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2025 SITE INVESTIGATION & GROUNDWATER MONITORING WORK PLAN - FINAL

ERIE COKE SITE

ERIE COUNTY, PENNSYLVANIA

PADEP Contract No.: SAP4000023226
General Environmental Technical Assistance Contract
Work Requisition No.: GTAC7-6-181

Prepared for:

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Commonwealth of Pennsylvania
Department of Environmental Protection

Submitted by:

OBG | Baker Environmental Solutions Joint Venture
Moon Township, Pennsylvania

May 2025

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Submitted to:

Commonwealth of Pennsylvania
Department of Environmental Protection
Northwest Regional Office
Environmental Cleanup Program
Hazardous Sites Cleanup Section
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May 2025

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NOTICE

The information in this document has been funded by the Pennsylvania Department of Environmental Protection (PADEP) under Contract No. SAP4000023226 to OBG | Baker Environmental Solutions Joint Venture (OBG | Baker). This document has been formally released by OBG | Baker to the PADEP.

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1.0 INTRODUCTION

This 2025 Site Investigation & Groundwater Monitoring Work Plan has been prepared by OBG | Baker Environmental Solutions Joint Venture (OBG | Baker) for the Pennsylvania Department of Environmental Protection (PADEP or Department) as authorized under their General Environmental Technical Assistance Contract (GTAC), Contract Number 4000023226, Work Requisition Number 7-6-181. The Work Plan presents the strategy and technical approach, as well as schedule for conducting a small investigation followed by a comprehensive sampling event of monitoring wells at the Erie Coke Site (site) located in Erie, Pennsylvania. The Work Plan was prepared based on the findings from the Supplemental Site Investigation recently completed in December 2024.

It should be noted that because this small investigation is essentially an extension of the recently completed supplemental site investigation, some of the detailed discussions of investigation and sampling protocols and methodologies may not be presented herein. Rather, these detailed discussions can be located in the Supplemental Site Investigation Work Plan (OBG | Baker, October 2024). A presentation of the site background and investigation history are also not included in this truncated Work Plan but can be found in the referenced Supplemental Site Investigation Work Plan.

The associated Field Sampling and Analysis Plan (FSAP) and Quality Assurance Project Plan (QAPP) are included in Attachment A of this Work Plan. As there has been no change in health and safety conditions at the site, the current Health and Safety Plan (HASP) for the site (OBG | Baker, July 2022) will continue to be used for the investigation field activities. Project personnel are required to review the information presented in this Work Plan (and associated attachments), as well as the site-specific HASP, prior to conducting the supplemental field investigation activities.

2.0 SITE LOCATION AND PHYSICAL SETTING

The Erie Coke Site is located at 925 East Bay Drive in the City of Erie, Erie County, Pennsylvania at 42° 08’ 40.6602” N latitude and -80° 04’ 3.5976” W longitude on the USGS Erie North Quadrangle map (Figure 1). Erie Coke Corporation (Erie Coke) owns several parcels of land totaling approximately 183 acres. The site is bordered to the north by Lake Erie and Lampe Marina, to the east by East Avenue Boat Ramp (East Ave. Boat Launch), to the south by a residential area and the Barber National Institute, and to the west by the City of Erie wastewater treatment plant and downtown Erie (Figure 2).

The site is located within a state-designated Environmental Justice Area. The site is sparsely vegetated and not in use. The site is generally flat, except for steep banks along the site’s extreme northern and southern borders. The northern bank separates the site from Lake Erie and the southern bank separates the site from East Bay Drive. Access to the site for vehicles is restricted at the East Avenue gate entrance where a new gate and fencing were recently installed by the Department. However, other site controls, such as fencing, are not adequate to restrict trespassers from accessing the site.

General land uses proximate to the site include commercial, industrial, and residential areas. The population within a three-mile radius relies exclusively on a public water supply operated by Erie Water Works.

2.1 Project Objectives

The work objectives to be performed under this contractual assignment are to assess the level and extent of hazardous substances, pollutants, and/or contaminants in select areas of the site based on findings from the Supplemental Site Investigation completed in 2024. The investigation activities will include sampling and analyses (field and lab) of surface and subsurface soils and groundwater monitoring wells.

The primary goal of this truncated investigation is to collect data necessary to support and refine the evaluation/assessment of the former industrial site and its effects off site. Specifically, the investigation objectives are as follows:

- Determine the nature and extent of hazardous substances, pollutants, or contaminants that have been released into the environment on and off the Erie Coke property through surface and subsurface soil sampling and subsequent installation/sampling/gauging of current and proposed monitoring wells.

- Further characterize subsurface soils through test boring advancement (rotasonic technology) and collection of soil samples for analysis at strategic and biased depths in the Industrial North Area and the Industrial South Area (ISA)-East Region.

- Collect a sufficient number of soil samples to field screen and determine or corroborate the finalized number, locations, and construction of three additional monitoring wells (MW-46 through MW-48) to aid in the groundwater characterization effort.

- Complete a comprehensive sampling event of most groundwater monitoring wells on and off site for a refined laboratory analytical suite.

- Prepare and submit the ‘2025 Site Investigation & Groundwater Monitoring Report’ to the Department detailing the field activities and findings from the soil and groundwater well sampling activities (*will be completed under ensuing GTAC-8 contract).*

3.0 SCOPE OF WORK

To accomplish the project objectives and facilitate project planning and management, this project will be performed in accordance with the following tasks:

- Task 1000 – Project Management
- Task 1010 – Project Planning
- Task 1040 - Procurement
- Task 1050 – Mobilization/Demobilization
- Task 1100 – Site Security
- Task 2000 – Data Evaluation
- Task 2070 – Report Preparation
- Task 2200 – Project Meetings
- Task 3000 – Utility Clearance/Site Survey
- Task 3010 – Sample Collection
- Task 3020 – Laboratory Analyses
- Task 3030 – Monitoring Well Installation
- Task 3060 – Groundwater Monitoring
- Task 3080 – Investigation Derived Waste (IDW) Management
- Task 4100 – Site Preparation

The scope for each proposed task is provided in the following sections. It should be noted that the tasks in the ensuing sections of this Work Plan are presented in numeric order and not necessarily in the order that they will take place during the lifecycle of the project.

Field activities will be performed in accordance with this Work Plan and associated FSAP and QAPP as well as the site-specific HASP. The FSAP has been prepared to provide guidance for the field activities by describing detailed sampling and data collection methods.

Table 1 presents a summary of the proposed sampling and analytical program for all matrices and Table 2 presents a summary of the individual well sampling analytical suite. The proposed sample locations are shown on Figures 4 and 5 with Figure 3 being the figure layout key.

3.1 Task 1000 – Project Management

OBG | Baker's Project Manager, Mr. Christopher Kupfer, P.G., will be responsible for managing the overall efforts associated with this site. Mr. Kupfer will be responsible for management of the ongoing work as well as aid in development of this Work Plan and associated documents in conjunction with the Department project team.

Once this Work Plan is authorized, project management will include the following activities:

- Internal communication and coordination with project staff
- Control budget and schedule and track progress of work tasks
- Subcontractor coordination and management
- Personnel scheduling/planning for assignments
- Monthly progress report preparation
- Communications and coordination with the Department

In addition, this task includes program management efforts by OBG | Baker's GTAC Program Manager, Mr. Scott Moffett, P.G., PMP. Under this task, Mr. Moffett will provide program support including reviewing activities and resolution of issues, as necessary, to be consistent with the GTAC expectations/requirements. For cost estimating purposes, this task is assumed to start with the notice to proceed through completion of the assignment.

3.2 Task 1010 – Project Planning

This task includes the development of the draft and final versions of the 2025 Site Investigation & Groundwater Monitoring Work Plan, associated cost estimate, and all related documents. As no funding is currently in place to develop these documents, this task has been included in this Work Plan and Cost Estimate.

3.3 Task 1040 – Procurement

Procurement activities under this task will consist of securing subcontractors required by OBG | Baker to complete the scope of work. Separate bid packages, including a Request for Quote (RFQ), will be prepared for:

- Site security
- Site preparation activities (clearing pathways to borings/wells)
- Drilling activities (soil borings and well installations)
- Laboratory analytical testing
- Field office electric connection/removal
- Investigation-Derived Waste (IDW) management

No pre-bid meeting at the site will be required to complete these subcontracted activities.

Consistent with the previous supplemental site investigation activities, the Department agreed to the use of incumbent subcontractors as this truncated investigation is considered an extension of the recent supplemental investigation activities completed in December 2024. The stipulation being that the subcontractors agreed to the previously contracted unit rates.

Subcontractor bids will be evaluated and documented (Subcontractor Abstract) and recommendations will be presented (Subcontractor Approval Form) to the Department Regional Project Officer and Contract Manager for approval in accordance with Department guidelines. It should be noted that the incumbent security contractor (Fisher Security) was recently purchased by Arrow Security. Arrow Security requested that a new subcontractor agreement be developed prior to the issuance of the delivery order for this investigation.

3.4 Task 1050 – Mobilization/Demobilization

This task includes mobilization and demobilization of OBG | Baker personnel and equipment to the site. In addition, this task also includes daily vehicle charges associated with the investigation while on site.

3.5 Task 1100 – Site Security

This task includes having an unarmed security guard on site during non-working hours during the investigation activities. It is anticipated that the lone guard will work from approximately 5PM to 5AM each weekday and 24-hour shifts on the weekends.

Security is tentatively scheduled to start at the beginning of the site preparation activities on June 16, 2025, and continue through the completion of the comprehensive groundwater sampling event. Security needs will be completed immediately prior to the removal of the field office and support equipment tentatively scheduled for June 30, 2025.

3.6 Task 2000 – Data Evaluation

This task involves data management activities and evaluation of the data collected during the investigation, as follows:

- Communications and coordination of data with the Department Regional Project Officer
- Database preparation and population using the laboratory-prepared Electronic Data Deliverables (EDDs)
- Data and Quality Assurance/Quality Control (QA/QC) evaluation
- Tabulation of field and analytical data
- Comparison of soil and groundwater analytical results to appropriate Residential and Non-Residential Medium Specific Concentrations (MSCs) set forth in Act 2.

It should be noted that this task will not be budgeted with most of the other investigative tasks in the associated Cost Estimate. Rather, this task will be completed under the Department's GTAC-8 contract in an ensuing scope of work.

3.7 Task 2070 – Report Preparation

This task is intended to cover work efforts related to preparation of the '2025 Site Investigation & Groundwater Monitoring Report' once the soil and groundwater data have been received and evaluated. In general, the report will include, but not be limited to, the following:

- Summary of site description and previous investigations
- Summary of the field sampling activities
- Presentation of sample location maps, groundwater contour maps, contaminant distribution maps, and analytical data
- Discussion of the laboratory analytical results
- Conclusions and recommendations

Figures and tables will be prepared and included in the report to aid in presentation and comprehension of the investigation results. All draft and final documents will be submitted electronically (PDF) to the Department.

It should be noted that this task also will not be budgeted with most of the other investigative tasks in the associated Cost Estimate but will be completed under the Department's GTAC-8 contract in an ensuing scope of work.

3.8 Task 2200 – Project Meetings

For the scope of work included herein, one project meeting is anticipated. The project meeting will include preparation and participation in a meeting between the Department and OBG | Baker personnel to review the draft (handwritten at time of meeting, digitized later) boring logs from the field activities in the in the Industrial North Area and the ISA-East Region.

The focus of the virtual meeting will be to come to an agreement on the final number, locations, and construction specifications of the groundwater monitoring wells to be installed in both areas. The ultimate well number and locations will be based on the field screening and visual observations made by OBG | Baker and Department personnel. For purposes of the associated cost estimate, a total of four soil borings (SB-227 through SB-230) and three shallow groundwater monitoring wells (MW-46, MW-47, and MW-48) are initially planned for this scope of work.

3.9 Task 3000 – Utility Clearance/Site Survey

Because of the nature of the scope of work, the utility clearance and well survey have been segregated into two distinct activities.

3.9.1 Utility Clearance

Utility companies (e.g., pipeline, gas, electric, water, sewer, and telephone) suspected of having underground lines in the vicinity of the proposed drilling activities will be contacted by OBG | Baker prior to the start of the intrusive field activities through the Pennsylvania One Call System (811). It is anticipated that a site reconnaissance will not be necessary to stake out the proposed soil boring locations. Rather, it is expected that a previous 811 record for the two areas will be referenced and revisited. Work in this same area was completed in 2024.

Having a wide section of the ISA-East Region cleared for utilities will allow latitude in the ultimate number and placement of both soil borings and the ensuing groundwater monitoring wells. Utility clearance in the Industrial North Area will be more straightforward as more borings have historically been advanced in the area with utility clearances available for reference.

3.9.2 Monitoring Well Survey

For purposes of this Work Plan and associated cost estimate, three groundwater monitoring wells (MW-46 through MW-48) will be installed during this investigation. Each of the wells will need to be surveyed for accurate placement on a scaled site map and for accurate groundwater flow mapping. Although three wells are planned, the ultimate number and locations of the proposed wells may change based on field observations. However, preliminary locations of the three wells are shown on Figures 4 and 5.

The monitoring well survey activities under this task will include locating the horizontal position and establishing elevations of the newly installed monitoring wells. The horizontal data will be to the nearest 0.1-foot and referenced to the Pennsylvania State Plane Coordinate System, North American Datum (NAD) 1983. The vertical data will be to the nearest 0.01-foot and referenced to the North American Vertical Datum (NAVD) 1988.

The surveying activities will be conducted under the direction of a professional land surveyor licensed to practice surveying in the Commonwealth of Pennsylvania. The survey of the new wells is anticipated to take place concurrently with the comprehensive groundwater sampling event.

3.10 Task 3010 – Sample Collection

This task includes all soil sampling activities. Based on the findings from the recently completed Supplemental Site Investigation and a recent review by the Department of additional historical documents, OBG | Baker and the Department agreed that all soil samples presented below will be analyzed for Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs), and metals (including mercury) by a subcontracted laboratory.

Although soil samples will be collected at predetermined areas in the Industrial North Area and the ISA-East Region, real time decisions will be made in the field on the ultimate number and locations of additional groundwater monitoring wells based on field observations and screening of the retrieved soil samples from the borings. The proposed soil boring locations are shown on Figures 4 and 5.

It was agreed between the Department and OBG | Baker that a demobilization/remobilization of personnel and equipment until the soil samples are analyzed and evaluated was not the best option for the refined characterization of these areas. It was determined that it will be necessary to install the new monitoring wells based on the real-time soil boring field observations and knowledge in order to complete the scope of work before completion of the Department's 2024-2025 fiscal year.

3.10.1 Soil Sampling Activities

Surface and subsurface soil samples (including coke and other potential fill material) will be collected to better refine the level of environmental impact from hazardous substances, pollutants, and contaminants identified in the Industrial North Area and ISA-East Region. The proposed sample locations are shown on Figures 4 and 5 and the soil sampling and analytical program is summarized on Table 1.

One soil boring (SB-227) will be advanced in the Industrial North Area (Figure 4) where railroad spurs diverged in an apparent railcar staging and/or loading area. This boring will aid in the characterization of surface and subsurface soils and wastes between wells MW-13 and MW-45. Soil sampling associated with the installation of a shallow groundwater monitoring (MW-46) north of MW-13 will also aid in characterizing the soils in the area.

Three soil borings (SB-228, SB-229, and SB-230) will be advanced in ISA-East Region (Figure 5) to further evaluate documented contamination in the area. Boring SB-228 is proposed north of SB-225 to evaluate the extent of the SVOC impact exhibited in SB-225 soil. Similarly, one boring is proposed west (SB-229) and south (SB-230) of SB-225 to evaluate the extent of the SVOC impact exhibited in SB-225 soil.

A general overview of the soil sampling is provided below. Specific sampling and field screening procedures are detailed in the FSAP (Attachment A). As shown on the figure, proposed soil borings (and soil samples) have been placed in locations that will aid in the identification and delineation of contaminant impact at each area. All borings will be advanced to 25 feet or bedrock, whichever is reached first.

Rotasonic drilling method will be used for soil sampling and includes a combination of rotary power, hydraulic pull-down pressure, and mechanically generated oscillations to advance a dual line of drill pipe. Continuous four-inch diameter soil core samples will be collected for lithologic identification and field screening during boring advancement. As each boring is advanced, the inner casing will collect a continuous four-inch nominal diameter soil core in five- or ten-foot-long increments.

Once the soil core is extracted, it will be placed directly into a clear polyethylene liner using a vibration technique of the rotasonic rig. Housing the sample in a clear plastic liner will allow the OBG | Baker geologist to log the core and field screen the continuous soil sample while minimizing potential volatilization. Based on the anticipation of significant fill and non-cohesive soils, an outer six-inch diameter casing will likely be needed to advance the borings deeper than ten feet to achieve the desired boring depths.

Field screening of surface (0 to 1-foot depth interval) and subsurface soil samples will consist of placing the tip of a Photoionization Detector (PID) through small slits cut in the polyethylene liner at approximately one-foot intervals to measure the total concentration of VOCs in parts per million (ppm). The PID responses will be recorded on the associated boring logs. In addition to the PID results, other items that will be documented on the boring logs include geologic descriptions of the soil type, odor, discoloration, recovery amount, sample depth, moisture content, grain size, and any other features observed in the soil sample. Development of digitized versions of the soil boring logs are also included under this task.

3.10.1.1 Soil Sample Selection Methodology

Retrieved soil cores will be field-screened and up to two soil samples will be collected from each rotasonic boring for laboratory analysis described below.

Identified Areas with Contaminant Impact:

- One ‘worst-case’ soil sample above the water table based on PID readings and/or visual evidence of staining/odor. No soil samples will be collected for analysis below water table.

- One ‘clean’ soil sample collected below the ‘worst-case’ soil sample, above the soil/groundwater interface. No soil samples will be collected for analysis below water table.

Areas with No Obvious Contaminant Impact:

- One soil sample collected above water table at geologist’s discretion to document subsurface conditions and potentially delineate contaminant impact not obvious through screening (e.g., metals).

As summarized on Table 1, a maximum of one soil sample will be submitted for laboratory analysis from the well borings. If contamination is observed, one 'worst-case' soil sample above the water table will be submitted for analysis. If there is no evidence of contamination in the well boring, the geologist will use their discretion on the soil sample interval to be submitted for analysis from the boring.

As summarized in the waste management section of this Work Plan, residual soil cuttings from the sonic drill rig not collected for laboratory analysis will be returned to its boring of origin unless waste material (e.g., liquid or semi-solid waste, oils, etc.) or notable contamination is present based on field screening and visual/olfactory observations. If contamination is encountered, the contaminated soil cuttings will be drummed for later off-site disposal. Surrounding site materials and/or bentonite chips will be used to backfill any remaining void in the open borehole.

At the conclusion of each test boring, a handheld GPS unit will be used by OBG | Baker personnel to survey in the test boring locations for accurate placement on a scaled map for later presentation to the Department.

3.11 Task 3020 – Laboratory Analysis

Soil and groundwater monitoring well samples will be collected for laboratory analysis as part of the investigation activities. After compiling data from a majority of the monitoring wells over several groundwater sampling events, it has been determined that some wells will be eliminated from periodic monitoring and others will have a reduction in analyses due to lack of detections over time. A summary of the wells to be sampled and their associated analyses are provided on Table 2.

Select soil and groundwater samples will be analyzed for Target Compound List (TCL) VOCs (Method 8260D), TCL SVOCs (Method 8270E), and Target Analyte List (TAL) Metals including mercury (Methods 6010D and 7471B) by the subcontracted laboratory. Both a total and dissolved aliquot from designated wells will be submitted for the metals analyses through field filtering. General chemistry will be completed on select monitoring well samples through multiple analytical methods.

This task also involves communications and coordination with the laboratory as well as sample tracking and management. At the direction of the Department, all laboratory analytical services will be provided by a subcontracted laboratory. OBG | Baker will communicate directly with the laboratory to coordinate bottle/sample handling requirements, analyses, and analytical reporting.

Sample tracking and management will involve coordinating with the laboratory and tracking the samples from the time of collection through receipt of results. OBG | Baker will assign a single contact person to coordinate daily sample shipments to the laboratory and track sample data to ensure the samples have been received and processed by the laboratory. The laboratory management activities will include the following:

- Coordinating sample requirements and bottleware
- Accepting bottle delivery
- Sample bottle sorting and labeling
- Sample delivery/shipment to the laboratory
- Tracking sample delivery and receipt of the data
- Monitoring incoming data for completeness

The laboratory will be required to provide services as outlined in this Work Plan and associated QAPP (Attachment A). The services to be provided include analysis of samples in accordance with the quantities provided in Table 1 and the analyses on Table 2 and also provide EDDs in a Microsoft Excel spreadsheet format.

It should be noted that the number of samples shown on Table 1 is based on the anticipated number of samples to be collected and may expand as contamination is encountered and/or delineated during the sampling and screening activities. The laboratory will be made aware of this and will be requested to provide an additional 10% of bottleware to allow for scope or work expansion. The laboratory will be Pennsylvania certified.

3.12 Task 3030 – Monitoring Well Installation

For purposes of this Work Plan and associated Cost Estimate, three groundwater monitoring wells (MW-46 in the Industrial North Area and MW-47 and MW-48 in the ISA-East Region) are proposed to be installed for this investigation. Although the ultimate well locations will be based on real-time field observations and screening, the preliminary locations of the wells are shown on Figures 4 and 5. It is anticipated that the final well locations will be discussed with the Department based on the field observations and field screening before installation. A project meeting will take place between the Department and OBG | Baker to discuss the field observations and draft boring logs to finalize the well locations.

The well borings (anticipated to be 20 to 25 feet deep) will be drilled using rotasonic drilling methods, which use a combination of rotary power, hydraulic pull-down pressure, and mechanically generated oscillations to advance a dual line of drill pipe. The inner drill pipe (four-inch nominal diameter) contains a core bit and represents the core barrel sampler, while the outer pipe (six-inch nominal diameter) is used to prevent collapse of the borehole and in construction of wells. Rotasonic methods are ideally suited for monitoring well installations because the methods minimize generation of waste, reduce difficulties with heaving sands, and provide for more controlled well installations and reduced development time due to the ability to vibrate the outer casing in or out of the borehole.

Continuous soil core samples will be collected for lithologic identification during well boring advancement. As directed by OBG | Baker's on-site geologist, the wells will be constructed using two-inch inside diameter (ID), Schedule 40, Polyvinyl Chloride (PVC) well casing and screen materials. Well screens (0.010-inch slot) will be ten feet in length. The wells will be installed at the bottom of the borehole, if possible.

During the recent investigations, notable hydrostatic pressure (head) from the overburden aquifer's heaving sands (a.k.a., running sands) was encountered during the drilling activities across the site and proved to be more challenging during well drilling and installation. Two methodologies have been incorporated to mitigate this issue. One method included over drilling the boring past the targeted depth by up to five feet prior to screen and casing placement to allow for the inward flow of pressure. The other method included using a head of potable water (from on-site source) introduced into the casing to equalize the hydrostatic head of the overburden aquifer. Once the hydrostatic pressure is neutralized, the well construction activities will be initiated.

The annular space around the well screen will be backfilled with well-graded, fine sand applicable to the screen size. The sand will extend to approximately two feet above the top of the screened interval. The annular space above the sand pack will be backfilled with bentonite and hydrated with potable water to prevent surface and near subsurface water from infiltrating into the screened groundwater-monitoring zone. Each well will be completed with a stickup protective casing and two protective bollards. The bollards will be filled with concrete.

Development of digitized versions of the monitoring well installation construction diagrams are also included under this task.

3.12.1 Monitoring Well Development

Monitoring well development activities should be performed no sooner than 48 hours after completing the installation of the groundwater monitoring wells. However, development could be completed earlier based on the construction specifications of the well (e.g., bentonite seal is above the water table). Before development, groundwater level and total well depth measurements will be collected to calculate the volume of groundwater present within the well casing and determine the appropriate volume to be evacuated for development. Furthermore, any potable water that was needed during construction to suppress heaving sands (if present) will also be incorporated into the well development volume warranting removal.

Wells will be developed by bailing, surging, or pumping to remove fine sediments and residual drill cuttings from the well casing and the borehole annulus. The method of development will be based on the hydrogeologic conditions encountered and construction specifications (groundwater depth, total well depth, production/recharge rate, etc.). However, it is anticipated that most of the monitoring wells will be developed using a dedicated, disposable polyethylene bailer and retrieval line or a disposable Whale® pump (bottom intake submersible pump or similar).

During development, the bailer or pump also will be used to agitate (i.e., stir up) the water within the well to remove suspended solids. Assuming sufficient groundwater production, development will continue until the development water is clear or five well volumes have been removed, whichever is achieved first (not including potable water possibly introduced during well construction).

Water generated from the well development activities will be containerized accordingly. The management of waste is discussed further in the waste management section of this Work Plan.

3.12.2 Monitoring Well MW-42 Modification

It is recommended that the recently installed MW-42 in the Lampe Marina parking lot be retrofitted to be a stick-up well instead of a flush mounted well. At the time of well placement, it was unknown that the well was being installed in a low-lying corner of the parking lot causing the well protective casing and concrete pad to be submerged in standing water after snow melt or a rain event. Two protective bollards will be installed with the new stick-up casing, and all will be painted with reflective paint.

3.13 Task 3060 – Groundwater Monitoring

One groundwater sampling event is included in this scope of work. For the purposes of this Work Plan and associated Cost Estimate, three shallow groundwater monitoring wells will be installed and sampled as part of the investigation activities. A majority of the 58 other previously installed monitoring wells will be sampled concurrently with this sampling event (see Figure 6). Wells not included in the June 2025 groundwater sampling event include MW-3, MW-4, MW-7, MW-20, MW-25, and MW-32.

After completing the well development activities, the new monitoring wells will be allowed to equilibrate a minimum of 48 hours (ideally one week) to allow the wells to stabilize prior to sampling (generally accepted practice). Sampling of the previously installed wells can take place while the new wells are equilibrating.

A complete round of groundwater level and total depth measurements from the wells will be collected and recorded in the field notebook prior to initiating the purging and sampling activities. Non-Aqueous Phase Liquid (NAPL) measurements also will be collected for select wells. The monitoring wells will be purged prior to sampling to collect a representative groundwater sample from the aquifer.

The wells will be purged and sampled using low flow purging/sampling methods to minimize sampling-induced turbidity problems and provide samples more representative of actual groundwater quality. If groundwater production is not sufficient, the purging and sampling activities will be completed with dedicated, disposable polyethylene bailers. Specific sampling procedures are detailed in the FSAP (Attachment A).

As noted above, some wells are being eliminated from periodic monitoring and others are having a reduction in analyses due to lack of detections over time. A summary of the wells to be sampled and their associated analyses are provided on Table 2. The locations of the groundwater monitoring wells are presented on Figure 6.

Wells will be analyzed for either the extensive analytical suite completed previously (VOCs, SVOCs, metals [total and dissolved, including mercury], and general chemistry) or a reduced suite based on a lack of historical detections.

After collection of the samples for laboratory analysis, field parameter samples will be collected and measured for pH, specific conductance, temperature, dissolved oxygen, Oxidation-Reduction Potential (ORP), and turbidity. The field parameters will be recorded in the field notebook and digitized for the report.

3.14 Task 3080 – Investigation-Derived Waste Management

Investigation-Derived Waste (IDW) will be generated from performance of the field activities identified herein. Because of the large size of the site, all laydown areas and decontamination areas will be on site.

Liquid IDW generated during the field activities will be stored in drums. At the conclusion of the soil boring, well installation, well development, and groundwater sampling activities, the drums will be removed from the site by the IDW subcontractor, and their contents properly disposed at a Department-approved disposal facility.

As confirmed by the Department, most rotasonic drill rig soil cuttings generated from the investigation field activities will be returned to their boring of origin after logging, field screening, and sample collection. Any remaining borehole void will be backfilled with surrounding material. The exception would be if a notable amount of contaminant impact is observed in the retrieved soil core. If encountered, the contaminated soil cuttings will be drummed, labeled, and disposed off site at a Department-approved facility.

Soil cuttings generated from the monitoring well installation activities cannot be returned to the borehole to allow installation of the well materials. Because the well locations are anticipated to have contaminated soils, the soil cuttings from the well installations will be drummed for later disposal by the IDW management subcontractor.

It is anticipated that as soil cuttings are retrieved from the open borehole (well boring or soil boring), the on-site geologist will make the determination to either place the retrieved soil in a drum designated as hazardous waste (based on extensive knowledge of site soils and field screening) or spread on the ground surface near the boring or origin. Soil cuttings considered hazardous will be drummed, labeled, and disposed off site at a Department-approved facility.

Decontamination solids (collected on the decontamination pad) generated from the test borings and well installation equipment will be placed in properly labeled, steel, 55-gallon drums by the drilling subcontractor for later disposal.

Decontamination fluids (collected on the decontamination pad) generated from the test borings and well installation activities will be placed in drums by the drilling subcontractor for later disposal.

Solid wastes not anticipated to be a threat to the environment (e.g., trash bags, rope, paper towels, bailers, liners, temporary well screens/risers, etc.) will be disposed as municipal trash in an on-site rolloff box provided by the IDW subcontractor.

In addition to the staging of the drums in a centralized staging area, a temporary decontamination pad will be constructed by the drilling subcontractor to collect liquids and solids accumulated from the decontamination of test boring and well installation drilling equipment. To eliminate the need for excessive transportation of accumulated wastes, the decontamination pad may be mobile and be moved to an area closer to the investigation activities. The decontamination pad will be dismantled by the drilling subcontractor at the completion of the drilling and well installation activities and placed in the on-site rolloff box.

The characterization and disposal of IDW has already been completed during the previous investigation activities and it was confirmed with the IDW subcontractor that no additional waste profiles or waste characterizations are warranted for site activities. It is anticipated that all liquid wastes generated from the soil boring decontamination and the installation, decontamination, development, and sampling of the new wells will be characterized as non-hazardous waste. Soil cuttings that warrant placement in drums will be characterized and disposed as hazardous waste.

OBG | Baker will coordinate the waste removal date with the Department to have the manifests signed prior to the wastes being removed from the site. OBG | Baker personnel will be on site to oversee the loading and removal of the IDW.

3.15 Task 4100 – Site Preparation

To complete the investigation activities in an efficient and timely manner, numerous site preparation activities will be completed on site at the project onset. However, before mobilization, this task also includes the review of all investigation-related documents and an internal kickoff meeting to discuss the investigation methodology.

As part of the initial mobilization activities, an excavator and skid steer will be brought on site to complete some of the site preparation activities. Drums, the rolloff box, and the field office also will be mobilized during the site preparation activities. An electrical subcontractor will also be on site to connect electric to the field office temporarily. A summary of these activities includes, but are not limited to, the following.

- Procurement of field equipment and supplies.
- Coordination with subcontractors and vendors.
- Delivery, placement, and staging of subcontractor and vendor equipment including equipment calibrations, heavy equipment off loading/staging/fueling, etc.
- Site walk with the Department and field personnel to demarcate the proposed soil boring and preliminary well locations. It is anticipated that a utility clearance meeting will take place concurrently with applicable utility companies. Access pathways to the various sampling locations will also be determined.
- Develop pathways to, and clear around, existing wells designated for sampling that are located in areas with notable vegetation overgrowth. A handheld GPS unit will be used to guide personnel to the desired boring locations.
- Develop pathways to, and clear around, each of the proposed test boring and well locations that are inaccessible. A handheld GPS unit will be used to guide personnel to the desired boring locations.

4.0 PROJECT MANAGEMENT AND PROJECT SCHEDULE

This section provides an overview of the project management and staff and proposed work schedule.

4.1 Personnel

The primary participants for this project and their responsibilities are shown below. It should be noted that the availability of specific field personnel is dependent on timing of the actual field work and may be subject to change.

- Mr. Scott Moffett, P.G., PMP – GTAC Program Manager
- Mr. Christopher Kupfer, P.G. – Project Manager
- Mr. Joseph Burawa, P.G. – Project QC Officer
- Mr. David Gaviglia - Environmental Specialist/Site Supervisor
- Ms. Shannon Horn – Data Management Specialist

OBG | Baker's Project Manager, Mr. Christopher Kupfer, P.G., will be responsible for managing the overall technical and administrative efforts associated with this project, including interface and final negotiations with the Department. Field activities will be managed and coordinated by Mr. Kupfer. Mr. Kupfer also will be responsible for managing OBG | Baker support personnel and ensuring that the field tasks and QA/QC procedures are implemented according to the Work Plan, FSAP, QAPP, and HASP. The lead environmental specialist and site supervisor will be responsible for overall implementation of the field program (as well as oversee site Health and Safety). Mr. Burawa will provide senior review and technical guidance. Resources required to support this investigation will be obtained through Mr. Moffett.

4.2 Project Schedule

The field activities will be completed on June 30, 2025, based on an anticipated authorization from the Department by May 23, 2025. As noted previously, both the data evaluation (Task 2000) and the report development (Task 2070) will not be completed under the current scope of work but will be completed after issuance of the GTAC-8 contract by the Department. The estimated project schedule is depicted on Figure 7.

FIGURES

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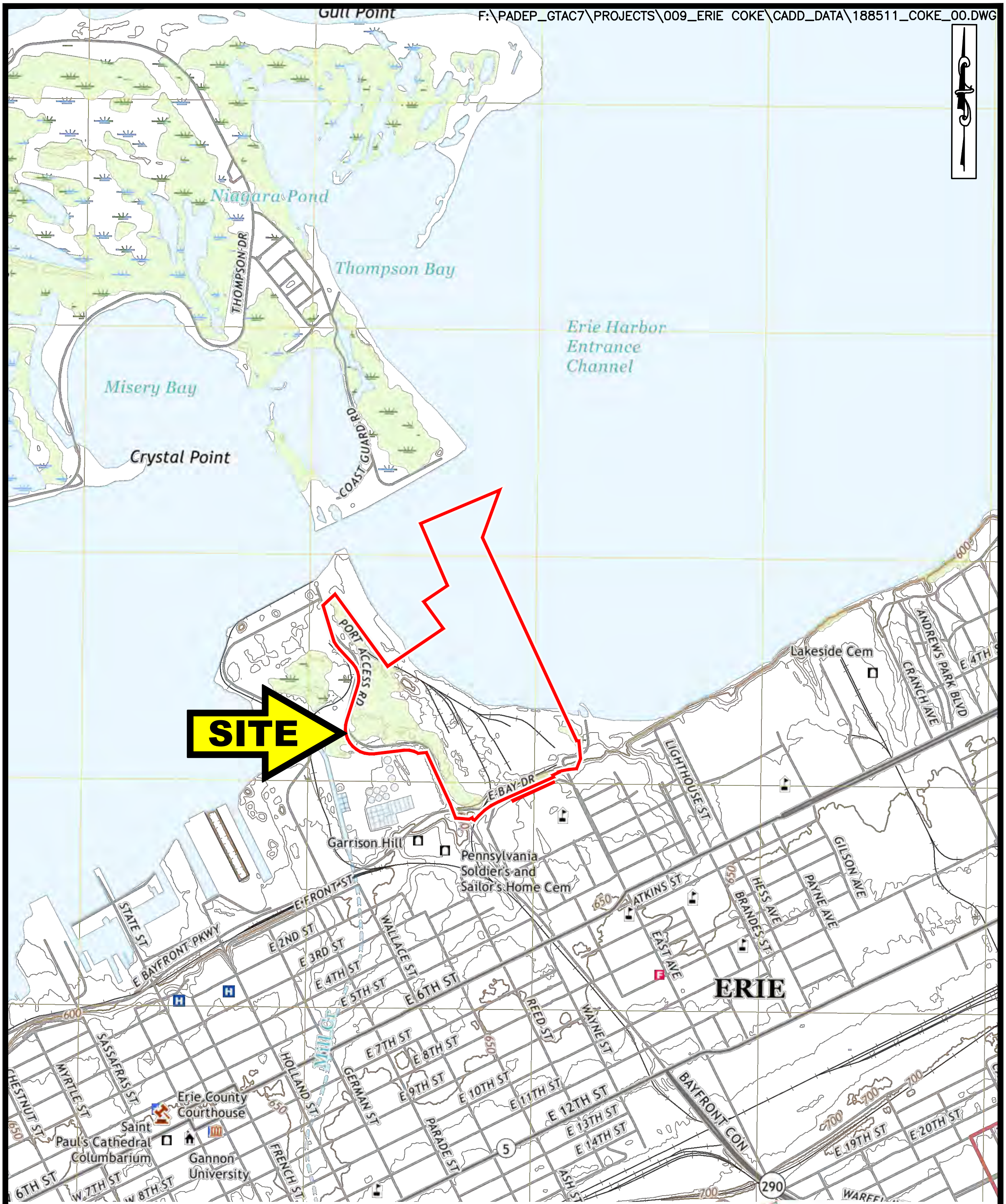

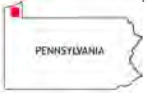

QUADRANGLE LOCATION

FIGURE 1
SITE LOCATION MAP
ERIE COKE SITE
CITY OF ERIE, ERIE COUNTY, PENNSYLVANIA

SOURCE:
USGS: ERIE NORTH, PA, 2019

SCALE: 0 2000
S.O. NO.: 188511
DSN/DWN: DMG/RRR

DATE: FEBRUARY 2023
FILE: 188511_COKE_00
CHK: CHK

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OBG|Baker Environmental Solutions Joint Venture

IMAGE SOURCE: GOOGLE; 2019

SCALE: 0 500	DATE: MARCH 2023	FIGURE 2 SITE FEATURES MAP ERIE COKE PLANT ERIE COUNTY, PENNSYLVANIA
S.O. NO.: 188511	FILE: 188511_COKE_09	
DSN/DWN: CHK/RRR	CHK: CHK	

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OBG|Baker Environmental Solutions Joint Venture

LEGEND

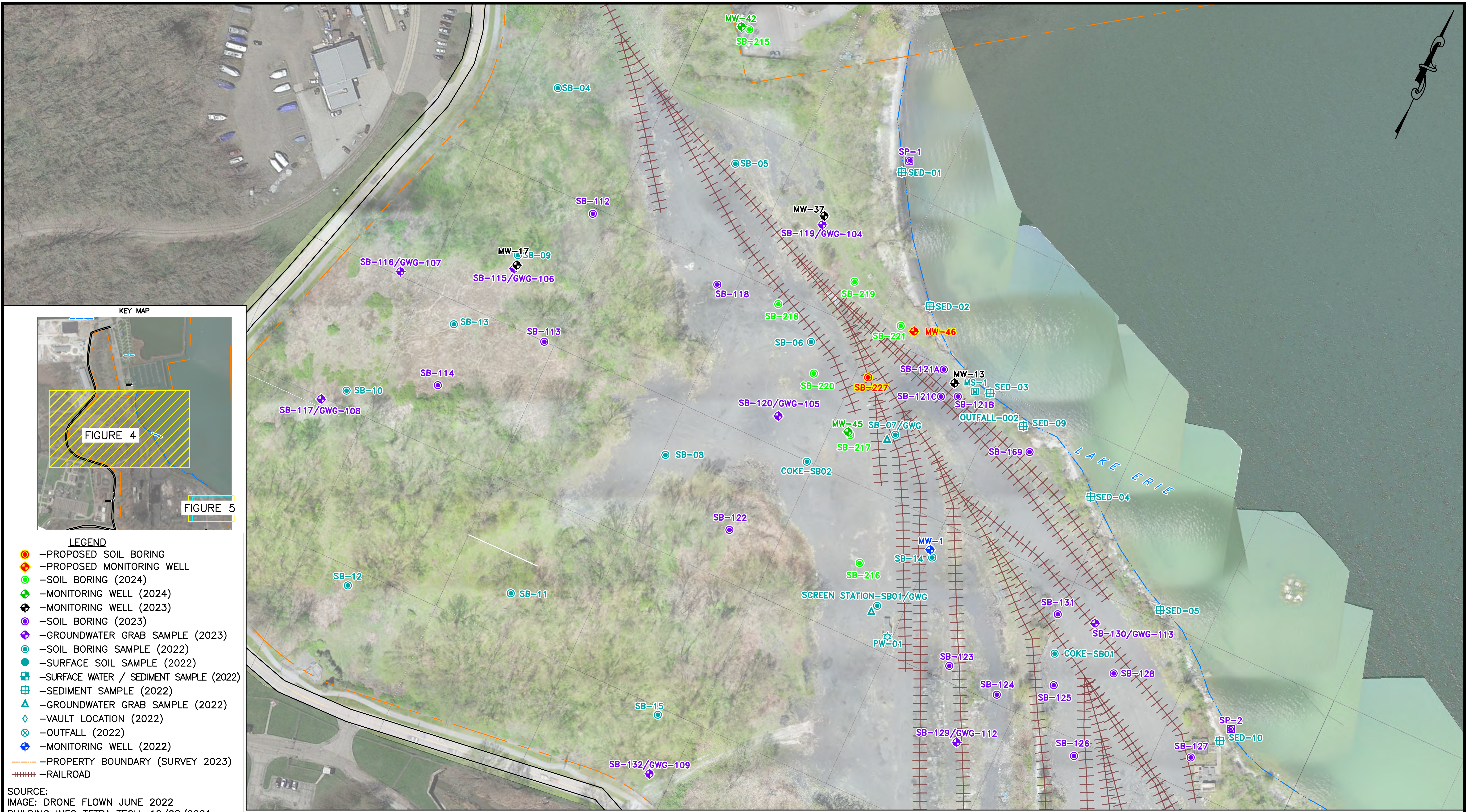
—·—·— PROPERTY BOUNDARY (SURVEY 2023)

IMAGE SOURCE: GOOGLE; 04/2022

SCALE:	NOT TO SCALE
DATE:	MARCH 2025
DSN/DWN:	CHK/RRR
FILE:	188511_COKE_26

OBG|Baker Environmental Solutions Joint Venture

FIGURE 3
FIGURE NUMBER LAYOUT
ERIE COKE SITE
ERIE, PENNSYLVANIA



LEGEND

- ◉ –PROPOSED SOIL BORING
- ⊕ –PROPOSED MONITORING WELL
- ◉ –SOIL BORING (2024)
- ⊕ –MONITORING WELL (2024)
- ⊕ –MONITORING WELL (2023)
- ◉ –SOIL BORING (2023)
- ⊕ –GROUNDWATER GRAB SAMPLE (2023)
- ◉ –SOIL BORING SAMPLE (2022)
- ● –SURFACE SOIL SAMPLE (2022)
- ⊞ –SURFACE WATER / SEDIMENT SAMPLE (2022)
- ⊞ –SEDIMENT SAMPLE (2022)
- △ –GROUNDWATER GRAB SAMPLE (2022)
- ◇ –VAULT LOCATION (2022)
- ⊗ –OUTFALL (2022)
- ⊕ –MONITORING WELL (2022)
- –PROPERTY BOUNDARY (SURVEY 2023)
- –RAILROAD

SOURCE:
IMAGE: DRONE FLOWN JUNE 2022
BUILDING INFO TETRA TECH; 12/08/2021

SCALE:	0 160 1" = 160'	DATE:	MAY 2025
S.O. NO.:	188511	FILE:	188511_COKE_26
DSN/DWN:	CHK/RRR	CHK:	CHK

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FIGURE 4
PROPOSED SOIL BORING AND MONITORING WELL LOCATIONS
INDUSTRIAL NORTH AREA
ERIE COKE SITE
ERIE, PENNSYLVANIA

F:\PADEP_GTAC7\PROJECTS\009_Erie Coke\CADD_Data\188511_COKE_16-EXHIBIT.dwg 2/8/2024 2:04 PM

SCALE: 0 50 1" = 50'

S.O. NO.: 188511

DSN/DWN: CHK/RRR

DATE: MAY 2025

FILE: 188511_COKE_26

CHK: CHK

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FIGURE 5
PROPOSED SOIL BORING AND MONITORING WELL LOCATIONS
INDUSTRIAL SOUTH AREA – EAST REGION
ERIE COKE SITE
ERIE, PENNSYLVANIA

F:\PADEP_GTAC7\PROJECTS\009_ERIE COKE\CADD_DATA\188511_COKE_26.DWG 5/5/2025 2:36 PM

LEGEND

- –MONITORING WELL
- –WELLS NOT DESIGNATED FOR SAMPLING IN JUNE 2025
- –STANDPIPE
- –PROPERTY BOUNDARY (2023)

NOTE:
DEEP MONITORING WELLS NOT SHOWN FOR CLARITY.

IMAGE SOURCE: GOOGLE; 04/2022

SCALE:	0 300
DATE:	MAY 2025
DSN/DWN:	CHK/RRR
FILE:	188511_COKE_27

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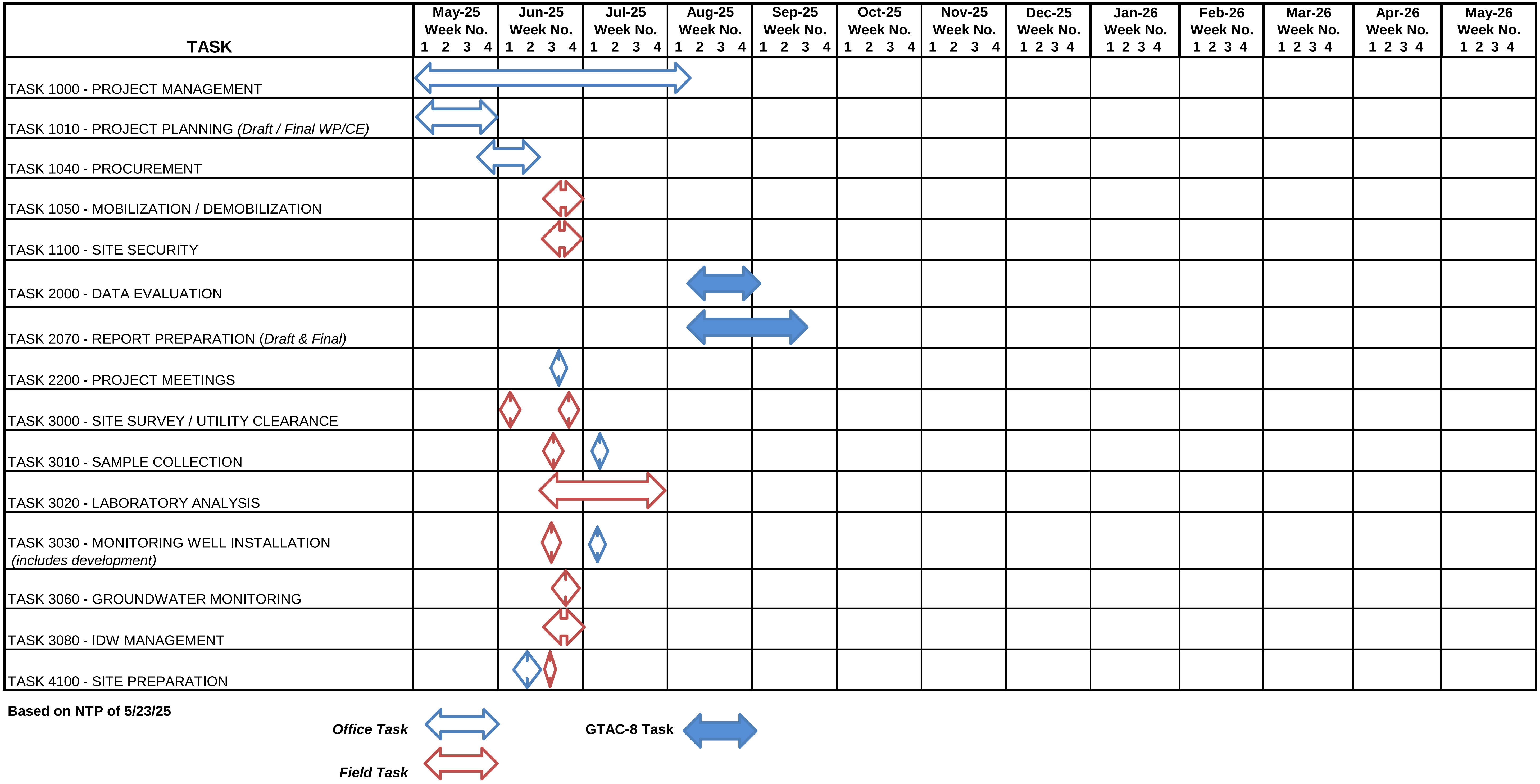
FIGURE 6
GROUNDWATER MONITORING WELL LOCATION MAP
ERIE COKE SITE
ERIE, PENNSYLVANIA

Figure 7

Proposed Project Schedule
2025 Site Investigation and Groundwater Monitoring
Erie Coke Site



Based on NTP of 5/23/25

TABLES

Table 1
Proposed Sampling Activities
2025 Site Investigation and Groundwater Monitoring
Erie Coke Site

Boring/Well Number	Site Feature	Work Plan Figure Number Location	Sampling Media	Number of Borings	Maximum Number of Samples	Anticipated Boring Depth (Feet)	Comments	Sampling Protocol
SB-227	Industrial North Area	4	Soil	1	2	< 25	Borings advanced to 25 ft. or bedrock, whichever encountered first. **Contamination Observed**: Two soil samples for analysis per boring **No Contamination Observed**: One soil sample for analysis per boring	**Contamination Observed:** Submit one sample from most contaminated zone and one sample from clean zone below comtamination (if above groundwater). **No Contamination Observed**: Sample depth is geologist's descretion above groundwater.
SB-228 through SB-230	Industrial South Area - East Region	5	Soil	3	6	< 25	Borings advanced to 25 ft. or bedrock, whichever encountered first. **Contamination Observed**: Two soil samples for analysis per boring **No Contamination Observed**: One soil sample for analysis per boring	**Contamination Observed:** Submit one sample from most contaminated zone and one sample from clean zone below comtamination (if above groundwater). **No Contamination Observed**: Sample depth is geologist's descretion above groundwater.
New Monitoring Well Installation and Sampling								
MW-46, MW-47 and MW-48	New Groundwater Monitoring Wells	4 & 5	Groundwater (Well)	2	3	20 - 25	Three shallow monitoring wells are proposed (One in Industrial North Area; Two in Industrial South Area-East Region). Prelimiary locations shown on site figures and may change.	One sampling event of the three new wells will take place concurrent with the comprehensive groundwater sampling event of the other wells on and off site.
			Soil		3		Soils will be field screened and logged during advancement of well installation borings.	**Contamination Observed:** Submit one sample from most contaminated zone during boring advancement. **No Contamination Observed**: Submit one soil sample at geologist's descretion above groundwater.
Monitoring Well Sampling								
MW-1 through MW-45(1)	Existing Groundwater Monitoring Wells	6	Aqueous	N/A	52	N/A	58 current wells with six eliminated for this sampling event = 52 wells. Analytical suite subjective to well. Refer to Table 2 for well-specific analyte list.	One comprehensive groundwater sampling event of wells summarized on Table 2 will be completed. Evaluate applicable wells for the presence of NAPL prior to sampling.
Quality Assurance / Quality Control (QA/QC) Samples								
N/A	QA/QC Duplicate Samples		Groundwater (Well)		6		Based on a maximum of 55 groundwater well samples	Duplicates submitted at a rate of 10% that of investigative samples
			Soil		2		Based on a maximum of 11 soil samples proposed above	
	QA/QC Field Blanks		Laboratory-Grade Water		2		One field blank during soil boring and well installation activities One field blank for the groundwater sampling event.	Document site conditions and the quality of the water for other blank development.
	QA/QC Equipment Rinsate Blanks		Laboratory-Grade Water		1		One equipment rinsate of drilling equipment. No rinsates needed for groundwater sampling event as only dedicated, disposable equipment will be used.	Completed on all non-disposable sampling equipment at an approximate rate of 5% of each piece of equipment.
	QA/QC Trip Blanks		Laboratory-Grade Water		9		One Trip Blank for the soil borings One Trip Blanks for the well borings/installations Seven Trip Blanks for the comprehensive well sampling event	One Trip Blank submitted for each batch of samples sent to the laboratory.

(1) - Excluding wells MW-3, MW-4, MW-7, MW-20, MW-25, and MW-32

Groundwater monitoring well samples will be analyzed for all or a portion of the following:

Target Compound List (TCL) Volatile Organic Compounds (VOCs) - Method 8260D
TCL Semi-Volatile Organic Compounds (SVOCs) - Method 8270E
Target Analyte List (TAL) Metals (including mercury) - Methods 6010D and 7470B (7471B for soil)
General Chemistry - Multiple laboratory methods

Soil samples will be analyzed for the above except General Chemistry.

N/A - Not Applicable
QA/QC - Quality Assurance/Quality Control

Table 2
Summary of Groundwater Analyses
June 2025 Sampling Event

Well	Discontinue Sampling	VOCs	SVOCs	pH	Metals	General Chemisty (1)	Notes
MW-1		X	X	X			
MW-2		X	X				
MW-3	X						
MW-4	X						
MW-5S, 5D		X	X				
MW-6S, 6D		X	X				
MW-7	X						
MW-8S, 8D		X	X				
MW-9S, 9D		X	X				
MW-10S, 10D		X	X				
MW-11S, 11D		X	X				
MW-12		X	X				
MW-13		X	X	X			
MW-14		X	X				
MW-15		X	X				
MW-16		X	X				
MW-17		X	X				
MW-18		X	X				
MW-19S, 19D		X	X				
MW-20	X						
MW-21		X	X	X			
MW-22S, 22D		X	X				
MW-23		X	X				
MW-24		X	X				
MW-25	X						
MW-26S, 26D		X	X				
MW-27S, 27D		X	X				
MW-28		X	X				
MW-29		X	X				
MW-30		X	X				
MW-31		X	X				
MW-32	X						
MW-33		X	X				
MW-34S, 34D		X	X				
MW-35S, 35D		X	X				
MW-36S, 36D		X	X				
MW-37		X	X				
MW-38		X	X				
MW-39		X	X		X	X	
MW-40		X	X		X	X	
MW-41		X	X		X	X	
MW-42		X	X		X	X	
MW-43		X	X		X	X	
MW-44		X	X		X	X	
MW-45		X	X		X	X	
MW-46		X	X		X	X	New Well
MW-47		X	X		X	X	New Well
MW-48		X	X		X	X	New Well

Total Samples		**55**	**55**	**3**	**10**	**10**	

(1) - General Chemistry includes pH analysis.

ATTACHMENT A

Field Sampling and Analysis Plan and Quality Assurance Project Plan

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FIELD SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

ERIE COKE SITE

ERIE COUNTY, PENNSYLVANIA

PADEP Contract No.: SAP4000023226
General Environmental Technical Assistance Contract
Work Requisition No.: GTAC7-6-181

Prepared for:

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Commonwealth of Pennsylvania
Department of Environmental Protection

Submitted by:
OBG | Baker Environmental Solutions Joint Venture
Moon Township, Pennsylvania

May 2025

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1.0 INTRODUCTION

This Field Sampling and Analysis Plan (FSAP) and Quality Assurance Project Plan (QAPP) has been prepared by OBG | Baker Federal Solutions Joint Venture (OBG | Baker) for the Pennsylvania Department of Environmental Protection (PADEP) as authorized under their General Technical Assistance Contract (GTAC), Contract Number 4000023226, Work Requisition Number 7-6-181. This FSAP and QAPP are associated with the investigation activities proposed to be conducted at the Erie Coke Site (site) located in Erie, Pennsylvania.

The primary purpose of the FSAP and QAPP is to provide guidance for the field activities by describing the detailed sampling and data collection methods to be used.

2.0 FIELD SAMPLING AND ANALYSIS PLAN

2.1 Site Background

Pertinent background information related to the site location and physical setting, historical operations and investigation history was presented previously in the Supplemental Site Investigation Work Plan and other associated documents and are not included in this truncated scope of work.

2.2 Project Objectives

The project objectives are summarized in the Work Plan.

2.3 Investigation Procedures

The following sections present the investigation procedures that will be used during the field activities. Supplemental information regarding the sampling and field procedures can be found in the OBG | Baker Standard Operating Procedures (SOPs) referenced herein. Support activities, sampling locations, sample matrices, and analytical parameters are discussed in the Work Plan.

2.3.1 Soil Sampling

Soil samples will be collected from the site as part of the investigation. The following sections describe the sample collection and field screening methods to be used as well as the criteria for selecting samples for chemical analyses.

Soil samples will be collected using rotasonic drilling methods, which include a combination of rotary power, hydraulic pull down pressure, and mechanically generated oscillations to advance a dual line of drill pipe. The inner drill pipe (typically four-inch nominal diameter) contains a core bit and represents the core barrel sampler, while the outer pipe (typically six-inch nominal diameter) is used to prevent collapse of the borehole. The samples will be collected continuously in minimum five-foot increments from the ground surface to the desired depth. The Work Plan details the depth to which each boring will be advanced. The sampling will be conducted as summarized below:

1. Push/vibrate the sampling device to the desired depth.

2. Bring the sampler to the surface and extract the soil core while placing it directly into a clear polyethylene liner using the vibration technique of the rotasonic rig. Cut small slits in the polyethylene liner at approximate one-foot intervals for field screening for total volatile organic vapors using the PID.

3. The field screening will be conducted by inserting the tip of the PID wand into the holes. The highest reading for each interval will be recorded in the field logbook.

4. Upon completion of the field screening, slice the liner with a cutting tool to expose the sample core. Collect a photograph of the complete soil core for the project database.

5. If applicable, collect the sample for volatile organics analysis using a TerraCore® sampling device (or equivalent). Preserve the sample by placing five grams of the sample in the vial containing methanol (supplied with the TerraCore® sampling kit).

6. After collecting the sample for volatile organics analysis, thoroughly homogenize the remaining portion of the sample interval for non-volatile constituents on a portion of the liner to ensure that the sample is as representative as possible of the sample interval. This step may be eliminated if the sample appears to already be homogenized.

7. Transfer the proper sample volume into appropriate, laboratory-supplied containers and place the sample in a cooler with ice.

8. Record all pertinent sampling information such as soil description, sample depth, sample number, sample location, analysis/preservation, and time of sample collection in the field logbook.

2.3.1.1 Soil Sample Selection Methodology

Retrieved soil cores will be field-screened and up to two soil samples will be collected from each sonic boring for laboratory analysis as described below.

Identified Areas with Contaminant Impact:

- One 'worst-case' soil sample above water table based on PID readings and/or visual evidence of staining/odor. No soil samples will be collected for analysis below water table.

- One 'clean' soil sample collected below the 'worst-case' soil sample, above the soil/groundwater interface. No soil samples will be collected for analysis below water table.

Areas with NO Obvious Contaminant Impact:

- One soil sample collected above water table at geologist's discretion to document subsurface conditions and potentially delineate contaminant impact not obvious through screening (e.g., metals).

Residual soil cuttings from the sonic drill rig not collected for laboratory analysis will be returned to its boring of origin unless waste material (e.g., liquid or semi-solid waste, oils, etc.) or notable contamination is present based on field screening and visual/olfactory observations. If contamination is encountered, the contaminated soil cuttings will be drummed for later characterization (as necessary) and off-site disposal. Surrounding site materials will be used to backfill any remaining void in the open borehole.

2.3.2 Groundwater Grab Sampling

No groundwater grab samples will be collected as part of this scope of work.

2.3.3 Monitoring Well Installation

Shallow overburden monitoring wells will be installed at the site. The monitoring well borings will be drilled using rotasonic drilling methods, which use a combination of rotary power, hydraulic pull down pressure, and mechanically generated oscillations to advance a dual line of drill pipe. The inner drill pipe (four-inch nominal diameter) contains a core bit and represents the core barrel sampler, while the outer pipe (six-inch nominal diameter) is used to prevent collapse of the borehole and in construction of wells.

During drilling, continuous soil core samples will be collected for lithologic identification by advancing the inner core barrel in front of the outer drill pipe. The inner core barrel will then be mechanically lifted to the surface for sample recovery. The soil core will be vibrated out of the core barrel into a polyethylene liner. This process will be repeated until the desired depth is achieved.

2.3.4 Groundwater Well Sampling

Groundwater samples will be collected from all monitoring wells at the site. Specific sampling procedures are described below.

Prior to sampling, a complete round of groundwater level measurements will be collected from the wells. The wells will be sampled using low flow purging/sampling methods as follows:

- At each well, tubing from a peristaltic pump will be lowered to the approximate mid-point of the well's screened interval. The pumping rate will be set to create a low sustainable flow. A water level meter will be used concurrently to monitor the water level within the well casing as necessary. Ideally, the water level should remain in 'steady state' during low-flow pumping and not be drawn down. If drawdown in the well occurs, the pump flow rate will be reduced until the water level in the well casing stabilizes. Typically, flow rates of less than one liter per minute are used initially. However, the flow is dependent upon the hydrogeologic characteristics of the well sampled.

- Water Quality Parameters (WQPs) including pH, Oxidation/Reduction Potential (ORP), specific conductance, dissolved oxygen, temperature, and turbidity will be measured at approximate five minute intervals during purging and recorded in the field logbook. The field testing will be conducted within a flow-through cell that limits exposure of the groundwater to the atmosphere while the field measurements are recorded.

- In general, purging will be complete when three successive WQP readings have stabilized within 0.1 Standard Units for pH, 10 millivolts for ORP, 3% for specific conductance, and 10% for dissolved oxygen and turbidity is less than 10 Nephelometric Turbidity Units (NTUs). Temperature readings will be recorded, but not used for stabilization evaluation. Temperatures measured at the surface are affected to some extent by the difference between ambient air and groundwater temperatures and thus can vary over short periods. If after two hours (or three well volumes, whichever is sooner) of purging, WQPs have not reached a stable plateau, purging may be discontinued, and the sample collected. A full explanation of attempts to achieve stabilization will be recorded in the field logbook.

- Upon WQP stabilization, the groundwater samples will be collected from the end of the tubing and placed into appropriate, laboratory-supplied containers with the appropriate preservatives. Samples for dissolved metals will be filtered in the field using dedicated 0.45-micron disposable filters.

2.3.5 Non-Aqueous Phase Liquid Sampling Activities

No Non-Aqueous Phase Liquids (NAPL) will be sampled as part of this investigation. However, NAPL levels will be measured in select wells prior to sampling.

2.3.6 Investigation Derived Waste Management

The disposal of wastes will be conducted following completion of the comprehensive groundwater sampling event. Drums will be used to house the applicable wastes that warrant disposal. Waste profiles are already in place and no additional profiles of aqueous or non-aqueous waste is warranted.

2.3.7 Quality Assurance / Quality Control Samples

Field Quality Assurance/Quality Control (QA/QC) samples will include trip blanks, equipment rinsate blanks, field blanks, and field duplicate samples:

Trip Blanks: Trip blanks are samples of analyte-free water prepared at the laboratory before commencement of the sampling event and shipped to the sampling team along with the unopened sample containers. The trip blanks will be randomly selected and included in each cooler containing samples for VOC analysis. The results will be used to verify that the sample containers and method of sample container handling used throughout the sampling program did not contribute to contamination of the samples. In addition, the results will be used to identify other potential sources of field or laboratory contamination.

Equipment Rinsate Blanks: Equipment rinsate blanks will be collected by running laboratory-grade, organic-free, deionized water over/through the drilling equipment and placing it into the appropriate sample containers for laboratory analyses. One equipment rinsate blank will be collected as they will be collected at a frequency of approximately five percent for each type of reusable sampling equipment. The results will be used to verify that the sampling equipment did not contribute to contamination of the samples.

Field Blanks: To document both the quality of the potable water used for the decontamination activities and document background/ambient site conditions, field blanks will be collected as part of the investigation activities. One field blank of laboratory-grade water will be collected for analysis during the soil sampling and well installation activities, and one will be collected during the groundwater sampling event.

The field blanks will be collected by pouring laboratory-grade, organic-free, deionized water (supplied by the subcontracted laboratory) into the appropriate sample containers for laboratory analyses. The analysis of these field blanks will document the integrity/quality of the water supplied by the laboratory in case erroneous detections are observed from the laboratory analytical results of the equipment rinsate samples and also document ambient site conditions during sample collection.

Field Duplicate Samples: Field duplicate samples will consist of one unique sample, split into two aliquots, and analyzed independently for the same parameters as the corresponding original samples. Duplicate soil samples analyzed for parameters other than VOCs will be homogenized and split. Samples for VOC analysis will not be mixed but select segments of the soil will be collected. Duplicate water samples will be collected simultaneously. Duplicate samples will be collected at a frequency of approximately ten percent for each group of samples of a similar matrix. For this scope of work, six groundwater duplicates are proposed, and one soil duplicate is proposed. The results will be used to verify the reproducibility of the laboratory results and degree of variability of reported concentrations.

2.3.8 Sample Preservation and Handling

Sample preservation and handling will be conducted in accordance with Baker SOP F301 (Sample Preservation and Handling). Samples collected for laboratory analyses will be placed into appropriate, laboratory-supplied containers with the appropriate preservatives, stored on ice in coolers at approximately four degrees Celsius, and delivered to the laboratory via Federal Express. Chain-of-Custody forms will be completed and enclosed in the shipping packages. In addition, Chain-of-Custody seals will be placed on each shipping package.

2.4 Sample Designation

The samples, including QA/QC samples, will be designated with a unique sequence number. The samples will also be designated with a unique number that will serve to identify the sample media or type, sampling location, depth, and QA/QC qualifiers. The sample designation format will be as follows:

Sample Media or Type/Location - Depth and/or QA/QC Qualifier

An explanation of each of these identifiers is provided below.

Sample Media or Type

SB = Soil Boring Sample
MW = Groundwater Monitoring Well Sample
TB = Trip Blank
ER = Equipment Rinsate Blank
FB = Field Blank

Location

Each sample location will be identified with a unique identification number. For consistency, soil boring numbering will continue from the supplemental investigation activities in 2024. Each soil boring and groundwater grab boring will begin with ‘200 series’ sequential numbering beginning with SB-227. New well numbering will begin with MW-46.

If additional delineation (‘step out’) borings are needed in an area, the delineation borings will have a sequential letter “A, B, C, etc.” suffix to associate them with their boring of origin (e.g., delineation borings from impacted boring SB-205 will be SB-205A, SB-205B, etc.)

Depth

Depth indicators will be used for soil samples. The number will reference the ending depth interval of the sample. For example:

<u>Soil:</u>
1 = Ground surface to 1 foot bgs

5 = 4 to 5 feet bgs
15 = 14 to 15 feet bgs

Groundwater Grab Samples:
GWG = Groundwater Grab
GWG-100, GWG-101, etc. = Groundwater Grab Sample #01, #02, etc. (numbering sequential and not AOC dependent)

QA/QC DUP = Field Duplicate Sample

Using the applicable sample designation format, the at-depth (11-12 ft. bgs) quality control duplicate soil sample from SB01-12 DUP refers to:

SB-201-12 DUP	Soil boring number 201
SB-201-12 DUP	Soil sample depth interval of 11-12 feet bgs
SB-201-12 DUP	Field duplicate (QA/QC) sample

This sample designation format will be followed throughout the field sampling activities as all soil samples are proposed to be collected in one-foot increments. Required deviations to this format in response to field conditions will be documented in the field logbook.

2.5 Decontamination

Reusable sampling equipment (e.g., stainless steel spoons, hand augers, etc.) that comes into direct contact with the sample will be decontaminated between samples as follows:

- Wash equipment thoroughly with laboratory detergent and potable water using a brush to remove any particulate matter or surface film
- Rinse equipment thoroughly with potable water
- Air dry equipment

Drilling equipment (e.g., sonic cutting head, drill rods) that comes into direct contact with the soil will be decontaminated between borings and wells at a centralized decontamination pad using a high-pressure, hot water wash (a.k.a., 'steam cleaning'). Because the use of acetate or polyethylene liners will be used during boring advancement/sample collection, only the drilling materials coming in direct contact with the soil will warrant decontamination through steam cleaning (e.g., cutting head). However, if notable contamination is encountered during boring advancement, all downhole drilling materials will be steam cleaned between borings.

The decontamination pad will be capable of containing water and sediment. In addition, the pad will be equipped with a sump and sump pump suitable to pump the spent decontamination water into the frac tank.

2.6 Monitoring and Data Collection Equipment

Field instruments will be used for screening (e.g., PID) various media samples and measuring water levels/well depths and WQPs (e.g., pH, specific conductance, temperature, dissolved oxygen, turbidity, and ORP). The PID will be calibrated and operated in accordance the manufacturer's instructions. The procedures to be used for on-site water quality testing and water level/well depth measurements are provided in the attached OBG | Baker SOPs F201 and F202, respectively.

2.7 Survey

Monitoring wells will be installed as part of the field activities and will need to be surveyed for accurate placement on a scaled site map and for groundwater flow mapping.

The monitoring well survey activities under this task will include locating the horizontal position and establishing elevations of the newly-installed monitoring wells. The horizontal data will be to the nearest 0.1-foot and referenced to the Pennsylvania State Plane Coordinate System, North American Datum (NAD) 1983. The vertical data will be to the nearest 0.01-foot and referenced to the North American Vertical Datum (NAVD) 1988. These surveying activities also will be conducted under the direction of a professional land surveyor licensed to practice surveying in the Commonwealth of Pennsylvania.

2.8 Site Management

The following sections outline the responsibilities and reporting requirements of on-site personnel.

2.8.1 Field Team Responsibilities

The field team will consist of a Field Team Leader and an Environmental Specialist. The Field Team Leader will coordinate the field activities and serve as the Site Health and Safety Officer. In addition, the Field Team Leader will ensure that all field activities are conducted in accordance with the Work Plan, FSAP, QAPP, and site-specific Health and Safety Plan. The Environmental Specialist will support the Field Team Leader during the sampling activities.

2.8.2 Reporting Requirements

The Field Team Leader will be responsible for tracking each day's field activities including, but not limited to, the following:

- Personnel on site
- Major activities of the day

- Subcontractor quantities (e.g., drilling footages)
- Samples collected and analyses requested
- Equipment on site
- Problems encountered
- Changes in scope of the investigation (discussed and agreed upon with the PADEP Regional Project Officer)
- Planned activities

In addition, the Field Team Leader will prepare Daily Activity Reports. These reports will be forwarded onto the Project Manager for review and discussion (if needed). The Project Manager will be responsible for submittal of the daily reports to the Department.

3.0 QUALITY ASSURANCE PROJECT PLAN

This QAPP presents the organization, objectives, functional activities, and specific QA/QC activities associated with the site investigation. It contains information concerning project objectives, sampling descriptions and rationale, and Data Quality Objectives (DQOs) as follows:

- Project Description
- Organization and Responsibility
- Data Quality Objectives
- Sampling Procedures
- Sample Custody Procedures and Frequency
- Analytical Procedures
- Data Reduction, Validation, and Reporting
- Preventive Action Procedures
- Corrective Action Procedures
- Quality Assurance Reports

3.1 Project Description

The project description and objectives are presented in the Work Plan.

3.2 Organization and Responsibility

The OBG | Baker project management organization is designed to provide a line of functional responsibility and authority supported by a management control structure and independent Quality Assurance (QA) review. This control structure provides for the following:

- Clearly identified lines of communication and coordination
- Project budget and schedule monitoring
- Key technical resources management
- Financial management and progress reports
- Quality Control (QC)

Key personnel for QA throughout the duration of this project are presented in the Work Plan.

3.3 Data Quality

3.3.1 Data Needs/Uses

The generation of data through the sampling and analyses efforts is intended to provide an assessment of current site conditions with respect to potential environmental impact from historical industrial operations conducted at the site. Table 1 of the Work Plan present a summary of the sampling and analytical program.

3.3.2 Data Quality Objectives

DQOs are qualitative or quantitative statements developed by the users to specify the quality of data needed from a particular data collection activity to support specific uses. DQOs consider analytical method precision, accuracy, representativeness, completeness, and comparability as discussed below.

Precision

Precision is a measure of the amount of variability and bias inherent in a data set. Furthermore, precision describes the reproducibility of measurements of the same parameter for samples collected under similar conditions.

Field duplicate precision monitors the consistency with which environmental samples were obtained and analyzed. In general, field duplicate results for solid matrix and aqueous matrix samples are precise if the Relative Percent Difference (RPD) is less than or equal to 35 percent and 20 percent, respectively. Field precision will be assessed through collection and measurement of field duplicate samples at a rate of 1 duplicate per 10 analytical samples per matrix.

Laboratory precision QC samples will be analyzed with a minimum frequency of 5 percent (i.e., 1 QC sample per 20 environmental samples per matrix). Laboratory precision will be measured via comparison of RPD values and precision control limits specified in the analytical method or by the laboratory's QA/QC program. Laboratory limits at the time of analysis will be used to assess the data.

The RPD between the sample (or spike) and duplicate (or duplicate spike) will be calculated using the following formula:

$$\text{RPD} = \frac{\text{Amount in Sample 1} - \text{Amount in Sample 2}}{0.5(\text{Amount in Sample 1} + \text{Amount in Sample 2})} \text{ X } 100$$

Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy in the field will be assessed using equipment rinsate, field, and trip blanks and will be ensured through adherence to all sample handling, preservation, and holding time requirements.

Accuracy in the laboratory will be measured through the comparison of a spiked sample result with a known or calculated value and is expressed as a percent recovery (%R). Percent recoveries will be derived from the analysis of known amounts of compounds spiked into deionized water (i.e., Laboratory Control Sample [LCS] analysis) or into actual samples (i.e., surrogate or internal MS analysis). LCS analysis, which may also be referred to as blank spike analysis, measures the accuracy of laboratory operations. Surrogate and MS analyses measure the accuracy of laboratory operations as affected by sample matrix. LCS and MS analyses will be performed at a frequency of 1 per 20 associated samples of similar matrix. Surrogate spike analysis is performed for all organic chromatographic analyses. Laboratory accuracy will be assessed via comparison of calculated %R values with accuracy control limits specified in the analytical method or by the laboratory's QA/QC program. Laboratory recovery limits at the time of analysis will be used to assess the data.

The %R for a spiked sample will be calculated by using the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample - Amount in Sample}}{\text{Known Amount Added}} \text{ X } 100$$

The %R for LCS and surrogate compound results will be determined according to the following equation:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Known Amount Added}} \text{ X } 100$$

Completeness

Completeness is a measure of the amount of usable, valid, analytical data obtained, compared with the amount expected to be obtained. Completeness is typically expressed as a percentage.

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed), errors can be introduced during analysis (e.g., loss of instrument sensitivity, introduction of ambient laboratory contamination), or strong matrix effects can become apparent (e.g., extremely low MS recovery). These instances result in data that do not meet QC criteria. Completeness will be calculated for each chemical category (e.g., VOCs, SVOCs, metals, etc.) per media. If critical data points are lost, re-sampling and/or re-analysis may be required. For this project, the completeness goal is 95 percent or greater.

Following completion of the analytical testing, the percent completeness will be calculated using the following equation:

$$\text{Completeness} = \frac{\underline{\text{(Number of Valid Measurements)}}}{\text{(Number of Measurements Planned)}} \times 100$$

Representativeness

Representativeness is an expression of the degree to which the data accurately and precisely depict the actual characteristics of a population or environmental condition existing at an individual sampling point. Use of standardized sampling, handling, analytical, and reporting procedures ensures that the final data accurately represent actual site conditions.

Representativeness in this sampling and analysis program will be ensured by following the Work Plan, FSAP, and QAPP and using proper sampling techniques. From the analytical end, representativeness will be ensured by using the proper analytical procedures, meeting sample holding times, and analyzing and assessing field duplicate samples.

Comparability

Comparability is defined as the confidence with which one data set can be compared with another (e.g., between sampling points; between sampling events). Comparability will be achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measure). In addition, consideration will be given to seasonal conditions and other environmental variations that could exist to influence analytical results.

3.4 Sampling Procedures

Field sample collection procedures are presented in the Work Plan and FSAP. Appropriate sample containers and preservatives will be obtained directly from the subcontracted analytical laboratory. The sample containers will be certified as clean by the laboratory. Tables 1 and 2 of this QAPP present a summary of sample containers, preservation, and holding times for the primary aqueous and solid samples.

3.5 Sample Custody Procedures

Each sample will be given a unique designation, which will be recorded in the field logbook, on the Chain-of-Custody record, and the label affixed to the sample container. The sample designation format is presented in the FSAP.

Sample labeling, custody seals, field tracking, field logbooks, and Chain-of-Custody procedures are described in Baker SOPs F302 (Chain-of-Custody) and F303 (Field Logbook). Samples for laboratory analyses will be stored on ice in coolers at approximately four degrees Celsius and submitted to a qualified, subcontracted laboratory. Chain-of-Custody forms will be completed and enclosed in the shipping packages. In addition, Chain-of-Custody seals will be placed on each shipping package.

3.6 Analytical Procedures

General procedures for field analyses and laboratory analyses provided below.

3.6.1 Field Analyses

Field instruments will be used for screening (e.g., PID) various media samples and measuring WQPs (e.g., pH, specific conductance, temperature, dissolved oxygen, turbidity, and ORP). The PID will be calibrated and operated in accordance the manufacturer's instructions. On-site water quality testing will be conducted in accordance with Baker SOP F201.

3.6.2 Laboratory Analyses

Table 1 of the Work Plan presents a summary of the proposed sampling and analytical program. The laboratory analyses will be conducted in accordance with standard U.S. Environmental Protection Agency (USEPA) methods and procedures used in the environmental industry.

3.7 Data Reduction and Reporting

Data reduction and reporting will ensure that all documents produced as part of the investigation can be accounted for upon project completion. Accountable documents include, but are not limited to, field logbooks, correspondence, Chain-of-Custody records, data packages, and photographs. The Project Manager will be responsible for maintaining a project file in which all accountable documents will be inventoried. The project records will be retained in accordance with OBG | Baker's and the Department's Document Retention Policy.

TABLE 1

SUMMARY OF CONTAINERS, ANALYSES, PRESERVATION, AND HOLDING TIMES FOR AQUEOUS SAMPLES

Parameter	Analytical Method	Container	Preservation	Holding Time
VOCs	Method 8260D	Two 40-ml glass vials with Teflon septum caps	Cool, 4°C HCl pH <2	14 days
SVOCs	Method 8270E	Two 250-ml amber glass bottle with Teflon cap	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
Total and Dissolved Metals (& Mercury)	Method 6010D/7471B	500-ml polyethylene bottle - Each	HNO_3 pH<2	6 months; Mercury 28 days
General Chemistry	Multiple Methods	Two - 1 Liter polyethylene bottles	Cool, 4°C	7 days
pH	9040C	One – 1 liter glass bottle	None	7 days

TABLE 2

SUMMARY OF CONTAINERS, ANALYSES, PRESERVATION, AND HOLDING TIMES FOR NON-AQUEOUS SAMPLES

Parameter	Analytical Method	Container	Preservation	Holding Time
VOCs	Method 8260D	TerraCore three – 40-ml glass VOA vials; one 2-ounce plastic	One vial with methanol; two vials with DI water; Cool, 4°C	14 days
SVOCs	Method 8270E	One 8-ounce wide-mouth jar	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
Metals (including mercury)	Method 6010D/7471B	One 8-ounce wide-mouth jar	Cool, 4°C	6 months; Mercury 28 days

3.7.1 Field Data Procedures

Field sampling activities will be documented in field logbooks in which information pertinent to sample collection will be entered in indelible ink. The field logbooks will be completed and maintained as described in Baker SOP F303 (Field Logbook). Appropriate information will be entered daily including weather, names of field personnel and visitors on site, sample identification, brief descriptions of samples collected, date and time of collection, sampling methodology, sampling remarks and observations, field measurements, conditions and observations, description of activities, QA/QC samples collected, and list of photographs taken.

3.7.2 Laboratory Data Procedures

The following procedures summarize the practices that will be routinely used by laboratory staff for data reduction, validation, and reporting. Numerical analyses, including manual calculations, will be documented and subjected to QC review. Records of analyses must be legible and complete enough to permit reconstruction of the work by a qualified individual other than the originator.

Laboratory Data Validation

Laboratory data validation begins with the receipt of samples and the documentation of proper sample custody. It continues with raw data reduction to the reporting of data.

Data processing will be checked by an individual other than the analyst who performed the data processing. The checker will review the data for the following:

- Utilization of the proper equations
- Correctness of numerical input
- Correctness of computations
- Correct interpretation of raw data (e.g., chromatographs, strip charts, etc.)

All entries made in bench books, data sheets, computation sheets, etc., will be made in ink. No entry will be rendered illegible, and changes will be lined-through and initialed by the person making the correction.

Analytical Data Package Requirements

An Electronic Data Deliverable (EDD) in Microsoft Excel format of the analytical data will be submitted to OBG | Baker from the subcontracted laboratory. For each analytical method run, the laboratory will report all required analytes for each sample as a detected concentration or as not detected at the specific limits of quantitation. In addition, applicable method detection limits and instrument detection limits will be required for every analysis. The Department requested that all analytical methods are sufficient to attain levels below the appliable Residential and Non-Residential MSCs.

Each analytical method run will be clearly identified as belonging to a specific analytical batch. All samples must be reported with dates of collection, preparation, and analysis. The laboratory will also report dilution factors for each sample.

A complete set of QC results, including calibration data, will be reported for each analytical batch. All required method QC will be performed on project samples. The required QC samples and their frequency are identified in the FSAP. A standard turnaround time (for complete data packages) from sample receipt at the laboratory to data receipt will be requested for all samples. The laboratory will hold and make available all project raw data for a minimum period of seven years after the samples have been analyzed.

3.8 Preventive Action Procedures

3.8.1 Field Equipment

Specific preventive maintenance procedures recommended by the manufacturer will be followed for field equipment. Field instruments will be checked and calibrated by OBG | Baker daily before use. In addition, the calibration will be checked anytime there is a questionable response from the equipment. Calibration will be documented in the field logbooks.

3.8.2 Laboratory Instruments

A routine preventive maintenance program will be conducted by the laboratory to minimize the occurrence of instrument failure and other system malfunctions. Section supervisors and/or analysts (organic, inorganic) will perform routine scheduled maintenance, and coordinate with the vendor for the repair of all instruments. All laboratory instruments will be maintained in accordance with the manufacturer's specifications and the requirements of the specific method employed. This maintenance will be carried out on a regular, scheduled basis and documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturers maintenance will be provided under a repair and maintenance contract with factory representatives.

3.9 Corrective Action Procedures

A corrective action protocol that is both technically effective and administratively compatible to ensure accurate and timely correction of non-conformance is imperative.

3.9.1 Field Procedures

The Field Team Leader will be responsible for all field activities. In this role, the Field Team Leader may be required to adjust the field program to accommodate site-specific needs. If it becomes necessary to modify the program, then the Field Team Leader will consult the Project Manager and PADEP Regional Project Officer regarding an appropriate corrective action. Agreed upon corrective actions for the program will be documented in the field logbook.

3.9.2 Laboratory Procedures

Nonconformance is any event, which is beyond the limits established for laboratory performance, such as data which fall outside accepted bounds for accuracy and precision due to improper equipment calibration/maintenance or improper data verification. Any activity in the laboratory which affects data quality can result in a nonconformance.

Nonconformance associated with the statistical analysis and review of data are straightforward to identify. The Laboratory QA Coordinator will be responsible for the assessment of QC sample information. The Project Manager and PADEP will be notified of any nonconformances.

Corrective actions will be designed to correct the associated problems and minimize the possibility of their recurrence. Examples of corrective actions are modifying nonconforming procedures; tagging, repairing, or replacing deficient equipment; training or replacing unqualified personnel; re-analyzing affected samples; marking rejected data, and reissuing affected reports.

3.10 Quality Assurance Reports

The Project Manager will be responsible for assessing the performance of measurement systems and data quality related to the field investigation. A written record will be maintained of the results of laboratory QC reports and other periodic assessments of measurement, data accuracy, precision, and completeness; performance and system audits; and any significant QC problems and recommended solutions. A QA/QC assessment will be performed any time a significant problem is identified.

The Project Manager will keep in contact with the PADEP Regional Project Officer through informal, verbal reports during the project as well as through monthly progress reports.

ATTACHMENT A

Standard Operating Procedures (SOPs)

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - ON-SITE WATER QUALITY TESTING

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SOP Number: F201
Effective Date: 09/06

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ON-SITE WATER QUALITY TESTING
(FIELD PARAMETERS)

1.0 PURPOSE

This SOP describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance/Salinity
- Temperature
- Dissolved Oxygen Concentration (DO)
- Turbidity (Secchi Disc)
- Oxidation Reduction Potential (ORP)

The first three bullets above are typical field parameters. Dissolved oxygen, turbidity, and ORP may be used in particular applications according to project-specific requirements.

2.0 SCOPE

These procedures are applicable for use in an on-site water quality monitoring program to be conducted during Remedial Investigations or Site Investigations at hazardous or non-hazardous sites. The procedures and equipment described are applicable to nearly all aqueous samples, including, but not limited to, potable well water, monitoring well water, surface water, leachate and drummed water, etc.

This SOP provides generic information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use (preferably prior to mobilization to the field).

3.0 DEFINITIONS

Specific Conductance - A measurement of water’s capacity for conveying electrical current and is directly related to the concentrations of ionized substances in the water. The units of measurement for conductance (µmhos) are the inverse of µohms, the unit commonly used to express resistance. The terms conductivity and specific conductance are used synonymously.

Electrolytic Cell - An electrochemical cell in which electrical energy is supplied from an external source. This cell functions in much the same way as a galvanic cell, only in the opposite direction due to the external source of applied voltage.

Galvanic Cell - An electrochemical cell in which chemical energy is spontaneously converted to electrical energy. The electrical energy produced is supplied to an external circuit.

Oxidation - The process in which an atom or group of atoms loses electrons to achieve an increasing positive charge.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration. The range of pH is 0 to 14 standard units.

Resistance - A measure of the solution's ability to oppose the passage of electrical current. For metals and solutions, resistance is defined by Ohm's Law, $E = IR$, where E is the potential difference (in units of volts), I is the current (in units of Amperes), and R is the resistance (in units of ohms).

Turbidity - An optical property of water that causes light to be scattered or absorbed in the water, resulting in a decrease in water transparency. It is a function of at least three variables: 1) dissolved chemicals; such as tannins, acids, or salts; 2) suspended particles; such as silt, clay, and organic matter; and, 3) density of microbial and planktonic life.

Salinity - refers to the total amount of soluble salts in water, either naturally or added to the environment as pollutants.

ORP - Oxidation reduction occurs when electrons are transformed from one atom to another during a chemical reaction. The atom losing electrons is said to be "oxidized", while the atom gaining electrons is termed "reduced". ORP is typically measured using a platinum electrode, attached to a pH meter, which is set to read in ‘Millivolt’ mode.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for determining which on-site water quality measurements shall be collected, the data quality objectives (DQOs) for these measurements, and for ensuring that these measurements are collected in accordance with project-specific plans.

Field Team Leader - The Field Team Leader is responsible for determining that these water quality measurement procedures are implemented in the field in accordance with this SOP, and/or in accordance with project-specific plans, and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures for collecting on-site water quality measurements including instrument calibration, quality control and recording of results, as well as care and maintenance of the instruments in the field. Furthermore, it is the sampling personnel’s responsibility to confirm that the meters are in good working order prior to mobilization to the field. In addition, extra batteries and meter probes also should be included in the field equipment list to minimize potential down time in the field.

5.0 PROCEDURES

The following sections provide general procedures for collecting pH, specific conductance/salinity, temperature, dissolved oxygen concentration, turbidity and ORP measurements.

Note: Though there are "multi-parameter" meters on the market today that can simultaneously measure the following parameters, only measurement with "parameter specific" meters will be discussed. If using a multi-parameter meter, all manufacturer's instructions for that specific model will be followed for calibration, maintenance, and care.

5.1 Measurement of pH

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment, such as acid-base neutralization, water softening, and corrosion control, is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Measurements of pH also can be used to check the quality and corrosivity of soil and solid waste samples. However, these samples must be immersed in water prior to analysis; specific measurement techniques for solids are not described in this SOP.

5.1.1 Principles of Equipment Operation

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on the establishment of a potential difference across a glass or other type of membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to hydrogen ion concentration can be generated and measured.

5.1.2 Equipment

The following equipment and reagents are needed for taking pH measurements:

- Laboratory-prepared buffer solutions for calibration of pH 4, 7 and 10, or other buffers which bracket the expected pH range.

5.1.3 Measurement Techniques for Field Determination of pH

A. pH Meter

Standardization, calibration, and operation and maintenance shall be performed according to the manufacturer's instructions for the "specific" model being used. The following general procedure is used for measuring pH with a pH meter:

1. The batteries shall be checked to make sure that they are fully charged and the instrument shall be calibrated prior to initiation of the field effort.

2. Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage.

3. Turn meter on and allow it to stabilize for 3 to 5 minutes.

4. Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s). Shake electrode as if a mercury thermometer to move air bubbles from the tip to the top.

5. Calibration procedures should be performed:
   - Following significant ambient temperature changes
   - When meter reads erratically
   - At beginning and middle of each day of use

6. When the meter is moved to a new sampling location, a single-point check/calibration should be performed with pH 7 buffer.

7. Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the field logbook.

8. After adjusting the temperature compensator to the sample temperature, read and record the pH of the solution. The pH value shall be recorded to the nearest 0.1 pH unit. Also record the sample temperature. All measurements shall be recorded in the Field Logbook.

9. Upon completion of measurement and removal of the electrode from the sample (or buffer), the electrode shall be thoroughly rinsed with deionized water and patted dry (never rub dry, due to potential interference by static electricity).

10. The electrode(s) shall remain immersed in storage solution provided, or pH buffer 4 water when not in use.

The sample used for pH measurement shall never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution within the electrode, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted in the Field Logbook.

5.2 Measurement of Specific Conductance/Salinity

Conductance provides a measure of dissolved ionic species in water and can be used to suggest the direction and extent of migration of contaminants in groundwater or surface water. Salinity refers to the total amount of soluble salts in water, either naturally or added to the environment as pollutants.

One basic measure of salinity is the ability of water to conduct electric current. Therefore, a measurement of specific conductance provides a measurement of salinity and the same instrument can be used. Salinity measurements also are important in ecological field investigations because flora and fauna can be limited in their distribution based on the salinity of the sampled waters.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is collected. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance and salinity measurement soon after taking the sample designated for laboratory analysis, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air affect the specific conductance.

5.2.1 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions (cations) migrate toward the negative electrode (cathode), while the negatively charged ions (anions) migrate toward the positive electrode (anode). Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not disassociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell also may be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.2.2 Equipment

A portable conductivity meter, probe and thermometer are needed for taking specific conductance and salinity measurements. Typically, a variety of conductivity meters are available which also may be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment may be obtained to meet the specific requirements of the sampling program.

5.2.3 Measurement Techniques for Specific Conductance/Salinity

Standardization, calibration, and operation and maintenance shall be performed according to manufacturers' instructions for the "specific" model being used. The general steps involved in taking specific conductance and salinity measurements are listed below.

1. Check batteries to make sure they are fully charged and calibrate instrument before going into the field.

2. Calibrate the instrument daily when used, at a minimum. Potassium chloride solutions with a specific conductance closest to the values expected in the field shall be used for the calibration process. Calibration information (time of calibration, solutions used, and meter output readings) shall be recorded in the field logbook.

3. Turn meter on and allow it to stabilize for 3 to 5 minutes.

4. Calibration procedures should be performed:
   - Following significant ambient temperature changes
   - When meter reads erratically
   - At beginning and middle of each day of use

5. Pour approximately 50 to 100 ml of sample into a rinsed plastic container. Immerse the electrode in the sample and measure the conductivity and salinity. If required by the meter being used, adjust the temperature setting to the sample temperature. Make sure that the electrode is fully immersed in the sample, but not touching the base of the container.

6. Read and record the results in the field logbook. For some antiquated meters also note the scale prior to recording the reading (i.e., 1x, 10x, 100x, etc.).

7. If the meter does not compensate for temperature variations, the corrections given in Attachment A shall be applied.

8. On some meters, specific conductance and salinity measurements may need to be reported with the associated temperature measurement. If the conductivity and salinity has been corrected, the measurements shall be reported as corrected to 25°C (Attachment A).

   a. Do not take readings if the sample temperature is less than 10° C, because the calibration curve no longer follows a straight line below this temperature. If necessary, heat the sample in your vehicle to at least 10° C.

   b. Measure the sample temperature to the nearest 0.1° C to comply with SW-846.

   c. Only report results to the nearest two significant digits for most circumstances because of the inherent inaccuracy in the test and conversion procedure(e.g., a calculated reading of 2353 umhos/cm @ 25° C should be reported as 2400 umhos/cm @ 25° C).

5.3 Measurement of Temperature

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field after sample collection for laboratory analysis. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.3.1 Equipment

Temperature measurements may be taken with Thermistor, alcohol-toluene, mercury or bimetal thermometers. In addition, most meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature can be performed.

5.3.2 Measurement Techniques for Water Temperature

If a thermometer is used on a collected water sample:

1. Visually inspect thermometer to ensure that there is not a break in the mercury column. If there is a break, the spare thermometer will be visually inspected. If both thermometers have a break in the mercury, neither will be used until the break is corrected. This will be done by cooling the bulb until the mercury is contained within the bulb.

2. Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.

3. Record values in a field logbook to the nearest 0.5 or 0.1EC, depending on the measurement device used.

If a temperature meter or probe is to be used, the instrument shall be calibrated according to the manufacturer's recommendations with an approved thermometer.

5.4 Measurement of Dissolved Oxygen Concentration

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms, as well as the rate of corrosivity, is dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time, if the sample is not adequately preserved. Other means of sample preservation may involve directing the sample flow from the well directly into a flow cell, which limits sample/air contact.

The method discussed here is limited to the use of DO meters only. Chemical methods of analysis (e.g., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible. DO meters also are free from interference caused by color, turbidity, colloidal material or suspended matter.

5.4.1 Principles of Equipment Operation

DO probes normally are electrochemical cells that have two solid metal electrodes of different potential immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of higher nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH) occurs at the cathode surface. An electrical current is developed directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. Therefore, it is necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface (frothing). To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, but to leave the surface of the solution undisturbed.

DO probes are relatively free of interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide which are not easily depolarized from the indicating electrode. If gaseous interference is suspected, it shall be noted in the Field Logbook and checked if possible. Temperature, pressure, and salinity variations also can cause interference. Automatic temperature compensation normally is provided by the manufacturer. Attachment B presents variations of DO in water as a fraction of temperature and pressure. Salinity should be compensated in accordance with the manufactures instructions.

5.4.2 Equipment

A portable conductivity meter, probe and thermometer (if not built into the conductivity meter) are needed for taking specific conductance and salinity measurements. A variety of conductivity meters are available which also may be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment may be obtained to meet the specific requirements of the sampling program.

5.4.3 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions for the specific model being used to obtain an accurate reading. The following general steps shall be used to measure the DO concentration.

1. Calibrate equipment and check batteries before going to the field.

2. The probe shall be conditioned in a water sample for as long as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.

3. The instrument shall be calibrated in the field before each measurement or group of closely spaced measurements by placing the probe in a freshly air-saturated water sample of known temperature.

4. Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane, either by stirring the sample, or placing the probe in a flowing stream. Probes without stirrers which are placed in wells should be moved up and down.

5. Record the dissolved oxygen content and temperature of the sample in a field logbook.

6. Recalibrate the probe when the membrane is replaced, or following similar maintenance, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This, however, may not always be practical. Be sure to record whether the liquid was analyzed in situ, or whether a sample was taken.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen dissolution and positive test interferences.

5.5 Measurement of Turbidity

Turbidity is caused by fine particles suspended in the water which cause light to scatter, rather than traveling in a straight line. Clay, silt, plankton, and other microorganisms are all examples of particulates that cause turbidity.

Most portable field turbidity meters display results in Nephelometric Turbidity Units (NTU's). This process determines the turbidity level of measuring the amount of light scattered 90° by the suspended particles, by a light of known strength beamed through the solution.

5.5.1 Equipment

A portable turbidity meter, sample vials, standard solutions, and sample cap are typically needed.

5.5.2 Measurement Techniques for Turbidity Measurement

Follow the manufacturer’s instructions, for the specific model being used. The following general steps shall be used to measure turbidity.

1. Calibrate equipment and check batteries, or charge status.

2. Turn on meter and allow to stabilize.

3. Fill a sample vial completely with sample to be obtained, and place cap on vial.

4. Insert vial into light chamber. (Align vial into chamber the same way each time, by making use of tick marks on vial lid). Cover vial with cap.

5. Switch meter to appropriate range and read. Record results into field logbook.

6. Rinse vials with distilled water between each sample.

7. Calibration procedures should be performed:
    - Following significant ambient temperature changes
    - When meter reads erratically
    - At beginning and middle of each day of use.

5.6 <u>Measurement of Oxidation Reduction Potential (ORP)</u>

Oxidation reduction occurs when electrons are transformed from one atom to another during a chemical reaction. The atom losing electrons is said to be "oxidized", while the atom gaining electrons is termed "reduced". ORP is typically measured using a platinum electrode, attached to a pH meter, which is set to read in millivolt mode.

5.6.1 Equipment

Though there are ion specific meters for ORP on the market, their very small size and shape do not coincide well with typical multi-parameter set-ups in the field. Typically a pH meter, fitted with a special ORP electrode is used.

5.6.2 Measurement Techniques

At present, only a check solution is available on the market, which is used to verify the performance of the electrode. If the probe reads +/- a certain percentage of the solution’s stated value, then the electrode is assumed to be in proper working condition.

1. Check batteries and calibrate (check) meter/electrode before heading into the field.

2. Switch pH meter so that it's in the millivolt (mV) mode.

3. Place electrode in sample solution and read results in mV's. Record results in the field logbook.

4. Rinse electrode with distilled water.

6.0 QUALITY ASSURANCE RECORDS

Quality assurance records for on-site water quality management consist principally of observations and measurements recorded in the field logbook.

7.0 REFERENCES

American Public Health Association, 1980. Standard Methods for the Examination of Water and Wastewater, 15th Edition, APHA, Washington, D.C.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

U.S. EPA, 1998. Test Methods for Evaluating Solid Wastes (SW-846) – Revision 5.
http://www.epa.gov/epaoswer/hazwaste/test/main.htm#Table

U.S. Geological Survey, 1984. National Handbook of Recommended Methods for Water Data Acquisition, Chapter 5: Chemical and Physical Quality of Water and Sediment. U.S. Department of the Interior, Reston, Virginia.

ATTACHMENT B

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

Temperature ºC	2.Dissolved Oxygen mg/l 2.1.Chloride Concentration in Water 2.1.1.0 2.1.2.5,000 2.1.3.10,000 2.1.4.15,000 2.1.5.20,000 2.2.Difference/ 100 mg chloride					
0	14.6	13.8	13.0	12.1	11.3	0.017
1	14.2	13.4	12.6	11.8	11.0	0.106
2	13.8	13.1	12.3	11.5	10.8	0.015
3	13.5	12.7	12.0	11.2	10.5	0.015
4	13.1	12.4	11.7	11.0	10.3	0.014
5	12.8	12.1	11.4	10.7	10.0	0.014
6	12.5	11.8	11.1	10.5	9.8	0.014
7	12.2	11.5	10.9	10.2	9.6	0.013
8	11.9	11.2	10.6	10.0	9.4	0.013
9	11.6	11.0	10.4	9.8	9.2	0.012
10	11.3	10.7	10.1	9.6	9.0	0.012
11	11.1	10.5	9.9	9.4	8.8	0.011
12	10.8	10.3	9.7	9.2	8.6	0.011
13	10.6	10.1	9.5	9.0	8.5	0.011
14	10.4	9.9	9.3	8.8	8.3	0.010
15	10.2	9.7	9.1	8.6	8.1	0.010

Temperature ºC	2.Dissolved Oxygen mg/l 2.1.Chloride Concentration in Water 2.1.1.0 2.1.2.5,000 2.1.3.10,000 2.1.4.15,000 2.1.5.20,000 2.2.Difference/ 100 mg chloride					
16	10.0	9.5	9.0	8.5	8.0	0.010
17	9.7	9.3	8.8	8.3	7.8	0.010
18	9.5	9.1	8.6	8.2	7.7	0.009
19	9.4	8.9	8.5	8.0	7.6	0.009
20	9.2	8.7	8.3	7.9	7.4	0.009
21	9.0	8.6	8.1	7.7	7.3	0.009
22	8.8	8.4	8.0	7.6	7.1	0.008
23	8.7	8.3	7.9	7.4	7.0	0.008
24	8.5	8.1	7.7	7.3	6.9	0.008
25	8.4	8.0	7.6	7.2	6.7	0.008
26	8.2	7.8	7.4	7.0	6.6	0.008
27	8.1	7.7	7.3	6.9	6.5	0.008
28	7.9	7.5	7.1	6.8	6.4	0.008
29	7.8	7.4	7.0	6.6	6.3	0.008
30	7.6	7.3	6.9	6.5	6.1	0.008

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - WATER LEVEL, WATER-PRODUCT INTERFACE LEVEL,AND WELL DEPTH MEASUREMENTS

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SOP Number: F202
Effective Date: 10/06

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WATER LEVEL, WATER-PRODUCT INTERFACE LEVEL, AND WELL DEPTH MEASUREMENTS

1.0 PURPOSE

The purpose of this procedure is to describe the method of determining various down-hole measurements: groundwater levels and free product (a.k.a. non-aqueous phase liquid) levels, if present, and total depth of groundwater monitoring wells and piezometers.

2.0 SCOPE

The methods described in this SOP generally are applicable to the measurement of groundwater levels, NAPL levels, and total well depths in monitoring wells and piezometers.

3.0 DEFINITIONS

NAPL – Non-Aqueous Phase Liquids
LNAPL – Light Non-Aqueous Phase Liquids
DNAPL – Dense Non-Aqueous Phase Liquids
MSL – Mean Sea Level
IFP – Interface Probe

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed.

Field Team Leader - The Field Team Leader is responsible for ensuring that these procedures are implemented in the field, and for ensuring that personnel performing these activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the sampling personnel to follow these procedures or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper acquisition of down-hole measurements.

5.0 PROCEDURES

Calculations of groundwater elevations and product or NAPL interface level measurements collected from a monitoring well give an indication of:

- The horizontal hydraulic gradient and the direction of groundwater flow.
- The vertical hydraulic gradient, if well nests are used (i.e., the direction of groundwater flow in the vertical plane).
- Floating or sinking free product thicknesses which are also known as Light Non-Aqueous Phase Liquids (LNAPLs) and Dense Non-Aqueous Phase Liquids (DNAPLs), respectively.

This information, when combined with other site specific information such as hydraulic conductivity or transmissivity, extent of contamination, and product density, may be used to estimate the rate of contaminant movement or source areas, etc.

Well depth is one of the factors used to determine the zone that a well monitors. Well depth also is used in the calculation of purge volumes as discussed in SOP F104, Groundwater Sample Acquisition.

The following sections briefly discuss the procedures for measuring groundwater levels, NAPL levels, and well depth. For all of the procedures discussed, it is assumed that the measurement will be taken from the top of the inner-most casing of the well or piezometer (though other measuring points can be used). The horizontal and vertical control is established for each well through a site survey, such that measurements may be converted to elevations above Mean Sea Level (MSL) or some other consistent datum (e.g., an on-site benchmark). A permanent notch or mark will be placed on the inner-most casing by Baker to facilitate consistent water level measurements over time.

The manufacturer's instructions for all equipment referenced herein should be read by the sampling personnel and accompany the equipment to the field.

5.1 Water Level Measurement

Water levels in groundwater monitoring wells or piezometers shall be measured from the permanent point indicated at the top of the inner-most casing (the surveyed elevation point), unless otherwise specified in the project plans, using an electronic water level measuring device (water level meter). The point of measurement will be documented in the field logbook if different from the top of the inner casing. The reason for deviating from the measurement point also should be noted.

Water levels are measured by lowering the probe into the well until the device indicates that water has been encountered, usually with either a constant buzz, or a light, or both. The water level is recorded to the nearest hundredth-of-a-foot (0.01 Feet) using the graduated markings on the water level indicator line. This measurement, when subtracted from the measuring point surveyed elevation, yields the groundwater elevation relative to either MSL or an on-site benchmark.

5.2 NAPL Level Measurements

The procedure for NAPL level measurement is nearly identical to that for groundwater elevation measurements. The only difference is the use of an interface probe (IFP) that can detect the level of both NAPL and water through varying indicator signals at the surface (IFP beeping and/or different color indicator light). Typically, encountering NAPLs in a monitoring well or piezometer is indicated by a constant sound. When water is encountered, the signal becomes an alternating on/off beeping sound. This allows for the measurement of both the top of the NAPL layer in a well and the water/NAPL interface. In addition, this same philosophy would be applicable to the water/DNAPL interface at the bottom of the well, if present.

The apparent water table elevation below the product level will be determined by subtracting the depth to water from the measuring point elevation. The corrected water table elevation will then be calculated using the following equation:

$$WTE_c = WTE_a + (\text{Free Product Thickness x } 0.80)$$

Where:

WTE_c = Corrected water table elevation
WTE_a = Apparent water table elevation
0.80 = Average value for the density of petroleum hydrocarbons. Site-specific data will be used where available.

However, the formula presented above should only be applied in the office during data evaluation for reporting purposes. For consistency, the actual measurements collected from the IFP in the field are what should be recorded in the site logbook.

5.3 Well Depth Measurements

Well depths typically are measured using a weighted measuring tape. A water level meter may also be used. The tape is lowered down the well until resistance is no longer felt, indicating that the weight has touched the bottom of the well. The weight should be moved in an up and down motion a few times so that obstructions, if present, may be bypassed. The slack in the tape then is collected until the tape is taut. The well depth measurement is read directly off of the measuring tape, at the top of the inner-most casing to the nearest 0.01-foot and recorded in the Field Logbook. It should be noted that on some weighted measuring tapes, the length shown on the measuring tape may not be truly representative of the entire well depth. This is because the weight at the end of the tape (below the 0.0 feet line) may extend below the base of the tape. Thus, the total well depth measured on the tape at the top of the casing may actually be greater. As a result, a measurement of the length from the tip of the weight to the end of the tape should be made prior to collecting well depth measurements. Furthermore, if a water level indicator is used, add the distance from the bottom of the probe to the point where water levels are measured (i.e., where the water level connects the circuit on the probe).

5.4 Decontamination of Measuring Devices

Water level indicators, IFPs, and weighted measuring tapes that come in contact with groundwater must be decontaminated using the following steps after use in each well:

- Rinse with potable water
- Rinse with deionized water
- Rinse with Methanol (if sampling for volatiles)
- Final Rinse with deionized water

Portions of the water level indicators or other similar equipment that do not come into contact with groundwater, but may encounter incidental contact during use, need only undergo potable water and deionized water rinses. In addition, if there is established documentation from a well indicating no historical evidence of contaminant impact, no decontamination is necessary other than providing a potable water rinse between wells. Furthermore, to mitigate the potential for cross contamination between wells, measurements should be collected from the least impacted to the most impacted wells on site, if possible.

6.0 QUALITY ASSURANCE RECORDS

The Field Logbook shall serve as the quality assurance record for water, product level, and/or well depth measurements. Both the time of day and the well order that the measurements were collected also should be documented in the field notebook.

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - SAMPLE PRESERVATION AND HANDLING

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SOP Number: F301
Effective Date: 04/94

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SAMPLE PRESERVATION AND HANDLING

1.0 PURPOSE

This SOP describes the appropriate containers for samples of particular matrices, and the steps necessary to preserve those samples when shipped off site for chemical analysis. It also identifies the qualifications for individuals responsible for the transportation of hazardous materials and samples and the regulations set forth by the Department of Transportation regarding the same.

2.0 SCOPE

Some chemicals react with sample containers made of certain materials; for example, trace metals adsorb more strongly to glass than to plastic, while many organic chemicals may dissolve various types of plastic containers. It is therefore critical to select the correct container in order to maintain the integrity of the sample prior to analysis.

Many water and soil samples are unstable and may change in chemical character during shipment. Therefore, preservation of the sample may be necessary when the time interval between field collection and laboratory analysis is long enough to produce changes in either the concentration or the physical condition of the constituent(s). While complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that may occur after the sample is collected.

Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/freezing. Their purposes are to (1) retard biological activity, (2) retard hydrolysis of chemical compounds/complexes, (3) reduce constituent volatility, and (4) reduce adsorption effects.

Typical sample container and preservation requirements for this project are provided in Attachment A of this SOP. Note that sample container requirements (i.e., volumes) may vary by laboratory.

The Department of Transportation, Code of Federal Regulations (CFR) Title 49 establishes regulations for all materials offered for transportation. The transportation of environmental samples for analysis is regulated by Code of Federal Regulations Title 40 (Protection of the Environment), along with 49 CFR Part 172 Subpart H. The transportation of chemicals used as preservatives and samples identified as hazardous (as defined by 49 CFR Part 171.8) are regulated by 49 CFR Part 172.

3.0 DEFINITIONS

HCl - Hydrochloric Acid

H_2SO_4- Sulfuric Acid

HNO_3 - Nitric Acid

NaOH - Sodium Hydroxide

Normality (N) - Concentration of a solution expressed as equivalents per liter, where an equivalent is the amount of a substance containing one mole of replaceable hydrogen or its equivalent. Thus, a one molar solution of HCl, containing one mole of H, is “one-normal,” while a one molar solution of H_2SO_4 containing two moles of H, is “two-normal.”

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is also responsible for proper certification of individuals responsible for transportation of samples of hazardous substances.

Field Team Leader - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures. The Field Team Leader is responsible to ensure all samples and/or hazardous substances are properly identified, labeled, and packaged prior to transportation.

Sampling Personnel - It is the responsibility of the field sampling personnel to initiate sample preservation and handling. It is also the responsibility of the field sampling personnel to understand and adhere to the requirements for proper transportation of samples and/or hazardous substances.

5.0 PROCEDURES

The following procedures discuss sample containerization and preservation techniques that are to be followed when collecting environmental samples for laboratory analysis.

5.1 Sample Containers

For most samples and analytical parameters either glass or plastic containers are satisfactory. In general, if the analyte(s) to be measured is organic in nature, the container shall be made of glass. If the analyte(s) is inorganic, then glass or plastic containers may be used. Containers shall be kept out of direct sunlight (to minimize biological or photo-oxidation/photolysis of constituents) until they reach the analytical laboratory. The sample container shall have approximately five to ten percent air space (“ullage”) to allow for expansion/vaporization if the sample is heated during transport (one liter of water at 4EC expands by 15 milliliters if heated to 130EF/55EC); however, head space for volatile organic analyses shall be omitted.

Soil samples that will be tested for volatile organic compounds should generally be stored in EnCore™ samplers in accordance with SW-846 Method 5035.

The analytical laboratory shall provide sample containers that have been certified clean according to USEPA procedures. Shipping containers for samples, consisting of sturdy ice chests, are to be provided by the laboratory.

Once opened, the sample container must be used at once for storage of a particular sample. Unused, but opened, containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or missing liners (if required for the container) shall be discarded.

General sample container, preservative, and holding time requirements are listed in Attachment A.

5.2 Preservation Techniques

The preservation techniques to be used for various analytes are listed in Attachment A. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or added in the field using laboratory supplied preservatives. Some of the more commonly used sample preservation techniques include storage of sample at a temperature of 4EC, acidification of water samples, and storage of samples in dark (i.e. amber) containers to prevent the samples from being exposed to light.

Most samples (except metals) shall be stored at a temperature of 4EC. Additional preservation techniques shall be applied to water samples as follows:

- Water samples to be analyzed for volatile organics shall be acidified.
- Water samples to be analyzed for semivolatile organics shall be stored in dark containers.
- Water samples to be analyzed for pesticides/PCBs shall be stored in dark containers.
- Water samples to be analyzed for inorganic compounds shall be acidified.

These preservation techniques generally apply to samples of low-level contamination. The preservation techniques utilized for samples may vary. However, unless documented otherwise in the project plans, all samples shall be considered low concentration. All samples preserved with chemicals shall be clearly identified by indicating on the sample label that the sample is preserved.

5.3 Sample Holding Times

The elapsed time between sample collection and initiation of laboratory analyses is considered the holding time and must be within a prescribed time frame for each individual analysis to be performed. Sample holding times for routine sample collection are provided in Attachment A.

6.0 SAMPLE HANDLING AND TRANSPORTATION

After collection, the outside of all sample containers will be wiped clean with a damp paper towel; however sample handling should be minimized. Personnel should use extreme care to ensure that samples are not contaminated. If samples are placed in an ice chest, personnel should ensure that melted ice cannot cause sample containers to become submerged, as this may result in sample cross-contamination and loss of sample labels. To help prevent loss of labels, clear packing tape should be placed over the labels. Additionally, Sealable plastic bags, (zipper-type bags), should be used when glass sample containers are placed in ice chests to prevent cross-contamination, if breakage should occur.

Samples may be hand delivered to the laboratory or they may be shipped by common carrier. Relevant regulations for the storage and shipping of samples are contained in 40 CFR 261.4(d). Parallel state regulations may also be relevant. Shipment of dangerous goods by air cargo is also regulated by the United Nations/International Civil Aviation Organization (UN/ICAO). The Dangerous Goods Regulations promulgated by the International Air Transport Association (IATA) meet or exceed DOT and UN/ICAO requirements and should be used for shipment of dangerous goods via air cargo. Standard procedures for shipping environmental samples are given in Attachment B.

7.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, Washington, D.C.

USEPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

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USEPA, Region IV, 1991. Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual. Athens, Georgia.

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Protection of the Environment, Code of Federal Regulation, Title 40, Parts 260 to 299.

Transportation, Code of Federal Regulation, Title 49, Parts 100 to 177.

ATTACHMENT B

SAMPLE SHIPPING PROCEDURES

ATTACHMENT B

SAMPLE SHIPPING PROCEDURES

Introduction

Samples collected during field investigations or in response to a hazardous materials incident must be classified by the project leader, prior to shipping by air, as either environmental or hazardous substances. The guidance for complying with U.S. DOT regulations in shipping environmental laboratory samples is given in the "National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples."

Pertinent regulations for the shipping of environmental samples are given in 40 CFR 261.4(d). Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods/hazardous substance. Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by the United Nations International Civil Aviation Organization (UN/ICAO), which is equivalent to IATA.

Individuals responsible for transportation of environmental samples or dangerous goods/hazardous substances must be tested and certified by their employer. This is required by 49 CFR Part 172 Subpart H Docket HM-126 to assure the required qualifications for individuals offering materials for transportation.

Environmental samples shall be packed prior to shipment by commercial air carrier using the following procedures:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug (inside and outside) with fiber or duct tape. Line the cooler with a large heavy duty plastic bag. This practice keeps the inside of the cooler clean and minimizes cleanup at the laboratory after samples are removed.

2. Allow sufficient headspace (ullage) in all bottles (except VOAs) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

3. Be sure the lids on all bottles are tight (will not leak). In many regions custody seals are also applied to sample container lids. The reason for this practice is two-fold: to maintain integrity of samples and keep lid on the container should the lid loosen during shipment. Check with the appropriate regional procedures prior to field work. In many cases, the laboratory manager of the analytical lot to be used on a particular project can also provide this information.

4. It is good practice to wrap all glass containers in bubblewrap or other suitable packing material prior to placing in plastic bags.

5. Place all bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape, unless the bag is a zipper-type bag). Up to three VOA bottles, separately wrapped in bubblewrap, may be packed in one plastic bag.

6. Put ice that has been placed in properly sealed, double-bagged, heavy duty polyethylene bags on top of and between the samples. Fill all remaining space between the bottles with packing material. Fold and securely fasten the top of the large heavy duty plastic bag with tape (preferably electrical or duct).

7. Place the Chain-of-Custody Record and the Request for Analysis Form (if applicable) into a plastic bag, tape the bag to the inner side of the cooler lid, and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler unit. Wrap the tape three to four times around each side of the cooler unit. Chain-of-custody seals (if required) should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

8. Label according to 40 CFR 261.4(d). The shipping containers should be marked "THIS END UP," and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper and laboratory shall be placed on the outside of the container. It is good practice to secure this label with clear plastic tape to prevent removal during shipment by blurring of important information should the label become wet. The commercial carrier is not required to sign the COC record as long as the custody seals remain intact and the COC record stays in the cooler. The only other documentation required is the completed airbill, which is secured to the top of the shipping container. Please note several coolers/shipping containers may be shipped under one airbill. However, each cooler must be labeled as "Cooler 1 of 3, Cooler 2 of 3, etc.," prior to shipping. Additionally it is good practice to label each COC form to correspond to each cooler (i.e., 1 of 3, 2 of 3, etc.).

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - CHAIN-OF-CUSTODY

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SOP Number: F302
Effective Date: 04/94

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CHAIN-OF-CUSTODY

1.0 PURPOSE

The purpose of this SOP is to provide information on chain-of-custody procedures to be used to document sample handling.

2.0 SCOPE

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

3.0 DEFINITIONS

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file. An example of a Chain-of-Custody Record Form is presented in Attachment B.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one=s custody if:

- ! It is in one=s actual possession.
- ! It is in one=s view, after being in one=s physical possession.
- ! It was in one=s physical possession and then he/she locked it up to prevent tampering.
- ! It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field

Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

5.0 PROCEDURES

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, record keeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

5.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook (or other suitable form), when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s)
- Project and Task Number
- Project Sample Number
- Sample location or sampling station number
- Date and time of sample collection and/or measurement
- Field observations
- Equipment used to collect samples and measurements
- Calibration data for equipment used

Measurements and observations should be recorded using waterproof ink.

5.1.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes (at a minimum):

- Project Name or Project Number.
- Station Location - The unique sample number identifying this sample.

Additional information on the sample label may also include:

- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 12/21/85).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

5.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

5.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.

5.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. When transferring the possession of samples, the individual(s) relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below.

- Enter header information (Project and Task number, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method, grab or composite, number and type of sample containers, and date/time sample was collected).
- Sign, date, and enter the time under "Relinquished by" entry.
- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).
- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner.
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seal across the shipping container opening so that it would be broken if the container was to be opened.
- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

6.0 QUALITY ASSURANCE RECORDS

Once samples have been packaged and shipped, the COC copy and airbill receipt becomes part of the Quality Assurance Record.

7.0 REFERENCES

1. USEPA. User's Guide to the Contract Laboratory Program. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - FIELD LOGBOOK

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SOP Number: F303
Effective Date: 03/05

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FIELD LOGBOOK FIELD LOGBOOK

1.0 PURPOSE

This SOP describes the process for maintaining a field logbook.

2.0 SCOPE

The field logbook is a document which records all major on-site activities conducted during a field investigation. At a minimum, the following activities/events shall be recorded in the field logbook by each member of the field crew.

- Arrival/departure of site workers and visitors
- Arrival/departure of equipment
- Sample pickup (sample numbers, carrier, time)
- Sampling activities
- Start and completion of boreholes, monitoring wells, or sampling activities
- Health and safety issues

Recording in the field logbook is initiated upon arrival at the site. Entries are made every day that on-site activities take place. At least one field logbook shall be maintained per site.

The field logbook becomes part of the permanent site file. Because information contained in the field logbook may be admitted as evidence in legal proceedings, it is critical that this document is properly maintained.

3.0 DEFINITIONS

Field logbook - The field logbook is a bound notebook with consecutively numbered pages. Upon entry of data, the logbook requires the signature of the responsible data/information recorder.

4.0 RESPONSIBILITIES

The Field Team Leader is responsible for maintaining a master field logbook for the duration of on-site activities. Each member of the sampling crew is responsible for maintaining a complete and accurate record of site activities for the duration of the crew members participation in the project.

5.0 PROCEDURES

The following sections present some of the information that must be recorded in the field logbook. In general, a record of all events and activities, as well as other potentially important information shall be recorded by each member of the field team.

5.1 Cover

The inside cover or title page of each field logbook shall contain the following information:

- Project and Task Number
- Project name and location
- Name of Field Team Leader
- Baker's address and telephone number (toll-free number preferably)
- Start date
- If several logbooks are required, a sequential field logbook number

It is good practice to list important phone numbers and points of contact here. This may include the telephone number of the hotel where the field crew is residing as well as applicable mobile phone number. The inclusion of this information may be invaluable if the field logbook is lost during field activities.

5.2 Daily Entries

Daily entries into the logbook may contain a variety of information. At the beginning of each day the following information should be recorded by each team member.

- Date
- Start time
- Weather
- All field personnel present (including subcontractors)
- All visitors present
- Other pertinent information (i.e., planned activities, schedule changes, expected visitors, and equipment changes)

During the day, an ongoing record of all pertinent site activities should be written in the logbook. The master logbook kept by the field team leader need not duplicate that recorded in other field logbooks, but should summarize the information in other books and, where appropriate, reference the page numbers of other logbooks where detailed information pertaining to a subject may be found.

Some specific information which should be recorded in the logbook includes the following:

- Equipment used, equipment numbers, calibration data, field servicing
- Field measurements
- Sample numbers, media, bottle size, preservatives, collection methods, and time
- Test boring and monitoring well construction information, including boring/well number and location
- Sketches for each sample location including appropriate measurements if required
- Photograph log
- Drum log
- Other pertinent information

All entries should be made in indelible ink; all pages numbered sequentially; and all pages must be signed or initialed and dated by the responsible field personnel completing the log. No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single line, initialed, and dated.

5.3 Photographs

If photographs are permitted at the site, the record shall be maintained in the field logbook. When movies, slides or photographs are taken of any site location, they are numbered or cross-referenced to correspond to logbook entries. The name of the photographer, date, time, site location, site description, direction of view and weather conditions are entered in the logbook as the photographs are taken. Special lenses, film, or other image-enhancement techniques also must be noted in the field logbook. Once processed, photographs shall be sequentially numbered and labeled corresponding to the field logbook entries.

6.0 QUALITY ASSURANCE RECORDS

Once on-site activities have been completed, the field logbook shall be considered a quality assurance record and stored in the project files at Baker’s respective office.

7.0 REFERENCES

None.

Table 1
Proposed Sampling Activities
2025 Site Investigation and Groundwater Monitoring
Erie Coke Site

Boring/Well Number	Site Feature	Work Plan Figure Number Location	Sampling Media	Number of Borings	Maximum Number of Samples	Anticipated Boring Depth (Feet)	Comments	Sampling Protocol
SB-227	Industrial North Area	4	Soil	1	2	< 25	Borings advanced to 25 ft. or bedrock, whichever encountered first. **Contamination Observed**: Two soil samples for analysis per boring **No Contamination Observed**: One soil sample for analysis per boring	**Contamination Observed:** Submit one sample from most contaminated zone and one sample from clean zone below comtamination (if above groundwater). **No Contamination Observed**: Sample depth is geologist's descretion above groundwater.
SB-228 through SB-230	Industrial South Area - East Region	5	Soil	3	6	< 25	Borings advanced to 25 ft. or bedrock, whichever encountered first. **Contamination Observed**: Two soil samples for analysis per boring **No Contamination Observed**: One soil sample for analysis per boring	**Contamination Observed:** Submit one sample from most contaminated zone and one sample from clean zone below comtamination (if above groundwater). **No Contamination Observed**: Sample depth is geologist's descretion above groundwater.
New Monitoring Well Installation and Sampling								
MW-46, MW-47 and MW-48	New Groundwater Monitoring Wells	4 & 5	Groundwater (Well)	2	3	20 - 25	Three shallow monitoring wells are proposed (One in Industrial North Area; Two in Industrial South Area-East Region). Prelimiary locations shown on site figures and may change.	One sampling event of the three new wells will take place concurrent with the comprehensive groundwater sampling event of the other wells on and off site.
			Soil		3		Soils will be field screened and logged during advancement of well installation borings.	**Contamination Observed:** Submit one sample from most contaminated zone during boring advancement. **No Contamination Observed**: Submit one soil sample at geologist's descretion above groundwater.
Monitoring Well Sampling								
MW-1 through MW-45(1)	Existing Groundwater Monitoring Wells	6	Aqueous	N/A	52	N/A	58 current wells with six eliminated for this sampling event = 52 wells. Analytical suite subjective to well. Refer to Table 2 for well-specific analyte list.	One comprehensive groundwater sampling event of wells summarized on Table 2 will be completed. Evaluate applicable wells for the presence of NAPL prior to sampling.
Quality Assurance / Quality Control (QA/QC) Samples								
N/A	QA/QC Duplicate Samples		Groundwater (Well)		6		Based on a maximum of 55 groundwater well samples	Duplicates submitted at a rate of 10% that of investigative samples
			Soil		2		Based on a maximum of 11 soil samples proposed above	
	QA/QC Field Blanks		Laboratory-Grade Water		2		One field blank during soil boring and well installation activities One field blank for the groundwater sampling event.	Document site conditions and the quality of the water for other blank development.
	QA/QC Equipment Rinsate Blanks		Laboratory-Grade Water		1		One equipment rinsate of drilling equipment. No rinsates needed for groundwater sampling event as only dedicated, disposable equipment will be used.	Completed on all non-disposable sampling equipment at an approximate rate of 5% of each piece of equipment.
	QA/QC Trip Blanks		Laboratory-Grade Water		9		One Trip Blank for the soil borings One Trip Blanks for the well borings/installations Seven Trip Blanks for the comprehensive well sampling event	One Trip Blank submitted for each batch of samples sent to the laboratory.

Table 1
Proposed Sampling Activities
2025 Site Investigation and Groundwater Monitoring
Erie Coke Site

Boring/Well Number	Site Feature	Work Plan Figure Number Location	Sampling Media	Number of Borings	Maximum Number of Samples	Anticipated Boring Depth (Feet)	Comments	Sampling Protocol

(1) - Excluding wells MW-3, MW-4, MW-7, MW-20, MW-25, and MW-32

Groundwater monitoring well samples will be analyzed for all or a portion of the following:

Target Compound List (TCL) Volatile Organic Compounds (VOCs) - Method 8260D
TCL Semi-Volatile Organic Compounds (SVOCs) - Method 8270E
Target Analyte List (TAL) Metals (including mercury) - Methods 6010D and 7470B (7471B for soil)
General Chemistry - Multiple laboratory methods

Soil samples will be analyzed for the above except General Chemistry.

N/A - Not Applicable
QA/QC - Quality Assurance/Quality Control

Table 2
Summary of Groundwater Analyses
June 2025 Sampling Event

Well	Discontinue Sampling	VOCs	SVOCs	pH	Metals	General Chemisty (1)	Notes
MW-1		X	X	X			
MW-2		X	X				
MW-3	X						
MW-4	X						
MW-5S, 5D		X	X				
MW-6S, 6D		X	X				
MW-7	X						
MW-8S, 8D		X	X				
MW-9S, 9D		X	X				
MW-10S, 10D		X	X				
MW-11S, 11D		X	X				
MW-12		X	X				
MW-13		X	X	X			
MW-14		X	X				
MW-15		X	X				
MW-16		X	X				
MW-17		X	X				
MW-18		X	X				
MW-19S, 19D		X	X				
MW-20	X						
MW-21		X	X	X			
MW-22S, 22D		X	X				
MW-23		X	X				
MW-24		X	X				
MW-25	X						
MW-26S, 26D		X	X				
MW-27S, 27D		X	X				
MW-28		X	X				
MW-29		X	X				
MW-30		X	X				
MW-31		X	X				
MW-32	X						
MW-33		X	X				
MW-34S, 34D		X	X				
MW-35S, 35D		X	X				
MW-36S, 36D		X	X				
MW-37		X	X				
MW-38		X	X				
MW-39		X	X		X	X	
MW-40		X	X		X	X	
MW-41		X	X		X	X	
MW-42		X	X		X	X	
MW-43		X	X		X	X	
MW-44		X	X		X	X	
MW-45		X	X		X	X	
MW-46		X	X		X	X	New Well
MW-47		X	X		X	X	New Well
MW-48		X	X		X	X	New Well
Total Samples		**55**	**55**	**3**	**10**	**10**	

(1) - General Chemistry includes pH analysis.

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FIELD SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

ERIE COKE SITE

ERIE COUNTY, PENNSYLVANIA

PADEP Contract No.: SAP4000023226
General Environmental Technical Assistance Contract
Work Requisition No.: GTAC7-6-181

Prepared for:

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Commonwealth of Pennsylvania
Department of Environmental Protection

Submitted by:
OBG | Baker Environmental Solutions Joint Venture
Moon Township, Pennsylvania

May 2025

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1.0 INTRODUCTION

This Field Sampling and Analysis Plan (FSAP) and Quality Assurance Project Plan (QAPP) has been prepared by OBG | Baker Federal Solutions Joint Venture (OBG | Baker) for the Pennsylvania Department of Environmental Protection (PADEP) as authorized under their General Technical Assistance Contract (GTAC), Contract Number 4000023226, Work Requisition Number 7-6-181. This FSAP and QAPP are associated with the investigation activities proposed to be conducted at the Erie Coke Site (site) located in Erie, Pennsylvania.

The primary purpose of the FSAP and QAPP is to provide guidance for the field activities by describing the detailed sampling and data collection methods to be used.

2.0 FIELD SAMPLING AND ANALYSIS PLAN

2.1 Site Background

Pertinent background information related to the site location and physical setting, historical operations and investigation history was presented previously in the Supplemental Site Investigation Work Plan and other associated documents and are not included in this truncated scope of work.

2.2 Project Objectives

The project objectives are summarized in the Work Plan.

2.3 Investigation Procedures

The following sections present the investigation procedures that will be used during the field activities. Supplemental information regarding the sampling and field procedures can be found in the OBG | Baker Standard Operating Procedures (SOPs) referenced herein. Support activities, sampling locations, sample matrices, and analytical parameters are discussed in the Work Plan.

2.3.1 Soil Sampling

Soil samples will be collected from the site as part of the investigation. The following sections describe the sample collection and field screening methods to be used as well as the criteria for selecting samples for chemical analyses.

Soil samples will be collected using rotasonic drilling methods, which include a combination of rotary power, hydraulic pull down pressure, and mechanically generated oscillations to advance a dual line of drill pipe. The inner drill pipe (typically four-inch nominal diameter) contains a core bit and represents the core barrel sampler, while the outer pipe (typically six-inch nominal diameter) is used to prevent collapse of the borehole. The samples will be collected continuously in minimum five-foot increments from the ground surface to the desired depth. The Work Plan details the depth to which each boring will be advanced. The sampling will be conducted as summarized below:

1. Push/vibrate the sampling device to the desired depth.

2. Bring the sampler to the surface and extract the soil core while placing it directly into a clear polyethylene liner using the vibration technique of the rotasonic rig. Cut small slits in the polyethylene liner at approximate one-foot intervals for field screening for total volatile organic vapors using the PID.

3. The field screening will be conducted by inserting the tip of the PID wand into the holes. The highest reading for each interval will be recorded in the field logbook.

4. Upon completion of the field screening, slice the liner with a cutting tool to expose the sample core. Collect a photograph of the complete soil core for the project database.

5. If applicable, collect the sample for volatile organics analysis using a TerraCore® sampling device (or equivalent). Preserve the sample by placing five grams of the sample in the vial containing methanol (supplied with the TerraCore® sampling kit).

6. After collecting the sample for volatile organics analysis, thoroughly homogenize the remaining portion of the sample interval for non-volatile constituents on a portion of the liner to ensure that the sample is as representative as possible of the sample interval. This step may be eliminated if the sample appears to already be homogenized.

7. Transfer the proper sample volume into appropriate, laboratory-supplied containers and place the sample in a cooler with ice.

8. Record all pertinent sampling information such as soil description, sample depth, sample number, sample location, analysis/preservation, and time of sample collection in the field logbook.

2.3.1.1 Soil Sample Selection Methodology

Retrieved soil cores will be field-screened and up to two soil samples will be collected from each sonic boring for laboratory analysis as described below.

Identified Areas with Contaminant Impact:

- One 'worst-case' soil sample above water table based on PID readings and/or visual evidence of staining/odor. No soil samples will be collected for analysis below water table.

- One 'clean' soil sample collected below the 'worst-case' soil sample, above the soil/groundwater interface. No soil samples will be collected for analysis below water table.

Areas with NO Obvious Contaminant Impact:

- One soil sample collected above water table at geologist's discretion to document subsurface conditions and potentially delineate contaminant impact not obvious through screening (e.g., metals).

Residual soil cuttings from the sonic drill rig not collected for laboratory analysis will be returned to its boring of origin unless waste material (e.g., liquid or semi-solid waste, oils, etc.) or notable contamination is present based on field screening and visual/olfactory observations. If contamination is encountered, the contaminated soil cuttings will be drummed for later characterization (as necessary) and off-site disposal. Surrounding site materials will be used to backfill any remaining void in the open borehole.

2.3.2 Groundwater Grab Sampling

No groundwater grab samples will be collected as part of this scope of work.

2.3.3 Monitoring Well Installation

Shallow overburden monitoring wells will be installed at the site. The monitoring well borings will be drilled using rotasonic drilling methods, which use a combination of rotary power, hydraulic pull down pressure, and mechanically generated oscillations to advance a dual line of drill pipe. The inner drill pipe (four-inch nominal diameter) contains a core bit and represents the core barrel sampler, while the outer pipe (six-inch nominal diameter) is used to prevent collapse of the borehole and in construction of wells.

During drilling, continuous soil core samples will be collected for lithologic identification by advancing the inner core barrel in front of the outer drill pipe. The inner core barrel will then be mechanically lifted to the surface for sample recovery. The soil core will be vibrated out of the core barrel into a polyethylene liner. This process will be repeated until the desired depth is achieved.

2.3.4 Groundwater Well Sampling

Groundwater samples will be collected from all monitoring wells at the site. Specific sampling procedures are described below.

Prior to sampling, a complete round of groundwater level measurements will be collected from the wells. The wells will be sampled using low flow purging/sampling methods as follows:

- At each well, tubing from a peristaltic pump will be lowered to the approximate mid-point of the well’s screened interval. The pumping rate will be set to create a low sustainable flow. A water level meter will be used concurrently to monitor the water level within the well casing as necessary. Ideally, the water level should remain in ‘steady state’ during low-flow pumping and not be drawn down. If drawdown in the well occurs, the pump flow rate will be reduced until the water level in the well casing stabilizes. Typically, flow rates of less than one liter per minute are used initially. However, the flow is dependent upon the hydrogeologic characteristics of the well sampled.

- Water Quality Parameters (WQPs) including pH, Oxidation/Reduction Potential (ORP), specific conductance, dissolved oxygen, temperature, and turbidity will be measured at approximate five minute intervals during purging and recorded in the field logbook. The field testing will be conducted within a flow-through cell that limits exposure of the groundwater to the atmosphere while the field measurements are recorded.

- In general, purging will be complete when three successive WQP readings have stabilized within 0.1 Standard Units for pH, 10 millivolts for ORP, 3% for specific conductance, and 10% for dissolved oxygen and turbidity is less than 10 Nephelometric Turbidity Units (NTUs). Temperature readings will be recorded, but not used for stabilization evaluation. Temperatures measured at the surface are affected to some extent by the difference between ambient air and groundwater temperatures and thus can vary over short periods. If after two hours (or three well volumes, whichever is sooner) of purging, WQPs have not reached a stable plateau, purging may be discontinued, and the sample collected. A full explanation of attempts to achieve stabilization will be recorded in the field logbook.

- Upon WQP stabilization, the groundwater samples will be collected from the end of the tubing and placed into appropriate, laboratory-supplied containers with the appropriate preservatives. Samples for dissolved metals will be filtered in the field using dedicated 0.45-micron disposable filters.

2.3.5 Non-Aqueous Phase Liquid Sampling Activities

No Non-Aqueous Phase Liquids (NAPL) will be sampled as part of this investigation. However, NAPL levels will be measured in select wells prior to sampling.

2.3.6 Investigation Derived Waste Management

The disposal of wastes will be conducted following completion of the comprehensive groundwater sampling event. Drums will be used to house the applicable wastes that warrant disposal. Waste profiles are already in place and no additional profiles of aqueous or non-aqueous waste is warranted.

2.3.7 Quality Assurance / Quality Control Samples

Field Quality Assurance/Quality Control (QA/QC) samples will include trip blanks, equipment rinsate blanks, field blanks, and field duplicate samples:

Trip Blanks: Trip blanks are samples of analyte-free water prepared at the laboratory before commencement of the sampling event and shipped to the sampling team along with the unopened sample containers. The trip blanks will be randomly selected and included in each cooler containing samples for VOC analysis. The results will be used to verify that the sample containers and method of sample container handling used throughout the sampling program did not contribute to contamination of the samples. In addition, the results will be used to identify other potential sources of field or laboratory contamination.

Equipment Rinsate Blanks: Equipment rinsate blanks will be collected by running laboratory-grade, organic-free, deionized water over/through the drilling equipment and placing it into the appropriate sample containers for laboratory analyses. One equipment rinsate blank will be collected as they will be collected at a frequency of approximately five percent for each type of reusable sampling equipment. The results will be used to verify that the sampling equipment did not contribute to contamination of the samples.

Field Blanks: To document both the quality of the potable water used for the decontamination activities and document background/ambient site conditions, field blanks will be collected as part of the investigation activities. One field blank of laboratory-grade water will be collected for analysis during the soil sampling and well installation activities, and one will be collected during the groundwater sampling event.

The field blanks will be collected by pouring laboratory-grade, organic-free, deionized water (supplied by the subcontracted laboratory) into the appropriate sample containers for laboratory analyses. The analysis of these field blanks will document the integrity/quality of the water supplied by the laboratory in case erroneous detections are observed from the laboratory analytical results of the equipment rinsate samples and also document ambient site conditions during sample collection.

Field Duplicate Samples: Field duplicate samples will consist of one unique sample, split into two aliquots, and analyzed independently for the same parameters as the corresponding original samples. Duplicate soil samples analyzed for parameters other than VOCs will be homogenized and split. Samples for VOC analysis will not be mixed but select segments of the soil will be collected. Duplicate water samples will be collected simultaneously. Duplicate samples will be collected at a frequency of approximately ten percent for each group of samples of a similar matrix. For this scope of work, six groundwater duplicates are proposed, and one soil duplicate is proposed. The results will be used to verify the reproducibility of the laboratory results and degree of variability of reported concentrations.

2.3.8 Sample Preservation and Handling

Sample preservation and handling will be conducted in accordance with Baker SOP F301 (Sample Preservation and Handling). Samples collected for laboratory analyses will be placed into appropriate, laboratory-supplied containers with the appropriate preservatives, stored on ice in coolers at approximately four degrees Celsius, and delivered to the laboratory via Federal Express. Chain-of-Custody forms will be completed and enclosed in the shipping packages. In addition, Chain-of-Custody seals will be placed on each shipping package.

2.4 Sample Designation

The samples, including QA/QC samples, will be designated with a unique sequence number. The samples will also be designated with a unique number that will serve to identify the sample media or type, sampling location, depth, and QA/QC qualifiers. The sample designation format will be as follows:

Sample Media or Type/Location - Depth and/or QA/QC Qualifier

An explanation of each of these identifiers is provided below.

Sample Media or Type

SB = Soil Boring Sample
MW = Groundwater Monitoring Well Sample
TB = Trip Blank
ER = Equipment Rinsate Blank
FB = Field Blank

Location

Each sample location will be identified with a unique identification number. For consistency, soil boring numbering will continue from the supplemental investigation activities in 2024. Each soil boring and groundwater grab boring will begin with ‘200 series’ sequential numbering beginning with SB-227. New well numbering will begin with MW-46.

If additional delineation (‘step out’) borings are needed in an area, the delineation borings will have a sequential letter “A, B, C, etc.” suffix to associate them with their boring of origin (e.g., delineation borings from impacted boring SB-205 will be SB-205A, SB-205B, etc.)

Depth

Depth indicators will be used for soil samples. The number will reference the ending depth interval of the sample. For example:

Soil:
1 = Ground surface to 1 foot bgs

5 = 4 to 5 feet bgs
15 = 14 to 15 feet bgs

Groundwater Grab Samples:
GWG = Groundwater Grab
GWG-100, GWG-101, etc. = Groundwater Grab Sample #01, #02, etc. (numbering sequential and not AOC dependent)

QA/QC DUP = Field Duplicate Sample

Using the applicable sample designation format, the at-depth (11-12 ft. bgs) quality control duplicate soil sample from SB01-12 DUP refers to:

SB-201-12 DUP	Soil boring number 201
SB-201-12 DUP	Soil sample depth interval of 11-12 feet bgs
SB-201-12 DUP	Field duplicate (QA/QC) sample

This sample designation format will be followed throughout the field sampling activities as all soil samples are proposed to be collected in one-foot increments. Required deviations to this format in response to field conditions will be documented in the field logbook.

2.5 Decontamination

Reusable sampling equipment (e.g., stainless steel spoons, hand augers, etc.) that comes into direct contact with the sample will be decontaminated between samples as follows:

- Wash equipment thoroughly with laboratory detergent and potable water using a brush to remove any particulate matter or surface film
- Rinse equipment thoroughly with potable water
- Air dry equipment

Drilling equipment (e.g., sonic cutting head, drill rods) that comes into direct contact with the soil will be decontaminated between borings and wells at a centralized decontamination pad using a high-pressure, hot water wash (a.k.a., ‘steam cleaning’). Because the use of acetate or polyethylene liners will be used during boring advancement/sample collection, only the drilling materials coming in direct contact with the soil will warrant decontamination through steam cleaning (e.g., cutting head). However, if notable contamination is encountered during boring advancement, all downhole drilling materials will be steam cleaned between borings.

The decontamination pad will be capable of containing water and sediment. In addition, the pad will be equipped with a sump and sump pump suitable to pump the spent decontamination water into the frac tank.

2.6 Monitoring and Data Collection Equipment

Field instruments will be used for screening (e.g., PID) various media samples and measuring water levels/well depths and WQPs (e.g., pH, specific conductance, temperature, dissolved oxygen, turbidity, and ORP). The PID will be calibrated and operated in accordance the manufacturer's instructions. The procedures to be used for on-site water quality testing and water level/well depth measurements are provided in the attached OBG | Baker SOPs F201 and F202, respectively.

2.7 Survey

Monitoring wells will be installed as part of the field activities and will need to be surveyed for accurate placement on a scaled site map and for groundwater flow mapping.

The monitoring well survey activities under this task will include locating the horizontal position and establishing elevations of the newly-installed monitoring wells. The horizontal data will be to the nearest 0.1-foot and referenced to the Pennsylvania State Plane Coordinate System, North American Datum (NAD) 1983. The vertical data will be to the nearest 0.01-foot and referenced to the North American Vertical Datum (NAVD) 1988. These surveying activities also will be conducted under the direction of a professional land surveyor licensed to practice surveying in the Commonwealth of Pennsylvania.

2.8 Site Management

The following sections outline the responsibilities and reporting requirements of on-site personnel.

2.8.1 Field Team Responsibilities

The field team will consist of a Field Team Leader and an Environmental Specialist. The Field Team Leader will coordinate the field activities and serve as the Site Health and Safety Officer. In addition, the Field Team Leader will ensure that all field activities are conducted in accordance with the Work Plan, FSAP, QAPP, and site-specific Health and Safety Plan. The Environmental Specialist will support the Field Team Leader during the sampling activities.

2.8.2 Reporting Requirements

The Field Team Leader will be responsible for tracking each day's field activities including, but not limited to, the following:

- Personnel on site
- Major activities of the day

- Subcontractor quantities (e.g., drilling footages)
- Samples collected and analyses requested
- Equipment on site
- Problems encountered
- Changes in scope of the investigation (discussed and agreed upon with the PADEP Regional Project Officer)
- Planned activities

In addition, the Field Team Leader will prepare Daily Activity Reports. These reports will be forwarded onto the Project Manager for review and discussion (if needed). The Project Manager will be responsible for submittal of the daily reports to the Department.

3.0 QUALITY ASSURANCE PROJECT PLAN

This QAPP presents the organization, objectives, functional activities, and specific QA/QC activities associated with the site investigation. It contains information concerning project objectives, sampling descriptions and rationale, and Data Quality Objectives (DQOs) as follows:

- Project Description
- Organization and Responsibility
- Data Quality Objectives
- Sampling Procedures
- Sample Custody Procedures and Frequency
- Analytical Procedures
- Data Reduction, Validation, and Reporting
- Preventive Action Procedures
- Corrective Action Procedures
- Quality Assurance Reports

3.1 Project Description

The project description and objectives are presented in the Work Plan.

3.2 Organization and Responsibility

The OBG | Baker project management organization is designed to provide a line of functional responsibility and authority supported by a management control structure and independent Quality Assurance (QA) review. This control structure provides for the following:

- Clearly identified lines of communication and coordination
- Project budget and schedule monitoring
- Key technical resources management
- Financial management and progress reports
- Quality Control (QC)

Key personnel for QA throughout the duration of this project are presented in the Work Plan.

3.3 Data Quality

3.3.1 Data Needs/Uses

The generation of data through the sampling and analyses efforts is intended to provide an assessment of current site conditions with respect to potential environmental impact from historical industrial operations conducted at the site. Table 1 of the Work Plan present a summary of the sampling and analytical program.

3.3.2 Data Quality Objectives

DQOs are qualitative or quantitative statements developed by the users to specify the quality of data needed from a particular data collection activity to support specific uses. DQOs consider analytical method precision, accuracy, representativeness, completeness, and comparability as discussed below.

Precision

Precision is a measure of the amount of variability and bias inherent in a data set. Furthermore, precision describes the reproducibility of measurements of the same parameter for samples collected under similar conditions.

Field duplicate precision monitors the consistency with which environmental samples were obtained and analyzed. In general, field duplicate results for solid matrix and aqueous matrix samples are precise if the Relative Percent Difference (RPD) is less than or equal to 35 percent and 20 percent, respectively. Field precision will be assessed through collection and measurement of field duplicate samples at a rate of 1 duplicate per 10 analytical samples per matrix.

Laboratory precision QC samples will be analyzed with a minimum frequency of 5 percent (i.e., 1 QC sample per 20 environmental samples per matrix). Laboratory precision will be measured via comparison of RPD values and precision control limits specified in the analytical method or by the laboratory’s QA/QC program. Laboratory limits at the time of analysis will be used to assess the data.

The RPD between the sample (or spike) and duplicate (or duplicate spike) will be calculated using the following formula:

$$\text{RPD} = \frac{\text{Amount in Sample 1} - \text{Amount in Sample 2}}{0.5(\text{Amount in Sample 1} + \text{Amount in Sample 2})} \text{ X } 100$$

Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy in the field will be assessed using equipment rinsate, field, and trip blanks and will be ensured through adherence to all sample handling, preservation, and holding time requirements.

Accuracy in the laboratory will be measured through the comparison of a spiked sample result with a known or calculated value and is expressed as a percent recovery (%R). Percent recoveries will be derived from the analysis of known amounts of compounds spiked into deionized water (i.e., Laboratory Control Sample [LCS] analysis) or into actual samples (i.e., surrogate or internal MS analysis). LCS analysis, which may also be referred to as blank spike analysis, measures the accuracy of laboratory operations. Surrogate and MS analyses measure the accuracy of laboratory operations as affected by sample matrix. LCS and MS analyses will be performed at a frequency of 1 per 20 associated samples of similar matrix. Surrogate spike analysis is performed for all organic chromatographic analyses. Laboratory accuracy will be assessed via comparison of calculated %R values with accuracy control limits specified in the analytical method or by the laboratory's QA/QC program. Laboratory recovery limits at the time of analysis will be used to assess the data.

The %R for a spiked sample will be calculated by using the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample - Amount in Sample}}{\text{Known Amount Added}} \text{ X } 100$$

The %R for LCS and surrogate compound results will be determined according to the following equation:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Known Amount Added}} \text{ X } 100$$

Completeness

Completeness is a measure of the amount of usable, valid, analytical data obtained, compared with the amount expected to be obtained. Completeness is typically expressed as a percentage.

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed), errors can be introduced during analysis (e.g., loss of instrument sensitivity, introduction of ambient laboratory contamination), or strong matrix effects can become apparent (e.g., extremely low MS recovery). These instances result in data that do not meet QC criteria. Completeness will be calculated for each chemical category (e.g., VOCs, SVOCs, metals, etc.) per media. If critical data points are lost, re-sampling and/or re-analysis may be required. For this project, the completeness goal is 95 percent or greater.

Following completion of the analytical testing, the percent completeness will be calculated using the following equation:

$$\text{Completeness} = \frac{\text{(Number of Valid Measurements)}}{\text{(Number of Measurements Planned)}} \times 100$$

Representativeness

Representativeness is an expression of the degree to which the data accurately and precisely depict the actual characteristics of a population or environmental condition existing at an individual sampling point. Use of standardized sampling, handling, analytical, and reporting procedures ensures that the final data accurately represent actual site conditions.

Representativeness in this sampling and analysis program will be ensured by following the Work Plan, FSAP, and QAPP and using proper sampling techniques. From the analytical end, representativeness will be ensured by using the proper analytical procedures, meeting sample holding times, and analyzing and assessing field duplicate samples.

Comparability

Comparability is defined as the confidence with which one data set can be compared with another (e.g., between sampling points; between sampling events). Comparability will be achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measure). In addition, consideration will be given to seasonal conditions and other environmental variations that could exist to influence analytical results.

3.4 Sampling Procedures

Field sample collection procedures are presented in the Work Plan and FSAP. Appropriate sample containers and preservatives will be obtained directly from the subcontracted analytical laboratory. The sample containers will be certified as clean by the laboratory. Tables 1 and 2 of this QAPP present a summary of sample containers, preservation, and holding times for the primary aqueous and solid samples.

3.5 Sample Custody Procedures

Each sample will be given a unique designation, which will be recorded in the field logbook, on the Chain-of-Custody record, and the label affixed to the sample container. The sample designation format is presented in the FSAP.

Sample labeling, custody seals, field tracking, field logbooks, and Chain-of-Custody procedures are described in Baker SOPs F302 (Chain-of-Custody) and F303 (Field Logbook). Samples for laboratory analyses will be stored on ice in coolers at approximately four degrees Celsius and submitted to a qualified, subcontracted laboratory. Chain-of-Custody forms will be completed and enclosed in the shipping packages. In addition, Chain-of-Custody seals will be placed on each shipping package.

3.6 Analytical Procedures

General procedures for field analyses and laboratory analyses provided below.

3.6.1 Field Analyses

Field instruments will be used for screening (e.g., PID) various media samples and measuring WQPs (e.g., pH, specific conductance, temperature, dissolved oxygen, turbidity, and ORP). The PID will be calibrated and operated in accordance the manufacturer's instructions. On-site water quality testing will be conducted in accordance with Baker SOP F201.

3.6.2 Laboratory Analyses

Table 1 of the Work Plan presents a summary of the proposed sampling and analytical program. The laboratory analyses will be conducted in accordance with standard U.S. Environmental Protection Agency (USEPA) methods and procedures used in the environmental industry.

3.7 Data Reduction and Reporting

Data reduction and reporting will ensure that all documents produced as part of the investigation can be accounted for upon project completion. Accountable documents include, but are not limited to, field logbooks, correspondence, Chain-of-Custody records, data packages, and photographs. The Project Manager will be responsible for maintaining a project file in which all accountable documents will be inventoried. The project records will be retained in accordance with OBG | Baker's and the Department's Document Retention Policy.

TABLE 1

SUMMARY OF CONTAINERS, ANALYSES, PRESERVATION, AND HOLDING TIMES FOR AQUEOUS SAMPLES

Parameter	Analytical Method	Container	Preservation	Holding Time
VOCs	Method 8260D	Two 40-ml glass vials with Teflon septum caps	Cool, 4°C HCl pH <2	14 days
SVOCs	Method 8270E	Two 250-ml amber glass bottle with Teflon cap	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
Total and Dissolved Metals (& Mercury)	Method 6010D/7471B	500-ml polyethylene bottle - Each	HNO_3 pH<2	6 months; Mercury 28 days
General Chemistry	Multiple Methods	Two - 1 Liter polyethylene bottles	Cool, 4°C	7 days
pH	9040C	One – 1 liter glass bottle	None	7 days

TABLE 2

SUMMARY OF CONTAINERS, ANALYSES, PRESERVATION, AND HOLDING TIMES FOR NON-AQUEOUS SAMPLES

Parameter	Analytical Method	Container	Preservation	Holding Time
VOCs	Method 8260D	TerraCore three – 40-ml glass VOA vials; one 2-ounce plastic	One vial with methanol; two vials with DI water; Cool, 4°C	14 days
SVOCs	Method 8270E	One 8-ounce wide-mouth jar	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
Metals (including mercury)	Method 6010D/7471B	One 8-ounce wide-mouth jar	Cool, 4°C	6 months; Mercury 28 days

3.7.1 Field Data Procedures

Field sampling activities will be documented in field logbooks in which information pertinent to sample collection will be entered in indelible ink. The field logbooks will be completed and maintained as described in Baker SOP F303 (Field Logbook). Appropriate information will be entered daily including weather, names of field personnel and visitors on site, sample identification, brief descriptions of samples collected, date and time of collection, sampling methodology, sampling remarks and observations, field measurements, conditions and observations, description of activities, QA/QC samples collected, and list of photographs taken.

3.7.2 Laboratory Data Procedures

The following procedures summarize the practices that will be routinely used by laboratory staff for data reduction, validation, and reporting. Numerical analyses, including manual calculations, will be documented and subjected to QC review. Records of analyses must be legible and complete enough to permit reconstruction of the work by a qualified individual other than the originator.

Laboratory Data Validation

Laboratory data validation begins with the receipt of samples and the documentation of proper sample custody. It continues with raw data reduction to the reporting of data.

Data processing will be checked by an individual other than the analyst who performed the data processing. The checker will review the data for the following:

- Utilization of the proper equations
- Correctness of numerical input
- Correctness of computations
- Correct interpretation of raw data (e.g., chromatographs, strip charts, etc.)

All entries made in bench books, data sheets, computation sheets, etc., will be made in ink. No entry will be rendered illegible, and changes will be lined-through and initialed by the person making the correction.

Analytical Data Package Requirements

An Electronic Data Deliverable (EDD) in Microsoft Excel format of the analytical data will be submitted to OBG | Baker from the subcontracted laboratory. For each analytical method run, the laboratory will report all required analytes for each sample as a detected concentration or as not detected at the specific limits of quantitation. In addition, applicable method detection limits and instrument detection limits will be required for every analysis. The Department requested that all analytical methods are sufficient to attain levels below the appliable Residential and Non-Residential MSCs.

Each analytical method run will be clearly identified as belonging to a specific analytical batch. All samples must be reported with dates of collection, preparation, and analysis. The laboratory will also report dilution factors for each sample.

A complete set of QC results, including calibration data, will be reported for each analytical batch. All required method QC will be performed on project samples. The required QC samples and their frequency are identified in the FSAP. A standard turnaround time (for complete data packages) from sample receipt at the laboratory to data receipt will be requested for all samples. The laboratory will hold and make available all project raw data for a minimum period of seven years after the samples have been analyzed.

3.8 Preventive Action Procedures

3.8.1 Field Equipment

Specific preventive maintenance procedures recommended by the manufacturer will be followed for field equipment. Field instruments will be checked and calibrated by OBG | Baker daily before use. In addition, the calibration will be checked anytime there is a questionable response from the equipment. Calibration will be documented in the field logbooks.

3.8.2 Laboratory Instruments

A routine preventive maintenance program will be conducted by the laboratory to minimize the occurrence of instrument failure and other system malfunctions. Section supervisors and/or analysts (organic, inorganic) will perform routine scheduled maintenance, and coordinate with the vendor for the repair of all instruments. All laboratory instruments will be maintained in accordance with the manufacturer's specifications and the requirements of the specific method employed. This maintenance will be carried out on a regular, scheduled basis and documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturers maintenance will be provided under a repair and maintenance contract with factory representatives.

3.9 Corrective Action Procedures

A corrective action protocol that is both technically effective and administratively compatible to ensure accurate and timely correction of non-conformance is imperative.

3.9.1 Field Procedures

The Field Team Leader will be responsible for all field activities. In this role, the Field Team Leader may be required to adjust the field program to accommodate site-specific needs. If it becomes necessary to modify the program, then the Field Team Leader will consult the Project Manager and PADEP Regional Project Officer regarding an appropriate corrective action. Agreed upon corrective actions for the program will be documented in the field logbook.

3.9.2 Laboratory Procedures

Nonconformance is any event, which is beyond the limits established for laboratory performance, such as data which fall outside accepted bounds for accuracy and precision due to improper equipment calibration/maintenance or improper data verification. Any activity in the laboratory which affects data quality can result in a nonconformance.

Nonconformance associated with the statistical analysis and review of data are straightforward to identify. The Laboratory QA Coordinator will be responsible for the assessment of QC sample information. The Project Manager and PADEP will be notified of any nonconformances.

Corrective actions will be designed to correct the associated problems and minimize the possibility of their recurrence. Examples of corrective actions are modifying nonconforming procedures; tagging, repairing, or replacing deficient equipment; training or replacing unqualified personnel; re-analyzing affected samples; marking rejected data, and reissuing affected reports.

3.10 Quality Assurance Reports

The Project Manager will be responsible for assessing the performance of measurement systems and data quality related to the field investigation. A written record will be maintained of the results of laboratory QC reports and other periodic assessments of measurement, data accuracy, precision, and completeness; performance and system audits; and any significant QC problems and recommended solutions. A QA/QC assessment will be performed any time a significant problem is identified.

The Project Manager will keep in contact with the PADEP Regional Project Officer through informal, verbal reports during the project as well as through monthly progress reports.

ATTACHMENT A

Standard Operating Procedures (SOPs)

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - ON-SITE WATER QUALITY TESTING

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SOP Number: F201
Effective Date: 09/06

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ON-SITE WATER QUALITY TESTING
(FIELD PARAMETERS)

1.0 PURPOSE

This SOP describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance/Salinity
- Temperature
- Dissolved Oxygen Concentration (DO)
- Turbidity (Secchi Disc)
- Oxidation Reduction Potential (ORP)

The first three bullets above are typical field parameters. Dissolved oxygen, turbidity, and ORP may be used in particular applications according to project-specific requirements.

2.0 SCOPE

These procedures are applicable for use in an on-site water quality monitoring program to be conducted during Remedial Investigations or Site Investigations at hazardous or non-hazardous sites. The procedures and equipment described are applicable to nearly all aqueous samples, including, but not limited to, potable well water, monitoring well water, surface water, leachate and drummed water, etc.

This SOP provides generic information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use (preferably prior to mobilization to the field).

3.0 DEFINITIONS

Specific Conductance - A measurement of water’s capacity for conveying electrical current and is directly related to the concentrations of ionized substances in the water. The units of measurement for conductance (μmhos) are the inverse of μohms, the unit commonly used to express resistance. The terms conductivity and specific conductance are used synonymously.

Electrolytic Cell - An electrochemical cell in which electrical energy is supplied from an external source. This cell functions in much the same way as a galvanic cell, only in the opposite direction due to the external source of applied voltage.

Galvanic Cell - An electrochemical cell in which chemical energy is spontaneously converted to electrical energy. The electrical energy produced is supplied to an external circuit.

Oxidation - The process in which an atom or group of atoms loses electrons to achieve an increasing positive charge.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration. The range of pH is 0 to 14 standard units.

Resistance - A measure of the solution's ability to oppose the passage of electrical current. For metals and solutions, resistance is defined by Ohm's Law, $E = IR$, where E is the potential difference (in units of volts), I is the current (in units of Amperes), and R is the resistance (in units of ohms).

Turbidity - An optical property of water that causes light to be scattered or absorbed in the water, resulting in a decrease in water transparency. It is a function of at least three variables: 1) dissolved chemicals; such as tannins, acids, or salts; 2) suspended particles; such as silt, clay, and organic matter; and, 3) density of microbial and planktonic life.

Salinity - refers to the total amount of soluble salts in water, either naturally or added to the environment as pollutants.

ORP - Oxidation reduction occurs when electrons are transformed from one atom to another during a chemical reaction. The atom losing electrons is said to be "oxidized", while the atom gaining electrons is termed "reduced". ORP is typically measured using a platinum electrode, attached to a pH meter, which is set to read in ‘Millivolt’ mode.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for determining which on-site water quality measurements shall be collected, the data quality objectives (DQOs) for these measurements, and for ensuring that these measurements are collected in accordance with project-specific plans.

Field Team Leader - The Field Team Leader is responsible for determining that these water quality measurement procedures are implemented in the field in accordance with this SOP, and/or in accordance with project-specific plans, and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures for collecting on-site water quality measurements including instrument calibration, quality control and recording of results, as well as care and maintenance of the instruments in the field. Furthermore, it is the sampling personnel’s responsibility to confirm that the meters are in good working order prior to mobilization to the field. In addition, extra batteries and meter probes also should be included in the field equipment list to minimize potential down time in the field.

5.0 PROCEDURES

The following sections provide general procedures for collecting pH, specific conductance/salinity, temperature, dissolved oxygen concentration, turbidity and ORP measurements.

Note: Though there are "multi-parameter" meters on the market today that can simultaneously measure the following parameters, only measurement with "parameter specific" meters will be discussed. If using a multi-parameter meter, all manufacturer's instructions for that specific model will be followed for calibration, maintenance, and care.

5.1 Measurement of pH

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment, such as acid-base neutralization, water softening, and corrosion control, is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Measurements of pH also can be used to check the quality and corrosivity of soil and solid waste samples. However, these samples must be immersed in water prior to analysis; specific measurement techniques for solids are not described in this SOP.

5.1.1 Principles of Equipment Operation

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on the establishment of a potential difference across a glass or other type of membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to hydrogen ion concentration can be generated and measured.

5.1.2 Equipment

The following equipment and reagents are needed for taking pH measurements:

- Laboratory-prepared buffer solutions for calibration of pH 4, 7 and 10, or other buffers which bracket the expected pH range.

5.1.3 Measurement Techniques for Field Determination of pH

A. pH Meter

Standardization, calibration, and operation and maintenance shall be performed according to the manufacturer's instructions for the "specific" model being used. The following general procedure is used for measuring pH with a pH meter:

1. The batteries shall be checked to make sure that they are fully charged and the instrument shall be calibrated prior to initiation of the field effort.

2. Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage.

3. Turn meter on and allow it to stabilize for 3 to 5 minutes.

4. Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s). Shake electrode as if a mercury thermometer to move air bubbles from the tip to the top.

5. Calibration procedures should be performed:
   - Following significant ambient temperature changes
   - When meter reads erratically
   - At beginning and middle of each day of use

6. When the meter is moved to a new sampling location, a single-point check/calibration should be performed with pH 7 buffer.

7. Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the field logbook.

8. After adjusting the temperature compensator to the sample temperature, read and record the pH of the solution. The pH value shall be recorded to the nearest 0.1 pH unit. Also record the sample temperature. All measurements shall be recorded in the Field Logbook.

9. Upon completion of measurement and removal of the electrode from the sample (or buffer), the electrode shall be thoroughly rinsed with deionized water and patted dry (never rub dry, due to potential interference by static electricity).

10. The electrode(s) shall remain immersed in storage solution provided, or pH buffer 4 water when not in use.

The sample used for pH measurement shall never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution within the electrode, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted in the Field Logbook.

5.2 <u>Measurement of Specific Conductance/Salinity</u>

Conductance provides a measure of dissolved ionic species in water and can be used to suggest the direction and extent of migration of contaminants in groundwater or surface water. Salinity refers to the total amount of soluble salts in water, either naturally or added to the environment as pollutants.

One basic measure of salinity is the ability of water to conduct electric current. Therefore, a measurement of specific conductance provides a measurement of salinity and the same instrument can be used. Salinity measurements also are important in ecological field investigations because flora and fauna can be limited in their distribution based on the salinity of the sampled waters.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is collected. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance and salinity measurement soon <u>after</u> taking the sample designated for laboratory analysis, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air affect the specific conductance.

5.2.1 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions (cations) migrate toward the negative electrode (cathode), while the negatively charged ions (anions) migrate toward the positive electrode (anode). Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not disassociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell also may be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.2.2 Equipment

A portable conductivity meter, probe and thermometer are needed for taking specific conductance and salinity measurements. Typically, a variety of conductivity meters are available which also may be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment may be obtained to meet the specific requirements of the sampling program.

5.2.3 Measurement Techniques for Specific Conductance/Salinity

Standardization, calibration, and operation and maintenance shall be performed according to manufacturers' instructions for the "specific" model being used. The general steps involved in taking specific conductance and salinity measurements are listed below.

1. Check batteries to make sure they are fully charged and calibrate instrument before going into the field.

2. Calibrate the instrument daily when used, at a minimum. Potassium chloride solutions with a specific conductance closest to the values expected in the field shall be used for the calibration process. Calibration information (time of calibration, solutions used, and meter output readings) shall be recorded in the field logbook.

3. Turn meter on and allow it to stabilize for 3 to 5 minutes.

4. Calibration procedures should be performed:
   - Following significant ambient temperature changes
   - When meter reads erratically
   - At beginning and middle of each day of use

5. Pour approximately 50 to 100 ml of sample into a rinsed plastic container. Immerse the electrode in the sample and measure the conductivity and salinity. If required by the meter being used, adjust the temperature setting to the sample temperature. Make sure that the electrode is fully immersed in the sample, but not touching the base of the container.

6. Read and record the results in the field logbook. For some antiquated meters also note the scale prior to recording the reading (i.e., 1x, 10x, 100x, etc.).

7. If the meter does not compensate for temperature variations, the corrections given in Attachment A shall be applied.

8. On some meters, specific conductance and salinity measurements may need to be reported with the associated temperature measurement. If the conductivity and salinity has been corrected, the measurements shall be reported as corrected to 25°C (Attachment A).

   a. Do not take readings if the sample temperature is less than 10° C, because the calibration curve no longer follows a straight line below this temperature. If necessary, heat the sample in your vehicle to at least 10° C.

   b. Measure the sample temperature to the nearest 0.1° C to comply with SW-846.

   c. Only report results to the nearest two significant digits for most circumstances because of the inherent inaccuracy in the test and conversion procedure(e.g., a calculated reading of 2353 umhos/cm @ 25° C should be reported as 2400 umhos/cm @ 25° C).

5.3 Measurement of Temperature

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field after sample collection for laboratory analysis. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.3.1 Equipment

Temperature measurements may be taken with Thermistor, alcohol-toluene, mercury or bimetal thermometers. In addition, most meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature can be performed.

5.3.2 Measurement Techniques for Water Temperature

If a thermometer is used on a collected water sample:

1. Visually inspect thermometer to ensure that there is not a break in the mercury column. If there is a break, the spare thermometer will be visually inspected. If both thermometers have a break in the mercury, neither will be used until the break is corrected. This will be done by cooling the bulb until the mercury is contained within the bulb.

2. Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.

3. Record values in a field logbook to the nearest 0.5 or 0.1EC, depending on the measurement device used.

If a temperature meter or probe is to be used, the instrument shall be calibrated according to the manufacturer's recommendations with an approved thermometer.

5.4 Measurement of Dissolved Oxygen Concentration

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms, as well as the rate of corrosivity, is dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time, if the sample is not adequately preserved. Other means of sample preservation may involve directing the sample flow from the well directly into a flow cell, which limits sample/air contact.

The method discussed here is limited to the use of DO meters only. Chemical methods of analysis (e.g., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible. DO meters also are free from interference caused by color, turbidity, colloidal material or suspended matter.

5.4.1 Principles of Equipment Operation

DO probes normally are electrochemical cells that have two solid metal electrodes of different potential immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of higher nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH) occurs at the cathode surface. An electrical current is developed directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. Therefore, it is necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface (frothing). To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, but to leave the surface of the solution undisturbed.

DO probes are relatively free of interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide which are not easily depolarized from the indicating electrode. If gaseous interference is suspected, it shall be noted in the Field Logbook and checked if possible. Temperature, pressure, and salinity variations also can cause interference. Automatic temperature compensation normally is provided by the manufacturer. Attachment B presents variations of DO in water as a fraction of temperature and pressure. Salinity should be compensated in accordance with the manufactures instructions.

5.4.2 Equipment

A portable conductivity meter, probe and thermometer (if not built into the conductivity meter) are needed for taking specific conductance and salinity measurements. A variety of conductivity meters are available which also may be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment may be obtained to meet the specific requirements of the sampling program.

5.4.3 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions for the specific model being used to obtain an accurate reading. The following general steps shall be used to measure the DO concentration.

1. Calibrate equipment and check batteries before going to the field.

2. The probe shall be conditioned in a water sample for as long as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.

3. The instrument shall be calibrated in the field before each measurement or group of closely spaced measurements by placing the probe in a freshly air-saturated water sample of known temperature.

4. Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane, either by stirring the sample, or placing the probe in a flowing stream. Probes without stirrers which are placed in wells should be moved up and down.

5. Record the dissolved oxygen content and temperature of the sample in a field logbook.

6. Recalibrate the probe when the membrane is replaced, or following similar maintenance, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This, however, may not always be practical. Be sure to record whether the liquid was analyzed in situ, or whether a sample was taken.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen dissolution and positive test interferences.

5.5 Measurement of Turbidity

Turbidity is caused by fine particles suspended in the water which cause light to scatter, rather than traveling in a straight line. Clay, silt, plankton, and other microorganisms are all examples of particulates that cause turbidity.

Most portable field turbidity meters display results in Nephelometric Turbidity Units (NTU's). This process determines the turbidity level of measuring the amount of light scattered 90° by the suspended particles, by a light of known strength beamed through the solution.

5.5.1 Equipment

A portable turbidity meter, sample vials, standard solutions, and sample cap are typically needed.

5.5.2 Measurement Techniques for Turbidity Measurement

Follow the manufacturer’s instructions, for the specific model being used. The following general steps shall be used to measure turbidity.

1. Calibrate equipment and check batteries, or charge status.

2. Turn on meter and allow to stabilize.

3. Fill a sample vial completely with sample to be obtained, and place cap on vial.

4. Insert vial into light chamber. (Align vial into chamber the same way each time, by making use of tick marks on vial lid). Cover vial with cap.

5. Switch meter to appropriate range and read. Record results into field logbook.

6. Rinse vials with distilled water between each sample.

7. Calibration procedures should be performed:
    - Following significant ambient temperature changes
    - When meter reads erratically
    - At beginning and middle of each day of use.

5.6 Measurement of Oxidation Reduction Potential (ORP)

Oxidation reduction occurs when electrons are transformed from one atom to another during a chemical reaction. The atom losing electrons is said to be "oxidized", while the atom gaining electrons is termed "reduced". ORP is typically measured using a platinum electrode, attached to a pH meter, which is set to read in millivolt mode.

5.6.1 Equipment

Though there are ion specific meters for ORP on the market, their very small size and shape do not coincide well with typical multi-parameter set-ups in the field. Typically a pH meter, fitted with a special ORP electrode is used.

5.6.2 Measurement Techniques

At present, only a check solution is available on the market, which is used to verify the performance of the electrode. If the probe reads +/- a certain percentage of the solution’s stated value, then the electrode is assumed to be in proper working condition.

1. Check batteries and calibrate (check) meter/electrode before heading into the field.

2. Switch pH meter so that it's in the millivolt (mV) mode.

3. Place electrode in sample solution and read results in mV's. Record results in the field logbook.

4. Rinse electrode with distilled water.

6.0 QUALITY ASSURANCE RECORDS

Quality assurance records for on-site water quality management consist principally of observations and measurements recorded in the field logbook.

7.0 REFERENCES

American Public Health Association, 1980. Standard Methods for the Examination of Water and Wastewater, 15th Edition, APHA, Washington, D.C.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

U.S. EPA, 1998. Test Methods for Evaluating Solid Wastes (SW-846) – Revision 5. http://www.epa.gov/epaoswer/hazwaste/test/main.htm#Table

U.S. Geological Survey, 1984. National Handbook of Recommended Methods for Water Data Acquisition, Chapter 5: Chemical and Physical Quality of Water and Sediment. U.S. Department of the Interior, Reston, Virginia.

ATTACHMENT B

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

Temperature ºC	2.Dissolved Oxygen mg/l 2.1.Chloride Concentration in Water 2.1.1.0 2.1.2.5,000 2.1.3.10,000 2.1.4.15,000 2.1.5.20,000 2.2.Difference/ 100 mg chloride					
0	14.6	13.8	13.0	12.1	11.3	0.017
1	14.2	13.4	12.6	11.8	11.0	0.106
2	13.8	13.1	12.3	11.5	10.8	0.015
3	13.5	12.7	12.0	11.2	10.5	0.015
4	13.1	12.4	11.7	11.0	10.3	0.014
5	12.8	12.1	11.4	10.7	10.0	0.014
6	12.5	11.8	11.1	10.5	9.8	0.014
7	12.2	11.5	10.9	10.2	9.6	0.013
8	11.9	11.2	10.6	10.0	9.4	0.013
9	11.6	11.0	10.4	9.8	9.2	0.012
10	11.3	10.7	10.1	9.6	9.0	0.012
11	11.1	10.5	9.9	9.4	8.8	0.011
12	10.8	10.3	9.7	9.2	8.6	0.011
13	10.6	10.1	9.5	9.0	8.5	0.011
14	10.4	9.9	9.3	8.8	8.3	0.010
15	10.2	9.7	9.1	8.6	8.1	0.010

Temperature ºC	2.Dissolved Oxygen mg/l 2.1.Chloride Concentration in Water 2.1.1.0 2.1.2.5,000 2.1.3.10,000 2.1.4.15,000 2.1.5.20,000 2.2.Difference/ 100 mg chloride					
16	10.0	9.5	9.0	8.5	8.0	0.010
17	9.7	9.3	8.8	8.3	7.8	0.010
18	9.5	9.1	8.6	8.2	7.7	0.009
19	9.4	8.9	8.5	8.0	7.6	0.009
20	9.2	8.7	8.3	7.9	7.4	0.009
21	9.0	8.6	8.1	7.7	7.3	0.009
22	8.8	8.4	8.0	7.6	7.1	0.008
23	8.7	8.3	7.9	7.4	7.0	0.008
24	8.5	8.1	7.7	7.3	6.9	0.008
25	8.4	8.0	7.6	7.2	6.7	0.008
26	8.2	7.8	7.4	7.0	6.6	0.008
27	8.1	7.7	7.3	6.9	6.5	0.008
28	7.9	7.5	7.1	6.8	6.4	0.008
29	7.8	7.4	7.0	6.6	6.3	0.008
30	7.6	7.3	6.9	6.5	6.1	0.008

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - WATER LEVEL, WATER-PRODUCT INTERFACE LEVEL,AND WELL DEPTH MEASUREMENTS

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SOP Number: F202
Effective Date: 10/06

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WATER LEVEL, WATER-PRODUCT INTERFACE LEVEL, AND WELL DEPTH MEASUREMENTS

1.0 PURPOSE

The purpose of this procedure is to describe the method of determining various down-hole measurements: groundwater levels and free product (a.k.a. non-aqueous phase liquid) levels, if present, and total depth of groundwater monitoring wells and piezometers.

2.0 SCOPE

The methods described in this SOP generally are applicable to the measurement of groundwater levels, NAPL levels, and total well depths in monitoring wells and piezometers.

3.0 DEFINITIONS

NAPL – Non-Aqueous Phase Liquids
LNAPL – Light Non-Aqueous Phase Liquids
DNAPL – Dense Non-Aqueous Phase Liquids
MSL – Mean Sea Level
IFP – Interface Probe

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed.

Field Team Leader - The Field Team Leader is responsible for ensuring that these procedures are implemented in the field, and for ensuring that personnel performing these activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the sampling personnel to follow these procedures or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper acquisition of down-hole measurements.

5.0 PROCEDURES

Calculations of groundwater elevations and product or NAPL interface level measurements collected from a monitoring well give an indication of:

- The horizontal hydraulic gradient and the direction of groundwater flow.
- The vertical hydraulic gradient, if well nests are used (i.e., the direction of groundwater flow in the vertical plane).
- Floating or sinking free product thicknesses which are also known as Light Non-Aqueous Phase Liquids (LNAPLs) and Dense Non-Aqueous Phase Liquids (DNAPLs), respectively.

This information, when combined with other site specific information such as hydraulic conductivity or transmissivity, extent of contamination, and product density, may be used to estimate the rate of contaminant movement or source areas, etc.

Well depth is one of the factors used to determine the zone that a well monitors. Well depth also is used in the calculation of purge volumes as discussed in SOP F104, Groundwater Sample Acquisition.

The following sections briefly discuss the procedures for measuring groundwater levels, NAPL levels, and well depth. For all of the procedures discussed, it is assumed that the measurement will be taken from the top of the inner-most casing of the well or piezometer (though other measuring points can be used). The horizontal and vertical control is established for each well through a site survey, such that measurements may be converted to elevations above Mean Sea Level (MSL) or some other consistent datum (e.g., an on-site benchmark). A permanent notch or mark will be placed on the inner-most casing by Baker to facilitate consistent water level measurements over time.

The manufacturer's instructions for all equipment referenced herein should be read by the sampling personnel and accompany the equipment to the field.

5.1 Water Level Measurement

Water levels in groundwater monitoring wells or piezometers shall be measured from the permanent point indicated at the top of the inner-most casing (the surveyed elevation point), unless otherwise specified in the project plans, using an electronic water level measuring device (water level meter). The point of measurement will be documented in the field logbook if different from the top of the inner casing. The reason for deviating from the measurement point also should be noted.

Water levels are measured by lowering the probe into the well until the device indicates that water has been encountered, usually with either a constant buzz, or a light, or both. The water level is recorded to the nearest hundredth-of-a-foot (0.01 Feet) using the graduated markings on the water level indicator line. This measurement, when subtracted from the measuring point surveyed elevation, yields the groundwater elevation relative to either MSL or an on-site benchmark.

5.2 NAPL Level Measurements

The procedure for NAPL level measurement is nearly identical to that for groundwater elevation measurements. The only difference is the use of an interface probe (IFP) that can detect the level of both NAPL and water through varying indicator signals at the surface (IFP beeping and/or different color indicator light). Typically, encountering NAPLs in a monitoring well or piezometer is indicated by a constant sound. When water is encountered, the signal becomes an alternating on/off beeping sound. This allows for the measurement of both the top of the NAPL layer in a well and the water/NAPL interface. In addition, this same philosophy would be applicable to the water/DNAPL interface at the bottom of the well, if present.

The apparent water table elevation below the product level will be determined by subtracting the depth to water from the measuring point elevation. The corrected water table elevation will then be calculated using the following equation:

$$WTE_c = WTE_a + (\text{Free Product Thickness x } 0.80)$$

Where:

WTE_c = Corrected water table elevation
WTE_a = Apparent water table elevation
0.80 = Average value for the density of petroleum hydrocarbons. Site-specific data will be used where available.

However, the formula presented above should only be applied in the office during data evaluation for reporting purposes. For consistency, the actual measurements collected from the IFP in the field are what should be recorded in the site logbook.

5.3 Well Depth Measurements

Well depths typically are measured using a weighted measuring tape. A water level meter may also be used. The tape is lowered down the well until resistance is no longer felt, indicating that the weight has touched the bottom of the well. The weight should be moved in an up and down motion a few times so that obstructions, if present, may be bypassed. The slack in the tape then is collected until the tape is taut. The well depth measurement is read directly off of the measuring tape, at the top of the inner-most casing to the nearest 0.01-foot and recorded in the Field Logbook. It should be noted that on some weighted measuring tapes, the length shown on the measuring tape may not be truly representative of the entire well depth. This is because the weight at the end of the tape (below the 0.0 feet line) may extend below the base of the tape. Thus, the total well depth measured on the tape at the top of the casing may actually be greater. As a result, a measurement of the length from the tip of the weight to the end of the tape should be made prior to collecting well depth measurements. Furthermore, if a water level indicator is used, add the distance from the bottom of the probe to the point where water levels are measured (i.e., where the water level connects the circuit on the probe).

5.4 Decontamination of Measuring Devices

Water level indicators, IFPs, and weighted measuring tapes that come in contact with groundwater must be decontaminated using the following steps after use in each well:

- Rinse with potable water
- Rinse with deionized water
- Rinse with Methanol (if sampling for volatiles)
- Final Rinse with deionized water

Portions of the water level indicators or other similar equipment that do not come into contact with groundwater, but may encounter incidental contact during use, need only undergo potable water and deionized water rinses. In addition, if there is established documentation from a well indicating no historical evidence of contaminant impact, no decontamination is necessary other than providing a potable water rinse between wells. Furthermore, to mitigate the potential for cross contamination between wells, measurements should be collected from the least impacted to the most impacted wells on site, if possible.

6.0 QUALITY ASSURANCE RECORDS

The Field Logbook shall serve as the quality assurance record for water, product level, and/or well depth measurements. Both the time of day and the well order that the measurements were collected also should be documented in the field notebook.

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - SAMPLE PRESERVATION AND HANDLING

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SOP Number: F301
Effective Date: 04/94

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SAMPLE PRESERVATION AND HANDLING

1.0 PURPOSE

This SOP describes the appropriate containers for samples of particular matrices, and the steps necessary to preserve those samples when shipped off site for chemical analysis. It also identifies the qualifications for individuals responsible for the transportation of hazardous materials and samples and the regulations set forth by the Department of Transportation regarding the same.

2.0 SCOPE

Some chemicals react with sample containers made of certain materials; for example, trace metals adsorb more strongly to glass than to plastic, while many organic chemicals may dissolve various types of plastic containers. It is therefore critical to select the correct container in order to maintain the integrity of the sample prior to analysis.

Many water and soil samples are unstable and may change in chemical character during shipment. Therefore, preservation of the sample may be necessary when the time interval between field collection and laboratory analysis is long enough to produce changes in either the concentration or the physical condition of the constituent(s). While complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that may occur after the sample is collected.

Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/freezing. Their purposes are to (1) retard biological activity, (2) retard hydrolysis of chemical compounds/complexes, (3) reduce constituent volatility, and (4) reduce adsorption effects.

Typical sample container and preservation requirements for this project are provided in Attachment A of this SOP. Note that sample container requirements (i.e., volumes) may vary by laboratory.

The Department of Transportation, Code of Federal Regulations (CFR) Title 49 establishes regulations for all materials offered for transportation. The transportation of environmental samples for analysis is regulated by Code of Federal Regulations Title 40 (Protection of the Environment), along with 49 CFR Part 172 Subpart H. The transportation of chemicals used as preservatives and samples identified as hazardous (as defined by 49 CFR Part 171.8) are regulated by 49 CFR Part 172.

3.0 DEFINITIONS

HCl - Hydrochloric Acid

H_2SO_4- Sulfuric Acid

HNO_3 - Nitric Acid

$NaOH$ - Sodium Hydroxide

<u>Normality (N)</u> - Concentration of a solution expressed as equivalents per liter, where an equivalent is the amount of a substance containing one mole of replaceable hydrogen or its equivalent. Thus, a one molar

solution of HCl, containing one mole of H, is "one-normal," while a one molar solution of H_2SO_4 containing two moles of H, is "two-normal."

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is also responsible for proper certification of individuals responsible for transportation of samples of hazardous substances.

Field Team Leader - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures. The Field Team Leader is responsible to ensure all samples and/or hazardous substances are properly identified, labeled, and packaged prior to transportation.

Sampling Personnel - It is the responsibility of the field sampling personnel to initiate sample preservation and handling. It is also the responsibility of the field sampling personnel to understand and adhere to the requirements for proper transportation of samples and/or hazardous substances.

5.0 PROCEDURES

The following procedures discuss sample containerization and preservation techniques that are to be followed when collecting environmental samples for laboratory analysis.

5.1 Sample Containers

For most samples and analytical parameters either glass or plastic containers are satisfactory. In general, if the analyte(s) to be measured is organic in nature, the container shall be made of glass. If the analyte(s) is inorganic, then glass or plastic containers may be used. Containers shall be kept out of direct sunlight (to minimize biological or photo-oxidation/photolysis of constituents) until they reach the analytical laboratory. The sample container shall have approximately five to ten percent air space ("ullage") to allow for expansion/vaporization if the sample is heated during transport (one liter of water at 4EC expands by 15 milliliters if heated to 130EF/55EC); however, head space for volatile organic analyses shall be omitted.

Soil samples that will be tested for volatile organic compounds should generally be stored in EnCore^{TM} samplers in accordance with SW-846 Method 5035.

The analytical laboratory shall provide sample containers that have been certified clean according to USEPA procedures. Shipping containers for samples, consisting of sturdy ice chests, are to be provided by the laboratory.

Once opened, the sample container must be used at once for storage of a particular sample. Unused, but opened, containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or missing liners (if required for the container) shall be discarded.

General sample container, preservative, and holding time requirements are listed in Attachment A.

5.2 Preservation Techniques

The preservation techniques to be used for various analytes are listed in Attachment A. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or added in the field using laboratory supplied preservatives. Some of the more commonly used sample preservation techniques include storage of sample at a temperature of 4EC, acidification of water samples, and storage of samples in dark (i.e. amber) containers to prevent the samples from being exposed to light.

Most samples (except metals) shall be stored at a temperature of 4EC. Additional preservation techniques shall be applied to water samples as follows:

- Water samples to be analyzed for volatile organics shall be acidified.
- Water samples to be analyzed for semivolatile organics shall be stored in dark containers.
- Water samples to be analyzed for pesticides/PCBs shall be stored in dark containers.
- Water samples to be analyzed for inorganic compounds shall be acidified.

These preservation techniques generally apply to samples of low-level contamination. The preservation techniques utilized for samples may vary. However, unless documented otherwise in the project plans, all samples shall be considered low concentration. All samples preserved with chemicals shall be clearly identified by indicating on the sample label that the sample is preserved.

5.3 Sample Holding Times

The elapsed time between sample collection and initiation of laboratory analyses is considered the holding time and must be within a prescribed time frame for each individual analysis to be performed. Sample holding times for routine sample collection are provided in Attachment A.

6.0 SAMPLE HANDLING AND TRANSPORTATION

After collection, the outside of all sample containers will be wiped clean with a damp paper towel; however sample handling should be minimized. Personnel should use extreme care to ensure that samples are not contaminated. If samples are placed in an ice chest, personnel should ensure that melted ice cannot cause sample containers to become submerged, as this may result in sample cross-contamination and loss of sample labels. To help prevent loss of labels, clear packing tape should be placed over the labels. Additionally, Sealable plastic bags, (zipper-type bags), should be used when glass sample containers are placed in ice chests to prevent cross-contamination, if breakage should occur.

Samples may be hand delivered to the laboratory or they may be shipped by common carrier. Relevant regulations for the storage and shipping of samples are contained in 40 CFR 261.4(d). Parallel state regulations may also be relevant. Shipment of dangerous goods by air cargo is also regulated by the United Nations/International Civil Aviation Organization (UN/ICAO). The Dangerous Goods Regulations promulgated by the International Air Transport Association (IATA) meet or exceed DOT and UN/ICAO requirements and should be used for shipment of dangerous goods via air cargo. Standard procedures for shipping environmental samples are given in Attachment B.

7.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, Washington, D.C.

USEPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

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Protection of the Environment, Code of Federal Regulation, Title 40, Parts 260 to 299.

Transportation, Code of Federal Regulation, Title 49, Parts 100 to 177.

ATTACHMENT B

SAMPLE SHIPPING PROCEDURES

ATTACHMENT B

SAMPLE SHIPPING PROCEDURES

Introduction

Samples collected during field investigations or in response to a hazardous materials incident must be classified by the project leader, prior to shipping by air, as either environmental or hazardous substances. The guidance for complying with U.S. DOT regulations in shipping environmental laboratory samples is given in the “National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples.”

Pertinent regulations for the shipping of environmental samples are given in 40 CFR 261.4(d). Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods/hazardous substance. Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by the United Nations International Civil Aviation Organization (UN/ICAO), which is equivalent to IATA.

Individuals responsible for transportation of environmental samples or dangerous goods/hazardous substances must be tested and certified by their employer. This is required by 49 CFR Part 172 Subpart H Docket HM-126 to assure the required qualifications for individuals offering materials for transportation.

Environmental samples shall be packed prior to shipment by commercial air carrier using the following procedures:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug (inside and outside) with fiber or duct tape. Line the cooler with a large heavy duty plastic bag. This practice keeps the inside of the cooler clean and minimizes cleanup at the laboratory after samples are removed.

2. Allow sufficient headspace (ullage) in all bottles (except VOAs) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

3. Be sure the lids on all bottles are tight (will not leak). In many regions custody seals are also applied to sample container lids. The reason for this practice is two-fold: to maintain integrity of samples and keep lid on the container should the lid loosen during shipment. Check with the appropriate regional procedures prior to field work. In many cases, the laboratory manager of the analytical lot to be used on a particular project can also provide this information.

4. It is good practice to wrap all glass containers in bubblewrap or other suitable packing material prior to placing in plastic bags.

5. Place all bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape, unless the bag is a zipper-type bag). Up to three VOA bottles, separately wrapped in bubblewrap, may be packed in one plastic bag.

6. Put ice that has been placed in properly sealed, double-bagged, heavy duty polyethylene bags on top of and between the samples. Fill all remaining space between the bottles with packing material. Fold and securely fasten the top of the large heavy duty plastic bag with tape (preferably electrical or duct).

7. Place the Chain-of-Custody Record and the Request for Analysis Form (if applicable) into a plastic bag, tape the bag to the inner side of the cooler lid, and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler unit. Wrap the tape three to four times around each side of the cooler unit. Chain-of-custody seals (if required) should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

8. Label according to 40 CFR 261.4(d). The shipping containers should be marked “THIS END UP,” and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper and laboratory shall be placed on the outside of the container. It is good practice to secure this label with clear plastic tape to prevent removal during shipment by blurring of important information should the label become wet. The commercial carrier is not required to sign the COC record as long as the custody seals remain intact and the COC record stays in the cooler. The only other documentation required is the completed airbill, which is secured to the top of the shipping container. Please note several coolers/shipping containers may be shipped under one airbill. However, each cooler must be labeled as “Cooler 1 of 3, Cooler 2 of 3, etc.,” prior to shipping. Additionally it is good practice to label each COC form to correspond to each cooler (i.e., 1 of 3, 2 of 3, etc.).

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - CHAIN-OF-CUSTODY

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Effective Date: 04/94

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CHAIN-OF-CUSTODY

1.0 PURPOSE

The purpose of this SOP is to provide information on chain-of-custody procedures to be used to document sample handling.

2.0 SCOPE

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

3.0 DEFINITIONS

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file. An example of a Chain-of-Custody Record Form is presented in Attachment B.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one=s custody if:

- ! It is in one=s actual possession.
- ! It is in one=s view, after being in one=s physical possession.
- ! It was in one=s physical possession and then he/she locked it up to prevent tampering.
- ! It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field

Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

5.0 PROCEDURES

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, record keeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

5.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook (or other suitable form), when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s)
- Project and Task Number
- Project Sample Number
- Sample location or sampling station number
- Date and time of sample collection and/or measurement
- Field observations
- Equipment used to collect samples and measurements
- Calibration data for equipment used

Measurements and observations should be recorded using waterproof ink.

5.1.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes (at a minimum):

- Project Name or Project Number.
- Station Location - The unique sample number identifying this sample.

Additional information on the sample label may also include:

- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 12/21/85).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

5.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

5.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.

5.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. When transferring the possession of samples, the individual(s) relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below.

- Enter header information (Project and Task number, samplers, and project name).

- Enter sample specific information (sample number, media, sample analysis required and analytical method, grab or composite, number and type of sample containers, and date/time sample was collected).

- Sign, date, and enter the time under "Relinquished by" entry.

- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).

- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner.

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.

- Place the seal across the shipping container opening so that it would be broken if the container was to be opened.

- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

6.0 QUALITY ASSURANCE RECORDS

Once samples have been packaged and shipped, the COC copy and airbill receipt becomes part of the Quality Assurance Record.

7.0 REFERENCES

1. USEPA. User's Guide to the Contract Laboratory Program. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

FIELD EQUIPMENT OPERATION AND MAINTENANCE PROCEDURES - FIELD LOGBOOK

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SOP Number: F303
Effective Date: 03/05

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FIELD LOGBOOK FIELD LOGBOOK

1.0 PURPOSE

This SOP describes the process for maintaining a field logbook.

2.0 SCOPE

The field logbook is a document which records all major on-site activities conducted during a field investigation. At a minimum, the following activities/events shall be recorded in the field logbook by each member of the field crew.

- Arrival/departure of site workers and visitors
- Arrival/departure of equipment
- Sample pickup (sample numbers, carrier, time)
- Sampling activities
- Start and completion of boreholes, monitoring wells, or sampling activities
- Health and safety issues

Recording in the field logbook is initiated upon arrival at the site. Entries are made every day that on-site activities take place. At least one field logbook shall be maintained per site.

The field logbook becomes part of the permanent site file. Because information contained in the field logbook may be admitted as evidence in legal proceedings, it is critical that this document is properly maintained.

3.0 DEFINITIONS

<u>Field logbook</u> - The field logbook is a bound notebook with consecutively numbered pages. Upon entry of data, the logbook requires the signature of the responsible data/information recorder.

4.0 RESPONSIBILITIES

The Field Team Leader is responsible for maintaining a master field logbook for the duration of on-site activities. Each member of the sampling crew is responsible for maintaining a complete and accurate record of site activities for the duration of the crew members participation in the project.

5.0 PROCEDURES

The following sections present some of the information that must be recorded in the field logbook. In general, a record of all events and activities, as well as other potentially important information shall be recorded by each member of the field team.

5.1 <u>Cover</u>

The inside cover or title page of each field logbook shall contain the following information:

- Project and Task Number
- Project name and location
- Name of Field Team Leader
- Baker's address and telephone number (toll-free number preferably)
- Start date
- If several logbooks are required, a sequential field logbook number

It is good practice to list important phone numbers and points of contact here. This may include the telephone number of the hotel where the field crew is residing as well as applicable mobile phone number. The inclusion of this information may be invaluable if the field logbook is lost during field activities.

5.2 Daily Entries

Daily entries into the logbook may contain a variety of information. At the beginning of each day the following information should be recorded by each team member.

- Date
- Start time
- Weather
- All field personnel present (including subcontractors)
- All visitors present
- Other pertinent information (i.e., planned activities, schedule changes, expected visitors, and equipment changes)

During the day, an ongoing record of all pertinent site activities should be written in the logbook. The master logbook kept by the field team leader need not duplicate that recorded in other field logbooks, but should summarize the information in other books and, where appropriate, reference the page numbers of other logbooks where detailed information pertaining to a subject may be found.

Some specific information which should be recorded in the logbook includes the following:

- Equipment used, equipment numbers, calibration data, field servicing
- Field measurements
- Sample numbers, media, bottle size, preservatives, collection methods, and time
- Test boring and monitoring well construction information, including boring/well number and location
- Sketches for each sample location including appropriate measurements if required
- Photograph log
- Drum log
- Other pertinent information

All entries should be made in indelible ink; all pages numbered sequentially; and all pages must be signed or initialed and dated by the responsible field personnel completing the log. No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single line, initialed, and dated.

5.3 Photographs

If photographs are permitted at the site, the record shall be maintained in the field logbook. When movies, slides or photographs are taken of any site location, they are numbered or cross-referenced to correspond to logbook entries. The name of the photographer, date, time, site location, site description, direction of view and weather conditions are entered in the logbook as the photographs are taken. Special lenses, film, or other image-enhancement techniques also must be noted in the field logbook. Once processed, photographs shall be sequentially numbered and labeled corresponding to the field logbook entries.

6.0 QUALITY ASSURANCE RECORDS

Once on-site activities have been completed, the field logbook shall be considered a quality assurance record and stored in the project files at Baker's respective office.

7.0 REFERENCES

None.