meter	units		Myron I. Company Ultra Meter 6P	606987		4.00 7.00 10.01 < 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20 100 800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron I. Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID			open air zero ppm Iso. Gas		MIBK re factor :
<input type="checkbox"/> Particulate meter	mg/m ³					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/hr					background area		
<input type="checkbox"/>								

ADDITIONAL REMARKS: _____

PREPARED BY: _____ **DATE:** _____





FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Field Turbidity Meter

**CALIBRATION AND MAINTENANCE OF PORTABLE
FIELD TURBIDITY METER**

PURPOSE

This guideline describes the method for calibration of the HACH 2100P portable field turbidity meter. Turbidity is one water quality parameter measured during purging and development of wells. Turbidity is measured as a function of the samples ability to transmit light, expressed as Nephelometric Turbidity Units (NTUs). The turbidity meter is factory calibrated and must be checked daily prior to using the meter in the field. Calibration is performed to verify instrument accuracy and function. This procedure also documents critical maintenance activities for this meter.

ACCURACY

Accuracy shall be $\pm 2\%$ of reading below 499 NTU or $\pm 3\%$ of reading above 500 NTU with resolution to 0.01 NTU in the lowest range. The range key provides for automatic or manual range selection for ranges of 0.00 to 9.99, 0.0 to 99.9 and 0 to 1000 NTU. Another key provides for selecting automatic signal averaging. Pressing the key shall toggle signal averaging on or off.

PROCEDURE

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provides long-term stability and minimizes the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. **A formazin recalibration should be performed at least once every three months**, more often if experience indicates the need. During calibration, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

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CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER

Note: Meters produced by different manufacturers may have different calibration check procedures. These manufacturers' instructions will take precedence over the procedure provided here. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

Note: Because the turbidity meter measures light transmission, it is critical that the meter and standards be cared for as precision optical instruments. Scratches, dirt, dust, etc. can all temporarily or permanently affect the accuracy of meter readings.

Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

Note: These instructions do not apply to < 0.1 NTU StablCal Standards; < 0.1 NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to re-suspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the vial of StablCal 5 to 7 times.
4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2 on page 11 of the manual*)



FOP 009.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER

and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3 on page 12 of the manual*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure.

Calibration Procedure

1. Turn the meter on.
2. Shake pre-mixed formazin primary standards in accordance with the above procedure.
3. Wipe the outside of the < 0.1 NTU standard and insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.
4. Close the lid and press **I/O**.
5. Press the **CAL** button. The **CAL** and **S0** icons will be displayed and the 0 will flash. The four-digit display will show the value of the **S0** standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank. Press the right arrow key (\rightarrow) to get a numerical display.
6. Press **READ**. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (see *Section 3.6.2.3 on page 31 of the manual*). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment

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CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER

Note: The turbidity of the dilution water can be “forced” to zero by pressing → rather than reading the dilution water. The display will show “S0 NTU” and the ↑ key must be pressed to continue with the next standard.

7. Repeat steps 1 through 7 for the 20, 100 and 800 standards.
8. Following the 800 NTU standard calibration, the display will increment back to the **S0** display. Remove the sample cell from the cell compartment.
9. Press **CAL** to accept the calibration. The instrument will return to measurement mode automatically.
10. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
 - Time, date, and initials of the field team member performing the calibration
 - The unique identifier for the meter, including manufacturer, model, and serial number
 - The brand of calibration standards
 - The instrument readings
 - The instrument settings (if applicable)
 - Pass or fail designation in accordance with the accuracy specifications presented above
 - Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

Note: Pressing **CAL** completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after **CAL** is pressed. If **E 1** or **E 2** appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If “**CAL?**” appears, an error may have



**CALIBRATION AND MAINTENANCE OF PORTABLE
FIELD TURBIDITY METER**

occurred during calibration. If “CAL?” is flashing, the instrument is using the default calibration.

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ**, **I/O**, **↑**, and **→** keys function. Signal averaging and range mode must be selected before entering the calibration mode.
- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If “CAL?” is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.
- To review a calibration, press **CAL** and then **↑** to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

MAINTENANCE

- **Cleaning:** Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1 on page 11 of the manual* for more information about sample cell care.
- **Battery Replacement:** AA alkaline cells typically last for about 300 tests with the signal-averaging mode off, about 180 tests if signal averaging is used. The “battery” icon flashes when battery replacement is needed. Refer to *Section 1.4.2 on page 5 of the manual* for battery installation instructions. If the batteries are changed within 30



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seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings. If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

- **Lamp Replacement:** The procedure in *Section 4.0 on page 49 of the manual* explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

ATTACHMENTS

Equipment Calibration Log (sample)



FOP 009.0

**CALIBRATION AND MAINTENANCE OF PORTABLE
FIELD TURBIDITY METER**



EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: _____

Date: _____

Project No.: _____

Client: _____

Instrument Source: ☐ TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTL
<input type="checkbox"/> pH meter	units		Myron L. Company Ultra Meter 6P	606987		4.00 7.00 10.01		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4 20 100 800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L. Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID	21107		open air zero ppm Iso. Gas		MIBK re factor :
<input type="checkbox"/> Particulate meter	mg/m ³					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/h					background area		
<input type="checkbox"/>								

ADDITIONAL REMARKS:

PREPARED BY: _____

DATE: _____





FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Photoionization Meter

FOP 011.0

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

PURPOSE

This procedure describes a general method for the calibration and maintenance of a portable photoionization detector (PID). The PID detects and initially quantifies a reading of the volatile organic compound (VOC) concentration in air. The PID is used as a field-screening tool for initial evaluation of soil samples and for ambient air monitoring of compounds with ionization potentials (IP) less than the PID lamp electron voltage (eV) rating. The IP is the amount of energy required to move an electron to an infinite distance from the nucleus thus creating a positive ion plus an electron. It should be noted that all of the major components of air (i.e., carbon dioxide, methane, nitrogen, oxygen etc.) have IP's above 12 eV. As a result, they will not be ionized by the 9.5, 10.2, 10.6 or 11.7 eV lamps typically utilized in field PIDs. The response of the PID will then be the sum of the organic and inorganic compounds in air that are ionized by the appropriate lamp (i.e., 9.5, 10.2, 10.6 or 11.7 eV). Attached to this FOP is a table summarizing common organic compounds and their respective IPs.

Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable



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CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

equipment are typically similar. The information below pertains to the Photovac 2020 photoionization detector equipped with a 10.6 eV lamp. The actual equipment to be used in the field will be equivalent or similar. The previously mentioned attached table indicates the compounds that cannot be detected by a standard 10.6 eV lamp.

Note: The PID indicates total VOC concentration readings that are normalized to an isobutylene standard, so actual quantification of individual compounds is not provided. In addition, the PID response to compounds is highly variable, dependent on ionization potential of the compound, and the presence or absence of other compounds.

ACCURACY

The Photovac 2020 is temperature compensated so that a 20 °C change in temperature corresponds to a change in reading of less than two percent full-scale at maximum sensitivity. The useful range of the instrument is from 0.5 – 2000 ppm isobutylene with an accuracy of $\pm 10\%$ or ± 2 ppm. Response time is less than three seconds to 90 percent of full-scale. The operating temperature range is 0 to 40° C and the operating humidity range is 0 to 100 % relative humidity (non-condensing).

PROCEDURE

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the PID according to the manufacture's specifications.
2. Calibrate the PID meter using a compressed gas cylinder containing a 100-ppm isobutylene standard, a flow regulator, and a tubing assembly. In



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CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

addition, a compressed gas cylinder containing zero air (“clean” air) may be required if ambient air conditions do not permit calibration to “clean air”.

3. Fill two Tedlar bags equipped with a one-way valve with zero-air (if applicable) and 100-ppm isobutylene gas.
4. Assemble the calibration equipment and actuate the PID in its calibration mode. Connect the PID probe to the zero air calibration bag (or calibrate to ambient air if conditions permit) and wait for a stable indication.
5. Change the response factor of the PID to the Methyl Isobutyl Ketone (MIBK) setting, which is a response factor of 1.0 for the Photovac 2020.
6. Connect the PID probe to the 100-ppm isobutylene standard calibration bag. Measure an initial reading of the isobutylene standard and wait for a stable indication.
7. Keep the PID probe connected to the 100-ppm isobutylene standard calibration bag, calibrate to 100-ppm with the isobutylene standard and wait for a stable indication.
8. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish maintenance schedules and component replacement. Information will include, at a minimum:
 - Time, date and initials of the field team member performing the calibration
 - The unique identifier for the meter, including manufacturer, model, and serial number
 - The brand and expiration date of the isobutylene gas
 - The instrument readings: before and after calibration
 - The instrument settings (if applicable)

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CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

- The probe and dust filter of the PID should be checked before and after every use for cleanliness. Should instrument response become unstable, recalibration should be performed. If this does not resolve the problem, access the photoionization bulb and clean with the manufacturer-supplied abrasive compound, then recalibrate.
- The PID battery must be recharged after each use. Store the PID in its carrying case when not in use. Additional maintenance details related to individual components of the PID are provided in the equipment manufacturer's instruction manual. If calibration or instrument performance is not in accordance with specifications, send the instrument to the equipment manufacturer for repair.
- Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

Table 1; Summary of Ionization Potentials
Equipment Calibration Log (sample)



FOP 011.0

CALIBRATION AND MAINTENANCE OF PORTABLE
PHOTOIONIZATION DETECTOR

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
A		
2-Amino pyridine	8	
Acetaldehyde	10.21	
Acetamide	9.77	
Acetic acid	10.69	X
Acetic anhydride	10	
Acetone	9.69	
Acetonitrile	12.2	X
Acetophenone	9.27	
Acetyl bromide	10.55	
Acetyl chloride	11.02	X
Acetylene	11.41	X
Acrolein	10.1	
Acrylamide	9.5	
Acrylonitrile	10.91	X
Allyl alcohol	9.67	
Allyl chloride	9.9	
Ammonia	10.2	
Aniline	7.7	
Anisidine	7.44	
Anisole	8.22	
Arsine	9.89	
B		
1,3-Butadiene (butadiene)	9.07	
1-Bromo-2-chloroethane	10.63	X
1-Bromo-2-methylpropane	10.09	
1-Bromo-4-fluorobenzene	8.99	
1-Bromobutane	10.13	
1-Bromopentane	10.1	
1-Bromopropane	10.18	
1-Bromopropene	9.3	
1-Butanethiol	9.14	
1-Butene	9.58	
1-Butyne	10.18	
2,3-Butadione	9.23	
2-Bromo-2-methylpropane	9.89	
2-Bromobutane	9.98	
2-Bromopropane	10.08	



**CALIBRATION AND MAINTENANCE OF PORTABLE
PHOTOIONIZATION DETECTOR**

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
2-Bromothiophene	8.63	
2-Butanone (MEK)	9.54	
3-Bromopropene	9.7	
3-Butene nitrile	10.39	
Benzaldehyde	9.53	
Benzene	9.25	
Benzenethiol	8.33	
Benzonitrile	9.71	
Benzotrifluoride	9.68	
Biphenyl	8.27	
Boron oxide	13.5	X
Boron trifluoride	15.56	X
Bromine	10.54	
Bromobenzene	8.98	
Bromochloromethane	10.77	X
Bromoform	10.48	
Butane	10.63	X
Butyl mercaptan	9.15	
cis-2-Butene	9.13	
m-Bromotoluene	8.81	
n-Butyl acetate	10.01	
n-Butyl alcohol	10.04	
n-Butyl amine	8.71	
n-Butyl benzene	8.69	
n-Butyl formate	10.5	
n-Butyraldehyde	9.86	
n-Butyric acid	10.16	
n-Butyronitrile	11.67	X
o-Bromotoluene	8.79	
p-Bromotoluene	8.67	
p-tert-Butyltoluene	8.28	
s-Butyl amine	8.7	
s-Butyl benzene	8.68	
sec-Butyl acetate	9.91	
t-Butyl amine	8.64	
t-Butyl benzene	8.68	
trans-2-Butene	9.13	
C		



CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
1-Chloro-2-methylpropane	10.66	X
1-Chloro-3-fluorobenzene	9.21	
1-Chlorobutane	10.67	X
1-Chloropropane	10.82	X
2-Chloro-2-methylpropane	10.61	X
2-Chlorobutane	10.65	X
2-Chloropropane	10.78	X
2-Chlorothiophene	8.68	
3-Chloropropene	10.04	
Camphor	8.76	
Carbon dioxide	13.79	X
Carbon disulfide	10.07	
Carbon monoxide	14.01	X
Carbon tetrachloride	11.47	X
Chlorine	11.48	X
Chlorine dioxide	10.36	
Chlorine trifluoride	12.65	X
Chloroacetaldehyde	10.61	X
α -Chloroacetophenone	9.44	
Chlorobenzene	9.07	
Chlorobromomethane	10.77	X
Chlorofluoromethane (Freon 22)	12.45	X
Chloroform	11.37	X
Chlorotrifluoromethane (Freon 13)	12.91	X
Chrysene	7.59	
Cresol	8.14	
Crotonaldehyde	9.73	
Cumene (isopropyl benzene)	8.75	
Cyanogen	13.8	X
Cyclohexane	9.8	
Cyclohexanol	9.75	
Cyclohexanone	9.14	
Cyclohexene	8.95	
Cyclo-octatetraene	7.99	
Cyclopentadiene	8.56	
Cyclopentane	10.53	
Cyclopentanone	9.26	
Cyclopentene	9.01	

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Cyclopropane	10.06	
m-Chlorotoluene	8.83	
o-Chlorotoluene	8.83	
p-Chlorotoluene	8.7	
D		
1,1-Dibromoethane	10.19	
1,1-Dichloroethane	11.12	X
1,1-Dimethoxyethane	9.65	
1,1-Dimethylhydrazine	7.28	
1,2-Dibromoethene	9.45	
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	12.2	X
1,2-Dichloroethane	11.12	X
1,2-Dichloropropane	10.87	X
1,3-Dibromopropane	10.07	
1,3-Dichloropropane	10.85	X
2,2-Dimethyl butane	10.06	
2,2-Dimethyl propane	10.35	
2,3-Dichloropropene	9.82	
2,3-Dimethyl butane	10.02	
3,3-Dimethyl butanone	9.17	
cis-Dichloroethene	9.65	
Decaborane	9.88	
Diazomethane	9	
Diborane	12	X
Dibromochloromethane	10.59	
Dibromodifluoromethane	11.07	X
Dibromomethane	10.49	
Dibutylamine	7.69	
Dichlorodifluoromethane (Freon 12)	12.31	X
Dichlorofluoromethane	12.39	X
Dichloromethane	11.35	X
Diethoxymethane	9.7	
Diethyl amine	8.01	
Diethyl ether	9.53	
Diethyl ketone	9.32	
Diethyl sulfide	8.43	
Diethyl sulfite	9.68	
Difluorodibromomethane	11.07	X



**CALIBRATION AND MAINTENANCE OF PORTABLE
PHOTOIONIZATION DETECTOR**

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Dihydropyran	8.34	
Diiodomethane	9.34	
Diisopropylamine	7.73	
Dimethoxymethane (methylal)	10	
Dimethyl amine	8.24	
Dimethyl ether	10	
Dimethyl sulfide	8.69	
Dimethylaniline	7.13	
Dimethylformamide	9.18	
Dimethylphthalate	9.64	
Dinitrobenzene	10.71	X
Dioxane	9.19	
Diphenyl	7.95	
Dipropyl amine	7.84	
Dipropyl sulfide	8.3	
Durene	8.03	
m-Dichlorobenzene	9.12	
N,N-Diethyl acetamide	8.6	
N,N-Diethyl formamide	8.89	
N,N-Dimethyl acetamide	8.81	
N,N-Dimethyl formamide	9.12	
o-Dichlorobenzene	9.06	
p-Dichlorobenzene	8.95	
p-Dioxane	9.13	
trans-Dichloroethene	9.66	
E		
Epichlorohydrin	10.2	
Ethane	11.65	X
Ethanethiol (ethyl mercaptan)	9.29	
Ethanolamine	8.96	
Ethene	10.52	
Ethyl acetate	10.11	
Ethyl alcohol	10.48	
Ethyl amine	8.86	
Ethyl benzene	8.76	
Ethyl bromide	10.29	
Ethyl chloride (chloroethane)	10.98	X
Ethyl disulfide	8.27	

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Ethyl ether	9.51	
Ethyl formate	10.61	X
Ethyl iodide	9.33	
Ethyl isothiocyanate	9.14	
Ethyl mercaptan	9.29	
Ethyl methyl sulfide	8.55	
Ethyl nitrate	11.22	X
Ethyl propionate	10	
Ethyl thiocyanate	9.89	
Ethylene chlorohydrin	10.52	
Ethylene diamine	8.6	
Ethylene dibromide	10.37	
Ethylene dichloride	11.05	X
Ethylene oxide	10.57	
Ethylenimine	9.2	
Ethynylbenzene	8.82	
F		
2-Furaldehyde	9.21	
Fluorine	15.7	X
Fluorobenzene	9.2	
Formaldehyde	10.87	X
Formamide	10.25	
Formic acid	11.05	X
Freon 11 (trichlorofluoromethane)	11.77	X
Freon 112 (1,1,2,2-tetrachloro-1,2-difluoroethane)	11.3	X
Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane)	11.78	X
Freon 114 (1,2-dichloro-1,1,2,2-tetrafluoroethane)	12.2	X
Freon 12 (dichlorodifluoromethane)	12.31	X
Freon 13 (chlorotrifluoromethane)	12.91	X
Freon 22 (chlorofluoromethane)	12.45	X
Furan	8.89	
Furfural	9.21	
m-Fluorotoluene	8.92	
o-Fluorophenol	8.66	
o-Fluorotoluene	8.92	
p-Fluorotoluene	8.79	
H		
1-Hexene	9.46	

**CALIBRATION AND MAINTENANCE OF PORTABLE
PHOTOIONIZATION DETECTOR**

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
2-Heptanone	9.33	
2-Hexanone	9.35	
Heptane	10.08	
Hexachloroethane	11.1	X
Hexane	10.18	
Hydrazine	8.1	
Hydrogen	15.43	X
Hydrogen bromide	11.62	X
Hydrogen chloride	12.74	X
Hydrogen cyanide	13.91	X
Hydrogen fluoride	15.77	X
Hydrogen iodide	10.38	
Hydrogen selenide	9.88	
Hydrogen sulfide	10.46	
Hydrogen telluride	9.14	
Hydroquinone	7.95	
I		
1-Iodo-2-methylpropane	9.18	
1-Iodobutane	9.21	
1-Iodopentane	9.19	
1-Iodopropane	9.26	
2-Iodobutane	9.09	
2-Iodopropane	9.17	
Iodine	9.28	
Iodobenzene	8.73	
Isobutane	10.57	
Isobutyl acetate	9.97	
Isobutyl alcohol	10.12	
Isobutyl amine	8.7	
Isobutyl formate	10.46	
Isobutyraldehyde	9.74	
Isobutyric acid	10.02	
Isopentane	10.32	
Isophorone	9.07	
Isoprene	8.85	
Isopropyl acetate	9.99	
Isopropyl alcohol	10.16	
Isopropyl amine	8.72	

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Isopropyl benzene	8.69	
Isopropyl ether	9.2	
Isovaleraldehyde	9.71	
m-Iodotoluene	8.61	
o-Iodotoluene	8.62	
p-Iodotoluene	8.5	
K		
Ketene	9.61	
L		
2,3-Lutidine	8.85	
2,4-Lutidine	8.85	
2,6-Lutidine	8.85	
M		
2-Methyl furan	8.39	
2-Methyl naphthalene	7.96	
1-Methyl naphthalene	7.96	
2-Methyl propene	9.23	
2-Methyl-1-butene	9.12	
2-Methylpentane	10.12	
3-Methyl-1-butene	9.51	
3-Methyl-2-butene	8.67	
3-Methylpentane	10.08	
4-Methylcyclohexene	8.91	
Maleic anhydride	10.8	X
Mesityl oxide	9.08	
Mesitylene	8.4	
Methane	12.98	X
Methanethiol (methyl mercaptan)	9.44	
Methyl acetate	10.27	
Methyl acetylene	10.37	
Methyl acrylate	9.9	
Methyl alcohol	10.85	X
Methyl amine	8.97	
Methyl bromide	10.54	
Methyl butyl ketone	9.34	
Methyl butyrate	10.07	
Methyl cellosolve	9.6	
Methyl chloride	11.28	X

**CALIBRATION AND MAINTENANCE OF PORTABLE
PHOTOIONIZATION DETECTOR**

TABLE 1**SUMMARY OF IONIZATION POTENTIALS**

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Methyl chloroform (1,1,1-trichloroethane)	11	X
Methyl disulfide	8.46	
Methyl ethyl ketone	9.53	
Methyl formate	10.82	X
Methyl iodide	9.54	
Methyl isobutyl ketone	9.3	
Methyl isobutyrate	9.98	
Methyl isocyanate	10.67	X
Methyl isopropyl ketone	9.32	
Methyl isothiocyanate	9.25	
Methyl mercaptan	9.44	
Methyl methacrylate	9.7	
Methyl propionate	10.15	
Methyl propyl ketone	9.39	
α -Methyl styrene	8.35	
Methyl thiocyanate	10.07	
Methylal (dimethoxymethane)	10	
Methylcyclohexane	9.85	
Methylene chloride	11.32	X
Methyl-n-amyl ketone	9.3	
Monomethyl aniline	7.32	
Monomethyl hydrazine	7.67	
Morpholine	8.2	
n-Methyl acetamide	8.9	
N		
1-Nitropropane	10.88	X
2-Nitropropane	10.71	X
Naphthalene	8.12	
Nickel carbonyl	8.27	
Nitric oxide, (NO)	9.25	
Nitrobenzene	9.92	
Nitroethane	10.88	X
Nitrogen	15.58	X
Nitrogen dioxide	9.78	
Nitrogen trifluoride	12.97	X
Nitromethane	11.08	X
Nitrotoluene	9.45	
p-Nitrochloro benzene	9.96	

FOP 011.0

**CALIBRATION AND MAINTENANCE OF PORTABLE
PHOTOIONIZATION DETECTOR**

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
O		
Octane	9.82	
Oxygen	12.08	X
Ozone	12.08	X
P		
1-Pentene	9.5	
1-Propanethiol	9.2	
2,4-Pentanedione	8.87	
2-Pentanone	9.38	
2-Picoline	9.02	
3-Picoline	9.02	
4-Picoline	9.04	
n-Propyl nitrate	11.07	X
Pentaborane	10.4	
Pentane	10.35	
Perchloroethylene	9.32	
Pheneloic	8.18	
Phenol	8.5	
Phenyl ether (diphenyl oxide)	8.82	
Phenyl hydrazine	7.64	
Phenyl isocyanate	8.77	
Phenyl isothiocyanate	8.52	
Phenylene diamine	6.89	
Phosgene	11.77	X
Phosphine	9.87	
Phosphorus trichloride	9.91	
Phthalic anhydride	10	
Propane	11.07	X
Propargyl alcohol	10.51	
Propiolactone	9.7	
Propionaldehyde	9.98	
Propionic acid	10.24	
Propionitrile	11.84	X
Propyl acetate	10.04	
Propyl alcohol	10.2	
Propyl amine	8.78	
Propyl benzene	8.72	
Propyl ether	9.27	



CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Propyl formate	10.54	
Propylene	9.73	
Propylene dichloride	10.87	X
Propylene imine	9	
Propylene oxide	10.22	
Propyne	10.36	
Pyridine	9.32	
Pyrrole	8.2	
Q		
Quinone	10.04	
S		
Stibine	9.51	
Styrene	8.47	
Sulfur dioxide	12.3	X
Sulfur hexafluoride	15.33	X
Sulfur monochloride	9.66	
Sulfuryl fluoride	13	X
T		
o-Terphenyls	7.78	
1,1,2,2-Tetrachloro-1,2-difluoroethane (Freon 112)	11.3	X
1,1,1-Trichloroethane	11	X
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	11.78	X
2,2,4-Trimethyl pentane	9.86	
o-Toluidine	7.44	
Tetrachloroethane	11.62	X
Tetrachloroethene	9.32	
Tetrachloromethane	11.47	X
Tetrahydrofuran	9.54	
Tetrahydropyran	9.25	
Thiolacetic acid	10	
Thiophene	8.86	
Toluene	8.82	
Tribromoethene	9.27	
Tribromofluoromethane	10.67	X
Tribromomethane	10.51	
Trichloroethene	9.45	
Trichloroethylene	9.47	
Trichlorofluoromethane (Freon 11)	11.77	X

FOP 011.0

**CALIBRATION AND MAINTENANCE OF PORTABLE
PHOTOIONIZATION DETECTOR**

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Trichloromethane	11.42	X
Triethylamine	7.5	
Trifluoromonobromo-methane	11.4	X
Trimethyl amine	7.82	
Tripropyl amine	7.23	
V		
o-Vinyl toluene	8.2	
Valeraldehyde	9.82	
Valeric acid	10.12	
Vinyl acetate	9.19	
Vinyl bromide	9.8	
Vinyl chloride	10	
Vinyl methyl ether	8.93	
W		
Water	12.59	X
X		
2,4-Xylidine	7.65	
m-Xylene	8.56	
o-Xylene	8.56	
p-Xylene	8.45	

FOP 011.0

**CALIBRATION AND MAINTENANCE OF PORTABLE
PHOTOIONIZATION DETECTOR**



EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: _____

Date: _____

Project No.: _____

Client: _____

Instrument Source: ☐ TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTL
<input type="checkbox"/> pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
						< 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20		
						100		
						800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID	2110000004		open air zero		MIBK re factor :
						ppm Iso. Gas		
<input type="checkbox"/> Particulate meter	mg/m ³					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/h					background area		
<input type="checkbox"/>								

ADDITIONAL REMARKS:

PREPARED BY: _____

DATE: _____





FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Specific Conductance Meter

FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

PURPOSE

This guideline describes a method for calibration of a portable specific conductance meter. This meter measures the ability of a water sample to conduct electricity, which is largely a function of the dissolved solids within the water. The instrument has been calibrated by the manufacturer according to factory specifications. This guideline presents a method for checking the factory calibration of a portable specific conductance meter. A calibration check is performed to verify instrument accuracy and function. All field test equipment will be checked at the beginning of each sampling day. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the specific conductance meter will be within ± 1 percent of full-scale, with repeatability of ± 1 percent. The built-in cell will be automatically temperature compensated from at least 32° to 160° F (0° to 71°C).

PROCEDURE

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable equipment are typically similar. The information below pertains to the Myron L Company Ultrameter Model 6P. The actual equipment to be used in the field will be equivalent or similar.



FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the specific conductance meter according to the manufacture's specifications.
2. Use a calibration solution of known specific conductivity and salinity. For maximum accuracy, use a Standard Solution Value closest to the samples to be tested.
3. Rinse conductivity cell three times with proper standard.
4. Re-fill conductivity cell with same standard.
5. Press **COND** or **TDS**, then press **CAL/MCLR**. The "CAL" icon will appear on the display.
6. Press the **↑/MS** or **MR/↓** key to step the displayed value toward the standard's value or hold a key down to cause rapid scrolling of the reading.
7. Press **CAL/MCLR** once to confirm new value and end the calibration sequence for this particular solution type.
8. Repeat steps 1 through 7 with additional new solutions, as necessary.
9. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish maintenance schedules and component replacement. Information will include, at a minimum:
 - Time, date and initials of the field team member performing the calibration
 - The unique identifier for the meter, including manufacturer, model, and serial number
 - The brand and expiration date of the calibration standards
 - The instrument readings: before and after calibration

FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

- The instrument settings (if applicable)
- The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above.
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

NOTE: Ultrameters should be rinsed with clean water after use. Solvents should be avoided. Shock damage from a fall may cause instrument failure.

Temperature Extremes

Solutions in excess of 160°F/71°C should not be placed in the cell cup area; this may cause damage. Care should be exercised not to exceed rated operating temperature. Leaving the Ultrameter in a vehicle or storage shed on a hot day can easily subject the instrument to over 150°F voiding the warranty.

Battery Replacement

Dry Instrument THOROUGHLY. Remove the four bottom screws. Open instrument carefully; it may be necessary to rock the bottom slightly side to side to release it from the RS-232 connector. Carefully detach battery from circuit board. Replace with 9-volt alkaline battery. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Re-install screws, tighten evenly and securely.



FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

NOTE: Because of nonvolatile EEPROM circuitry, all data stored in memory and all calibration settings are protected even during power loss or battery replacement.

Cleaning Sensors

The conductivity cell cup should be kept as clean as possible. Flushing with clean water following use will prevent buildup on electrodes. However, if very dirty samples — particularly scaling types — are allowed to dry in the cell cup, a film will form. This film reduces accuracy. When there are visible films of oil, dirt, or scale in the cell cup or on the electrodes, use a foaming non-abrasive household cleaner. Rinse out the cleaner and your Ultrameter is ready for accurate measurements.

NOTE: Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

Equipment Calibration Log (sample)



FOP 012.0

**CALIBRATION AND MAINTENANCE OF PORTABLE
SPECIFIC CONDUCTANCE METER**



EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: _____

Date: _____

Project No.: _____

Client: _____

Instrument Source: ☐ TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTLE
<input type="checkbox"/> pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
						< 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20		
						100		
						800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID	606987		open air zero		MIBK re factor
						ppm Iso. Gas		
<input type="checkbox"/> Particulate meter	mg/m ³					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/h					background area		
<input type="checkbox"/>								

ADDITIONAL REMARKS:

PREPARED BY: _____

DATE: _____





FIELD OPERATING PROCEDURES

Documentation Requirements for Drilling and Well Installation

FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

PURPOSE

The purpose of these documentation requirements is to document the procedures used for drilling and installing wells in order to ensure the quality of the data obtained from these operations. TurnKey field technical personnel will be responsible for developing and maintaining documentation for quality control of field operations. At least one field professional will monitor each major operation (e.g. one person per drilling rig) to document and record field procedures for quality control. These procedures provide a description of the format and information for this documentation.

PROCEDURE

Project Field Book

Personnel assigned by the TurnKey Field Team Leader or Project Manager will maintain a Project Field Book for all site activities. These Field Books will be started upon initiation of any site activities to document the field investigation process. The Field Books will meet the following criteria:

- Permanently bound, with nominal 8.5-inch by 11-inch gridded pages.
- Water resistant paper.
- Pages must be pre-numbered or numbered in the field, front and back.

Notations in the field book will be in black or blue ink that will not smudge when wet. Information that may be recorded in the Field Book includes:

- Time and date of all entries.



FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

- Name and location of project site and project job number.
- Listing of key project, client and agency personnel and telephone numbers.
- Date and time of daily arrivals and departures, name of person keeping the log, names and affiliation of persons on site, purpose of visit (if applicable), weather conditions, outline of project activities to be completed.
- Details of any variations to the procedures/protocols (i.e., as presented in the Work Plan or Field Operating Procedures) and the basis for the change.
- Field-generated data relating to implementation of the field program, including sample locations, sample descriptions, field measurements, instrument calibration, etc.
- Record of all photographs taken in the field, including date, time, photographer, site location and orientation, sequential number of photograph, and roll number.

Upon completion of the site activities, all Field Books will be photocopied and both the original and photocopied versions placed in the project files. In addition, all field notes except those presented on specific field forms will be neatly transcribed into Field Activity Daily Log (FADL) forms (sample attached).

Field Borehole/Monitoring Well Installation Log Form

Examples of the Field Borehole Log and Field Borehole/Monitoring Well Installation Log forms are attached to this Field Operating Procedure. One form will be completed for every boring by the TurnKey field person overseeing the drilling. At a minimum, these forms will include:

- Project name, location, and number.
- Boring number.



FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

- Rig type and drilling method.
- Drilling dates.
- Sampling method.
- Sample descriptions, to meet the requirements of the Unified Soil Classification System (USCS) for soils and the Unified Rock Classification System (URCS) for rock.
- Results of photoionization evaluations (scan and/or headspace determinations).
- Blow counts for sampler penetration (Standard Penetration Test, N-Value).
- Drilling rate, rig chatter, and other drilling-related information, as necessary.

All depths recorded on Boring/Monitoring Well Installation Log forms will be expressed in increments tenths of feet, and not in inches.

Well Completion Detail Form

An example of this form is attached to this Field Operating Procedure. One form will be completed for every boring by the TurnKey field person overseeing the well installation. At a minimum, these forms will include:

- Project name, location, and number.
- Well number.
- Installation dates.
- Dimensions and depths of the various well components illustrated in the Well Completion Detail (attached). These include the screened interval, bottom caps or plugs, centralizers, and the tops and bottoms of the various annular materials.



FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

- Drilling rate, rig chatter, and other drilling related information.

All depths recorded on Field Borehole/Monitoring Well Installation Logs will be expressed in tenths of feet, and not in inches.

Daily Drilling Report Form

An example of this form is attached to this Field Operating Procedure. This form should be used to summarize all drilling activities. One form should be completed for each rig for each day. These forms will include summaries of:

- Footage drilled, broken down by diameter (e.g. 200 feet of 6-inch diameter hole, 50 feet of 10-inch diameter hole).
- Footage of well and screen installed, broken down by diameter.
- Quantities of materials used, including sand, cement, bentonite, centralizers, protective casings, traffic covers, etc. recorded by well or boring location.
- Active time (hours), and activity (drilling, decontamination, development, well installation, surface completions, etc.)
- Down-time (hours) and reason.
- Mobilizations and other events.
- Other quantities that will be the basis for drilling invoices.

The form should be signed daily by both the TurnKey field supervisor and the driller's representative, and provided to the TurnKey Field Team Leader.



FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

Other Project Field Forms

Well purging/well development forms, test pit logs, environmental sampling field data sheets, water level monitoring forms, and well testing (slug test or pumping test) forms. Refer to specific guidelines for form descriptions.

ATTACHMENTS

- Field Activity Daily Log (FADL) (sample)
- Field Borehole Log (sample)
- Field Borehole/Monitoring Well Installation Log (sample)
- Stick-up Well/Piezometer Completion Detail (sample)
- Flush-mount Well/Piezometer Completion Detail (sample)
- Daily Drilling Report (sample)



FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL
INSTALLATION



DAILY LOG	DATE			
	NO.			
	SHEET		OF	

FIELD ACTIVITY DAILY LOG

PROJECT NAME:		PROJECT NO.	
PROJECT LOCATION:		CLIENT:	
FIELD ACTIVITY SUBJECT:			
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:			
TIME	DESCRIPTION		
VISITORS ON SITE:			
WEATHER CONDITIONS:		IMPORTANT TELEPHONE CALLS:	
A.M.:			
P.M.:			
BM/TK PERSONNEL ON SITE:			
SIGNATURE		DATE:	



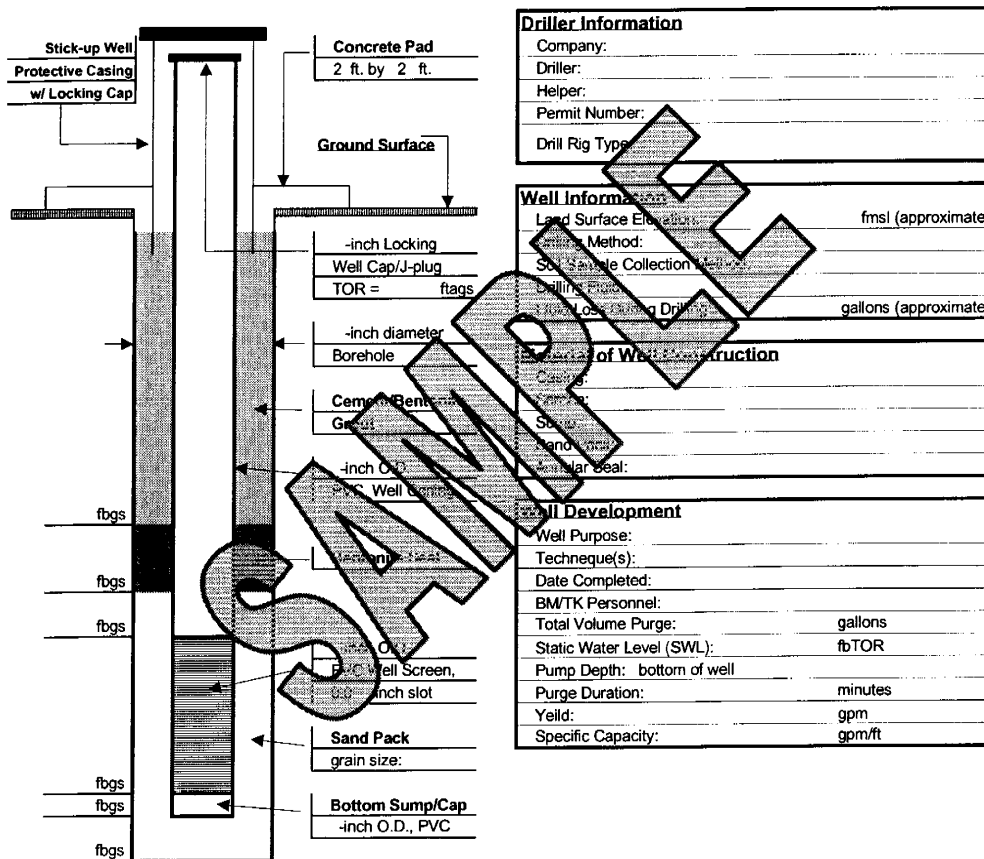
FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION



STICK-UP MONITORING WELL COMPLETION DETAIL

Project Name: _____ WELL NUMBER: _____
 Client: _____ Date Installed: _____
 Boring Location: _____ Project Number: _____



Comments: _____ saturated thickness: _____ SWL - stickup = _____ fbgs
 Total Depth = _____ fbTOR Total Depth - SWL = _____ feet
 stick-up = _____ feet
 Total Depth = _____ fbgs

PREPARED BY: _____ DATE: _____



FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL
INSTALLATION



FLUSHMOUNT WELL/PIEZOMETER
COMPLETION DETAIL

Project Name: _____ WELL NUMBER: _____
Client: _____ Date Installed: _____
Boring Location: _____ Project Number: _____

Driller Information

Company: _____
Driller: _____
Helper: _____
Permit Number: _____
Drill Rig Type: _____

Well Information

Land Surface Elevation: _____ fmsl (approximate)
Drilling Method: _____
Soil Sample Collection Method: _____
Drilling Fluid: _____
Estimated Drilling Time: _____ gallons (approximate)

Materials of Well Construction

Casing: _____
Screen: _____
Sand Seal: _____
Well Cap: _____

Well Development

Well Purpose: _____
Technique(s): _____
Date Completed: _____
BM/TK Personnel: _____
Total Volume Purge: _____ gallons
Static Water Level: _____ ft/TOR
Pump Depth: _____
Purge Duration: _____ minutes
Yield: _____ gpm
Specific Capacity: _____ gpm/ft

Comments:

PREPARED BY: _____ DATE: _____



FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL
INSTALLATION



DAILY DRILLING REPORT

CONTRACTOR: _____ DATE: _____
 DRILLING EQUIPMENT: _____ PROJECT: _____
 CREW MEMBERS: _____ JOB NUMBER: _____
 SITE NAME: _____ BM PERSONNEL: _____

CATEGORY	Total Hours	a.m.												p.m.												a.m.					
		6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6					
MOB / DEMOB																															
DRILLING																															
WELL INSTALLATION																															
DEVELOPMENT / TESTING																															
GROUTING																															
STEAM / DECON																															
DOWN TIME (explain below)																															
STANDBY (explain below)																															
CLEANUP																															
PREP FOR DRILLING																															
LUNCH																															
OTHER:																															
REMARKS:																															
DRILLING & WELL MATERIALS: Describe nature, quantity, size																															
ITEM OR SERVICE		LOCATION																								TOTALS					
Starting depth (ftgs)																										-					
Ending depth (ftgs)																										-					
Total footage drilled (feet)																										-					
Drilling Method (HSA, air rotary, cable tool)																										-					
Auger/Bit size																										-					
CSSS starting depth (ftgs)																										-					
CSSS ending depth (ftgs)																										-					
Total CSSS footage																										-					
-inch Schedule 40 PVC screen, slot size =																															
-inch Schedule 40 PVC riser																															
-inch Schedule 40 PVC screen, slot size =																															
-inch Schedule 40 PVC riser																															
-inch Schedule 40 PVC screen, slot size =																															
-inch Schedule 40 PVC riser																															
Sand pack, size =																															
Bentonite pellets/chips, size =																															
Cement/beontonite grout																															
<input type="checkbox"/> Protective casing <input type="checkbox"/> Flushmount road box																															
Lockable J-plug																															
Lock																															
PERSONNEL TIME LOG:																															
POSITION	NAME																								HOURS						
Observer																															
Drillers																															
DRILLER (optional):														BM REP.																	





FIELD OPERATING PROCEDURES

Drill Site Selection Procedure

FOP 017.0

DRILL SITE SELECTION PROCEDURE

PURPOSE

This procedure presents a method for selecting a site location for drilling. Drill site selection should be based on the project objectives, ease of site access, freedom from obstructions and buried metallic objects (drums) and site safety (appropriate set backs from overhead and buried services).

PROCEDURE

The following procedure outlines procedures prior to drilling activities:

1. Review project objectives and tentatively select drilling locations that provide necessary information for achieving objectives (i.e., Work Plan).
2. Clear locations with property owner/operator to ensure that drilling activities will not interfere with site operations and select appropriate access routes.
3. Stake locations in the field, measure distance from locations to recognizable landmarks, such as building or fence lines and plot locations on site plan. Ensure location is relatively flat, free of overhead wires and readily accessible. Survey location if property ownership is in doubt.
4. Obtain clearances from appropriate utilities and if buried waste/metallic objects are suspected, screen location with appropriate geophysical method.
5. Establish a secure central staging area for storage of drilling supplies and for equipment decontamination. Locate a secure storage area for drilling samples, as necessary.

ATTACHMENTS

none





FIELD OPERATING PROCEDURES

Drilling & Excavation Equipment Decontamination Procedures

FOP 018.0

DRILLING AND EXCAVATION EQUIPMENT DECONTAMINATION PROCEDURES

PURPOSE

This procedure is to be used for the decontamination of drilling and excavation equipment (i.e., drill rigs, backhoes, augers, drill bits, drill rods, buckets, and associated equipment) used during a subsurface investigation. The purpose of this procedure is to remove chemical constituents associated with a particular drilling or excavation location from this equipment. This prevents these constituents from being transferred between drilling or excavation locations, or being transported out of controlled areas.

PROCEDURE

The following procedure will be utilized prior to the use of drilling or excavation equipment at each location, and prior to the demobilization of such equipment from the site:

1. Remove all loose soil and other particulate materials from the equipment at the survey site.
2. Wrap augers, tools, plywood, and other reusable items with a plastic cover prior to transport from the site of use to the decontamination facility.
3. Transport equipment to the decontamination facility. All equipment must be decontaminated at an established decontamination facility. This facility will be placed within a controlled area, and will be equipped with necessary features to contain and collect wash water and entrained materials.
4. Wash equipment thoroughly with pressurized low-volume water or steam, supplied by a pressure washer or steam cleaner.
5. If necessary, use a brush or scraper to remove visible soils adhering to the equipment, and a non-phosphate detergent to remove any oils, grease, and/or hydraulic fluids adhering to the equipment. Continue pressure washing until all visible contaminants are removed.



FOP 018.0

**DRILLING AND EXCAVATION EQUIPMENT
DECONTAMINATION PROCEDURES**

6. Allow equipment to air dry.
7. Store equipment in a clean area or wrap the equipment in new plastic sheeting as necessary to ensure cleanliness until ready for use.
8. Manage all wash waters and entrained solids as described in the TurnKey Field Operating Procedure for Management of Investigation-Derived Waste.

ATTACHMENTS

none





FIELD OPERATING PROCEDURES

Establishing Horizontal and Vertical Control

FOP 021.0

ESTABLISHING HORIZONTAL AND VERTICAL CONTROL

PURPOSE

This guideline presents a method for establishing horizontal and vertical controls at a project site. It is imperative that this procedure be performed accurately, as all topographic and site maps, monitoring well locations and test pit locations will be based on these controls.

PROCEDURE

A. Establishing Horizontal Primary and Project Control

1. Research the State Plan Coordinate, USGS or project site applicable horizontal control monuments.
2. At the project site, recover the above-mentioned monuments, two markers minimum being recovered.
3. Establish control points on the project site by bringing in the primary control points recovered in the field.
4. All control points will be tied into a closed traverse to assure the error of closure.
5. Compute closures for obtaining degree of accuracy to adjust traverse points.

B. Establishing Vertical Primary and Project Control

1. Research project or USGS datum for recovering monument(s) for vertical control if different than those previously found.
2. Recover the monuments in the field, two markers minimum being found.
3. Set the projects benchmarks.
4. Run a level line from the monuments to the set project benchmarks and back, setting turning points on all benchmarks set on site.



FOP 021.0

ESTABLISHING HORIZONTAL AND VERTICAL CONTROL

5. Reduce field notes and compute error of closure to adjust benchmarks set on site.
6. Prepare the recovery sketches and tabulate a list for horizontal and vertical control throughout project site.



FIELD OPERATING PROCEDURES

Groundwater Level Measurement

GROUNDWATER LEVEL MEASUREMENT

PURPOSE

This procedure describes the methods used to obtain accurate and consistent water level measurements in monitoring wells, piezometers and well points. Water levels will be measured at monitoring wells and, if practicable, in supply wells to estimate purge volumes associated with sampling, and to develop a potentiometric surface of the groundwater in order to estimate the direction and velocity of flow in the aquifer. Water levels in monitoring wells will be measured using an electronic water level indicator (e-line) that has been checked for operation prior to mobilization.

PROCEDURE

1. Decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the TurnKey's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.
2. Unlock and remove the well protective cap or cover and place on clean plastic.
3. Lower the probe slowly into the monitoring well until the audible alarm sounds. This indicates the depth to water has been reached.
4. Move the cable up and down slowly to identify the depth at which the alarm just begins to sound. Measure this depth against the mark on the lip of the well riser used as a surveyed reference point (typically the north side of the riser).
5. Read depth from the graduated cable to the nearest 0.01 foot. Do not use inches. If the e-line is not graduated, use a rule or tape measure graduated in 0.01-foot increments to measure from the nearest reference mark on the e-line cable.

FOP 022.0

GROUNDWATER LEVEL MEASUREMENT

6. Record the water level on a Water Level Monitoring Record (sample attached).
7. Remove the probe from the well slowly, drying the cable and probe with a clean paper wipe. Be sure to repeat decontamination before use in another well.
8. Replace well plug and protective cap or cover. Lock in place as appropriate.

ATTACHMENTS

Water Level Monitoring Record (sample)

REFERENCES

TurnKey FOPs:

040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*



GROUNDWATER LEVEL MEASUREMENT

PREAPRED BY: _____ DATE: _____



FIELD OPERATING PROCEDURES

Groundwater Sample Collection Procedures

FOP 024.0

GROUNDWATER SAMPLE COLLECTION PROCEDURES

PURPOSE

This procedure describes the methods for collecting groundwater samples from monitoring wells and domestic supply wells following purging and sufficient recovery. This procedure also includes the preferred collection order in which water samples are collected based on the volatilization sensitivity or suite of analytical parameters required.

PROCEDURE

Allow approximately 3 to 10 days following well development before performing purge and sample activities at any well location. Conversely, perform sampling as soon as practical after sample purging at any time after the well has recovered sufficiently to sample, or within 24 hours after evacuation, if the well recharges slowly. If the well does not yield sufficient volume for all required laboratory analytical testing (including quality control), a decision should be made to prioritize analyses based on contaminants of concern at the site. If the well takes longer than 24 hours to recharge, the Project Manager should be consulted. The following two procedures outline sample collection activities for monitoring and domestic type wells.

Monitoring Wells

1. Purge the monitoring well in accordance with the TurnKey's FOPs for Groundwater Purging Procedures Prior to Sample Collection or Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures. Perform sampling as soon as practical after purging at any time after the well has recovered sufficiently to sample, or within 24 hours after evacuation, if the well recharges slowly. If the well does not yield sufficient volume for all required laboratory analytical testing (including quality control), a decision should be made to prioritize analyses based on contaminants of concern at the site. Analyses will be prioritized in the order of the parameters volatilization sensitivity. After volatile organics have been collected, field parameters



FOP 024.0

GROUNDWATER SAMPLE COLLECTION PROCEDURES

- must be measured from the next sample collected. If a well takes longer than 24 hours to recharge, the Project Manager should be consulted.
2. Sampling equipment that is not disposable or dedicated to the well will be decontaminated in accordance with the TurnKey's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
 3. Calibrate all field meters (i.e., pH/Eh, turbidity, specific conductance, dissolved oxygen, PID etc.) in accordance with the TurnKey's Field Operating Procedure for Calibration and Maintenance of the specific field meter.
 4. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the TurnKey's Field Operating Procedure for Groundwater Level Measurement and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the TurnKey's Field Operating Procedure for Non-disposable and Non-dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.
 5. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Well Purge & Sample Collection Log (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.
 6. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.
 7. Calibrate the photoionization detector (PID) in accordance with the TurnKey's Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.
 8. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging. Record PID measurements on a well-specific Groundwater Well Purge & Sample Collection Log (sample attached).

GROUNDWATER SAMPLE COLLECTION PROCEDURES

9. Lower the e-line probe slowly into the monitoring well and record the measurement on a well-specific Groundwater Well Purge & Sample Collection Log (sample attached).
10. Groundwater samples will be collected directly from the sampling valve on the flow through cell (low-flow), discharge port of a standard pump assembly (peristaltic, pneumatic, submersible, or Waterra™ pump) or bailer (stainless steel, PVC or polyethylene) into appropriate laboratory provided containers. In low-yielding wells at which the flow through cell is not used, the samples may be collected using a disposable bailer.
11. If disposable polyethylene bailers are used, the bailer should be lowered *slowly* below the surface of the water to minimize agitation and volatilization. For wells that are known to produce turbid samples (values greater than 50 NTU), the bailer should be lowered and retrieved at a rate that limits surging of the well.
12. Sampling data will be recorded on a Groundwater Well Purge & Sample Collection Log (sample attached).
13. Pre-label all sample bottles in the field using a waterproof permanent marker in accordance with the TurnKey's Sample Labeling, Storage and Shipment FOP. The following information, at a minimum, should be included on the label:
 - Project Number;
 - Sample identification code (as per project specifications);
 - Date of sample collection (mm, dd, yy);
 - Time of sample collection (military time only) (hh:mm);
 - Specify "grab" or "composite" sample type;
 - Sampler initials;
 - Preservative(s) (if applicable); and
 - Analytes for analysis (if practicable).
14. Collect a separate sample of approximately 200 ml into an appropriate container prior to collecting the first and following the last groundwater sample collected to measure the following field parameters:

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GROUNDWATER SAMPLE COLLECTION PROCEDURES

Parameter	Units
Dissolved Oxygen	parts per million (ppm)
Specific Conductance	μ mhos/cm or μ S or mS
pH	pH units
Temperature	°C or °F
Turbidity	NTU
Eh (<i>optional</i>)	mV
PID VOCs (<i>optional</i>)	ppm

Record all field measurements on a Groundwater Well Purge & Sample Collection Log (sample attached).

15. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated in the **Sample Collection Order** section below.
16. Lower the e-line probe slowly into the monitoring well and record the measurement on a well-specific Groundwater Well Purge & Sample Collection Log (sample attached).
17. The samples will be labeled, stored and shipped in accordance with the TurnKey's Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

Domestic Supply Wells

1. Calculate or estimate the volume of water in the well. It is desirable to purge at least one casing volume before sampling. This is controlled, to some extent, by the depth of the well, well yield and the rate of the existing pump. If the volume of water in the well cannot be calculated, the well should be purged continuously for no less than 15 minutes.



FOP 024.0

GROUNDWATER SAMPLE COLLECTION PROCEDURES

2. Connect a sampling tap to an accessible fitting between the well and the pressure tank where practicable. A hose will be connected to the device and the hose discharge located 25 to 50 feet away. The well will be allowed to pump until the lines and one well volume is removed. Flow rate will be measured with a container of known volume and a stopwatch.
3. Place a clean piece of polyethylene or Teflon™ tubing on the sampling port and collect the samples in the order designated below and in the sample containers supplied by the laboratory for the specified analytes. **DO NOT** use standard garden hose to collect samples.
4. Sampling results and measurements will be recorded on a Groundwater Well Purge & Sample Collection Log (sample attached) as described in the previous section.
5. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated in the **Sample Collection Order** section below.
6. The samples will be labeled, stored and shipped in accordance with the TurnKey's Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

SAMPLE COLLECTION ORDER

All groundwater samples, from monitoring wells and domestic supply wells, will be collected in accordance with the following.

1. Samples will be collected preferentially in recognition of volatilization sensitivity. The preferred order of sampling if no free product is present is:
 - Field parameters
 - Volatile Organic Compounds (VOCs)
 - Purgeable organic carbons (POC)
 - Purgeable organic halogens (POH)
 - Total Organic Halogens (TOX)
 - Total Organic Carbon (TOC)



GROUNDWATER SAMPLE COLLECTION PROCEDURES

- Extractable Organic Compounds (i.e., BNAs, SVOCs, etc.)
 - Total petroleum hydrocarbons (TPH) and oil and grease
 - PCBs and pesticides
 - Total metals (Dissolved Metals)
 - Total Phenolic Compounds
 - Cyanide
 - Sulfate and Chloride
 - Turbidity
 - Nitrate (as Nitrogen) and Ammonia
 - Preserved inorganics
 - Radionuclides
 - Unpreserved inorganics
 - Bacteria
 - Field parameters
2. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Well Purge & Sample Collection Log (sample attached).

DOCUMENTATION

The three words used to ensure adequate documentation for groundwater sampling are accountability, controllability, and traceability. Accountability is undertaken in the sampling plan and answers the questions who, what, where, when, and why to assure that the sampling effort meets its goals. Controllability refers to checks (including QA/QC) used to ensure that the procedures used are those specified in the sampling plan. Traceability is documentation of what was done, when it was done, how it was done, and by whom it was done, and is found in the field forms, Project Field Book, and chain-of-custody forms. At a minimum, adequate documentation of the sampling conducted in the field consists of an entry in the Project Field Book (with sewn binding), field data sheets for each well, and a chain-of-custody form.

GROUNDWATER SAMPLE COLLECTION PROCEDURES

As a general rule, if one is not sure whether the information is necessary, it should nevertheless be recorded, as it is impossible to over-document one's fieldwork. Years may go by before the documentation comes under close scrutiny, so the documentation must be capable of defending the sampling effort without the assistance or translation of the sampling crew.

The minimum information to be recorded daily with an indelible pen in the Project Field Book and/or field data sheets includes date and time(s), name of the facility, name(s) of the sampling crew, site conditions, the wells sampled, a description of how the sample shipment was handled, and a QA/QC summary. After the last entry for the day in the Project Field Book, the Field Team Leader should sign the bottom of the page under the last entry and then draw a line across the page directly under the signature.

PRECAUTIONS/RECOMMENDATIONS

The following precautions should be adhered to prior to and during sample collection activities:

- Field vehicles should be parked downwind (to avoid potential sample contamination concerns) at a minimum of 15 feet from the well and the engine turned off prior to PID vapor analysis and VOC sample collection.
- Ambient odors, vehicle exhaust, precipitation, or windy/dusty conditions can potentially interfere with obtaining representative samples. These conditions should be minimized and should be recorded in the field notes. Shield sample bottles from strong winds, rain, and dust when being filled.

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GROUNDWATER SAMPLE COLLECTION PROCEDURES

- The outlet from the sampling device should discharge below the top of the sample's air/water interface, when possible. The sampling plan should specify how the samples will be transferred from the sample collection device to the sample container to minimize sample alterations.
- The order of sampling should be from the least contaminated to the most contaminated well to reduce the potential for cross contamination of sampling equipment (see the Sampling Plan or Work Plan).
- Samples should not be transferred from one sampling container to another.
- Sampling equipment must not be placed on the ground, because the ground may be contaminated and soil contains trace metals. Equipment and supplies should be removed from the field vehicle only when needed.
- Smoking and eating should not be allowed until the well is sampled and hands are washed with soap and water, due to safety and possibly sample contamination concerns. These activities should be conducted beyond a 15-foot radius of the well.
- No heat-producing or electrical instruments should be within 15 feet of the well, unless they are intrinsically safe, prior to PID vapor analysis.
- Minimize the amount of time that the sample containers remain open.
- Do not touch the inside of sample bottles or the groundwater sample as it enters the bottle. Disposable gloves may be a source of phthalates, which could be introduced into groundwater samples if the gloves contact the sample.
- Sampling personnel should use a new pair of disposable gloves for each well sampled to reduce the potential for exposure of the sampling personnel to contaminants and to reduce sample cross contamination. In addition, sampling personnel should change disposable gloves between purging and sampling operations at the same well.

FOP 024.0

GROUNDWATER SAMPLE COLLECTION PROCEDURES

- Sampling personnel should not use perfume, insect repellent, hand lotion, etc., when taking groundwater samples. If insect repellent must be used, then sampling personnel should not allow samples or sampling equipment to contact the repellent, and it should be noted in the documentation that insect repellent was used.
- Complete the documentation of the well. A completed assemblage of paperwork for a sampling event includes the completed field forms, entries in the Project Field Book (with a sewn binding), transportation documentation (if required), and possibly chain-of-custody forms.

ATTACHMENTS

Groundwater Well Purge & Sample Collection Log (sample)

REFERENCES

1. Wilson, Neal. *Soil Water and Ground Water Sampling*, 1995

TurnKey FOPs:

- 007 *Calibration and Maintenance of Portable Dissolved Oxygen Meter*
- 008 *Calibration and Maintenance of Portable Field pH/Eh Meter*
- 009 *Calibration and Maintenance of Portable Field Turbidity Meter*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 012 *Calibration and Maintenance of Portable Specific Conductance Meter*
- 022 *Groundwater Level Measurement*
- 023 *Groundwater Purging Procedures Prior to Sample Collection (optional)*
- 031 *Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures (optional)*
- 040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
- 046 *Sample Labeling, Storage and Shipment Procedures*



GROUNDWATER SAMPLE COLLECTION PROCEDURES

GROUNDWATER WELL
PURGE & SAMPLE COLLECTION LOG

Project Name: _____ WELL NUMBER: _____
 Project Number: _____ Sample Matrix: _____
 Client: _____ Weather: _____

WELL DATA:		DATE: _____	TIME: _____
Casing Diameter (inches): _____	Casing Material: _____		
Screened interval (ftTOR): _____	Screen Material: _____		
Static Water Level (ftTOR): _____	Bottom Depth (ftTOR): _____		
Elevation Top of Well Riser (fmsl): _____	Ground Surface Elevation (fmsl): _____		
Elevation Top of Screen (fmsl): _____	Stick-up (feet): _____		

PURGING DATA:		DATE: _____	START TIME: _____	END TIME: _____
Method: _____	Is purge equipment dedicated to sample location?	yes	no	
No. of Well Volumes Purged: _____	Was well purged to dryness?	yes	no	
Standing Volume (gallons): _____	Was well purged below top of sand pack?	yes	no	
Volume Purged (gallons): _____	Condition of Well: _____			
Purge Rate (gal/min): _____	Field Personnel: _____			

VOLUME CALCULATION:		Volume Calculation		Stabilization Criteria	
(A) Total Depth of Well (ftTOR): _____	(B) Casing Diameter (inches): _____	Well Diameter (inches)	Volume gal/ft	Parameter	Criteria
(C) Static Water Level (ftTOR): _____	One Well Volume (V, gallons): _____	1"	0.41	pH	+/- 0.1 unit
$V = 0.0408 [(B)^2 \times (A) - (C)]$		2"	1.63	Specific Gravity	+/- 3%
		4"	6.52	Turbidity	+/- 10%
		6"	1.02	DO	+/- 0.3 mg/L
		8"	1.469	ORP	+/- 10 mV

* Use the table to the right to calculate one well volume by subtracting C from A, then multiplying by the volume calculation in the table per well diameter.

EVACUATION STABILIZATION TEST DATA:								
Time	Water Level (ftTOR)	Accumulated Volume (gallons)	pH (units)	Specific Gravity (units)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	Initial	0.0						

SAMPLING DATA:		START TIME: _____	END TIME: _____
Method: _____	Is sampling equipment dedicated to sample location?	yes	no
Initial Water Level (ftTOR): _____	Was well sampled to dryness?	yes	no
Final Water Level (ftTOR): _____	Was well sampled below top of sand pack?	yes	no
Air Temperature (°F): _____	Field Personnel: _____		
Source and type of water used in the field for QC purposes: _____			

PHYSICAL & CHEMICAL DATA:		WATER QUALITY MEASUREMENTS							
DESCRIPTION OF WATER SAMPLE		Sample	Time	pH (units)	TEMP. (°C)	SC (uS)	TURB. (NTU)	DO (ppm)	ORP (mV)
Odor		initial							
Color		final							
NAPL									
Contains Sediment?	yes no								

REMARKS:

PREPARED BY: _____



FIELD OPERATING PROCEDURES

Hollow Stem Auger (HSA) Drilling Procedures

FOP 026.0

HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES

PURPOSE

This guideline presents a method for drilling a borehole through unconsolidated materials, including soils or overburden, and consolidated materials, including bedrock.

PROCEDURE

The following procedure will be used to drill a borehole for sampling and/or well installation, using hollow-stem auger methods and equipment.

1. Follow TurnKey's Field Operating Procedure for Drill Site Selection Procedure prior to implementing any drilling activity.
2. Perform drill rig safety checks with the driller by completing the Drilling Safety Checklist form (sample attached).
3. Conduct tailgate health and safety meeting with project team and drillers by completing the Tailgate Safety Meeting Form.
4. Calibrate air-monitoring equipment in accordance with the appropriate TurnKey's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
5. Ensure all drilling equipment (i.e., augers, rods, split-spoons) appear clean and free of soil prior to initiating any subsurface intrusion. Decontamination of drilling equipment should be in accordance with TurnKey's FOP: Drilling and Excavation Equipment Decontamination Procedures.
6. Mobilize the auger rig to the site and position over the borehole.
7. Level and stabilize the rig using the rig jacks, and recheck the rig location against the planned drilling location. If necessary, raise the jacks and adjust the rig position.



FOP 026.0

HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES

8. Place a metal or plywood auger pan over the borehole location to collect the auger cuttings. This auger pan will be equipped with a 12-inch nominal diameter hole for auger passage. As an alternative, a piece of polyethylene tarp may be used as a substitute.
9. Advance augers into the subsurface. For sampling or pilot-hole drilling, nominal 8-inch outside diameter (OD) augers should be used. The boring diameter will be approved by the TurnKey field supervisor.
10. Collect soil samples via split spoon sampler in accordance with TurnKey's Field Operating Procedure for Split Spoon Sampling.
11. Check augers periodically during drilling to ensure the boring is plumb. Adjust rig position as necessary to maintain plumb.
12. Continue drilling until reaching the assigned total depth, or until auger refusal occurs. Auger refusal is when the drilling penetration drops below 0.1 feet per 10 minutes, with the full weight of the rig on the auger bit, and a center bit (not center plug) in place.
13. Plug and abandon boreholes not used for well installation in accordance with TurnKey's Field Operating Procedure for Abandonment of Borehole.

OTHER PROCEDURAL ISSUES

- Slip rings may be used for lifting a sampling or bit string. The string will not be permitted to extend more than 15 feet above the mast crown.
- Borings will not be over drilled (rat holed) without the express permission of the TurnKey field supervisor. All depth measurements should be accurate to the nearest 0.1 foot, to the extent practicable.
- Potable water may be placed in the auger stem if critically necessary for borehole control or to accomplish sampling objectives. This will be performed only with the express permission of the TurnKey field supervisor.



FOP 026.0

HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES

ATTACHMENTS

Drilling Safety Checklist (sample)
Tailgate Safety Meeting Form (sample)

REFERENCES

TurnKey FOPs:

- 001 *Abandonment of Borehole Procedures*
- 010 *Calibration and Maintenance of Portable Flame Ionization Detector*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 017 *Drill Site Selection Procedure*
- 018 *Drilling and Excavation Equipment Decontamination Procedures*
- 058 *Split Spoon Sampling Procedures*



FOP 026.0

HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES



DRILLING SAFETY CHECKLIST

Project: _____ Date: _____
 Project No.: _____ Drilling Company: _____
 Client: _____ Drill Rig Type: _____

ITEMS TO CHECK	OK	ACTION NEEDED
"Kill switches" installed by the manufacturer are in operable condition and all workers at the drill site are familiar with their location and how to activate them?		
"Kill switches" are accessible to workers on both sides of the rotating stem? NOTE: Optional based on location and number of switches provided by the manufacturer.		
Cables on drill rig are free of kinks, frayed wires, "bird cages" and worn or missing sections?		
Cables are terminated at the working end with a proper eye splice, swaged Coupling or using cable clamps?		
Cable clamps are installed with the saddle on the live or dead side? Clamps should not be alternated and should be of the correct size and number for the cable size to which it is installed. Clamps are complete with the missing parts?		
Hooks installed on hoist cables are the safety type with a functional latch to prevent accidental separation?		
Safety latches are functional and completely close the entire throat of the hook and have positive action to close the throat once when manually displaced for connecting or disconnecting a load?		
Drive shafts, belts, chain drives and rotating parts shall be guarded to prevent accidental insertion of hands and limbs?		
Outriggers shall be extended and locked when the boom is raised off its cradle. Hydraulic outriggers must maintain pressure to continuously support and stabilize the drill rig even when suspended.		
Outriggers shall be properly supported on the ground surface to prevent settling into the soil.		
Controls are properly labeled and have freedom of movement? Controls should not be blocked or locked in an action position.		
Safeties on any device shall not be bypassed or neutralized.		
Controls shall be operated smoothly and cables and lifting devices shall not be jerked or operated erratically to overcome resistance.		
Slings, chokers and lifting devices are inspected before using and are in proper working order? Damaged units are removed from service and are properly tagged?		
Shackles and clevises are in proper working order and pins and screws are fully inserted before placing under a load?		
High-pressure hoses have a safety (chain, cable or strap) at each end of the hose section to prevent whipping in the event of a failure?		
Rotating parts of the drill string shall be free of sharp projections or hooks, which could entrap clothing or foreign objects?		



FOP 026.0

HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES



DRILLING SAFETY CHECKLIST

Project: _____

Date: _____

ITEMS TO CHECK	OK	ACTION NEEDED
Wire ropes should not be allowed to bend around sharp edges without cushion material.		
The exclusion zone is centered over the borehole and the radius is equal or greater than the boom height?		
The work area around the borehole shall be kept clear of trip hazards and walking surfaces should be free of slippery material.		
Workers shall not proceed higher than the drilling deck without a fall restraining device and must attach the device in a manner to restrict fall to less than 6 feet.		
A fire extinguisher of appropriate size shall be immediately available to the crew. The drill crew shall have received annual training on proper use of the fire extinguisher.		
29 CFR 1910.333 © (3) Except where electric distribution and transmission lines have been de-energized and visibly grounded, drill rigs will be operated proximate to, under, by, or near power lines only in accordance with the following: 333 © (3) (ii) 50 kV or less - minimum clearance is 10 ft. For 50 kV or over - 10ft. Plus 4 in. for each additional kV. TurnKey Policy: Maintain 20 feet clearance.		
29 CFR 1910.333 © (3) (iii) When the rig is in contact with the boom in the down position, clearance from energized power lines will be maintained as follows: Less than 50 kV - 4 feet 50 to 365 kV - 10 feet 365 to 725 kV - 18 feet		

Name: _____ (printed)

Signed: _____ Date: _____



HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES



TAILGATE SAFETY MEETING FORM

Project Name: _____ Date: _____ Time: _____
 Project Number: _____ Client: _____
 Work Activities: _____

HOSPITAL INFORMATION:

Name: _____
 Address: _____ City: _____ State: _____ Zip: _____
 Phone No.: _____ Ambulance Phone No. _____

SAFETY TOPICS PRESENTED:

Chemical Hazards: _____

 Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity:	Eye Protection	Head Protection	Hand Protection	Foot Protection
Activity:	A	B	C	D
Activity:	A	B	C	D
Activity:	A	B	C	D
Activity:	A	B	C	D
Activity:	A	B	C	D

New Equipment: _____

Other Safety Topic (s): Environmental Hazards (sensitive fauna)
 Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by: _____





FIELD OPERATING PROCEDURES

Low-Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedure

FOP 031.0

LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods used for performing low flow (minimal drawdown) purging, also referred to as micro-purging, at a well prior to groundwater sampling to obtain a representative sample from the water-bearing zone. This method of purging is used to minimize the turbidity of the produced water. This may increase the representativeness of the groundwater samples by avoiding the necessity of filtering suspended solids in the field prior to preservation of the sample.

Well purging is typically performed immediately preceding groundwater sampling. The sample should be collected as soon as the parameters measured in the field (i.e., pH, specific conductance, dissolved oxygen, Eh, temperature, and turbidity) have stabilized.

PROCEDURE

1. Water samples should not be taken immediately following well development. Sufficient time should be allowed to stabilize the groundwater flow regime in the vicinity of the monitoring well. This lag time will depend on site conditions and methods of installation but may exceed one week.
2. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the TurnKey's Groundwater Level Measurement FOP and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the TurnKey's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.
3. Calibrate all sampling devices and monitoring equipment in accordance with manufacturer's recommendations, the site Quality Assurance Project Plan (QAPP) and/or Field Sampling Plan (FSP). Calibration of field



FOP 031.0

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instrumentation should be followed as specified in TurnKey's Calibration and Maintenance FOP for each individual meter.

4. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Well Purge & Sample Collection Log form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.
5. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.
6. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging.
7. Lower the e-line probe slowly into the monitoring well and record the initial water level in accordance with the procedures referenced in TurnKey's Groundwater Level Measurement FOP. Refer to the construction diagram for the well to identify the screened depth.
8. Decontaminate all non-dedicated pump and tubing equipment following the procedures referenced in the TurnKey's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP.
9. Lower the purge pump or tubing (i.e., low-flow electrical submersible, peristaltic, etc.) slowly into the well until the pump/tubing intake is approximately in the middle of the screened interval. Rapid insertion of the pump will increase the turbidity of well water, and can increase the required purge time. This step can be eliminated if dedicated tubing is already within the well.

Placement of the pump close to the bottom of the well will cause increased entrainment of solids, which may have settled in the well over time. Low-flow purging has the advantage of minimizing mixing between the overlying

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PURGING & SAMPLING PROCEDURES**

stagnant casing water and water within the screened interval. The objective of low-flow purging is to maintain a purging rate, which minimizes stress (drawdown) of the water level in the well. Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen.

10. Lower the e-line back down the well as water levels will be frequently monitored during purge and sample activities.
11. Begin pumping to purge the well. The pumping rate should be between 100 and 500 milliliters (ml) per minute (0.03 to 0.13 gallons per minute) depending on site hydrogeology. Periodically check the well water level with the e-line adjusting the flow rate as necessary to stabilize drawdown within the well. If possible, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 feet or less). If the water level exceeds 2 feet below static and declining, slow the purge rate until the water level generally stabilizes. Record each pumping rate and water level during the event.

The low flow rate determined during purging will be maintained during the collection of analytical samples. At some sites where geologic heterogeneities are sufficiently different within the screened interval, high conductivity zones may be preferentially sampled.

12. Measure and record field parameters (pH, specific conductance, Eh, dissolved oxygen (DO), temperature, and turbidity) during purging activities. In lieu of measuring all of the parameters, a minimum subset could be limited to pH, specific conductance, and turbidity or DO.

Water quality indicator parameters should be used to determine purging needs prior to sample collection in each well. Stabilization of indicator parameters should be used to determine when formation water is first encountered during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by Eh, DO and turbidity. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator

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LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

parameters. An in-line flow through cell to continuously measure the above parameters may be used. The in-line device should be disconnected or bypassed during sample collection.

13. Purging will continue until parameters of water quality have stabilized. Record measurements for field indicator parameters (including water levels) at regular intervals during purging. The stability of these parameters with time can be used to guide the decision to discontinue purging. Proper adjustments must be made to stabilize the flow rate as soon as possible.
14. Record well purging and sampling data in the Project Field Book or on the attached Groundwater Well Purge & Sample Collection Log (sample attached). Measurements should be taken approximately every three to five minutes, or as merited given the rapidity of change.
15. Purging is complete when field indicator parameters stabilize. Stabilization is achieved after all field parameters have stabilized for three successive readings. Three successive readings should be within ± 0.1 units for pH, $\pm 3\%$ for specific conductance, ± 10 mV for Eh, and $\pm 10\%$ for turbidity and dissolved oxygen. These stabilization guidelines are provided for rough estimates only, actual site-specific knowledge may be used to adjust these requirements higher or lower.

An in-line water quality measurement device (e.g., flow-through cell) should be used to establish the stabilization time for several field parameters on a well-specific basis. Data on pumping rate, drawdown and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

16. Collect all project-required samples from the discharge tubing at the flow rate established during purging in accordance with TurnKey's Groundwater Sample Collection Procedures FOP. **If a peristaltic pump and dedicated tubing is used, collect all project-required samples from the discharge tubing as stated before, however volatile organic compounds should be collected in accordance with the procedure presented in the next**

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LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

section. Continue to maintain a constant flow rate such that the water level is not drawn down as described above. Fill sample containers with minimal turbulence by allowing the ground water to flow from the tubing along the inside walls of the container.

17. If field filtration is recommended as a result of increased turbidity, an in-line filter equipped with a 0.45-micron filter should be utilized.
18. Replace the dedicated tubing down the well taking care to avoid contact with the ground surface.
19. Restore the well to its capped/covered and locked condition.
20. Upon purge and sample collection completion, slowly lower the e-line to the bottom of the well/piezometer. Record the total depth to the nearest 0.01-foot and compare to the previous total depth measurement. If a significant discrepancy exists, re-measure the total depth. Record observations of purge water to determine whether the well/piezometer had become silted due to inactivity or damaged (i.e., well sand within purge water). Upon confirmation of the new total depth and determination of the cause (i.e., siltation or damage), notify the Project Manager following project field activities.

PERISTALTIC PUMP VOC SAMPLE COLLECTION PROCEDURE

The collection of VOCs from a peristaltic pump and dedicated tubing assembly shall be collected using the following procedure.

1. Once all other required sample containers have been filled, turn off the peristaltic pump. The negative pressure effects of the pump head have not altered groundwater remaining within the dedicated tubing assembly and as such, this groundwater can be collected for VOC analysis.
2. While maintaining the pressure on the flexible tubing within the pump head assembly, carefully remove and coil the polyethylene tubing from the well; taking care to prevent the tubing from coming in contact with the ground



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LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

surface and without allowing groundwater to escape or drain from the tubing intake.

3. Once the polyethylene tubing is removed, turn the variable speed control to zero and reverse the pump direction.
4. Slowly increase the pump rate allowing the groundwater within the polyethylene tubing to be “pushed” out of the intake end (i.e., positive displacement) making sure the groundwater within the tubing is not “pulled” through the original discharge end (i.e., negative displacement). Groundwater pulled through the pump head assembly **CANNOT** be collected for VOC analysis.
5. Slowly fill each VOC vial by holding the vial at a 45-degree angle and allowing the flowing groundwater to cascade down the side until the vial is filled with as minimal disturbance as possible. As the vial fills, slowly rotate the vial to vertical. **DO NOT OVERFILL THE VIAL, AS THE PRESERVATIVE WILL BE LOST.** The vial should be filled only enough so that the water creates a slight meniscus at the vial mouth.
6. Cap the VOC vials leaving no visible headspace (i.e., air-bubbles). Gently tap each vial against your hand checking for air bubbles.
7. If an air bubble is observed, slowly remove the cap and repeat Steps 5 and 6.

ATTACHMENTS

Groundwater Well Purge & Sample Collection Log (sample)

REFERENCES

United States Environmental Protection Agency, 540/S-95/504, 1995. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.*



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**LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER
PURGING & SAMPLING PROCEDURES**

TurnKey FOPs:

- 007 *Calibration and Maintenance of Portable Dissolved Oxygen Meter*
- 008 *Calibration and Maintenance of Portable Field pH/Eh Meter*
- 009 *Calibration and Maintenance of Portable Field Turbidity Meter*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 012 *Calibration and Maintenance of Portable Specific Conductance Meter*
- 022 *Groundwater Level Measurement*
- 024 *Groundwater Sample Collection Procedures*
- 040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
- 046 *Sample Labeling, Storage and Shipment Procedures*



LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES



WELL DATA:		Volume Calculation	
DATE:	TIME:	Well Diameter	Volume gal/ft
Casing Diameter (inches):	Casing Material:	1"	0.041
Screened interval (ftTOR):	Screen Material:	2"	0.163
Static Water Level (ftTOR):	Bottom Depth (ftTOR):	3"	0.367
Elevation Top of Well Riser (fmsl):	Ground Surface Elevation (fmsl):	4"	0.653
Elevation Top of Screen (fmsl):	Stick-up (feet):	5"	1.020
Standing volume in gallons: [(bottom depth - static water level) x vol calculation in table per well diameter]:		6"	1.469

[illegible]

SAMPLING DATA: [DATE: _____]		START TIME: _____	END TIME: _____
Method: low-flow with dedicated pump	Was well sampled to dryness? yes no		
Initial Water Level (fbTOR): _____	Was well sampled below top of sand pack? yes no		
Final Water Level (fbTOR): _____	Field Personnel: _____		

PHYSICAL & CHEMICAL DATA:	WATER QUALITY MEASUREMENTS					
Appearance:	pH (units)	TEMP. (°C)	SC (uS)	TURB. (NTU)	DO (ppm)	ORP (mV)
Color:						
Odor:						
Sediment Present?						

REMARKS:

PREPARED BY: _____





FIELD OPERATING PROCEDURES

Management of Investigation-Derived Waste (IDW)

MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

PURPOSE

The purpose of these guidelines is to ensure the proper holding, storage, transportation, and disposal of materials generated from field investigation activities that may contain hazardous wastes. Investigation-derived waste (IDW) include the following:

- Drill cuttings, discarded soil samples, drilling mud solids, and used sample containers.
- Well development and purge waters and discarded groundwater samples.
- Decontamination waters and associated solids.
- Soiled disposable personal protective equipment (PPE).
- Used disposable sampling equipment.
- Used plastic sheeting and aluminum foil.
- Other equipment or materials that either contain or have been in contact with potentially impacted environmental media.

Because these materials may contain regulated chemical constituents, they must be managed as a solid waste. This management may be terminated if characterization analytical results indicate the absence of these constituents.

PROCEDURE

1. Contain all investigation-derived wastes in Department of Transportation (DOT)-approved 55-gallon drums, roll-off boxes, or other containers suitable for the wastes.



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MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

2. Contain wastes from separate borings or wells in separate containers (i.e. do not combine wastes from several borings/wells in a single container, unless it is a container used specifically for transfer purposes, or unless specific permission to do so has been provided by the TurnKey Field Team Leader. Unused samples from surface sample locations within a given area may be combined.
3. To the extent practicable, separate solids from drilling muds, decontamination waters, and similar liquids. Place solids within separate containers.
4. Transfer all waste containers to a staging area. Access to this area will be controlled. Waste containers must be transferred to the staging area as soon as practicable after the generating activity is complete.
5. Pending transfer, all containers will be covered and secured when not immediately attended.
6. Label all containers with regard to contents, origin, date of generation, using TurnKey's IDW container label (sample attached). Use indelible ink for all labeling.
7. Complete the Investigative Derived Waste Container Log (sample attached) as waste containers are labeled in order to track and inventory project waste. Leave a copy of the log with the site manager or fax copy to the owner/operator as necessary.
8. Collect samples for waste characterization purposes, or use boring/well sample analytical data for characterization.
9. For wastes determined to be hazardous in character, **be aware of accumulation time limitations**. Coordinate the disposal of these wastes with the plant manager/owner/operator, if applicable.
10. Dispose of investigation-derived wastes as follows:
 - Soil, water, and other environmental media for which analysis does not detect organic constituents, and for which inorganic constituents are at



MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

levels consistent with background, may be spread on the Property or otherwise treated as a non-waste material as directed by the plant manager/owner/operator or Project Manager.

- Soils, water, and other environmental media in which organic compounds are detected or metals are present above background will be disposed as industrial waste. Alternate disposition must be consistent with applicable State and Federal laws.
- Personal protective equipment, disposable bailers, and similar equipment may be disposed as municipal waste, unless waste characterization results mandate disposal as industrial wastes.

WASTE STORAGE MANAGEMENT

Hazardous materials generated on site should be temporarily stored in a secure location that is under the control of the owner/operator or does not allow for vandalism (i.e., within a locked building structure or within a locked fenced in area). A waste-staging area should be designated on-site by the Project Manager in conjunction with the owner/operator.

ATTACHMENTS

Investigation Derived Waste Container Log (sample)
Investigation Derived Waste Container Label (sample)

REFERENCES


None



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MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

IDW Container Label (sample):


Project Name: _____
Project Number: _____
Container I.D.: _____
Contents/Matrix: _____
Estimated Quantity: _____
Date of Generation: _____
Date of Sample Collection: _____
Contact Name: _____
Contact Phone Number: _____



FIELD OPERATING PROCEDURES

Monitoring Well Construction for Hollow Stem Auger Boreholes

FOP 033.0

MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

PURPOSE

Wells will be installed within selected boreholes for the purpose of evaluating groundwater characteristics. Well installation procedures depend upon the drilling method. This procedure describes well construction and installation for boreholes drilled using the hollow stem auger method. Refer to the TurnKey's Hollow Stem Auger Drilling Procedures FOP. Nominal dimensions and materials for the well are shown in the attached well construction diagram.

PROCEDURE

1. Advance borehole in accordance with the TurnKey's Hollow Stem Auger Drilling Procedure FOP to the required depth. The nominal inside diameter (ID) of the auger stem used should be at least 2 inches larger than the outside diameter (OD) of the riser and screen selected for the well installation. Record the monitoring well construction on the Field Borehole/Monitoring Well Installation Log (sample attached) (see Documentation Requirements for Drilling and Well Installation FOP).
2. Remove the drill rods and center bit/plug from the auger stem and verify borehole depth using weighted measuring tape.
3. In the event of an over drill (i.e. borehole depth is more than one foot greater than desired base of screen depth), use bentonite chips poured through the auger stem to seal the over drilled portion of the borehole. Be sure to note bentonite chip thickness on Field Borehole/Monitoring Well Installation Log.
4. Add a maximum of 6 inches of filter pack material through the auger stem to the base of the borehole. (Note: This step may be avoided if dense non-aqueous phase liquids are suspected to be present and it is desirable to have the screen and/or sump at the base of the borehole.)



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MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

5. Measure the length of the well string (i.e. riser and screen), and lower the well string into the well assembly to the desired depth. All measurements during the well installation process will be accurate to 0.1 foot.
6. Surface pour filter pack material into the annulus between the well and the auger stem as the augers are gradually withdrawn from the borehole. Use a weighted tape to confirm that the level of sand is maintained within the augers at all times. Record material volumes used.
7. After filter pack materials are brought to the required level, surface pour bentonite chips or pellets into the annulus between the well and the auger stem to form the filter pack seal. If necessary to avoid bridging, delayed hydration (coated) pellets may be used. Record the volume of material used.
8. Allow the bentonite chips/pellets to adequately hydrate for approximately 30 to 45-minutes. Cap or cover the well top of riser.
9. Mix cement/bentonite grout to a smooth consistency using a centrifugal or reciprocating pump. Do not hand mix. All water used must be potable quality. Record the volume of water used.
10. Fill the remaining annulus between the well and the auger stem with grout by surface pouring or pumping, and begin withdrawal of the auger string. Periodically top the auger string off with additional grout. If groundwater is present within the annulus above the bentonite chip/pellet seal, cement/bentonite grout will be pressure tremie grouted from bottom to top in order to displace groundwater from the borehole.
11. When the auger string is withdrawn, center the upper portion of the well riser within the borehole, and place drums or barricades around the well for protection while the grout cures. Place and lock a security cap (i.e., J-plug) in the opening of the well riser.
12. Leave the well undisturbed for at least 24 hours to allow the grout to cure. If excessive grout fallback occurs, top off as necessary with bentonite chips or additional grout.

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MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

13. Construct the surface completion as shown in the attached Typical Monitoring Well Detail (Figure 1). Select flush completions for all locations in active operational or high traffic areas, or in other areas where an above grade completion would be undesirable. Use aboveground completions in all other areas.
14. Place a dedicated lock on the well or protective casing, and keep well locked when not actively attended.
15. Permanently label the well with the appropriate well identifier as determined by the Project Manager or specified in the Work Plan.
16. Permanently mark a survey location on the north side at the top of the casing with a saw cut. Survey all wells for horizontal location and elevation, using a surveyor licensed by the State of New York. Coordinates and elevations will be provided in a coordinate system consistent with previous well surveys at the Site. Information obtained will include location (x and y) of the well, and elevation (z) of the ground surface, the pad, and the top of riser.
17. Develop the well as described in the TurnKey's Field Operating Procedure for Monitoring Well Development.
18. Manage all waste materials generated during well installation and development as described in the TurnKey's Field Operating Procedure for Management of Investigation Derived Waste.

ATTACHMENTS

Field Borehole/Monitoring Well Installation Log (sample)
Typical Monitoring Well Detail (Figure 1)



FOP 033.0

**MONITORING WELL CONSTRUCTION FOR
HOLLOW STEM AUGER BOREHOLES**

REFERENCES

TurnKey FOPs:

- 015 *Documentation Requirements for Drilling and Well Installation*
- 026 *Hollow Stem Auger Drilling Procedures*
- 032 *Management of Investigation Derived Waste*
- 036 *Monitoring Well Development Procedures*



FOP 033.0

**MONITORING WELL CONSTRUCTION FOR
HOLLOW STEM AUGER BOREHOLES**



**FIELD BOREHOLE/MONITORING WELL
INSTALLATION LOG**

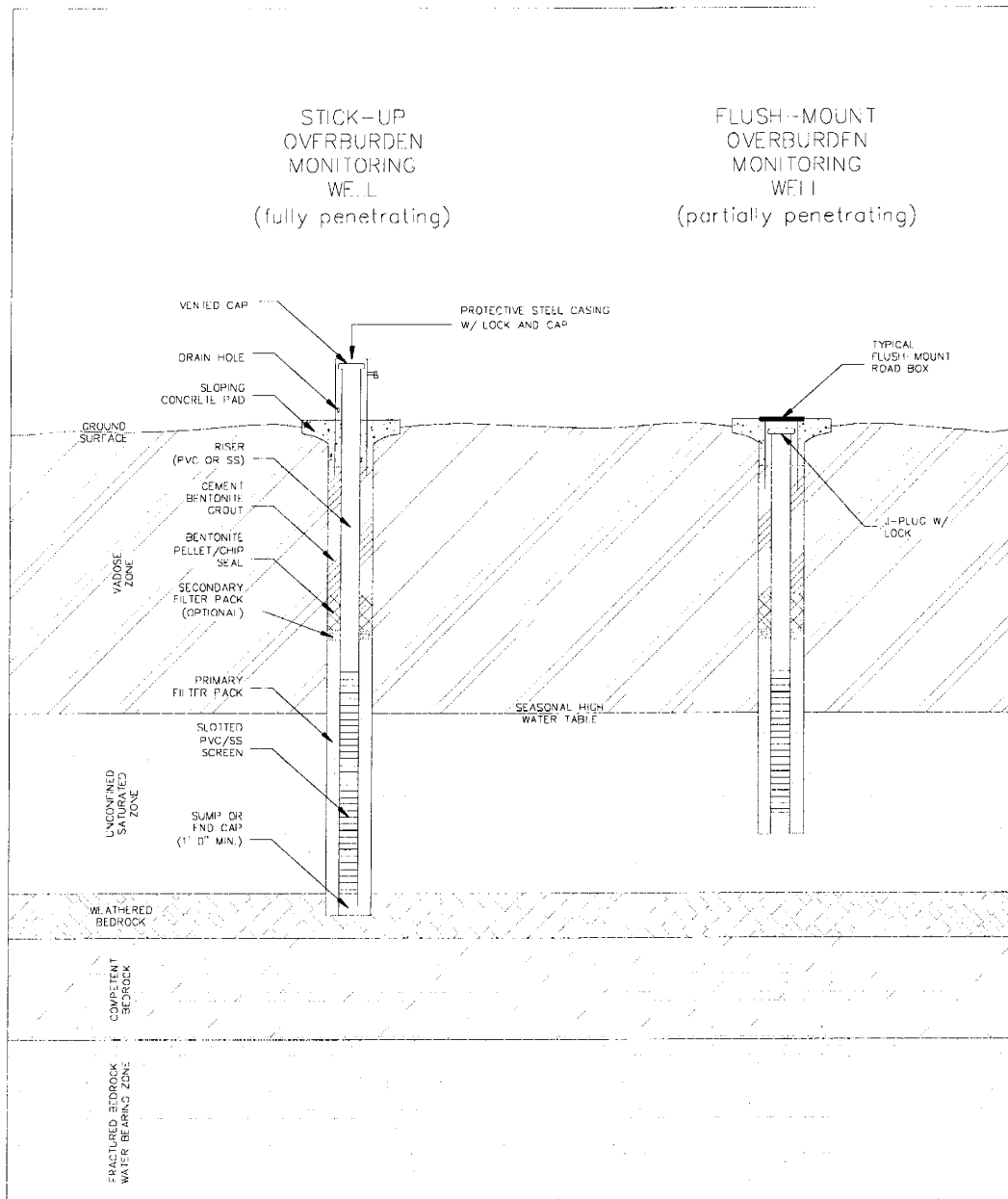
PROJECT:						Log of Well No.:														
BORING LOCATION:						ELEVATION AND DATUM:														
DRILLING CONTRACTOR:						DATE STARTED:		DATE FINISHED:												
DRILLING METHOD:						TOTAL DEPTH:		SCREEN INTERVAL:												
DRILLING EQUIPMENT:						DEPTH TO WATER:	FIRST:	COMPL.:	CASING:											
SAMPLING METHOD:						LOGGED BY:														
HAMMER WEIGHT:				DROP:		RESPONSIBLE PROFESSIONAL:			REG. NO.											
Depth (fms)	SAMPLES					SAMPLE DESCRIPTION				WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS										
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	USCS Classification: Color, Moisture Condition, % of Soil Type, Fabric, Bedding, Weathering/Fracturing, Odor, Other														
SURFACE ELEVATION (FMSL):																				
<div style="text-align: center; font-size: 100px; opacity: 0.5; transform: rotate(-30deg);">SAMPLE</div>																				
											Project No:						TurnKey Environmental Restoration, LLC			Figure



FOP 033.0

MONITORING WELL CONSTRUCTION FOR
HOLLOW STEM AUGER BOREHOLES

FIGURE 1





FIELD OPERATING PROCEDURES

Monitoring Well Development Procedures

MONITORING WELL DEVELOPMENT PROCEDURES

PURPOSE

This procedure describes the methods for the development of newly installed monitoring wells and re-development of existing monitoring wells that have been inactive for an extended period of time (i.e., one year or more). Monitoring wells are developed after installation in order to remove introduced water and drilling fluids, reduce the turbidity of the water, and improve the hydraulic communication between the well and the water-bearing formation. Well development will not commence until the annular grout seal has cured, but will be performed within ten calendar days of well installation.

PROCEDURE

1. All well development will include surge blocking or false bailing with one or more of the following fluid removal methods. Well development activities may include:
 - Bailing
 - Air Lifting
 - Submersible Pumping
 - Other methods as approved by the TurnKey Field Team Leader.
 - The appropriate water removal method will be selected based on water level depth and anticipated well productivity.
2. Assemble and decontaminate equipment (if necessary), and place in the well. Reference the TurnKey's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
3. Alternate the use of agitation methods with water removal methods, using the former to suspend solids in the well water, and the latter to remove the turbid water. For example, use a vented surge block to agitate the well, moving up and down within the screened interval and then use a pump to clear the well. A bailer may be used for both purposes, by surging with the bailer (false

FOP 036.0

MONITORING WELL DEVELOPMENT PROCEDURES

bailing) for a period within the screened interval, then bailing a volume of water from the well.

4. When using surging methods, initiate this activity gradually, with short (2 to 3 feet) strokes. After several passes across the screened interval, increase the speed and length of the surge strokes.
5. Continue development until the following objectives are achieved:
 - Field parameters stabilize to the following criteria:
 - o Dissolved Oxygen: ± 0.3 mg/L
 - o Turbidity: $\pm 10\%$
 - o Specific Conductance: $\pm 3\%$
 - o ORP: ± 10 mV
 - o pH: ± 0.1 units
 - The well will generate non-turbid water during continued pumping typically less than 50 NTU.
 - A minimum of 10 well volumes has been evacuated from the well.
 - In the case of lost water during drilling activities, the volume of water removed exceeds twice the volume of water lost to the formation during the drilling process, as indicated by the water balance.
6. Document the development methods, volumes, field parameter measurements, and other observations on the attached Groundwater Well Development Log (sample attached).

ATTACHMENTS

Groundwater Well Development Log (sample)

REFERENCES

TurnKey FOPs:

040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*





FIELD OPERATING PROCEDURES

NAPL Detection and Sample Collection Procedure

**NON-AQUEOUS PHASE LIQUID DETECTION
AND SAMPLE COLLECTION PROCEDURE**

PURPOSE

This procedure describes the methods to detect the presence and sample collection of Non-Aqueous Phase Liquid (NAPL) in groundwater monitoring wells prior to purging activities. If NAPL is suspected, all activities should be performed with proper personnel protective equipment (PPE).

DETECTION PROCEDURE

Groundwater monitoring wells suspected of containing NAPL will be sounded with an interface probe, or similar device, in accordance with the following.

1. Remove the locking and protective caps from the well suspected of containing NAPL.
2. Screen the ambient air in the well headspace for organic vapors using either a photoionization detector (PID) or an organic vapor analyzer (OVA) and record measurements. The organic vapor detection device should be calibrated in accordance with the TurnKey's Field Operating Procedure for Calibration and Maintenance of Portable PIDs.
3. Slowly lower an interface probe down the well, avoiding contact with the well casing. Upon contact with the static liquid level in the well, the interface probe will signal contact with an audible tone and/or a visible light mounted inside the reel.

Note:

- If the signal is constant, the probe is in contact with groundwater; and
- If the signal oscillates, the probe is in contact with NAPL.

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NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

4. Record the depth, type of liquid encountered (if applicable) and any other related information in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).
5. Slowly lower the interface probe to the well bottom. Record the depth(s) and type(s) of any additional phases encountered.
6. Slowly raise the interface probe to the surface, avoiding contact with the well casing.
7. Place the interface probe and storage reel in a plastic bag for subsequent decontamination in accordance with the TurnKey's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

SAMPLE COLLECTION PROCEDURE

All NAPL samples collected from groundwater monitoring wells will be collected in accordance with the following.

1. Place plastic sheeting on the ground around the well to prevent equipment from coming in contact with soil and also to prevent the surface transmission of NAPL.
2. All sampling personnel will don the appropriate PPE in accordance with the site health and safety plan.
3. Measure the static water level and NAPL level(s) using an interface probe as described in the previous section.
4. Determine depth to NAPL layer and thickness. Record appropriate data in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).



**NON-AQUEOUS PHASE LIQUID DETECTION
AND SAMPLE COLLECTION PROCEDURE**

DNAPL SAMPLE COLLECTION

The following procedure should be used in sampling dense, heavier than water NAPL (i.e., with a high specific gravity) (DNAPL).

1. Collect samples using a translucent double check valve bailer (i.e., a bailer with a ball valve on both the top and bottom) constructed of Teflon, polyethylene or PVC which is connected to polypropylene rope for lowering into the well. All non-dedicated equipment shall be decontaminated in accordance with the TurnKey's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
2. Remove wrapping (i.e., aluminum foil, manufacturers packaging etc.), attach bailer to new polypropylene rope and slowly lower the bailer until it contacts the well bottom.
3. Slowly raise and lower the bailer to create a gentle surging action thereby inducing DNAPL into the bailer past the bottom ball valve.
4. Slowly raise the bailer to the surface. Avoid contact of the bailer line with the well casing and/or ground surface.
5. Observe the DNAPL through the translucent wall of the bailer and check if the immiscible phases have separated. If not, allow the bailer to stand upright until the phases have separated.
6. Carefully attach a bottom-emptying device with stopcock to the bottom of the bailer and discharge the DNAPL gently down the side of the sample bottle to minimize turbulence.
7. Repeat steps 2 through 6 until a sufficient sample volume is obtained.
8. Cap the sample bottle and label, preserve and ship samples in accordance with the TurnKey's Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

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NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

9. Place the used plastic sheeting, bailer and polyethylene rope in a plastic bag for subsequent decontamination or disposal.
10. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).

LNAPL SAMPLE COLLECTION

The following procedure should be used in sampling lighter than water NAPL (i.e., with a low specific gravity) (LNAPL).

1. Collect samples using a translucent double check valve bailer (i.e., a bailer with a ball valve on both the top and bottom) constructed of Teflon, polyethylene or PVC which is connected to polypropylene rope for lowering into the well. All non-dedicated equipment shall be decontaminated in accordance with the TurnKey's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
2. Remove wrapping (i.e., aluminum foil, manufacturers packaging etc.), attach bailer to new polypropylene rope and slowly lower the bailer down the well into the immiscible phase of LNAPL. Care should be taken to lower the bailer just through the LNAPL layer, but not significantly down into the underlying groundwater.
3. Slowly raise the bailer to the surface. Avoid contact of the bailer line with the well casing and/or ground surface.
4. Observe the LNAPL through the translucent wall of the bailer and check if the immiscible phases have separated. If not, allow the bailer to stand upright until the phases have separated.



FOP 039.0

NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

5. Carefully attach a bottom-emptying device with stopcock to the bottom of the bailer and decant the denser groundwater portion of the bailer contents into a DOT-approved 55-gallon drum for proper disposal.
6. Discharge the LNAPL gently down the side of the sample bottle to minimize turbulence.
7. Repeat steps 2 through 6 until a sufficient sample volume is obtained.
8. Cap the sample bottle and label, preserve and ship samples in accordance with the TurnKey's Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.
9. Place the used plastic sheeting, bailer and polyethylene rope in a plastic bag for subsequent decontamination or disposal.
10. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).

ATTACHMENTS

Groundwater Well Purge & Sample Collection Log (sample)

REFERENCES

TurnKey FOPs:

- 010 *Calibration and Maintenance of Portable Flame Ionization Detector*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
- 046 *Sample Labeling, Storage and Shipment Procedures*



FOP 039.0

NON-AQUEOUS PHASE LIQUID DETECTION
AND SAMPLE COLLECTION PROCEDUREGROUNDWATER WELL
PURGE & SAMPLE COLLECTION LOG

Project Name: _____ WELL NUMBER: _____
Project Number: _____ Sample Matrix: _____
Client: _____ Weather: _____

WELL DATA:	DATE: _____	TIME: _____
Casing Diameter (inches): _____	Casing Material: _____	
Screened interval (ftTOR): _____	Screen Material: _____	
Static Water Level (ftTOR): _____	Bottom Depth (ftTOR): _____	
Elevation Top of Well Riser (fmsl): _____	Ground Surface Elevation (fmsl): _____	
Elevation Top of Screen (fmsl): _____	Stick-up (feet): _____	

PURGING DATA:	DATE: _____	START TIME: _____	END TIME: _____
Method: _____	Is purge equipment dedicated to sample location?	yes	no
No. of Well Volumes Purged: _____	Was well purged to dryness?	yes	no
Standing Volume (gallons): _____	Was well purged below top of sand pack?	yes	no
Volume Purged (gallons): _____	Condition of Well: _____		
Purge Rate (gal/min): _____	Field Personnel: _____		

VOLUME CALCULATION:	Volume Calculations	Stabilization Criteria	
(A) Total Depth of Well (ftTOR): _____	Well Diameter	Parameter	Criteria
(B) Casing Diameter (inches): _____	Volume gal/ft		
(C) Static Water Level (ftTOR): _____	1" 0.041	DO	+/- 0.1 unit
One Well Volume (V, gallons): _____	2" 0.163	Specific Conductivity	+/- 3%
$V = 0.0408 [(B)^2 \times ((A) - (C))]$	3" 0.357	Turbidity	+/- 10%
* Use the table to the right to calculate one well volume by subtracting C from A, then multiplying by the volume calculation in the table per well diameter.	4" 0.628	DO	+/- 0.3 mg/L
	5" 1.020	ORP	+/- 10 mV
	6" 1.469		

EVACUATION STABILIZATION TEST DATA								
Time	Water Level (ftTOR)	Accumulated Volume (gallons)	Temperature (°F)	Specific Conductivity (µS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	Initial	0.0						

SAMPLING DATA:	START TIME: _____	END TIME: _____	
Method: _____	Is sampling equipment dedicated to sample location?	yes	no
Initial Water Level (ftTOR): _____	Was well sampled to dryness?	yes	no
Final Water Level (ftTOR): _____	Was well sampled below top of sand pack?	yes	no
Air Temperature (°F): _____	Field Personnel: _____		
Source and type of water used in the field for QC purposes: _____			

PHYSICAL & CHEMICAL DATA:							
DESCRIPTION OF WATER SAMPLE							
Odor							
Color							
NAPL							
Contains Sediment?	yes	no					
WATER QUALITY MEASUREMENTS							
Sample	Time	pH (units)	TEMP. (°C)	SC (µS)	TURB. (NTU)	DO (ppm)	ORP (mV)
Initial							
Final							

REMARKS: _____

PREPARED BY: _____





FIELD OPERATING PROCEDURES

Sample Labeling, Storage, and Shipment Procedures

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

PURPOSE

The collection and analysis of samples of environmental media, including soils, groundwater, surface water, and sediment, are the central activities of the field investigation. These samples must be properly labeled to preserve its identity, and properly stored and shipped in a manner that preserves its integrity and chain of custody. This procedure presents methods for these activities.

SAMPLE LABELING PROCEDURE

1. Assign each sample retained for analysis a unique 9-digit alphanumeric identification code or as indicated in the Project Work Plan. Typically, this code will be formatted as follows:

Sample I.D. Example: GW051402047	
GW	Sample matrix GW = groundwater; SW = surface water; SUB = subsurface soil; SS = surface soil; SED = sediment; L = leachate; A = air
05	Month of sample collection
14	Day of sample collection
02	Year of sample collection
047	Consecutive sample number

2. Consecutive sample numbers will indicate the individual sample's sequence in the total set of samples collected during the investigation/sampling event. The sample number above, for example, would indicate the 47th sample retained for analysis during the field investigation, collected on May 14, 2002.

FOP 046.0

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

3. Affix a non-removable (when wet) label to each sample container. The following information will be written on the label with black or blue ink that will not smudge when wet:
 - Project number
 - Sample ID (see Step 1 above)
 - Date of sample collection
 - Time of sample collection (military time only)
 - Specify “grab” or “composite” sample with an “X”
 - Sampler initials
 - Preservative(s) (if applicable)
 - Analytes for analysis (if practicable)
4. Record all sample label information in the Project Field Book and on a Sample Summary Collection Log (see attached samples), keyed to the sample identification number. In addition, add information regarding the matrix, sample location, depth, etc. to provide a complete description of the sample.

SAMPLE STORAGE PROCEDURE

1. Immediately after collection, placement in the proper container, and labeling, place samples to be retained for chemical analysis into resealable plastic bags.
2. Place bagged samples into an ice chest filled approximately half-full of double bagged ice. Blue ice is not an acceptable substitute for ice.
3. Maintain samples in an ice chest or in an alternative location (e.g. sample refrigerator) as approved by the TurnKey Field Team Leader until time of shipment. Periodically drain melt-water off coolers and replenish ice as necessary.



FOP 046.0

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

4. Ship samples on a daily basis, unless otherwise directed by the TurnKey Field Team Leader.
5. Maintain appropriate custody procedures on coolers and other sample storage containers at all times. These procedures are discussed in detail in the Project Quality Assurance Project Plan, Monitoring Plan or Work Plan.
6. Samples shall be kept in a secure location locked and controlled (i.e., locked building or fenced area) so that only the Project Field Team Leader has access to the location or under the constant visual surveillance of the same.

SAMPLE SHIPPING PROCEDURE

1. Fill out the chain-of-custody form completely (see attached sample) with all relevant information. The white original goes with the samples and should be placed in a resealable plastic bag and taped inside the sample cooler lid; the sampler should retain the copy.
2. Place a layer of inert cushioning material such as bubble pack in the bottom of cooler.
3. Place each bottle in a bubble wrap sleeve or other protective wrap. To the extent practicable, then place each bottle in a resealable plastic bag.
4. Open a garbage bag (or similar) into a cooler and place sample bottles into the garbage bag (or similar) with volatile organic analysis (VOA) vials near the center of the cooler.
5. Pack bottles with ice in plastic bags. At packing completion, cooler should be at least 50 percent ice, by volume. Coolers should be completely filled, so that samples do not move excessively during shipping.
6. Duct tape (or similar) cooler drain closed and wrap cooler completely in two or more locations to secure lid, specifically covering the hinges of the cooler.



FOP 046.0

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

7. Place laboratory label address identifying cooler number (i.e., 1 of 4, 2 of 4 etc.) and overnight delivery waybill sleeves on cooler lid or handle sleeve (Federal Express).
8. Sign the custody seal tape with an indelible soft-tip marker and place over the duct tape across the front and back seam between the lid and cooler body.
9. Cover the signed custody seal tape with an additional wrap of transparent strapping tape.
10. Place "Fragile" and "This Side Up" labels on all four sides of the cooler. "This Side Up" labels are yellow labels with a black arrow with the arrowhead pointing toward the cooler lid.
11. For coolers shipped by overnight delivery, retain a copy of the shipping waybill, and attach to the chain-of-custody documentation.

ATTACHMENTS

Soil/Sediment Sample Summary Collection Log (sample)
Groundwater/Surface Water Sample Summary Collection Log (sample)
Wipe Sample Summary Collection Log (sample)
Air Sample Summary Collection Log (sample)
Chain-Of-Custody Form (sample)

REFERENCES

None



SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

[illegible]

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES



water over or through decontaminated sample containers. Collect at a frequency collected the same day. Field blanks should be collected by the same person of concern to rinse/decontaminate. Water manufacturers info & date.

samples of each water source. Analyze for all metals analyzed for the samples collected.

nal decon rinse water. Collect field blanks at the sampling site. Collect field blanks at a frequency.

One collection of decon fluids and soil. Please note number.

4. FD - Field Duplicate.
5. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate
6. BD - Blind Duplicate.

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

[illegible]

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES



SAMPLE

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

[illegible]



FIELD OPERATING PROCEDURES

Screening of Soil Samples for Organic Vapors During Drilling Activities

FOP 047.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

PURPOSE

This procedure is used to screen soil samples for the presence of volatile organic constituents (VOCs) using a field organic vapor meter. These meters will be either photoionization detector (PID) or flame-ionization detector (FID) type. This screening is performed at the drilling and sampling location as a procedure for ensuring the health and safety of personnel at the site and to identify potentially contaminated soil samples for laboratory analysis. All soil samples will be field screened to provide a vertical profile of soil contamination by volatile organic substances.

PROCEDURE

1. Calibrate air-monitoring equipment in accordance with the appropriate TurnKey's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
2. Collect split-spoon (or other sampler) samples in accordance with TurnKey's Split Spoon Sampling Procedure FOP.
3. When the split-spoon or other sampler is opened or accessed, shave a thin layer of material from the entire length of the core.
4. Scan the core visually and with the PID or FID noting stratification, visible staining, or other evidence of contamination.
5. Based on this initial scan of the sample, collect approximately 100 milliliters (ml) of soil using a decontaminated or dedicated stainless steel spatula, scoop, or equivalent. Place this soil into a labeled wide-mouth glass jar approximately $\frac{1}{2}$ to $\frac{3}{4}$ full and seal with aluminum foil and a screw top cap. Alternatively, the soil may be placed into a clean, re-sealable plastic bag and sealed. Be sure to leave some headspace above the soil sample within the sealed container.



FOP 047.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

6. Place field screening sample (i.e., jar or bag) in a location where the ambient temperature is at least 70° Fahrenheit.
7. Leave the field screening sample bag for at least 30 minutes, but no more than 60 minutes.
8. Carefully remove the screw top cap from the jar and slowly insert the tip of the organic vapor meter (PID or FID) through the aluminum foil seal making the smallest hole possible. Alternatively, unseal a portion of the plastic bag just big enough to insert the probe of a calibrated PID.
9. Record the maximum reading in parts per million by volume (ppmv) on the Field Borehole Log or Field Borehole/Monitoring Well Installation Log form (see attached samples) (see Documentation Requirements for Drilling and Well Installation FOP), at the depth interval corresponding to the depth of sample collection.

ATTACHMENTS

Field Borehole Log (sample)
Field Borehole/Monitoring Well Installation Log (sample)

REFERENCES

TurnKey FOPs:

- 010 *Calibration and Maintenance of Portable Flame Ionization Detector*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 015 *Documentation Requirements for Drilling and Well Installation*
- 058 *Split Spoon Sampling Procedures*



SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

FIELD BOREHOLE LOG

PROJECT:										Log of Boring No.:											
BORING LOCATION:										ELEVATION AND DATUM:											
DRILLING CONTRACTOR:										DATE STARTED:					DATE FINISHED:						
DRILLING METHOD:										TOTAL DEPTH:					SCREEN INTERVAL:						
DRILLING EQUIPMENT:										DEPTH TO WATER:			FIRST:		COMPL.:		CASING:				
SAMPLING METHOD:										LOGGED BY:											
HAMMER WEIGHT:					DROP:					RESPONSIBLE PROFESSIONAL:					REG. NO.						
Depth (ftgs)		SAMPLES					SAMPLE DESCRIPTION										REMARKS				
		Sample No.	Sample	Blows (per ft)	SPT N-Value	Recovery	USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other														
							SURFACE ELEVATION (FMSL):														
							<div style="position: absolute; top: 50%; left: 50%; transform: translate(-50%, -50%) rotate(-45deg); font-size: 100px; opacity: 0.5; pointer-events: none;"> SAMPLE </div>														

ABANDONMENT:

Volume of cement/bentonite grout required: $V = \pi r^2 \times 7.48 =$ gallons borehole depth = ft.

Volume of cement/bentonite grout installed: gallons borehole diameter = ft.

Has bridging of grout occurred? ☐ yes ☐ no borehole radius = ft.

If yes, explain resolution:

Method of installation:

Project No:
TurnKey Environmental Restoration, LLC
Figure

FOP 047.0

**SCREENING OF SOIL SAMPLES FOR ORGANIC
VAPORS DURING DRILLING ACTIVITIES**



**FIELD GEOPROBE BOREHOLE \ TEMPORARY
WELL INSTALLATION LOG**

PROJECT:						Log of Temp. Well No.:														
BORING LOCATION:						ELEVATION AND DATUM:														
DRILLING CONTRACTOR:						DATE STARTED:		DATE FINISHED:												
DRILLING METHOD:						TOTAL DEPTH:		SCREEN INTERVAL:												
DRILLING EQUIPMENT:						DEPTH TO WATER:	FIRST:	COMPL.:	CASING:											
SAMPLING METHOD:						LOGGED BY:														
HAMMER WEIGHT:				DROP:		RESPONSIBLE PROFESSIONAL:			REG. NO.											
Depth (fsgs)	SAMPLES					SAMPLE DESCRIPTION				WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS										
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, etc.														
SURFACE ELEVATION (FMSL):																				
<div style="text-align: center; font-size: 100px; opacity: 0.5; transform: rotate(-45deg);">SAMPLE</div>																				
											Project No:						TurnKey Environmental Restoration, LLC			Figure





FIELD OPERATING PROCEDURES

Soil Description Procedures Using the USCS

FOP 054.0

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

PURPOSE

This guideline presents a means for insuring consistent and proper field identification and description of collected soils during a project (via, split-spoon (barrel) sampler, hand auger, test pit etc.). The lithology and moisture content of each soil sample will be physically characterized by visual observation in accordance with Bureau of Reclamation Standards as modified from the Unified Soil Classification System (USCS). This method of soil characterization describes soil types based on grain size and liquid and plastic limits and includes moisture content. This FOP is fairly consistent with ASTM Designation: D 2488 “Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).” When using this FOP to classify soil, the detail of description provided for a particular material should be dictated by the complexity and objectives of the project. However, more often than not, “after the fact” field information is required later in the project, therefore, every attempt to describe the soil as completely as possibly should be made.

Intensely weathered or decomposed rock that is friable and can be reduced to gravel size or smaller by normal hand pressure should be classified as a soil. The soil classification would be followed by the parent rock name in parenthesis. Projects requiring depth to bedrock determinations should always classify weathered or decomposed bedrock as bedrock (i.e., landfill siting). The project manager should always be consulted prior to making this determination.

PROCEDURE

Assemble necessary equipment and discuss program requirements with drilling contractor.



FOP 054.0

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

1. Calibrate air-monitoring equipment in accordance with the appropriate TurnKey's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
2. Collect desired soil sample in accordance with appropriate TurnKey's FOP (i.e., split-spoon sampling, hand augering, test pitting etc.).
3. Shave a thin layer off the entire length of the sample to expose fresh sample.
4. Photograph and scan the sample with a photoionization detector (PID) at this time, if applicable, in accordance with TurnKey's Screening of Soil Samples for Organic Vapors During Drilling Activities FOP.
5. Describe the sample using terminology presented in the Descriptive Terms section below.
6. Record all pertinent information in the Project Field Book and Field Borehole Log (sample attached) or Field Borehole/Monitoring Well Installation Log (sample attached).
7. After the sample has been described, place a representative portion of the sample in new, precleaned jars for archival purposes. Label the jar with a sample identification number, sample interval, date, project number and store in a secure location.
8. If the soil is to be submitted to a laboratory for analysis, collect the soil sample with a dedicated stainless steel sampling tool, place the sample into the appropriate laboratory-supplied containers, and store in an ice-chilled cooler staged in a secure location in accordance with TurnKey's Sample Labeling, Storage and Shipment Procedures FOP.
9. All remaining soil from soil sample collection activities shall be containerized in accordance with TurnKey's Management of Investigative-Derived Waste (IDW) FOP and/or the Project Work Plan.

**SOIL DESCRIPTION PROCEDURES
USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)**

DESCRIPTIVE TERMS

All field soil samples will be classified in accordance with the Unified Soil Classification System (USCS) (modified from ASTM D2488) presented in Figures 1 and 2 (attached) and using the descriptive terms detailed in this section. It is desirable to supplement the USCS classification with a geologic interpretation of the soil sample that is supported by the soil descriptive terms presented in this section as well as the attached Figures.

Use the following descriptive terms when classifying soils:

- **Group Name** (USCS, see Figure 2)
- **Group Symbol** (USCS, see Figure 2)
- **Angularity** (ASTM D2488; Table 1)
 - Angular – particles have sharp edges and relatively planar sides with unpolished surfaces
 - Subangular – particles are similar to angular description but have rounded edges
 - Subrounded – particles have nearly planar sides but have well-rounded corners and edges
 - Rounded – particles have smoothly curved sides and no edges
- **Particle Shape** (ASTM D2488; Table 2)
 - Flat – particles with width/thickness > 3
 - Elongated – particles with length/width > 3
 - Flat and Elongated – particles meet criteria for both flat and elongated
- **Moisture Condition** (ASTM D2488; Table 3)
 - Dry – absence of moisture, dusty, dry to the touch
 - Moist – damp, but no visible water

**SOIL DESCRIPTION PROCEDURES
USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)**

- Wet – visible free water, usually soil is below water table
- **Reaction with Hydrochloric Acid (HCl)** (ASTM D2488; Table 4)
 - None – no visible reaction
 - Weak – some reaction, with bubbles forming slowly
 - Strong – violent reaction, with bubbles forming immediately
- **Consistency of Cohesive Soils** (ASTM D2488; Table 5)
 - Very soft – squeezes between fingers when fist is closed; easily penetrated several inches by fist
 - Soft – easily molded by fingers; easily penetrated several inches by thumb
 - Firm – molded by strong pressure of fingers; can be penetrated several inches by thumb with moderate effort
 - Stiff – dented by strong pressure of fingers; readily indented by thumb but can be penetrated only with great effort
 - Very stiff – readily indented by thumbnail
 - Hard – indented with difficulty by thumbnail
- **Cementation** (ASTM D2488; Table 6)
 - Weak – crumbles or breaks with handling or slight finger pressure
 - Moderate – crumbles or breaks with considerable finger pressure
 - Strong – will not crumble or break with finger pressure
- **Structure (Fabric)** (ASTM D2488; Table 7)
 - Varved – alternating 1 mm to 12 mm (0.04 – 0.5 inch) layers of sand, silt and clay
 - Stratified – alternating layers of varying material or color with the layers less than 6 mm (0.23 inches) thick; note thickness
 - Laminated – alternating layers of varying material or color with the layers less than 6 mm (0.23 inches) thick; note thickness
 - Fissured – contains shears or separations along planes of weakness

**SOIL DESCRIPTION PROCEDURES
USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)**

- Slickensided – shear planes appear polished or glossy, sometimes striated
- Blocky – cohesive soil that can be broken down into small angular lumps which resist further breakdown
- Lensed – inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
- Homogeneous – same color and appearance throughout
- **Inorganic Fine-Grained Soil Characteristics** (ASTM D2488; Table 12)
 - Dry Strength (ASTM D2488; Table 8)
 - None – the dry specimen crumbles with the slightest pressure of handling
 - Low – the dry specimen crumbles with some finger pressure
 - Medium – the dry specimen breaks into pieces or crumbles with considerable finger pressure
 - High – the dry specimen cannot be broken with finger pressure. The specimen will break into pieces between the thumb and a hard surface.
 - Very High – the dry specimen cannot be broken between the thumb and a hard surface
 - Dilatency (ASTM D2488; Table 9)
 - None – no visible change in the specimen
 - Slow – water slowly appears on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
 - Rapid – water quickly appears on the surface of the specimen during shaking and disappears upon squeezing
 - Toughness (ASTM D2488; Table 10)
 - Low – only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and very soft.
 - Medium – medium pressure is required to roll the thread to near the plastic limit. The thread and the lump are soft.

**SOIL DESCRIPTION PROCEDURES
USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)**

- High – considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump are firm.
- **Plasticity** (ASTM D2488; Table 11)
 - Nonplastic – a 3 mm (0.12 inches) thread cannot be rolled at any water content
 - Low Plasticity – the thread can barely be rolled, and crumbles easily
 - Medium Plasticity – the thread is easy to roll and not much time is required to reach the plastic limit before crumbling
 - High Plasticity – it takes considerable time rolling and kneading to reach the plastic limit; the thread can be rolled several times before crumbling
- **Relative Density of Cohesionless (Granular) Soils**
 - Very loose – easily penetrated 30 cm (1.2 inches) with 13 mm (0.5 inch) rebar pushed by hand
 - Loose – easily penetrated several cm with 13 mm (0.5 inch) rebar pushed by hand
 - Medium dense – easily to moderately penetrated with 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer
 - Dense – penetrated 0.3 m (1 foot) with difficulty using 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer
 - Very dense – penetrated only a few cm with 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer
- **Color** (use Munsel® Color System)
- **Particle Size** (see Figure 3)
 - Boulder – larger than a basketball
 - Cobble – grapefruit, orange, volleyball
 - Coarse Gravel – tennis ball, grape
 - Fine Gravel – pea
 - Coarse Sand – rock salt

**SOIL DESCRIPTION PROCEDURES
USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)**

- Medium Sand – opening in window screen
- Fine Sand – sugar, table salt
- Fines (silt and clay) – cannot visually determine size (unaided)
- **Gradation**
 - Well Graded (GW, SW) – full range and even distribution of grain sizes present
 - Poorly-graded (GP, SP) – narrow range of grain sizes present
 - Uniformly-graded (GP, SP) – consists predominantly of one grain size
 - Gap-graded (GP-SP) – within the range of grain sizes present, one or more sizes are missing
- **Organic Material** – Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread of the toughness test will be spongy.
 - PEAT – 50 to 100 percent organics by volume, primary constituent
 - Organic (soil name) – 15 to 50 percent organics by volume, secondary organic constituent
 - (Soil name) with some organics – 5 to 15 percent organics by volume, additional organic constituents
- **Fill Materials** – All soils should be examined to see if they contain materials indicative of man-made fills. Man-made fill items should be listed in each of the soil descriptions. Common fill indicators include glass, brick, dimensioned lumber, concrete, pavement sections, asphalt, metal, plastics, plaster etc. Other items that could suggest fill include buried vegetation mats, tree limbs, stumps etc. The soil description for a fill material should be followed by the term “FILL”, i.e., for a sandy silt with some brick fragments the description would be “SANDY SILT (ML), with brick fragments (Fill)”. The size and distribution of fill indicators should be noted. The limits (depth range) of fill material should be determined and identified at each exploration location.

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SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

- **Other Constituents/Characteristics**
 - Additional constituents and/or pertinent soil characteristics not included in the previous categories should be described depending on the scope and objectives of the project. Observations that may be discussed include:
 - Oxide staining
 - Odor
 - Origin
 - Presence of root cast
 - Presence of mica
 - Presence of gypsum
 - Presence of calcium carbonate
 - Percent by volume of cobbles & boulders with size description and appropriate rock classification
 - Other pertinent information from the exploratory program should be recorded, if it would be useful from a biddability/constructability perspective. The conditions that should be listed include caving or sloughing, difficulty in drilling and groundwater infiltration.

SOIL DESCRIPTIONS

Generally, soil descriptions presented in this FOP are not intended for civil engineering (construction) purposes, but rather for hydrogeologic and contaminant transport purposes. As such, the visual-manual tests performed are somewhat limited in that they are only performed in order to indicate important information about potential hydraulic properties of a soil. Therefore, at a minimum, soil descriptions should include:

- Color (using Munsell® charts) at moist condition, include mottling
- Field moisture condition;



FOP 054.0

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

- Percentage estimates of various grain sizes present (fines, sand, gravel);
- Plasticity (see Descriptive Terms section of this FOP);
- Consistency/Density (see Descriptive Terms section of this FOP);
- Other important geologic information such as consolidation, gravel size and shape, visible internal structure, root holes, mica, odors, etc.

Based on these data, and in conjunction with the flow charts provided in the ASTM Standard (see Figure 2), the soil is given a USCS group name and a two-letter symbol. If fill is identified, indicate the word FILL after the soil description (parenthetically).

The first step in this FOP is to determine if the sample is predominantly fine-grained or predominantly coarse-grained (see Figure 3). Coarse-grained soils are relatively easy to identify, however descriptions of fine-grained soils can be more difficult, requiring additional field tests to assist the field geologist arrive at the proper soils classification. These tests are explained in detail in the ASTM Standard. Generally, the differentiation between silt and clay is based on plasticity and “texture”. However, tests for dry strength and dilatency, along with plasticity, can be very helpful and are recommended in the ASTM Standard. If additional tests are performed, in addition to plasticity, to classify the fines, record them with the soil description on the logs. Doing this will assist the reader (i.e., Project Manager) to follow the logic used to describe a soil (e.g., medium plasticity, low dry strength = elastic silt [MH]; not a lean clay [CL]).

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SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

Fines described in the classification should be modified by the plasticity (e.g., nonplastic fines, low plasticity fines, etc.) reserving the words “silt” and “clay” for the USCS group name. This applies to fine-grained and coarse-grained soils.

According to a note in the ASTM Standard, percentage of grain size can be estimated in ranges using the words “few”, “little”, “some” and “mostly”. This FOP discourages the use of these modifiers based on practical reasons: (1) the range of percentages in a given word may cross a name designation on the flow charts used for classification, and (2) these words are meaningless to someone who does not have the obscure table in front of them for reference. Accordingly, this FOP encourages estimating grain sizes in percentages or range of percentages (e.g., “about or approximately 10% fine sand”; or “20-25% nonplastic fines). When estimating percentages of grain sizes, make sure that all of the estimates add up to 100%. Keep in mind, the “break over” percentages for fines in a coarse-grained soil and for sand or gravel in a fine-grained soil (refer to Figure 2). For example, do not say “10 to 20% nonplastic fines” when the “break over” occurs into a new USCS group name at 15% fines.

In summary, adhering to the ASTM Standard and the guidelines outlined in this FOP will provide uniformity in soil descriptions of field personnel. Pertinent criteria and their appropriate order are provided at the top of each boring log field sheet. Prior to mobilization to the field, field staff should make sure to have laminated copies of the ASTM Standard flow charts and tables as well as this FOP (as necessary). Some examples of complete soil descriptions are as follows:

FOP 054.0

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

Coarse-grained Soil

CLAYEY GRAVEL with SAND (GC): dark olive gray (5Y 3/2), wet, about 50% fine to coarse gravel, about 30% fine sand, about 20% low plasticity fines, subrounded gravel to 2-inch diameter of greenstone and chert.

Fine-grained Soil

LEAN CLAY with SAND (CL): dark olive gray (5Y 3/2), moist, about 80% fines, about 20% fine to medium sand, trace fine gravel, medium plasticity, firm, root holes.

BORING AND MONITORING WELL INSTALLATION LOGS

One of the most important functions of a boring/monitoring well installation log, besides transmitting the soil description, is to show where the “data” (soil samples) were collected, giving the reader an idea of how reliable or representative the description is. An example of a completed boring and monitoring well installation log is attached to this FOP.

On the example and sample logs, depths of attempted and recovered or non-recovered interval are shown. Do not include the “water level” symbol (inverted triangle) on the logs; instead, indicate the depth at which groundwater was first encountered and, as necessary, the depth to water at borehole/monitoring completion in the space provided on the log header. Also shown on the example and sample logs is the symbol for samples collected for chemical analysis and PID scan measurements. Odor, if noted, will be shown on the logs in the soil description; however, odor, if noted, is subjective and not necessarily indicative of specific compounds or concentrations. Also attached to this FOP is a disclaimer and log symbols used, which should be provided with each set of logs within the project final report.

FOP 054.0

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

Remember: field borehole/monitoring well installation logs should be NEAT, ACCURATE, and LEGIBLE. Don't forget that the well completion diagram completed for each well requires details of the surface completion (i.e., flush-mount, stick-up etc.). It is the responsibility of the field staff to double-check each log (i.e., percentages, classifications, well construction details etc.) prior to implementing into a final report. A registered professional (i.e., professional engineer, PE or professional geologist, PG) must review each log and will be ultimately responsible for its content and accuracy.

REQUIRED EQUIPMENT

- Knife
- Engineer's rule/measuring tape
- Permanent marker
- Pre-cleaned wide-mouth sample jars (typically provided by the driller)
- Pre-cleaned wide-mouth laboratory sample jars (provided by the laboratory)
- Stainless steel sampling equipment (i.e., spoons, spatulas, bowls etc.)
- 10x hand lens
- Hydrochloric acid
- ASTM D2488 flow charts (preferably laminated)
- ASTM D2488 test procedures (Tables 1 through 12) (preferably laminated)
- Camera (disposable, 35 mm or digital)
- Munsell soil color chart
- Project Field Book/field forms



**SOIL DESCRIPTION PROCEDURES
USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)**

ATTACHMENTS

Figure 1; Field Guide for Soil and Stratigraphic Analysis
Figure 2; USCS Soil Classification Flow Chart (modified from ASTM D2488)
Figure 3; Illustration of Particle Sizes

Field Borehole Log Explanation
Field Borehole Log (sample)
Field Borehole Log (completed example)
Field Borehole/Monitoring Well Installation Log Explanation
Field Borehole/Monitoring Well Installation Log (sample)
Field Borehole/Monitoring Well Installation Log (completed example)

REFERENCES

American Society for Testing and Materials, 2000. *ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

State of California, Department of Transportation, Engineering Service Center, Office of Structural Foundations, August 1996. *Soil & Rock Logging Classification Manual (Field Guide)*, by Joseph C. de Larios.

TurnKey FOPs:

- 010 Calibration and Maintenance of Portable Flame Ionization Detector
- 011 Calibration and Maintenance of Portable Photoionization Detector
- 015 Documentation Requirements for Drilling and Well Installation
- 025 Hand Augering Procedures
- 032 Management of Investigation-Derived Waste
- 046 Sample Labeling, Storage and Shipment Procedures
- 047 Screening of Soil Samples for Organic Vapors During Drilling Activities
- 058 Split-Spoon Sampling Procedures
- 065 Test Pit Excavation and Logging Procedures



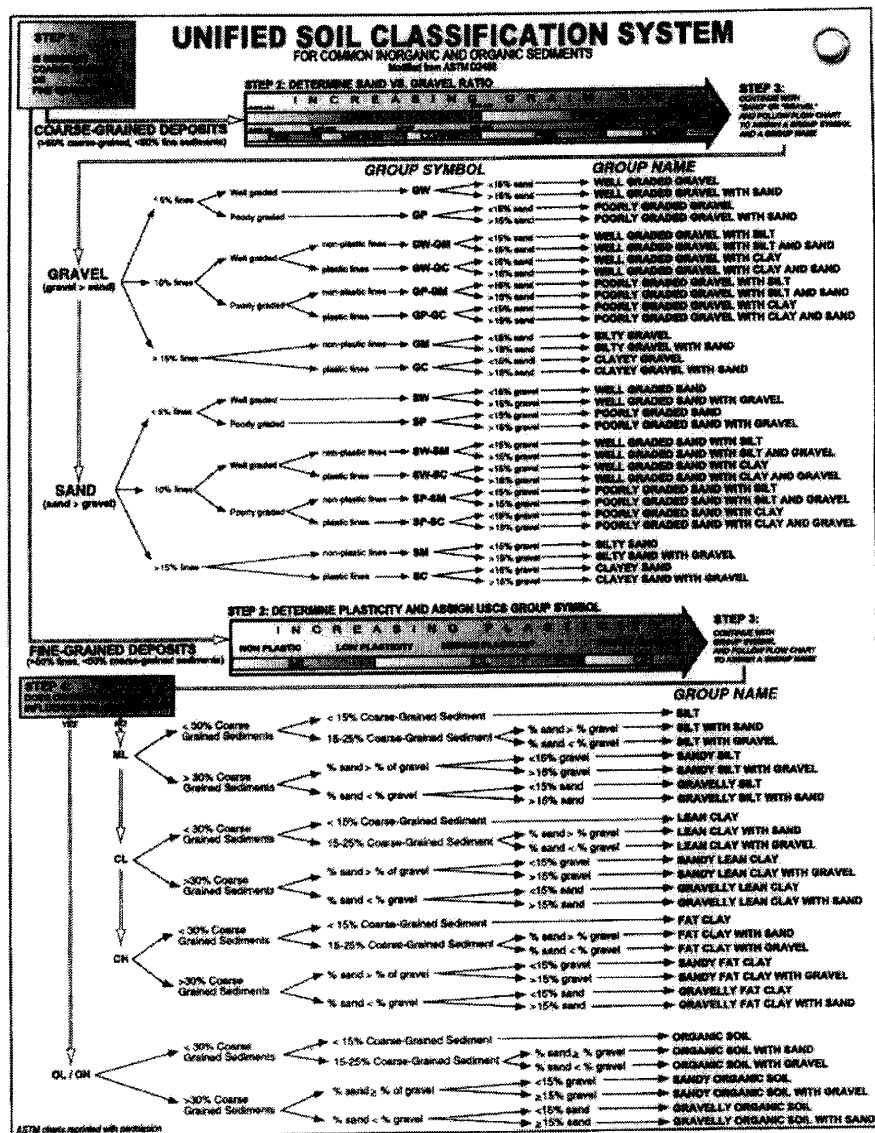
FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS



SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

FIGURE 2

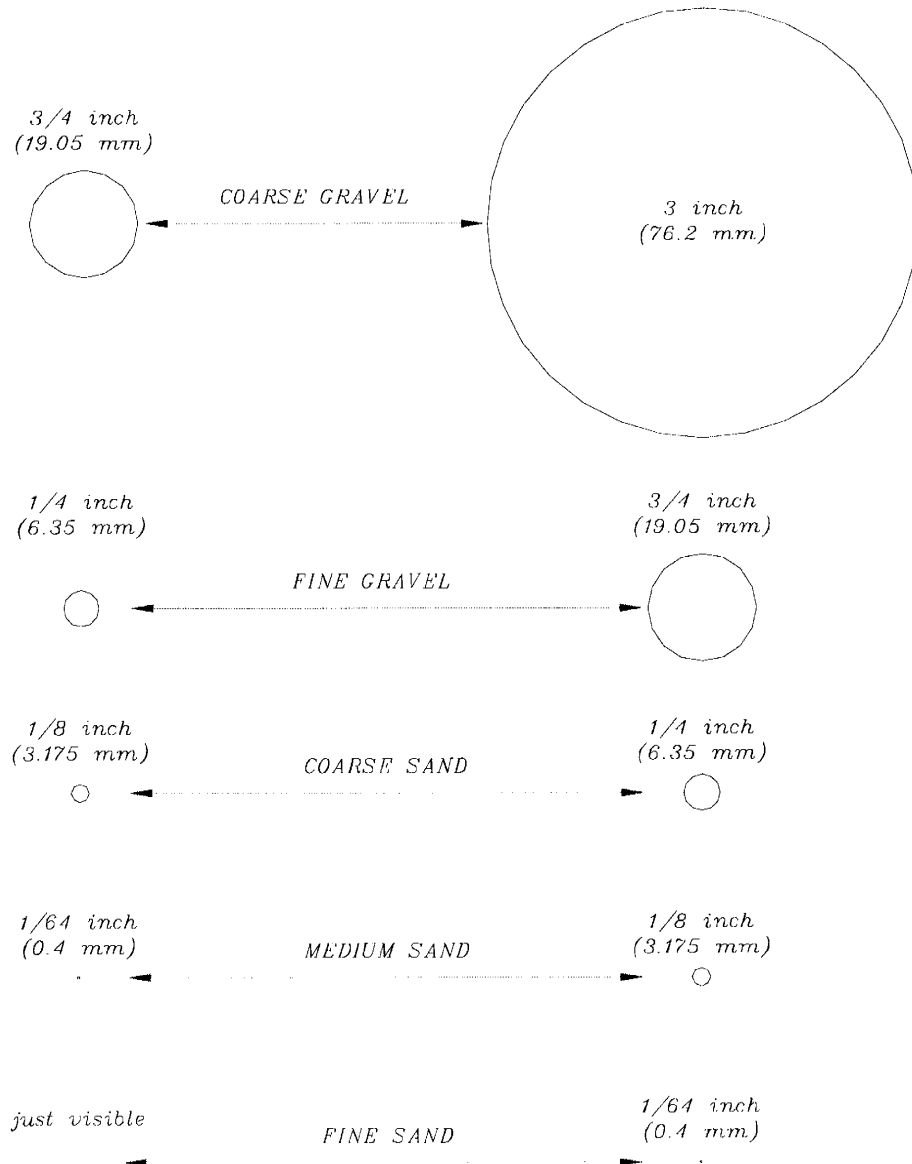
USCS SOIL CLASSIFICATION FLOW CHART (MODIFIED FROM ASTM D2488)



**SOIL DESCRIPTION PROCEDURES
USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)**

FIGURE 3

ILLUSTRATION OF PARTICLE SIZES



SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)



FIELD BOREHOLE LOG

PROJECT:						Borehole Log Explanation			
BORING LOCATION:						ELEVATION AND DATUM:			
DRILLING CONTRACTOR:						DATE STARTED:		DATE FINISHED:	
DRILLING METHOD:						TOTAL DEPTH:		SCREEN INTERVAL:	
DRILLING EQUIPMENT:						DEPTH TO WATER:		FIRST: COMPL: CASING:	
SAMPLING METHOD:						LOGGED BY:			
HAMMER WEIGHT:				DROP:		RESPONSIBLE PROFESSIONAL:			REG. NO.

Depth (ft)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION	REMARKS
	Sample No.	Sample	Blows (per ft)	SPT N-Value	Recovery			
<div style="display: flex; justify-content: space-between;"> <div> <p>USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other</p> <p>SURFACE ELEVATION (FMSL):</p> <p style="text-align: center;">Notes</p> <ol style="list-style-type: none"> Soil Descriptions are in accordance with the USCS as set forth by ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)." Soil color described according to Munsell Color Chart. Dashed lines separating soil strata represent inferred boundaries between sampled intervals that may be abrupt or gradual transitions. Solid lines represent approximate boundaries observed within sample intervals. PID = photoionization detector, reading in parts per million. Odor, if noted, is subjective and not necessarily indicative of specific compounds or concentrations. <p>Interval of recovered soil core collected with split-barrel sampler</p> <p>Interval of recovered soil core collected with split-spoon drive sampler</p> <p>Interval of no recovery</p> <p>Sample collected for chemical analysis and sample identification</p> </div> <div style="width: 60%;"></div> </div>								
S-1								

ABANDONMENT:			
Volume of cement/bentonite grout required:	$V = \pi r^2 \times 7.48 =$	gallons	borehole depth = ft.
Volume of cement/bentonite grout installed:		gallons	borehole diameter = ft.
Has bridging of grout occurred? <input type="checkbox"/> yes <input type="checkbox"/> no			borehole radius = ft.
If yes, explain resolution:			
Method of installation:			
Project No:		TurnKey Environmental Restoration, LLC	
		Figure	

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

FIELD BOREHOLE LOG

PROJECT:										Log of Boring No.:																			
BORING LOCATION:										ELEVATION AND DATUM:																			
DRILLING CONTRACTOR:										DATE STARTED:					DATE FINISHED:														
DRILLING METHOD:										TOTAL DEPTH:					SCREEN INTERVAL:														
DRILLING EQUIPMENT:										DEPTH TO WATER:			FIRST:		COMPL.:		CASING:												
SAMPLING METHOD:										LOGGED BY:																			
HAMMER WEIGHT:					DROP:					RESPONSIBLE PROFESSIONAL:					REG. NO.														
SAMPLES										SAMPLE DESCRIPTION										REMARKS									
Depth (logs)	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other																						
							SURFACE ELEVATION (FMSL):																						
							<div style="position: absolute; top: 50%; left: 50%; transform: translate(-50%, -50%) rotate(-45deg); font-size: 100px; opacity: 0.5; pointer-events: none;"> SAMPLE </div>																						

ABANDONMENT:

Volume of cement/bentonite grout required:	$V = \pi r^2 \times 7.48 =$	gallons	borehole depth =	ft.
Volume of cement/bentonite grout installed:		gallons	borehole diameter =	ft.
Has bridging of grout occurred?	<input type="checkbox"/> yes <input type="checkbox"/> no			
If yes, explain resolution:				
Method of installation:				

Project No.	TurnKey Environmental Restoration, LLC	Figure
-------------	--	--------

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

PROJECT: <i>Chemical, Inc.</i>				Log of Boring No. B-1			
BORING LOCATION: <i>150' SW of former UST @ Bldg 2</i>				ELEVATION AND DATUM: <i>ground surface</i>			
DRILLING CONTRACTOR: <i>Gregg Drilling & Testing</i>				DATE STARTED: <i>7/21/96</i>		DATE FINISHED: <i>7/21/96</i>	
DRILLING METHOD: <i>Hollow stem auger (7 1/4" o.d.)</i>				TOTAL DEPTH: <i>11'</i>		MEASURING POINT: <i>ground surface</i>	
DRILLING EQUIPMENT: <i>Mobile Drill B-61</i>				DEPTH TO WATER: <i>7'</i>		FIRST: <i>7'</i> COMPT: <i>7'</i>	
SAMPLING METHOD: <i>18" split-spoon drive sampler (2" φ)</i>				LOGGED BY: <i>Bill Bates</i>			
HAMMER WEIGHT: <i>140 lbs.</i> DROP: <i>30 inches</i>				RESPONSIBLE PROFESSIONAL: <i>Bill Jones</i>		REG. NO. <i>KG 1234</i>	

DEPTH (feet)	SAMPLES			OVM Reading (feet)	DESCRIPTION NAME (USCS Symbol): color, moist, % by weight, plast. consistency, structure, orientation, sect. w/HC, geo. descr.	REMARKS
	Sample No.	Sample Depth (feet)	Sample Foot			
1					SANDY LEAN CLAY WITH GRAVEL (CL) black (10YR 2 1/2), moist, 70% fines, 15% fine to coarse sand, 15% fine gravel, low plasticity soft [FILL].	log cuttings
2						
3					LEAN CLAY WITH SAND (CL) Very dark grayish brown (10YR 2 1/2), moist, 80% fines, 20% fine sand, trace fine gravel, medium plasticity.	
4						
5					color change to olive gray (5Y 5/2), drilled foot holes	
6						
7					SILT, SAND (SM) Dark olive brown (2.5Y 3/2), wet, 85% medium sand, 15% low plasticity fines	
8						
9						
10					WELL GRADED SAND (SW) Very dark grayish brown (2.5Y 3/2), wet, 90% fine to coarse sand, 10% fine to coarse gravel, trace low plasticity fines, sand and gravel are subrounded.	put on sand catcher
11						
12						
13						
14						
15						

Bottom of boring @ 11'
Boring grouted to ground surface with Cement-bentonite grout.

Project No. _____ Figure _____

B-1 (12/95)

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)



FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:						Well Log Explanation				
BORING LOCATION:						ELEVATION AND DATUM:				
DRILLING CONTRACTOR:						DATE STARTED:		DATE FINISHED:		
DRILLING METHOD:						TOTAL DEPTH:		SCREEN INTERVAL:		
DRILLING EQUIPMENT:						DEPTH TO WATER:	FIRST:	COMPL:	CASING:	
SAMPLING METHOD:						LOGGED BY:				
HAMMER WEIGHT:				DROP:		RESPONSIBLE PROFESSIONAL:			REG. NO.	
Depth (logs)	SAMPLES					SAMPLE DESCRIPTION				WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per ft)	SPT N-Value	Recovery	PID Scan (ppm)				
						USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other				
						SURFACE ELEVATION (FMSL):				
						Notes				
						<p>1. Soil Descriptions are in accordance with the USCS as set forth by ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)."</p> <p>2. Soil color described according to Munsell Color Chart.</p> <p>3. Dashed lines separating soil strata represent inferred boundaries between sampled intervals that may be abrupt or gradual transitions. Solid lines represent approximate boundaries observed within sample intervals.</p> <p>4. PID = photoionization detector, reading in parts per million.</p> <p>5. Odor, if noted, is subjective and not necessarily indicative of specific compounds or concentrations.</p>				
						Interval of recovered soil core collected with split-barrel sampler				
						Interval of recovered soil core collected with split-spoon drive sampler				
						Interval of no recovery				
						Sample collected for chemical analysis and sample identification				
S-1										
Project No:						TurnKey Environmental Restoration, LLC			Figure	



SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

[illegible]

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

PROJECT: <i>Megatank, Inc.</i>				Log of Well No. <i>MW-1</i>	
BORING LOCATION: <i>100' SW of Former UST</i>				ELEVATION AND DATUM: <i>TOC 7.58 feet (MSL)</i>	
DRILLING CONTRACTOR: <i>HEW</i>				DATE STARTED: <i>11/10/96</i>	DATE FINISHED: <i>11/10/96</i>
DRILLING METHOD: <i>Hollow stem auger (8 1/4" OD)</i>				TOTAL DEPTH: <i>14' borng / 12.5' well</i>	SCREEN INTERVAL: <i>5-12'</i>
DRILLING EQUIPMENT: <i>CME-75</i>				DEPTH TO FIRST WATER: <i>7'</i>	CASING: <i>2" Sch 40 PVC</i>
SAMPLING METHOD: <i>CME Continuous core</i>				LOGGED BY: <i>Susan Smith</i>	
HAMMER WEIGHT: <i>NA</i>		DROP: <i>NA</i>		RESPONSIBLE PROFESSIONAL: <i>Jim James</i>	
				REG. NO. <i>CEG 9999</i>	

DEPTH (feet)	SAMPLES			DESCRIPTION	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample Depth (feet)	Notes		
1				Surface Elevation: <i>7.83 feet (MSL)</i>	
2				<i>3" asphalt w/rock base</i>	
3				<i>CLAYEY GRAVEL WITH SAND (GC)</i> Dark brown (7.5 YR 4/6), moist, 70% fine to coarse gravel, 15% medium sand, 15% low to medium plasticity fines, gravel is subrounded to 3/8"	Flush-mount G-S Christy box 12" x 2" x 2" water-tight backing expansion cap
4					Neat cement grout 2" Sch 40 PVC blank casing
5					Bentonite pellet seal
6				<i>PODSOLIC GRAVELLY SAND WITH SILT (SP-SM)</i> Vibrant brown (10 YR 4/6), moist to wet, 90% fine to medium sand, 10% non-plastic fines, color 1 wet 0.7	8 1/4" x 4" borehole
7					Lonestar 2 1/2" silica sand filter pack
8					2" Sch 40 PVC slotted screen 0.020-inch slots
9					PVC slip cap w/SS screws
10				<i>trace gravel, no odor</i>	
11					
12				<i>LEANS CLAY WITH SAND (CL)</i> Dark olive gray (5Y 3/2), moist, 80% fines, 20% fine sand, trace gravel, medium plasticity, firm.	Bentonite pellet seal
13					
14				<i>Bottom of boring c 14'</i>	
15					

Project No. _____ Figure _____

W-1 (12/95)



FIELD OPERATING PROCEDURES

Surface and Subsurface Soil Sampling Procedures

FOP 063.1

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods for sampling surface soil and subsurface soil samples for physical and chemical laboratory analysis during intrusive activities such as test pitting, hand augering, drilling, surface soil sampling etc. Typical health and safety related issues should be addressed in the Project Health and Safety Plan.

PRE-SAMPLING PROCEDURES

1. Review project objectives and the Project Health and Safety Plan (HASP).
2. Commence intrusive activities in accordance with specific TurnKey's FOPs (test pitting, hand augering, drilling etc.) or as directed by the Project Work Plan.
3. Conduct tailgate health and safety meeting with project team and/or subcontractor(s) by completing the Tailgate Safety Meeting Form (sample attached).
4. Calibrate air-monitoring equipment in accordance with the appropriate TurnKey's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
5. Conduct air monitoring as required by the HASP, Project Work Plan or TurnKey's FOP Real-Time Air Monitoring During Intrusive Activities. Record all results on the Real Time Air Monitoring Log (sample attached).
6. Decontaminate all non-dedicated stainless steel (or Pyrex glass) equipment in accordance with TurnKey's Non-disposable and Non-dedicated Sampling Equipment Decontamination procedures.
7. Collect soil samples in accordance with the following sections.



FOP 063.1

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

SURFACE SOIL/FILL SAMPLING PROCEDURES

Collection of surface soil/fill samples facilitates the evaluation of potential health risks to current site receptors that may be exposed to soil/fill via direct contact, incidental ingestion, or inhalation of airborne particulates. The following procedure is in accordance with NYSDEC sampling protocol of surface soil/fill material. Volatile organic analysis of surface soil/fill utilizing this method will yield negatively biased results and should not be performed.

1. Collect all soil samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls etc.), preferably constructed of stainless steel.
2. If the sample area is vegetated, then collect the surface soil sample from 0 to 2 inches below ground surface (bgs) following removal of the sod.
3. If there is no soil present within the sample area (i.e., only slag, concrete, mixed with fines), excavate an area 12 inches by 12 inches by 6 inches deep, screen the material to less than 1/8 inch (No. 4 sieve), and submit the screened material for analysis. If there is not enough material to completely fill the sample jar, then expand the excavation 3 inches in all four directions screening the additional material. Expand the excavation in this manner until sufficient sample volume is obtained.

SURFACE/SUBSURFACE SOIL SAMPLING PROCEDURES

1. Collect all soil samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls etc.), preferably constructed of stainless steel.

Surface soil samples are typically collected from 0 to 6 inches below ground surface (bgs). Subsurface soils are typically sampled from varying depths



FOP 063.1

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

greater than 6-inches bgs based on field observations and as directed by the Project Work Plan.

2. Transfer samples for chemical (VOC, SVOC, Metals etc.) and physical (i.e., Atterberg Limits, Grain Size, Permeability etc.) analytical testing by direct grab (i.e., directly from the bucket of the excavation equipment, split-spoon sampler, hand auger etc.) using the dedicated (or decontaminated non-dedicated) sampling tools into appropriate laboratory-supplied containers and seal. The chemical or physical laboratory selected to perform the analysis should determine minimum sample volume for analysis.
3. Prepare collected samples in accordance with TurnKey's FOP: Sample Labeling, Storage and Shipment Procedures. Do not allow the chemical soil samples to freeze during storage and shipping. It should be noted, ice is not required for physical soil samples and all physical soil samples should be kept at the collected soil moisture by securing with a tight sealing lid. Do not allow physical soil samples to gain or lose moisture from the collected soil moisture prior to analysis.
4. Record all sampling details (i.e., depth and location) in the Project Field Book; appropriate TurnKey log sheets depending on method of intrusion (i.e., drilling, test pitting, hand augering etc.); and on the Soil/Sediment Sample Collection Summary Log (sample attached).

PARAMETER-SPECIFIC PROCEDURES

1. Volatile Organic Compound (VOCs): Transfer sufficient soil volume to fill the laboratory-supplied container (typically 4 ounces) by packing the soil sample with the sampling tool to the top of the container leaving no headspace. At no time should a gloved hand (i.e., latex, nitrile etc.) be used to pack the sample into the sample container as the sample may be compromised via cross-contamination.
2. All Other Parameters: All other parameters include, but are not limited to, Semi-VOCs (SVOCs), polychlorinated biphenyls (PCBs), herbicides,



FOP 063.1

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

pesticides, total metals etc. Transfer sufficient soil volume to fill the laboratory-supplied container by packing the soil sample with the sampling tool to the top of the container. Unless otherwise indicated by the laboratory or the Project Work Plan, the sample jar for all other parameters does not have to be packed completely leaving no headspace as with the VOC containers.

ATTACHMENTS

Tailgate Safety Meeting Form (sample)
Soil/Sediment Sample Collection Summary Log (sample)
Real Time Air Monitoring Log (sample)

REFERENCES

TurnKey FOPs:

- 006 *Calibration and Maintenance of Combustible Gas/Oxygen Meter*
- 010 *Calibration and Maintenance of Portable Flame Ionization Detector*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 040 *Non-disposable and Non-dedicated Sampling Equipment Decontamination*
- 046 *Sample Labeling, Storage and Shipment Procedures*
- 073 *Real-Time Air Monitoring During Intrusive Activities*



FOP 063.1

**SURFACE AND SUBSURFACE SOIL
SAMPLING PROCEDURES**



TAILGATE SAFETY MEETING FORM

Project Name: _____ Date: _____ Time: _____
 Project Number: _____ Client: _____
 Work Activities: _____

HOSPITAL INFORMATION:

Name: _____
 Address: _____ City: _____ State: _____ Zip: _____
 Phone No.: _____ Ambulance Phone No. _____

SAFETY TOPICS PRESENTED:

Chemical Hazards: _____

 Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity: _____	PPE Level: _____	A	B	C	D
Activity: _____	PPE Level: _____	A	B	C	D
Activity: _____	PPE Level: _____	A	B	C	D
Activity: _____	PPE Level: _____	A	B	C	D
Activity: _____	PPE Level: _____	A	B	C	D

New Equipment: _____

Other Safety Topic (s): Environmental Hazards (e.g., live fauna)
 Eating, drinking, or using tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Meeting conducted by: _____



SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

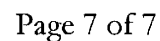


WEATHER CONDITIONS:

Time of Day:	A.M.
Ambient Air Temp.:	
Wind Direction:	
Wind Speed:	
Precipitation:	

[illegible]

Prepared By: _____





FIELD OPERATING PROCEDURES

Real-Time Air Monitoring During Intrusive Activities

FOP 073.0

REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

PURPOSE

This guideline presents requirements for real-time community air monitoring and required responses during all project required intrusive activities, such as drilling, test pitting, earthwork construction etc. This procedure is consistent with the requirements for community air monitoring for all intrusive projects, including projects conducted at remediation sites, as established by the New York State Department of Health (NYSDOH) and the New York State Department of Environmental Conservation (NYSDEC). Accordingly, this Field Operating Procedure (FOP) follows procedures and practices outlined under the NYSDOH's generic Community Air Monitoring Plan dated June 20, 2000 and NYSDEC Technical Assistance and Guidance Memorandum (TAGM) 4031: Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites.

This FOP requires real-time monitoring for constituents of concern (COC) (i.e., volatile organic compounds (VOCs), lower explosive limit (% LEL), particulates (i.e., dust) etc.) at the upwind and downwind perimeter as well as the exclusion zone of a project site during all intrusive activities. This FOP is not intended for use in establishing action levels for worker respiratory protection (see Project Health and Safety Plan (HASP) for worker protection action levels). Rather, its intent is to provide a measure of protection for the surrounding community from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The community, as referenced in this document, includes any off-site residences, public buildings/grounds and commercial or industrial establishments adjacent to the project site. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, this FOP helps



FOP 073.0

REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

to confirm that work activities did not spread contamination off-site through via air transport mechanisms. Community air monitoring shall be integrated with the construction worker personal exposure-monitoring program contained in the project and site-specific HASP.

MONITORING & MITIGATION PROCEDURE

Real-time air monitoring for COC levels at the upwind and downwind perimeter as well as the exclusion zone of the project site will be required. The perimeter locations of monitoring stations will be established based on the location of the exclusion zone (i.e., immediate work area) and wind direction. Where wind direction is shifting or winds are calm, the downwind monitoring location will default to the perimeter location nearest the most sensitive receptor (i.e., residential property). All downwind receptors being equal, the downwind monitoring location will default to the perimeter location downwind of the prevailing winds at the site. Real-time air monitoring will be required for all ground intrusive activities at a minimum of 30-minute intervals. Ground intrusive activities include, but are not limited to, soil/fill excavation and handling, test pitting or trenching, borehole advancement and monitoring well installation. Although additional site specific COCs may be monitored during real-time air monitoring activities, the most common COCs are discussed in this FOP, including organic vapors (i.e., VOCs), airborne particulates (i.e., fugitive dust) and combustible gases (i.e., methane) and oxygen.



FOP 073.0

REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

ORGANIC VAPORS

Ambient organic vapor concentrations should be measured prior to commencing intrusive activities each workday and a minimum of every 30-minutes thereafter. Air monitoring activities should be performed using equipment appropriate to measure the types of COCs known or suspected to be present. The equipment should be calibrated daily for the COCs or for an appropriate surrogate. All organic vapor readings must be recorded in the Project Field Book and/or Real-Time Air Monitoring Logs (sample attached) and, if applicable, be made available for State (DEC and DOH) personnel to review.

Mitigation upon the detection of various action levels of organic vapors are presented below:

- If the sustained ambient air concentration of total organic vapors at the downwind perimeter of the site exceeds a reading of 5 parts per million (ppm) above background, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.
- If sustained total organic vapor levels at the downwind perimeter of the site persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions and monitoring continued. Following organic vapor mitigation, work activities can resume provided that the sustained total organic vapor level 200 feet downwind of the exclusions zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less, (but in no case less than 20 feet) is below a sustained value of 5 ppm over background.
- If the sustained organic vapor level is above 25 ppm at the downwind perimeter of the site, the designated Site Safety and Health Officer must be notified and work activities shut down. The Site Safety and Health Officer will determine



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when re-entry of the work zone is possible and will implement downwind air monitoring to ensure vapor emissions do not impact the nearest off-site residential or commercial structure at levels exceeding those specified under the Major Vapor Emission Monitoring program described below.

Major Vapor Emission Monitoring

- If the sustained organic vapor level is greater than 5 ppm over background 200 feet downwind from the site or half the distance to the nearest off-site receptor (residential or commercial structure), whichever is less, all work activities must be halted. If, following the cessation of the work activities or as the result of an emergency, organic levels persist above 5 ppm above background 200 feet downwind or half the distance to the nearest off-site residential or commercial structure from the site perimeter, then the air quality must be monitored within 20 feet of the perimeter of the nearest off-site receptor (20-foot zone).
- If efforts to abate the emission source are unsuccessful and if organic vapor levels approach or exceed 5 ppm above background within the 20-foot zone for more than 30 minutes, or are sustained at levels greater than 10 ppm above background for longer than one minute, then the Major Vapor Emission Response Plan will automatically be placed into effect (see next section).

Major Vapor Emission Response Plan

Upon activation of Major Vapor Emission Response Plan, the following activities will be undertaken:

1. All Emergency Response Contacts as listed below and in the Site-Specific Health and Safety Plan will be contacted.
2. The local police authorities will immediately be contacted by the Site Safety and Health Officer and advised of the situation.
3. Frequent air monitoring will be conducted at 30-minute intervals within the 20-foot zone. If two successive readings below action levels are measured, air



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monitoring may be halted or modified by the Site Safety and Health Officer.

4. The Site Safety and Health Officer will determine if site workers can safely undertake source abatement measures. Abatement measures may include covering the source area with clean fill or plastic sheeting, or consolidating contaminated materials to minimize surface area. The Site Safety and Health Officer will adjust worker personal protective equipment as necessary to protect workers from over-exposure to organic vapors.

The following personnel are to be notified by the Site Safety and Health Officer in the listed sequence if the Major Vapor Emission Response Plan is activated:

Contact	Phone
Police/Fire Department	911
New York State Dept. of Health	(716) 847-4502
New York State Dept. of Environmental Conservation	(716) 851-7220
State Emergency Response Hotline	(800) 457-7362

In addition, the Site Safety and Health Officer will provide these authorities with a description of the apparent source of the contamination and abatement measures being taken by the contractor, if any.

AIRBORNE PARTICULATES

Fugitive dust suppression and airborne particulate monitoring shall be performed during any intrusive activities involving disturbance or handling of site soil/fill materials. Fugitive dust suppression techniques will include the following minimum measures:



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- Excavated stockpiles will be seeded or covered with clean soil or synthetic materials (e.g., tarps, membranes, etc.) whenever stockpiling activities cease for a period of longer than 90 days.
- Spraying potable water on all excessively dry work areas and roads.
- All fill materials leaving the site will be hauled in properly covered containers or haul trailers.
- Additional dust suppression efforts may be required as discussed below.

Particulate concentrations should be measured prior to commencing intrusive activities each workday and a minimum of every 30-minutes thereafter. The particulate monitoring should be performed using equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level and calibrated daily. In addition, fugitive dust migration should be visually assessed during all work activities. All air borne particulate readings must be recorded in the Project Field Book and/or Real-Time Air Monitoring Logs (sample attached) and, if applicable, be made available for State (DEC and DOH) personnel to review. Mitigation upon the detection of various action levels of airborne particulates are presented below:

- If the sustained downwind PM-10 particulate level is 100 micrograms per cubic meter (ug/m^3) greater than background (upwind perimeter) or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed $150 \text{ ug}/\text{m}^3$ above the upwind level and provided that no visible dust is migrating from the work area.

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- If, after implementation of dust suppression techniques, sustained downwind PM-10 particulate levels are greater than 150 ug/m³ above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures, such as those described the Supplemental Dust Suppression section below are employed and are successful in reducing the downwind PM-10 particulate concentration to within 150 ug/m³ of the upwind level and in preventing visible dust migration.

Visual Assessment

In conjunction with the real-time monitoring program, TurnKey personnel and any subcontractors thereof will be responsible for visually assessing fugitive dust migration from the site. If airborne dust is observed leaving the site, the work will be stopped until supplemental dust suppression techniques are employed in those areas.

Supplemental Dust Suppression

Supplemental dust suppression techniques may include but are not necessarily limited to the following measures:

- Reducing the excavation size, number of excavations or volume of material handled.
- Restricting vehicle speeds.
- Applying water on buckets during excavation and dumping.
- Wetting equipment and excavation faces.
- Wetting haul roads.
- Restricting work during extreme wind conditions.



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- Use of a street sweeper on paved haul roads, where feasible.

Work can resume using supplemental dust suppression techniques provided that the measures are successful in reducing the sustained downwind particulate concentration to below 150 ug/m³ above background, and in preventing visible dust migration off-site.

COMBUSTIBLE GASES & OXYGEN

Ambient combustible gas and oxygen concentrations should be measured prior to commencing intrusive activities each workday and a minimum of every 30-minutes thereafter. Air monitoring activities should be performed using equipment appropriate to measure combustible gases in percent lower explosive limit (LEL) and percent oxygen and calibrated daily. All combustible gas and oxygen readings must be recorded in the Project Field Book and/or Real-Time Air Monitoring Logs (sample attached) and, if applicable, be made available for State (DEC and DOH) personnel to review.

Mitigation upon the detection of various action levels of organic vapors are presented below:

Combustible Gas:

- If the sustained ambient air concentration of combustible gas at the downwind perimeter of the site exceeds a reading of 10 to 25% LEL, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 10% LEL, work activities can resume with continued monitoring.
- If sustained combustible gas levels at the downwind perimeter of the site persist at levels in excess of 25% LEL, work activities must be halted, the source of explosion hazards identified, corrective actions taken to abate emissions and monitoring continued. Following combustible gas mitigation, work activities can



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resume provided that the sustained total organic vapor level 200 feet downwind of the exclusions zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less, (but in no case less than 20 feet) is below a sustained value of 10% LEL.

Oxygen:

- If the sustained ambient oxygen concentration at the downwind perimeter of the site measures a reading between 19.5% - 21% oxygen, work activities can continue with extreme caution, however attempts to determine the potential source of oxygen displacement must be conducted.
- If the sustained oxygen level readily decreases below 19.5% LEL, work activities should be discontinued and all personnel must leave the area immediately.
- If the sustained oxygen level at the downwind perimeter of the site persists at levels between 21-25%, work activities can resume with caution.
- If the sustained oxygen level at the downwind perimeter of the site persists at levels exceeding 25% (fire hazard potential), work activities should be discontinued and all personnel must leave the area immediately.

ATTACHMENTS

Real-Time Air Monitoring Log (sample)

REFERENCES

TurnKey FOPs:

- 006 *Calibration and Maintenance of Combustible Gas/Oxygen Meter*
- 010 *Calibration and Maintenance of Flame Ionization Detector*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- xxx *Calibration and Maintenance of Portable Particulate Meter (as per Manufacturers Specifications)*



REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

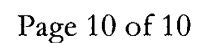


WEATHER CONDITIONS:

Time of Day:	A.M.
Ambient Air Temp.:	
Wind Direction:	
Wind Speed:	
Precipitation:	

[illegible]

Prepared By: _____





FIELD OPERATING PROCEDURES

“Before Going Into the Field” Procedure

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“BEFORE GOING INTO THE FIELD” PROCEDURE

PURPOSE

This procedure describes the activities to be preformed and the checklists to be completed prior to commencing field-sampling activities. Field-sampling activities may include, but are not limited to, soil, sediment, groundwater, surface water, wipe, and/or air matrix sample collection. The goal of this procedure is to eliminate delays and unnecessary budgetary “strain” due to a lack of preparedness and knowledge of the site by the field team members.

CHECKLISTS

Checklists should be developed and used so that all of the required steps prior to going into the field are undertaken. A good checklist will include:

- Adequate review of the documents listed in this FOP
- Any documents, equipment, and supplies presented in this FOP
- Providing adequate notification to the laboratory (so that holding times are not exceeded) and to the owner of the site and the primary regulatory agency (usually in writing) that a round of sampling is to commence in order to facilitate sampling and allow for a sampling audit or split sampling.
- Specifying and documenting the equipment maintenance and calibration undertaken prior to going into the field relative to the sampling event.
- Checking and calibrating the equipment.
- Listing the documents, equipment, and supplies required to collect samples at the site as presented in this FOP.

Prior to going into the field, sampling personnel should reacquaint themselves with the sampling plan. The review is undertaken so that the required specific protocol such as sampling from the least to the most contaminated wells, knowing where quality control



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samples are to be taken, knowing the disposition of purge water, etc., is understood and followed.

The amount of equipment maintenance and calibration required prior to going into the field should be clearly specified in the presampling equipment maintenance and calibration checklists, which are based on the manufacturer’s recommendations, sampling objectives, and prior experience. Maintenance and calibration performed before sampling must be documented to provide evidence that the equipment was adequately maintained and calibrated and to keep a permanent record of equipment servicing and performance.

A list of all the documents, equipment, and supplies required for the sampling event should be prepared and used. It can be frustrating and time consuming to forget equipment and supplies, so some up-front preparation is warranted. The following sections provide a list of the documentation, equipment, and supplies, which should assist in preparing a site-specific equipment and supply checklist. Once prepared, the checklist and project requirements should be reviewed with the Project Manager.

DOCUMENTATION

Prior to going into the field, the field team should review and understand all of the project documents including, but not limited to:

- The Health and Safety Plan (HASP)
- The Site Analytical Plan (SAP), Sampling Plan, or similar document
- The Quality Assurance Project Plan (QAPP)
- The Work Plan
- Project specific Field Operating Procedures and field forms
- Site Maps
- Equipment operation manuals
- Chain-of-Custody forms
- Shipping labels and custody seals



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- Any reference materials (i.e., conversion tables, volume calculation, etc.). The Pocket Ref, Third Edition by Thomas Glover is a great source for the field.

If at any time, the field team does not understand the project required protocol, procedures, sample locations, etc.; the Project Manager should be consulted for clarification.

EQUIPMENT

Prior to going into the field, the field team should review the following equipment checklist, noting that project specific equipment may not be included in this list:

- Water level indicator
- Pumps, sample tubing, flow controllers, power cord(s), batteries, compressors, generators, etc.
- Bailers (disposable, PVC, stainless steel, glass), rope
- Flow-through cell
- Field meters with adequate calibration solutions (pH/Eh meter, conductivity meter, dissolved oxygen meter, turbidity meter, batteries, etc.)
- Garden hose
- Explosive gas meter and/or photoionization detector (PID) with calibration supplies
- Complete set of hand tools including a sharp knife, screw drivers, pliers, hacksaw, flashlight, large pipe wrench, hammer, bolt cutters, and replacement locks
- Fish hook with weight and string
- Field filtering equipment and supplies
- Decontamination supplies, such as scrub brushes, Alconox®, distilled water, potable water, 5-gallon bucket, paper towels, aluminum foil
- 5-gallon bucket(s)
- Measuring cup
- Sample bottles/containers (with extras) and preservatives
- Stainless steel spoons, trowels, shovels
- Shipping containers (i.e., coolers)
- Clipboard



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- Calculator
- Water resistant clock or watch with second hand
- First aid kit

SUPPLIES

Prior to going into the field, the field team should review the following supplies checklist, noting that project specific supplies may not be included in this list:

- Laboratory grade non-phosphate detergent (Alconox®)
- Appropriate personal protective equipment appropriate to the contaminants of concern, such as nitrile gloves, Tyvek, boots, hardhat, safety glasses, hearing protection, etc.
- Bags of ice
- Plastic garbage bags
- Plastic sheeting
- Sufficient quantities of potable and laboratory grade deionized water for cleaning and equipment blanks
- Methanol
- Isopropyl alcohol
- Clean rags and paper towels
- Electrical tape, duct tape, and wide transparent tape
- Hand soap
- Regular, ballpoint, and indelible pens
- Hollow braid polyethylene rope

After providing adequate notification (lab, state and/or federal agencies), performing the presampling maintenance and calibration, obtaining the site and well keys, and packing the supplies and equipment, the field activities are ready to be performed.

REFERENCES

1. Wilson, Neal. *Soil Water and Ground Water Sampling*, 1995



APPENDIX B

LABORATORY CERTIFICATIONS & QUALITY ASSURANCE MANUAL

(AVAILABLE UPON REQUEST)

APPENDIX C

RÉSUMÉS

(AVAILABLE UPON REQUEST)