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**Final  
Field Sampling Plan Addendum  
for  
Occidental Chemical Corporation Property Data Gap and  
Lewiston-Porter Central School District Investigations  
at the Former Lake Ontario Ordnance Works (LOOW)  
Niagara County, New York**

**Addendum to the  
Phase IV Remedial Investigation of the  
Wastewater Treatment Plant (EU7)  
Field Sampling Plan**

August 2010

*Prepared for*

U.S. Army Corps of Engineers  
Baltimore District

Contract W912DR-06-D-0002  
Delivery Order 0009

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## COMPLETION OF SENIOR TECHNICAL REVIEW

This document has been produced within the framework of the Earth Resources Technology, Inc. (ERT) and EA Engineering, Science, and Technology, Inc. (EA) quality management system. As such, a senior technical review, as defined in the Quality Control Plan for this project, has been conducted. This included review of the overall design addressed within the document, proposed or utilized technologies and alternatives and their applications with respect to project objectives and framework of United States Army Corp of Engineers (USACE) regulatory constraints under the current Defense Environmental Restoration Program – Formerly Used Defense Sites (DERP-FUDS) No. C02NY0025 project, within which this work has been completed.

[REDACTED]

12 July 2010

[REDACTED] (EA)  
Senior Technical Reviewer

Date

## COMPLETION OF INDEPENDENT TECHNICAL REVIEW

This document has been produced within the framework of ERT's total quality management system. As such, an independent technical review, appropriate to the level of risk and complexity inherent in the project as defined in the Quality Control Plan (QCP) for this project, has been conducted. This included review of assumptions (methods, procedures, and material used in analyses), alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the project objectives. Comments and concerns resulting from review of the document have been addressed and corrected as necessary.

[REDACTED]

9 July 2010

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Independent Technical Reviewer

Date

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**LIST OF ACRONYMS**

AGC	US Army Geospatial Center
AL	Action level
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIH	Certified Industrial Hygienist
COPC	Constituent of Potential Concern
DERP	Defense Environmental Restoration Program
DI	Deionized
DOD	Department of Defense
DOE	Department of Energy
EA	EA Engineering, Science and Technology, Inc.
ELAP	Environmental Laboratory Accreditation Program
ERT	Earth Resources Technology, Inc
EU	Exposure Unit
EU 7	Wastewater Treatment Plant
EU 8	Occidental Property
ft	foot/feet
FS	Feasibility Study
FSP	Field Sampling Plan
FUDS	Formerly Used Defense Sites
GIS	Geographical Information System
GPS	Global Positioning System
HASL	Health and Safety Laboratory
HCl	Hydrochloric acid
HI	Hazard Index
HNO <sub>3</sub>	Nitric acid
HTRW	Hazardous, Toxic, and Radioactive Waste
IDW	Investigation Derived Waste
L	liter
LOOW	Lake Ontario Ordnance Works
LPCSD	Lewiston-Porter Central School District
mg/kg	milligrams per kilogram
mL	milliliter
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not applicable
NFSS	Niagara Falls Storage Site
NPL	National Priorities List
NYSDEC	New York State Department of Environmental Conservation
OCCP	Occidental Chemical Corporation Property
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl

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PEI	Panamerican Environmental Inc.
PID	Photoionization detector
PM	Project Manager
PRG	Preliminary Remedial Goal
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCP	Quality Control Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RIC	Reactivity, ignitability, and corrosivity
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SOW	Scope of Work
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
STR	Senior Technical Review
SVOC	Semi-volatile organic compound
SWDD	Southwest Drainage Ditch
TA	Test America
TAGM	Technical and Administrative Guidance Memorandum
TAL	Target Analyte List
TBC	To-be-considered
TBD	To-be-determined
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TEC	Topographic Engineering Center
TNB	Trinitrobenzene
TNT	Trinitrotoluene
TPH-DRO	Total Petroleum Hydrocarbons-Diesel Range Organics
TPP	Technical Project Planning
USACE	United States Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UXO	Unexploded ordnance
VOA	Volatile organic analysis
VOC	Volatile organic compound
WWTP	Waste Water Treatment Plant
µg/L	Micrograms per liter
°C	degrees Celsius

## **EXECUTIVE SUMMARY**

*This section of the original Phase IV Remedial Investigation (RI) Field Sampling Plan (FSP) Addendum (United States Army Corps of Engineers [USACE]/ Earth Resources Technology, Inc. [ERT], 2009h) is hereby replaced in its entirety by the following.*

Under contract number W912DR-06-D-0002, delivery order 0009 with the USACE-Baltimore, ERT has been tasked with conducting a Data Gap Investigation at the Occidental Chemical Corporation Property (OCCP) (EU 8) in support of an ongoing Feasibility Study (FS) and an Environmental Investigation at the Lewiston-Porter Central School District (LPCSD) at the former Lake Ontario Ordnance Works (LOOW) site in Niagara County, New York (NY).

The work at EU 8 is being conducted under the ongoing authorized Defense Environmental Restoration Program—Formerly Used Defense Sites (DERP-FUDS) Hazardous, Toxic, and Radioactive Waste (HTRW) project and as outlined in the scope of work (SOW) dated 30 June 2009. The work being performed at the LPCSD will address concerns identified by a review of historical aerial photographs which indicate potential impacts related to possible previous Department of Defense (DOD) activities at the school. It will also address drainages on the school property that originate near the federally owned Niagara Falls Storage Site property

The FSP Addendum detailed herein comprises the first part of the Sampling and Analysis Plan (SAP). The FSP presents the methods to be used for field sampling and data acquisition activities associated with the OCCP Data Gap and the LPCSD Investigations. The associated Quality Assurance Project Plan (QAPP) Addendum comprises part two of the SAP (USACE/ERT, 2009a). The SAP should be reviewed in conjunction with the other planning documents associated with the investigations, including:

- Site-Specific Safety and Health Plan Addendum (USACE/ERT, 2009b, 2010b)
- Radiation Safety Plan Addendum (USACE/ERT, 2009c)
- Field Sampling Plan Addendum (USACE/ERT, 2009h)

Other plans associated with the original Phase IV RI efforts are not applicable to the work covered within this FSP. These plans include: Asbestos Containing Material Removal Work Plan Addendum (USACE/ERT, 2009d), Munitions and Explosives of Concern Support Services Plan Addendum (USACE/ERT, 2009e), Human Health Risk Assessment Work Plan (USACE/ERT, 2009f), and Screening Level Ecological Risk Assessment Work Plan (USACE/ERT, 2009g).

The investigations covered by this addendum will employ the same sampling and analytical protocols and methods as those utilized in the previous Phase IV RI in order to maintain consistency of method reproducibility and representativeness of data. Therefore, this document is presented as an Addendum to the Phase IV FSP (USACE/ERT, 2009h). However, because sampling locations, number of samples, and sampling rationale differ from those presented in the original Phase IV RI FSP, this addendum presents the sampling and analytical program in sufficient detail so the reader can understand the data collection activities and methods associated with this work. Where there are no changes to particular sections or subsections, the reader is referred to the original Phase IV RI FSP (USACE/ERT, 2009h).



## **1.0 INTRODUCTION**

*This section of the original Phase IV Remedial Investigation (RI) Field Sampling Plan (FSP) Addendum (United States Army Corps of Engineers [USACE]/ Earth Resources Technology, Inc. [ERT], 2009h) is hereby replaced in its entirety by the following.*

This FSP is part one of an addendum to the *Final Field Sampling Plan Addendum for Phase IV Remedial Investigation-Town of Lewiston Property at the Former Lake Ontario Ordnance Works (LOOW) Niagara County, New York (USACE/ERT, 2009h)*. The Sampling and Analysis Plan (SAP) is comprised of the *Field Sampling Plan Addendum for the Occidental Chemical Corporation Property Data Gap and the Lewiston-Porter Central School District Investigations at the Former Lake Ontario Ordnance Works (LOOW) Niagara County, New York*, herein referred to as “FSP” and the *Quality Assurance Project Plan Addendum for the Occidental Chemical Corporation Property Data Gap Investigation and the Lewiston-Porter Central School District Investigation at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, New York (USACE/ERT, 2009a)*, herein referred to as the “Quality Assurance Project Plan (QAPP).” The analytical methodologies, details on quality control requirements, data assessment, and reporting requirements are presented in the QAPP and should be reviewed in conjunction with this addendum prior to initiating field activities. Figure 1-1 illustrates the location of LOOW.

This addendum details the specific locations and rationale for collection of proposed soil, surface water and sediment samples from the formerly used Department of Defense (DOD) locations on the OCCP and the undeveloped portions of the Lewiston-Porter Central School District (LPCSD) campus. The sampling locations are based on a detailed review of historic DOD operations and historic photographs, sampling results described in the Phase I and Phase II RI Reports, and other historical sources of information regarding the potential impacts. Section 4 presents the activities required prior to initiating the sampling program. Section 5 presents the site-specific sampling program.

Other planning documents, including the Site Safety and Health Plan (SSHP) Addendum (USACE/ERT, 2010a), QAPP Addendum (USACE/ERT, 2010b) and Radiation Safety Plan Addendum (USACE/ERT, 2009c) collectively comprise the Work Plan for the OCCP Data Gap Investigation and LPCSD Investigation at the former LOOW.

### **1.1 Site History**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

#### **1.1.1 OCCP History**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

Occidental Chemical Corporation currently owns approximately 304 acres south of Balmer Road within an area of the former LOOW that is west of the former Trinitrotoluene (TNT) production area and wastewater treatment plant (WWTP) (Figure 1-2). Based on a review of historical aerial photographs taken between 1938 and 1956, an area located in the southwest portion of the



property appeared to be fenced in and show indications of potential usage. The area in question was approximately 500 feet (ft) by 400 ft in size. Historical documents available for review do not reference the presumed storage area and due to the time frame which coincided with DOD ownership, the area was included for investigation during the Phase II RI.

### **1.1.2 LPCSD Property History**

The DOD owned the land parcel associated with the LPCSD campus from 1945 until 1952, when it was transferred to the General Services Administration (Figure 1-3). The parcel was part of the former LOOW Buffer Zone and documented DOD activities consisted of the construction and use of the 30-inch (in.) outfall line and the southwest drainage ditch (SWDD). During DOD ownership, the 30-in. outfall line transferred TNT wastewater, acid neutralized wastewater and sanitary wastewater from the former LOOW WWTP to the Niagara River. After the transfer of the parcel to the LPCSD, the 30-in. outfall line also accepted waste from the former Air Force Plant 68 and Nike base. The portion of the 30-in. outfall that traverses the campus is constructed of terracotta pipe encased in concrete forms and buried approximately 6 ft below ground surface (bgs) (USACE/ EA Engineering, Science, and Technology, Inc. [EA], 2008). Where the 30-in. outfall traverses the SWDD, it is suspended above the SWDD.

The SWDD is a manmade drainage originally constructed to improve surface drainage across the former LOOW. Although not intended for the drainage of wastes, surface drainage and runoff or spills from facilities near the ditch may potentially impact the SWDD.

The school district currently maintains a 376 acre campus consisting of an elementary school, middle school, and high school. The acreage currently maintained by the school was formerly part of the buffer zone (also known as the undeveloped zone) for the former LOOW. Construction of the Lewiston-Porter School campus began in the early 1950's with the construction of the North Elementary Building (USACE, EA, 1998).

### **1.1.3 Previous USACE Investigations Addressing OCCP and LPCSD Properties**

An ongoing RI/FS is assessing the nature and extent of contamination associated with the former LOOW operations and subsequent DOD operations at areas of concern (AOCs) fully eligible for investigation within the approved and ongoing DERP-FUDS HTRW program. During these previous RI phases, Exposure Units (EU's) were established from the AOC's and a quantitative risk assessment was performed. The risk assessment included the OCCP.

The OCCP was characterized during the Phase II RI and associated risk assessment (USACE/EA, 2002). Portions of the LPCSD property with known DOD activity were also included in the RI [i.e., the soil in the vicinity of the 30-in.outfall line].

#### **1.1.3.1 Historical Aerial Photography**

The US Army Topographic Engineering Center (TEC), near Alexandria, Virginia, completed an examination of historic aerial photos of the former LOOW and identified ground anomalies including ground scars, disturbed ground, and debris piles (TEC, 2002). The photos studied were from 1938, 1942, 1944, 1951, 1956, 1958, 1960, 1963, 1972, 1978, 1981, 1985, 1990, 1995, and 1997, and the anomalies identified in the photos are considered areas of possible DOD activity. Anomalies that were identified in association with the LPCSD campus were

categorized as mounded material. However, other than the construction of the 30-in. outfall line and the SWDD, there are no other available documents which indicate DOD use of the LPCSD property. The TEC database associated with the aerial anomaly investigation stated that the mounds “may be associated with local farming.” (TEC, 2002). Small bermed clearings and ground scars from the timeframe of DOD ownership were also visible on the OCCP.

Additionally, historical photos from 1938 through 1956 showed a fenced in area within the southwest portion of the OCCP (the area of the previously identified 55-gallon drum and impacted surface soil) and ground scarring (TEC, 2002), which may indicate previous DOD use as a storage area.

The US Army Geospatial Center (AGC), near Alexandria, Virginia, completed an examination of historical aerial photos of Niagara Falls Storage Site (NFSS) and identified additional ground anomalies including ground scars, disturbed ground and debris piles, not included in the previous TEC historic aerial photo analysis of the former LOOW. The photos studied were from 1942, 1944, 1951, 1956, 1958, 1978, 1985, 1990, and 1995, and the anomalies identified in the photos are considered areas of possible DOD activity. Anomalies that were identified in association with the LPCSD campus were categorized as mounded material, ground scars, pits transportation pathways and drainage ditches. AGC stated that mounding and ground scarring may be due to local agricultural activity (AGC, 2009).

#### *1.1.3.2 Phase I RI*

During the Phase I RI, subsurface soil samples were collected from below the 30-in. outfall line, which traverses both the Occidental Chemical Corporation and LPCSD properties. The samples were field screened for TNT and four samples were submitted for DOD marker compound analysis (boron, lithium and explosives). The results of the sample analysis indicated boron and lithium concentrations below the screening criteria and non-detection of explosives. Based on the results of the sample analysis, it was concluded that the results did not indicate an impact from the DOD marker compounds (USACE/EA, 1999).

#### *1.1.3.3 Phase II RI*

Ten surface soil samples, nine subsurface soil samples and one sample of an abandoned 55-gallon drum contents were collected from the presumed storage area on the OCCP during field activities associated with the Phase II RI. Contents of the drum were a caked, fibrous material which due to the degradation of the drum was observed on the ground surface (USACE/EA, 2002). Collected soil samples were laboratory analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), Target Analyte List (TAL) metals, boron, lithium, pesticides, polychlorinated biphenyls (PCBs) and explosives.

Pesticides, PCBs, VOC, and most SVOCs were either not detected or were reported at concentrations that did not exceed the project screening criteria in the collected samples. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, 2,4,6-trinitrotoluene and 2,6-dinitrotoluene (all SVOCs) were detected at concentrations exceeding the health-based screening criteria in the surface soil sample collected from beneath the drum contents (Figure 1-4) (USACE/EA, 2002).

Boron, cadmium, chromium, copper, lithium, selenium and thallium were detected at concentrations exceeding background concentrations in various surface soil samples. Chromium, manganese and thallium exceeded the site background concentrations in various subsurface soil samples.

The highest concentrations of constituents exceeding screening and background criteria were collected from the central portion of the fenced area. The area of the samples was identified as an apparent disposal area based on observations of the field sampling team identification of visible debris, drums, and topographic mounding. The highest reported concentrations of polycyclic aromatic hydrocarbons (PAHs), explosives, and metals were reported in the surface soil sample collected from beneath the degraded drum and associated contents.

Figure 1-4 presents the sample locations and constituent concentrations exceeding the screening criteria and background concentrations.

Analytical results of four soil samples collected from the LPCSD campus were assessed with other similar soil samples and used to derive background constituent concentrations at LOOW. Appendix A, from the Phase II RI report provides details of the process used to establish background soil concentrations LOOW site.

#### *1.1.3.4 LPCSD Sampling*

Surface soil samples were collected in 2001 at locations previously identified by USACE background sampling efforts that detected elevated concentrations of arsenic, as compared to the United States Environmental Protection Agency (USEPA) Region 9 Preliminary Remediation Goals (PRGs). During three separate sampling events, a total of 32 soil samples were collected and analyzed for lead and arsenic (Chopra Lee, 2001a, 2001b, and 2001c). Arsenic concentrations ranged from 3.98 milligrams per kilogram (mg/kg) to 58.5 mg/kg.

#### *1.1.3.5 Gamma Walkover Survey*

A gamma background study was performed on the LPCSD campus and used to compare a data set of background measurements obtained at the New York Army National Guard Weekend Training Site located on Balmer Road. The LPCSD campus was selected due to proximity and upwind location to the NFSS. The intent was to measure gamma radiation levels of surface media (i.e., soil, asphalt, concrete and gravel) using gamma radiation detectors linked to global positioning instruments.

The results of the survey were considered typical of properties found at similar properties, due to natural variations of elements found in the environment, as well as man-made construction and development projects (USACE/SAIC, 2002).

#### *1.1.3.6 LPCSD SWDD Sampling*

In response to citizen concerns, during 2002 three samples were collected from the SWDD which transects the school campus. The samples were collected from the point at which the SWDD enters the school campus, exits the school campus, and at a point centrally located along the SWDD within the school campus. The Niagara County Department of Health was asked to review the analytical results and found that the detected inorganic constituents were similar to background concentrations and below concentrations of concern to human health or the environment.

#### *1.1.3.7 LPCSD Playground Area Sampling*

LPCSD contracted Chopra-Lee, Inc. to collect three soil samples from the school campus in association with the construction of two playground areas. While PAHs were detected in a mound of soil that was sampled, the identified playground areas were concluded to not present a threat to human health, (Chopra-Lee, 2003).

#### *1.1.3.8 University of Buffalo Environment and Society Institute Study*

In 2004, Joseph Gardella and four graduate assistants at the University of Buffalo Environment and Society Institute published the results of a soil investigation conducted at the LPCSD property (Gardella et al, 2004). Samples were collected throughout different areas of the campus and analyzed for metals, SVOCs, PAHs, pesticides, PCBs, and DOD marker compounds (lithium, boron, and cesium). Results of the sample analysis identified elevated concentrations of arsenic and PAHs concentrations in the vicinity of the Campus Community Resource Center. No other compounds, including DOD marker compounds were detected at concentrations greater than background data and/or the New York State Department of Environmental Conservation (NYSDEC) Technical Administrative Guidance Memorandum (TAGM) soil cleanup objectives (Gardella et al 2004).

#### *1.1.3.9 LPCSD Soil Sampling*

In 2004, the LPCSD contracted Panamerican Environmental, Inc. (PEI) to conduct soil sampling as a follow-up to the sampling completed by the University of Buffalo. The objective of the 2004 sampling effort was to further investigate levels of arsenic, lead, and PAHs detected in the vicinity of the Campus Community Resource Center (PEI, 2004). Four samples were collected from each of 15 boring locations and analyzed for lead, arsenic and PAHs. Arsenic was not detected in any of the collected samples and lead was detected at concentrations below the TAGM level of 13 mg/kg. Slightly elevated levels of PAHs were identified from an area of construction/demolition material (PEI, 2004).

In 2005, PEI re-sampled ten locations to confirm arsenic and lead concentrations. The sampling was performed due to differences between their 2004 findings, which did not identify concentrations of arsenic, and the University of Buffalo findings that detected arsenic concentrations in each of the sampling areas (PEI, 2005). Concentrations of lead were consistent with the previous results and the detected concentration of arsenic, although lower concentrations, were consistent with the analytical data presented by Gardella in 2004 (PEI, 2005).

In 2006 PEI conducted another follow-up investigation, collecting five samples from each of four locations at depths ranging from the surface to four ft bgs. Samples were analyzed for arsenic and lead. Detected lead concentrations were below the TAGM level. Three of the five samples indicated arsenic concentrations greater than the TAGM soil cleanup levels. In addition, it was determined that the arsenic concentrations diminished proportionally with increased depth below grade (PEI, 2005).

In response to the elevated metals concentrations identified adjacent to the Campus Community resource Center and future plans to redevelop the campus, the school district contracted PEI to prepare a Soils Management Plan for the LPCSD campus (PEI, 2007), with the intent of

developing a plan to manage soils containing elevated concentrations of metals during current and future redevelopment projects.

#### 1.1.3.10 Phase III RI

During the Phase III RI (USACE/EA 2008), one sediment and one surface water sample were collected from the SWDD beneath the 30-in. outfall line where it traverses the SWDD. The results of the sample analysis indicated that constituent concentrations were comparable to the established background concentrations (USACE/EA, 2008).

### 1.2 Project Organization and Responsibilities

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

The overall project organization and management are described in this section. The work described in these investigations is being performed voluntarily under the authority of the USACE, as intended within the DERP-FUDS program. The FSP was developed in accordance with EM 200-1-3, Requirements for the Preparation of a Sampling and Analysis Plan (USACE, 2001). The NYSDEC may provide project input with respect to NY State regulations and guidance governing waste sites and investigations. The NY State Department of Health may provide additional oversight, particularly in reference to potential human health risk. The work outlined in the SAP shall follow Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) guidance and applicable Federal, State, and USACE regulations and guidance. The responsibilities of key project team members are provided as Figure 1-5. ERT is tasked with full responsibility to fulfill the requirements of the SOW, including planning, execution and reporting. EA will be providing technical support to ERT during the execution of this project. The ERT/EA team will work together as one seamless unit, with individuals from each firm working together to provide the highest quality deliverables. Additional subcontractors may be utilized for field activities as discussed in Section 1.5.

### 1.3 Project Delivery Team

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

The key project team members are provided as Figure 1-5. Additional individuals may be added to the project team as warranted.

#### **Program Manager**

██████████ ERT's President, is responsible for contracting, oversees contract specifications to be included in the execution of the project task, and has ultimate responsibility for client satisfaction. ██████████ has been the Program Manager for USACE HTRW projects for three years and has been managing USACE projects for over 15 years.

### **Project Principle for Quality Control**

██████████ is ERT's Chief Operating Officer and has 30 years experience in government contracting and quality assurance review. As the Project Principle, ██████████ provides overall project quality control by way of regular project review meetings in which client needs are reviewed, costs and schedules are assessed, and overall client satisfaction is monitored. The Project Principle is also consulted when decisions are made as to whether subcontractors are needed to provide additional technical, analytical, managerial, or professional capabilities.

### **Project Manager**

██████████ is responsible for managing schedule changes and funding needs, providing appropriate resources for execution of the SOW, developing the project delivery team, assisting in the design of the project with respect to overall objectives, and managing the final senior technical review (STR) and independent technical review of all project deliverables. ██████████ has over 30 years of experience and has served as a Deputy Program Manager and Project Manager (PM) on a number of USACE-Baltimore contracts.

### **Technical Task/Site Manager**

██████████ ney will be the Technical Task/Site Manager, responsible for organizing day-to-day tasks of a multidisciplinary technical staff, and promoting the efficient completion of tasks outlined in Section 2. He will be the primary staff responsible for production of planning documents, developing sampling plans, performing analysis to meet project quality objectives, and coordinating field efforts.

### **Field Team Leader**

██████████ is an Environmental Scientist who will serve as the Field Team Leader, responsible for organizing all field activities related to the Occidental Chemical Corporation Property Data Gap Investigation and the LPCSD Investigation, completing all field-related activities in an efficient and responsible manner, and ensuring adherence to all aspects of the approved Work Plan by field personnel.

### **Project Geologist**

██████████ will be the Project Geologist responsible for organizing day-to-day tasks of a multidisciplinary technical staff, and promoting the efficient completion of tasks outlined in the scope of work and approved work plans. ██████████ will be the technical lead for oversight of the subsurface soil sampling and data logging. He will also oversee the environmental sampling efforts, coordinating activities with the other field teams and the Site Manager.

### **Site Safety and Health Officer/UXO Technician III/UXO Safety Officer**

██████████ will also be designated as the Site Safety and Health Officer (SSHO) for all field tasks. The primary responsibility of the SSHO will be to ensure that all requirements of the SSHP are fully enforced for all field activities. The SSHO has the authority to stop work for health and safety concerns should the need arise.

The SSHO will be onsite throughout the project and will be responsible for daily compliance with site safety and health requirements. The SSHO will have the following responsibilities:

- Ensure all site activities are performed in a manner consistent with ERT's Corporate Safety and Health Program and the SSHP.

- Interface with the Project Certified Industrial Hygienist (CIH) about on-site implementation of the SSHP.
- Direct daily health and safety activities onsite.
- In conjunction with the PM, ensure that all of ERT's personnel and subcontractors designated to work at the project sites are qualified according to ERT's medical surveillance and training requirements.
- Report all incidents, accidents, and near misses to the PM, Site Manager, and the USACE Authorized Representative.
- Maintain health and safety equipment onsite.
- Inspect ongoing activities, and report any health and safety deficiencies to the Site Manager and PM.
- Accompany or maintain communication with each work crew.
- Perform site monitoring to ensure that site personnel are adequately protected.
- Conduct initial site-specific safety training and regular safety briefings for site personnel.
- Conduct periodic inspections for compliance with the SSHP.
- Monitor compliance with this SSHP.
- Maintain Accident/Incident Report Forms.

#### **1.4 EA, Science, Engineering and Technology, Inc**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

EA is an essential team member that will provide technical and strategic assistance in the development and execution of the investigation activities. EA has been involved with the RI and site risk assessment, Technical Project Planning (TPP), site database and geographical information systems (GIS) development, and public relations support at the LOOW site for over 10 years. Therefore, the project will be performed in partnership with EA. The intent of the partnership is to utilize the pre-existing knowledge in regards to the former LOOW property by the key members of the EA support staff to reduce the data review and site familiarization time. It is the intention of ERT to create an environment within which key personnel from ERT and EA can operate in a seamless manner to provide the most comprehensive deliverable.

EA will be the primary technical lead during the RI for the following tasks:

- Performing STR of all planning documents and deliverables.
- Participating in TPP meetings.
- Developing the Screening Level Risk Assessments for the Phase IV RI.
- Performing the GIS and data management tasks.

In addition, EA will assist in conducting site visits and attending the project meetings, development of the investigation reports and presentation of the results.

EA will assist in the development of and will conduct STR reviews of all FSP planning and reporting documents. EA will also provide limited field support, in the form of equipment and labor, necessary to complete field tasks associated with the collection of site characterization samples. EA will provide extensive technical support in the development of a Risk Assessment based on the results of the field sampling activities.

### **1.5 Other Subcontractors**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

Currently, it is anticipated that other necessary services will be provided by the following subcontractors.

#### **1.5.1 Test America, Inc.**

Test America, Inc. (TA) has been selected as the primary contract laboratory to provide analytical services. TA also has completed the DOD-Environmental Laboratory Accreditation Program (ELAP) certification for the analytical methods required for this project and is certified by the State of New York for performing analyses. TA will assist the project delivery team in preparing the QAPP Addendum. The laboratory will provide sample analysis and provide complete data packages for validation as well as Stage 2a electronic data deliverables as defined in the U.S. EPA Contract Laboratory Staged Electronic Data Deliverable.

#### **1.5.2 Cabrera Services, Inc.**

Cabrera Services, Inc. is a small business environmental firm specializing in characterization and remediation of radiological constituents with offices in New York, Connecticut and Maryland. Cabrera Services Inc. has been selected to provide health physics support. Cabrera will provide support for the development of planning documents, assist in the review of radiological data and review radiological screening as necessary to complete RI activities.

#### **1.5.3 Parrat-Wolff, Inc.**

Parrat-Wolf, Inc., is a licensed environmental and geotechnical drilling service company and will be providing direct push technology soil sampling services for the collection of soil samples at the OCCP and the LPCSD.

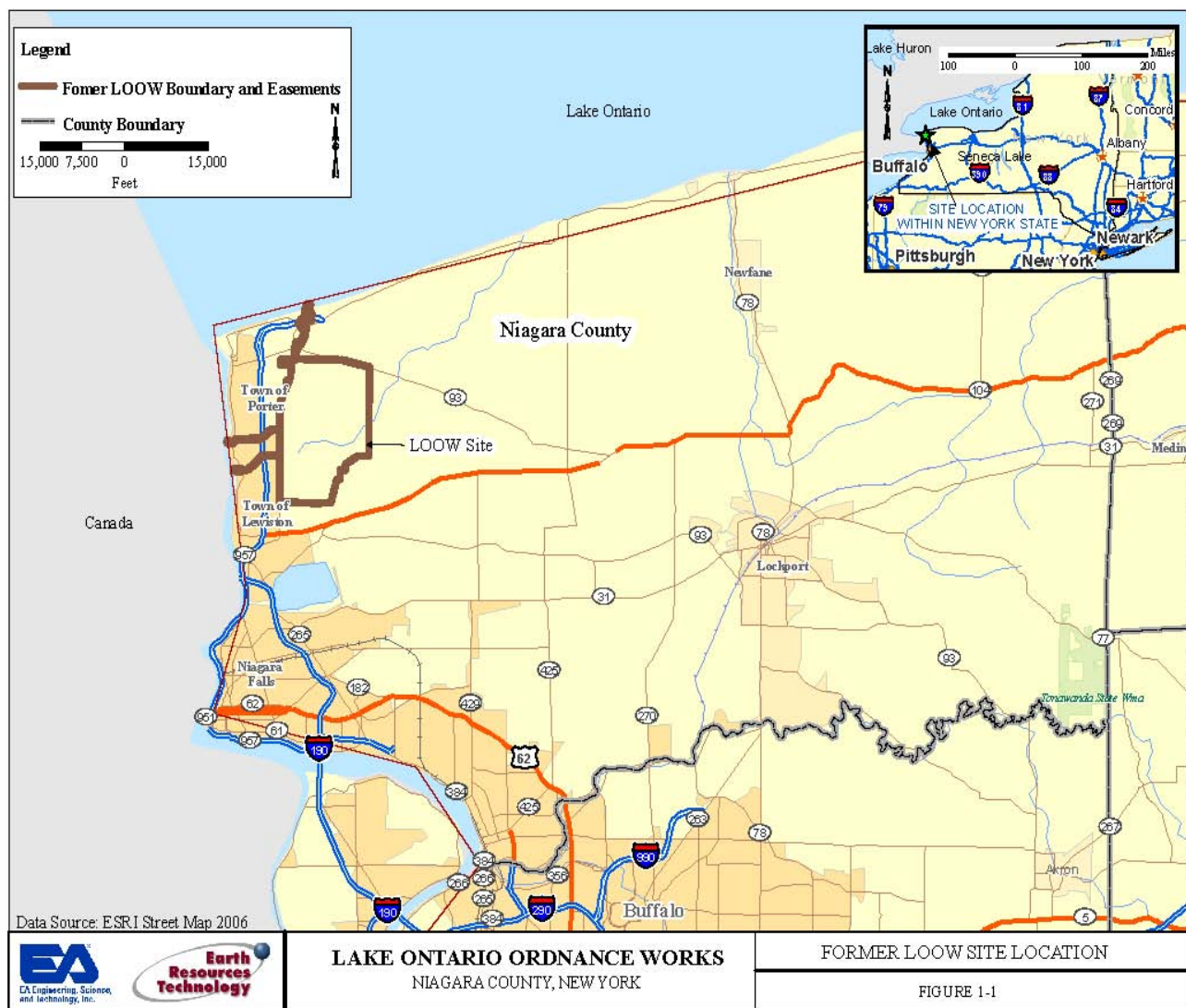
#### **1.5.4 D&M Landscavation**

D&M Landscavation will provide vegetation and debris clearance as necessary to provide access to the proposed sample locations described in this addendum.

#### **1.5.5 Other Subcontractors**

Additional subcontractors may be required during investigation activities. As necessary, new contractors will be utilized to ensure that the project quality objectives are maintained.





**Figure 1-1. Former LOOW Site Location**

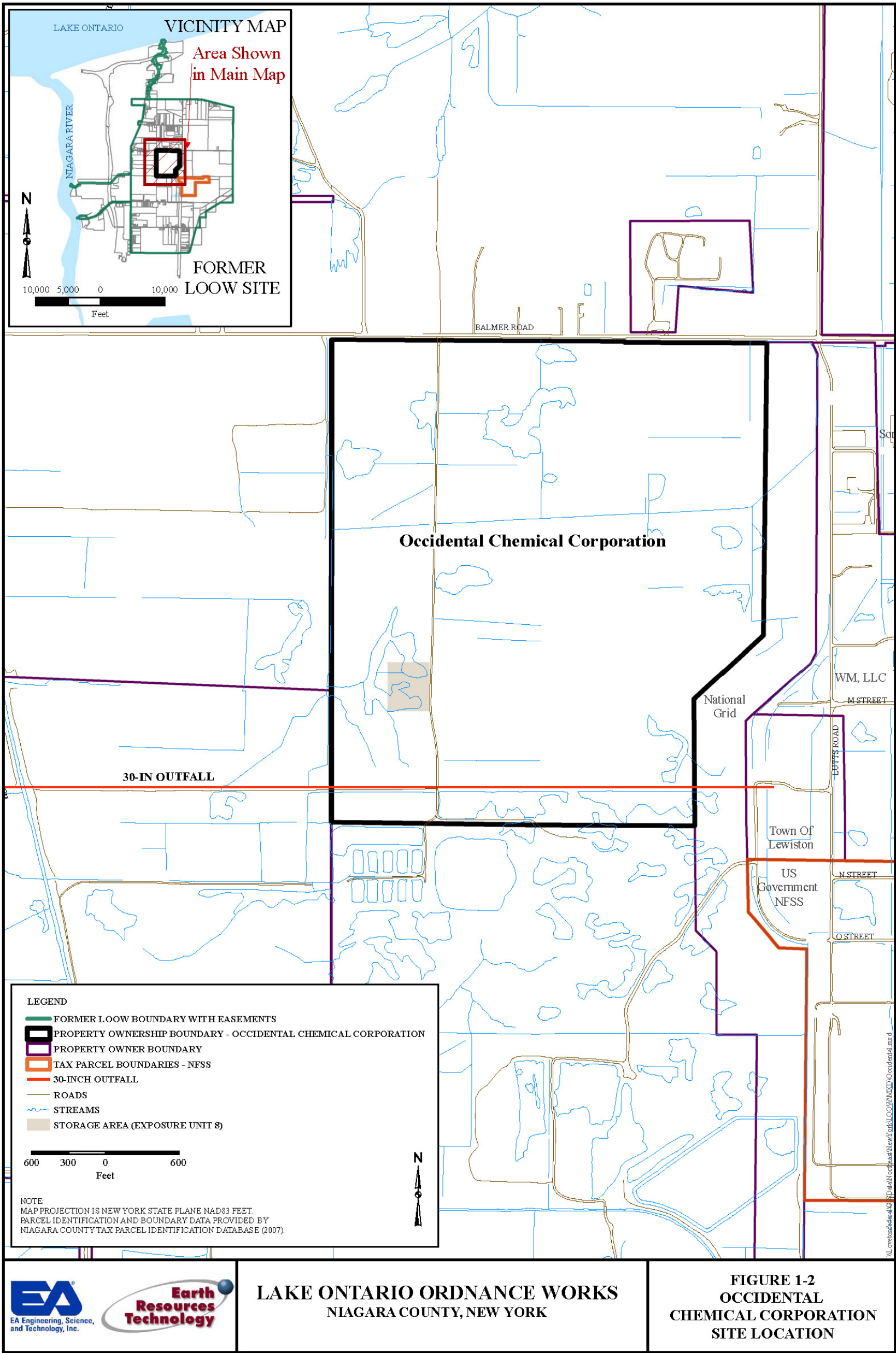


Figure 1-2. Occidental Chemical Corporation Site Location



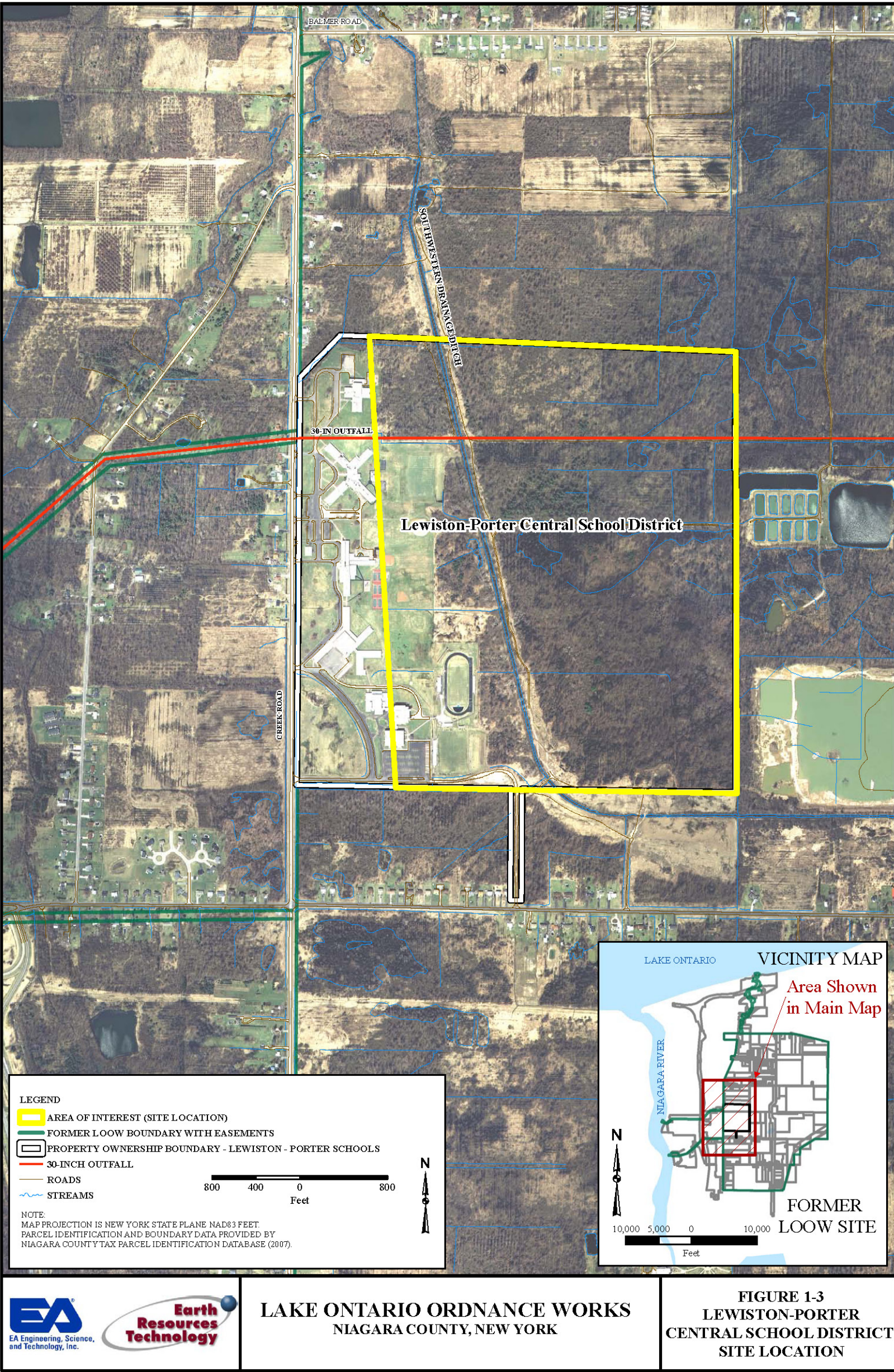
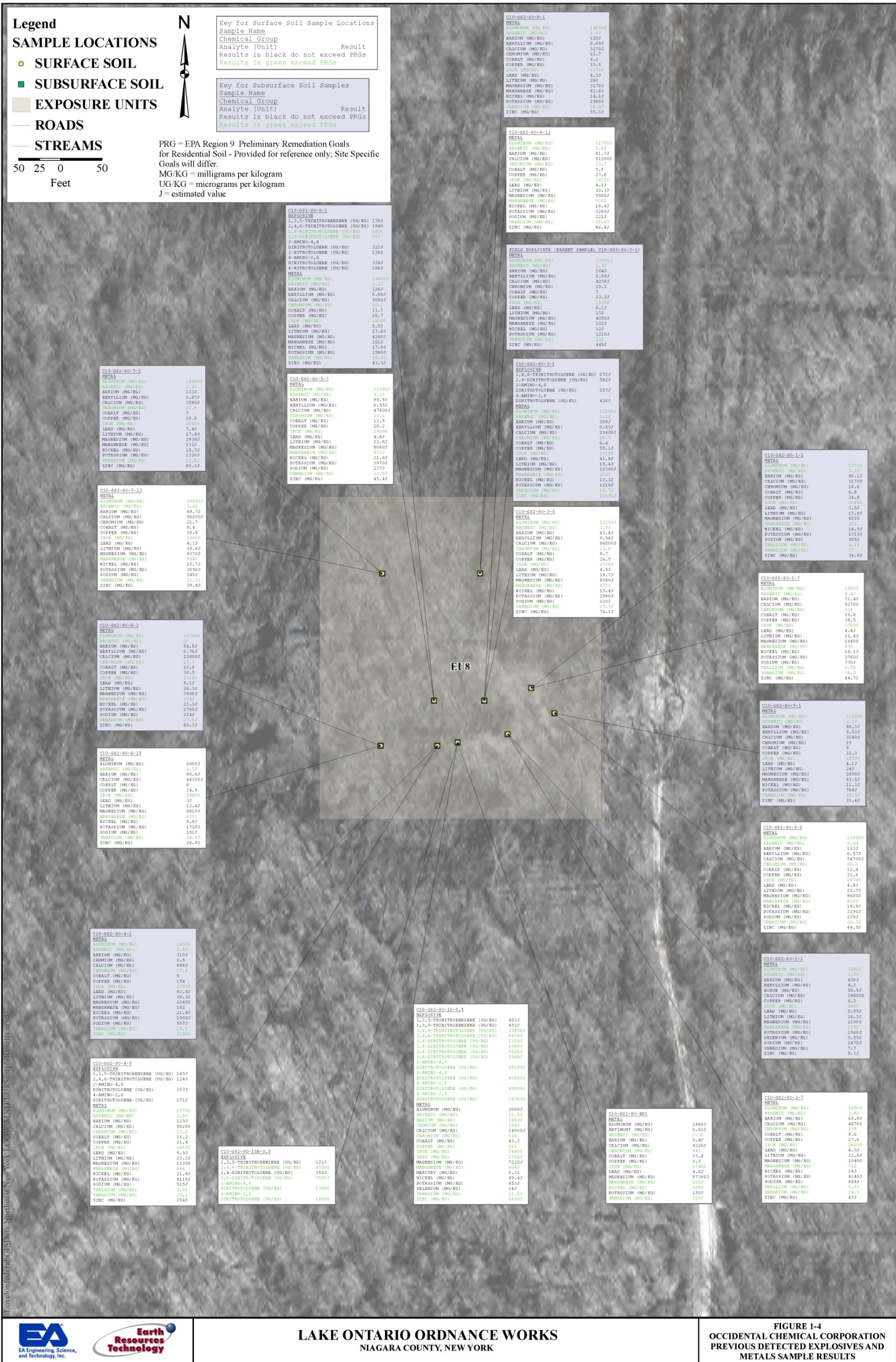


Figure 1-3. Lewiston-Porter Central School District Site Location







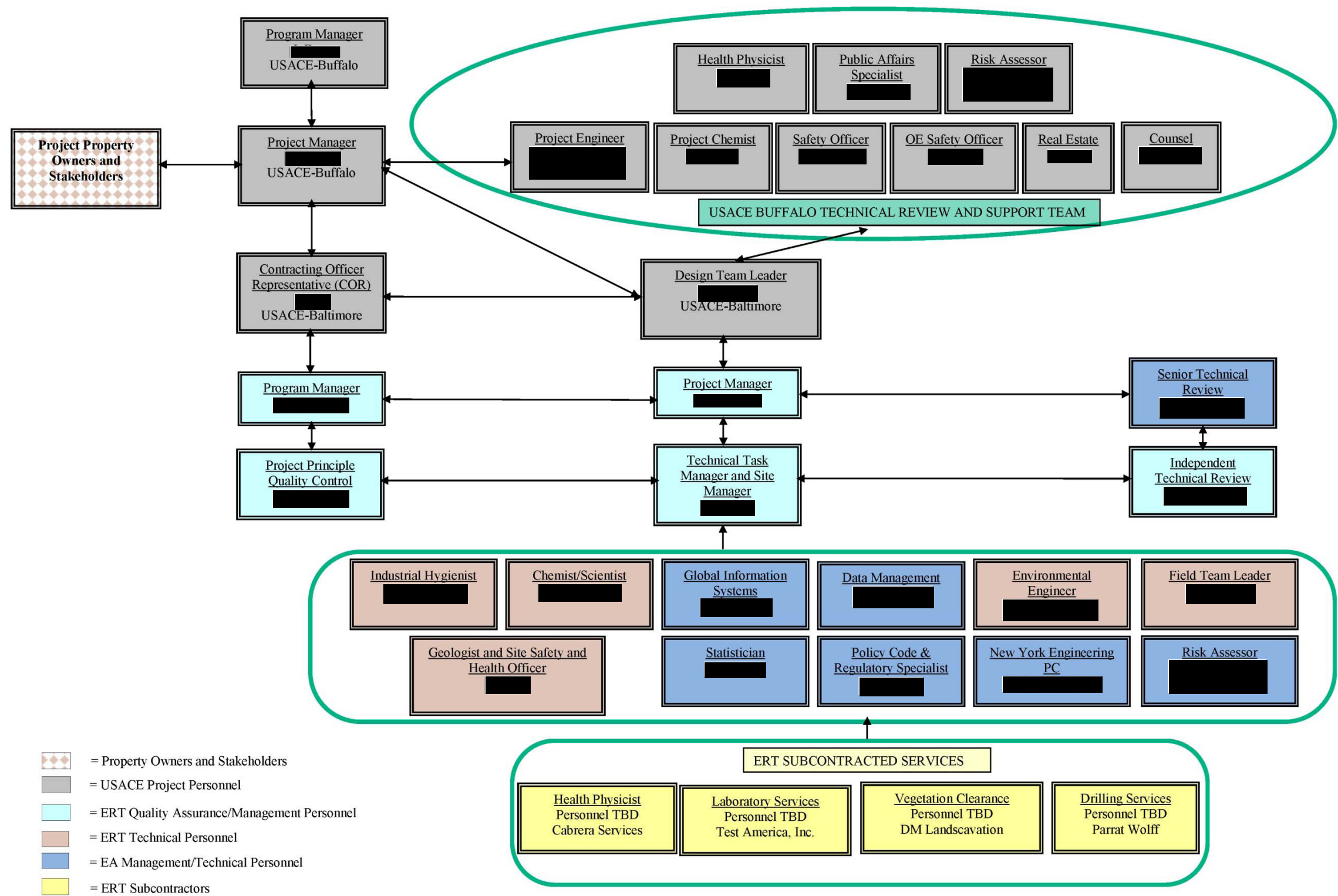


Figure 1-5. Project Organization Chart

## **2.0 PROJECT SCOPE AND OBJECTIVES**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

The SAP, inclusive of the FSP and accompanied by the QAPP, presents site-specific sampling locations for the OCCP Data Gap and the LPCSD Investigations. The objective is to provide a concise justification for sample placement, the number of proposed samples per matrix, and the analytical program for each site.

### **2.1 Project Objectives**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

#### **2.1.1 OCCP Data Gap Investigation Objectives**

There are several overall objectives associated with the Data Gap investigation at OCCP. These objectives involve determining the full extent of potential explosive constituent contamination around previous soil sampling locations; further investigating a explosives constituents hot spot; and evaluating the form (trivalent or hexavalent) of chromium previously detected. This information is being collected as part of an ongoing FS for the OCCP and will provide a more concise estimate of the total volume of impacted media for potential remedial actions. Volume calculations will be based on data collected during Phases I, II, and the ongoing data gap investigation, as well as other historical data. This information will be essential in the development of a future FS.

#### **2.1.2 LPCSD Investigation Objectives**

The objective of the LPCSD Investigation is to evaluate if previous DOD activities in the undeveloped portions of the LPCSD campus resulted in impacts to surface and subsurface soil associated with aerial anomalies, and sediment and surface water within the SWDD as it traverses the campus. This will be addressed as discussed in the following bullets:

- Evaluate whether chemical constituents exceed U.S. EPA Regional Screening Levels (RSLs) (USEPA, 2010). In addition, chemical constituents will be compared to local background levels.
- Evaluate whether reported constituents are the result of historic DOD site use or may be from non-DOD users potentially requiring an evaluation of impact from other responsible parties.

### **2.2 Screening Criteria**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

Under DERP-FUDS, the USACE performs environmental investigation activities consistent with the USEPA under the CERCLA/Superfund Amendments and Reauthorization Act program. As such, the screening criteria that will be used in assessing environmental conditions at the sites will include human health risk-based USEPA RSLs for Residential Soil (USEPA, 2010).

Screening criteria consists of potentially applicable or relevant and appropriate requirements (ARAR) and to-be-considered (TBC) standards and guidance.

The criteria that will be used at each of the two sampling locations (OCCP and LPCSD) will be different, as the purposes of each investigation are also different.

### **2.2.1 Soil**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

#### **2.2.1.1 OCCP**

The objective of the OCCP data gap investigation is to further define the nature and extent of explosives and metals contamination at the site. Soil sampling results will assist in determining the appropriate remedial actions to be evaluated in the FS.

Additionally, speciation of chromium and the extent of previously reported cadmium and chromium concentrations will be evaluated for use in the development of an ongoing FS.

#### **2.2.1.2 LPCSD**

The objective of the LPCSD Investigation is to determine if the property has been impacted by historic DOD operations. For this investigation, Federal and State technical guidance documents may be relevant and appropriate for the evaluation of soil. Human health risk-based USEPA RSLs for Residential Soil (USEPA, 2010), and project-specific background concentrations will be used as screening criteria for evaluating reported chemical concentrations in samples collected from the LPCSD campus. This is discussed in more detail in the *Human Health Risk Assessment Work Plan for the Phase IV Remedial Investigation/Feasibility Studies at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, New York, Addendum to the Human Health Risk Assessment of Selected Exposure Units EU1-EU6, EU8, EU9, Work Plan* (USACE/ERT, 2009f). Attachment A provides the methodology for performing background evaluations. The USEPA RSLs for Residential Soil will be used to screen reported chemical concentrations in soil to determine if further investigation is warranted at the LPCSD property. Generally, when evaluating sample results, data which falls below screening levels may be eliminated from further assessment consideration. Areas above the screening levels generally warrant further evaluation. The RSLs are not intended to be used to represent the cleanup goals for a site and soil concentrations which exceed RSLs should not be considered to represent intrinsic risk.

### **2.2.2 Groundwater**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby omitted in its entirety.*

## **2.3 Selection of COPC**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

### **2.3.1 OCCP**

Constituents of concern have already been identified for the Occidental property. These include explosives, chromium, and cadmium.

### **2.3.2 LPCSD**

Screening of reported concentrations against criteria for assessing potential human health risks from soil will be performed during reporting. Risk-based screening levels will be used in identification of constituents of potential concern (COPC) at the LPCSD campus. Screening levels are medium (i.e., soil, sediment and surface water etc.) and exposure specific. Identification of COPC will be determined by screening the results to the USEPA RSLs for Residential Soil. Soil concentrations will be screened against the USEPA RSLs for Residential Soil.

The LPCSD campus includes manmade drainages, including the SWDD. Upgradient and downgradient sampling will be conducted in order to assess constituents entering and exiting the school campus via this transport route. Although impacts to the SWDD may be attributable to other, non-DOD potentially responsible parties, because the upstream portion of the SWDD potentially receives run off from the Department of Energy (DOE) NFSS site (as well as other portions of the former LOOW), and the environmental response for both LOOW and NFSS is being administered by the USACE, sampling of the ditch by the USACE is appropriate. Sediment and surface water samples collected from the SWDD will be screened against the USEPA RSLs for Residential Soil and groundwater maximum contaminant levels, respectively.

### **2.4 Additional Screening Considerations**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

Reported inorganic and SVOC constituents will undergo a background comparison. Soil samples used to evaluate background concentrations for some constituents were collected during the Phase I and II of the RI (USACE/EA, 1999 and 2002). The procedure proposed for assessing whether soil data collected for the Phase IV RI data exceeds background concentrations is presented in Attachment A. Sediment and surface water background concentrations previously developed for NFSS (USACE, 2007) will be compared to the soil, sediment and surface water data collected from the SWDD that traverses the LPCSD campus.

For constituents with at least 10 detected concentrations, a comparison to background will be conducted using the quartile test in conjunction with the Wilcox Rank Sum test. Both tests will be conducted with the null hypothesis that site concentrations are less than or equal to background. If the null hypothesis is rejected for either the quartile test or Wilcox Rank Sum tests at the 95% significance level, then it will be concluded that the site data exceeded background.



### **3.0 NONMEASUREMENT DATA ACQUISITION**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

Data will be gathered and reviewed from non-measurement sources, and used during the execution of the investigations, including:

- Site-specific information from previous site activities
- Site-specific demographic and climatic data from the U.S. Census Bureau
- Site-specific geology, hydrology and soil information from other sources
- Site-specific aerial photographs from various sources
- Historical as-built drawings and figures of the WWTP

According to the USEPA guidance (USEPA, 2002) these are considered non-direct measurement data. Non-direct measurement data will need to meet several acceptance criteria in order to be acceptable for this project. Non-direct measurement data acceptance criteria include:

- The use of reputable sources
- Data comparison between multiple sources (where applicable)
- Expert review (where applicable)

## **4.0 PRE-SAMPLING ACTIVITIES**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **4.1 Rights-of-Entry**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **4.2 Pre-Activity Meetings**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

Prior to beginning intrusive activities, several meetings will be required including a project kick-off meeting, primary safety meeting, daily “tool box” discussions and safety briefings. A kick-off meeting will be held with parties from the LPCSD in order to provide additional details of the investigation activities and coordinate the activities.

Personnel involved with the project activities will be required to undergo a site-specific safety review as per the project SSHP. The safety meeting will include topics detailed in the SSHP including potential chemical, physical, radiological, explosive and biological hazards; activity hazard analyses; environmental monitoring requirements and action levels; emergency response procedures; emergency contact information and directions to the nearest emergency facilities; and the proper use of equipment. This meeting will be conducted by the SSHO. Prior to the meeting, the SSHO will review and file all safety and health certifications for personnel to ensure they are current.

### **4.3 Utility Clearance**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **4.4 Brush, Vegetation and Other Debris Clearance**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby replaced in its entirety by the following.*

Brush clearance may be required to access certain sample locations throughout the OCCP and the undeveloped areas of the LPCSD campus. It is intended to create a clearing pattern to access sampling locations. It is not intended to clear cut the entire acreage of either property. Brush clearance activities to the west of the SWDD will be conducted by hand and to the east of the SWDD will be conducted mechanically. Brush clearance will be performed in accordance with the planning documents approved for the Phase IV RI (USACE/ERT, 2009b, 2009c).

### **4.5 Cleanup of Suspected ACM**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby omitted in its entirety.*

#### **4.6 Manholes, Vaults and Other Openings**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) is hereby omitted in its entirety.*

## **5.0 FIELD SAMPLING PLAN**

*The entire Section 5 of the original Phase IV RI FSP Addendum (USACE, 2009h) is hereby replaced in its entirety by the following.*

The FSP has been developed in order to accomplish the project objectives of the OCCP Data Gap and the LPCSD Investigations. The objectives of these investigations are as follows:

### **OCCP Data Gap Investigation Objectives**

- Delineate explosives contamination in and around previous sample locations 3, 4, 5, and 10. Collect sufficient data (using both field screening techniques and laboratory analytical methods) to support engineering calculations of soil volumes requiring remediation.
- Delineate the horizontal and vertical component of the explosives hot spot (at boring 10) with analytical samples, sufficient to assist the development of remediation volumes for the FS.
- Determine the species of chromium present at the site. Since risks associated with chromium contamination are based on the hexavalent species of chromium, this data gap study will evaluate actual levels of total chromium and hexavalent chromium in the soils
- Verify the detected levels found at the previous chromium hot spot.

### **LPCSD Investigation Objectives**

- Characterize, via surface and subsurface soils, various anomalies (mounds) identified in previous aerial photographs of property associated with the historical LOOW property.
- Characterize, via surface water, sediment, and subsurface soil sampling, the portion of the SWDD that traverses the LPCSD campus.
- Determine if previous DOD activities have impacted the undeveloped portion of the LPCSD campus

## **5.1 Proposed Sample Parameters and Locations**

The proposed analytical sample parameters are summarized in Table 5-1. Table 5-1 includes the following information:

- Targeted Sample Collection Depth (Surface or Subsurface)
- Proposed Analyses
- Rationale for Sample Location (Sample Program)

Note, Table 5-1 does not reflect the explosives screening samples at the OCCP.

<b>Table 5-1. Proposed Analytical Sample Parameters</b>													
<b>Sample Program</b>	<b>Sample Matrix</b>				<b>Analytical Samples and Methods</b>								
	Surface Soil Samples	Subsurface Soil Samples	Sediment Samples	Surface Water Samples	TCL VOCs (SW846 8260B)	TCL SVOCs (SW846 8270C)	Explosives (SW846 8330)	PCBs (SW846 8082)	TAL Metals (SW846 6020A)	Boron	Lithium	Hexavalent Cr (SW846 7196A)	Radiological <sup>1</sup>
<b>OCCP Data Gap Investigation</b>													
Biased Samples – Occidental Property (Phase I)	8	8	-	-	-	-	16	-	16	-	-	16	1
Biased Samples – Occidental Property (Phase II)	8	8	-	-	-	-	16	-	16	-	-	16	1
Additional Optional Biased Samples <sup>2</sup> Occidental Property	3	3	-	-	-	-	6	-	6	-	-	6	2
Field Duplicate (collection frequency of 10% of normal samples)	2	2	-	-	-	-	4	-	4	-	-	4	1
Equipment Rinsate Blanks (frequency of one per day per media per equipment type)	2	2	-	-	-	-	2	-	2	-	-	2	2
Matrix Spike/Matrix Spike Duplicate (MS/MSD) (collection frequency of 5% of normal samples)	2	2	-	-	2	-	2	-	2	-	-	2	1
<b>LPCSD Investigation</b>													
Biased Samples - LPCSD Campus Historic Soil Disturbances	10	10	-	-	20	20	20	20	20	20	20	-	2
Biased Samples - Surface Water SWDD	-	-	-	6	6	6	6	6	6	6	6	-	1
Biased - Sediment and Soil SWDD	-	6	6	-	12	12	12	12	12	12	12	-	1
Additional Optional Biased Samples <sup>2</sup> – Campus Historic Soil Disturbances	3	3	-	-	6	6	6	6	6	6	6	-	1
Field Duplicate (collection frequency of 10% of normal samples)	2	2	1	1	5	5	5	5	5	5	5	-	1
Equipment Rinsate Blanks (frequency of one per day per media per equipment type)	2	2	1	1	3	3	3	3	3	3	3	-	3
MS/MSD (collection frequency of 5% of normal samples)	1	1	1	1	2	2	2	2	2	2	2	-	2
Trip (1 per cooler containing aliquots for VOC analysis) <sup>1</sup>	-	-			7 <sup>1</sup>	-	-	-	-	-	-	-	-

<sup>1</sup> If field screening of samples indicates radioactivity in excess of twice background activity, the sample will be submitted for the radiological analyses. Radiological analysis will be conducted for the purpose of health and safety only, and is assumed at a frequency of up to 10% of the environmental samples collected. Radiological samples will be laboratory analyzed for Gross Alpha/Beta (SW846 9310 Mod), Gamma Spec (DOE HASL 300 Ga-01-R Mod), Isotopic Uranium (DOE HASL 300 A-01-R Mod) Isotopic Plutonium (DOE HASL 300 A-01-R Mod) and Isotopic Thorium (DOE HASL 300 A-01-R Mod), Radium-226 (DOE HASL 300 Ra-006-RC Mod) and Strontium-90 (DOE HASL 300 Sr-03-RC)

<sup>2</sup> Additional optional biased point locations are proposed for sampling. However, the allocation of these samples will be based upon field reconnaissance of anomalies, analytical sample results at the Occidental Property and the professional judgment of the ERT Field Team Leader and the USACE Authorized Representative or PM.

<sup>3</sup> Trip Blank analyses will be dependent upon the number of sample deliveries to the contracted laboratory requiring VOC analysis. A Trip Blank is required for each sample delivery cooler containing samples for VOC analysis. It is unknown at this time how many sample deliveries will be necessary for environmental samples being analyzed for VOCs.

Sampling protocols, or standard operating procedures (SOPs), are provided in Appendix B of this FSP. Surface and subsurface soil samples are co-located at most proposed sample locations. Anomalies and former DOD areas of concern identified evaluating historic photographs will be targeted for sample collection and analysis. Sections 5.2 and 5.3 provide additional details concerning sample location and rationale. It is the intent of these proposed sampling locations to further delineate known impacts at EU 8 and investigate potential impacts from a subset of representative historic soil disturbances at the undeveloped portions of the LPCSD campus.

Sample designations were developed to include the type of sample, numbered sample location, as well as matrix and proposed sample depth. The sample designation/labeling protocol are described in detail in Section 6.1.2.

## **5.2 Biased Sampling**

Biased sampling has been included in the FSP and is designed to target historic locations which may constitute a higher potential for impacts. These areas include the known locations of historic soil disturbances at the undeveloped portion of the LPCSD, the SWDD and previously identified impacts at the OCCP.

Biased sampling is statistically significant when used in conjunction with a systematic sampling approach. A biased sample is one that is selected based upon professional judgment and which may not be representative of a randomly or systematically sampled population.

### **5.2.1 Explosives and Chromium Biased Sampling – OCCP**

Biased sampling at the OCCP has been included in this FSP Addendum in order to assess the extent of previously identified constituents exceeding potential clean up goals (calculated site-specific goals and potential chemical-specific ARARs). Previous sampling conducted during the Phase II RI identified constituents driving human health and environmental risk associated at boring locations 3, 4, 5 and 10. The locations were associated with and adjacent to unknown material that appeared to have been discarded in a 55-gallon drum. The drum has corroded over time; however, the contents (a dark spongy solid material) remain. This material was previously sampled, but no detected levels of explosives or metals were evident.

The primary constituents driving risk are explosives, chromium and cadmium; although the cadmium levels that would result in unacceptable risks were limited to a single sample location. The four previous sample locations with observed explosives concentrations driving human health risk are in the general vicinity of a single “hot” sample (sample location 10): sample location 4 is roughly 25 ft west; and sample locations 3 and 5 are approximately 60 ft in the northeast and northwest directions, respectively (refer to Figures 1-4 and 5-1).

In order to assess the potential remedial alternatives for this site and provide concise cost estimates for any recommended remedial actions, additional biased soil sampling will be conducted. The goal of additional sampling is to more clearly define the extent of chromium and explosives contamination present. The proposed delineation sampling approach would employ both explosives field screening techniques as well as laboratory analysis for explosives.

In addition, the majority of the risks associated with chromium assume that the chromium is in the hexavalent form. Soil samples will be collected for the analysis of the actual distribution of

trivalent versus hexavalent chromium to further define associated risk and remediation requirements.

Phase I of the OCCP investigation will involve using field screening methods for explosives across a grid pattern, and then based on the results of the field screening, sample volumes will be collected for laboratory analysis (explosives, metals, and hexavalent chromium). Phase II will involve collecting additional samples for laboratory analysis based on the Phase I analytical results.

#### *5.2.1.1 Field Screen Sampling for Explosives*

A 100 ft by 100 ft grid, with 20 ft spacing between nodes, will be established over the OCCP, with one of the nodes placed directly over the previous hot spot (boring location 10), with the use of both global positioning system (GPS) coordinates and measuring tapes, as well as visual observations. This grid was established to assist in further refining the overall extent of the explosives found during previous sampling efforts and encloses all sample locations with explosives concentrations exceeding the USEPA RSLs for Residential Soil. Around the hot spot (location 10), a more tightly spaced grid will be established with 5 ft spacing between nodes. The grids will be established as presented in Section 5.9. These grids are discussed in more detail below.

**Extent of Explosives Contamination Screening.** Field screen sampling will be conducted using DropEx<sup>®</sup> field sampling kits to survey for explosives levels in soil. The first objective of the field screen sampling is to determine the extent of explosives constituents associated with secondary explosives concentrations previously detected in analytical sample results (USACE, 2002). Field screen samples will be collected from a grid originating from the hot spot location and using a spacing of 20 ft. The grid will extend no more the 100 ft in each of the cardinal directions, resulting in 36 field screen samples. If positive results are found at all the grid nodes, the grid will be expanded 20 ft in each direction until negative results are detected. If the field screening results do not indicate positive detections at the expanded node, another sample will be taken between the nodes with positive and negative results, at a spacing of 10 ft.

**Hot Spot Screening.** The second objective of the field screen sampling is to assist in the delineation of explosives constituents directly adjacent to the hot spot location (Location 10). A sampling grid with 5 foot spacing would be placed on the hot spot location and extend in each of the cardinal directions (e.g., north, west, east and south) a distance of 5 ft, resulting in the allocation of 8 additional field screen sample locations (note the field screening location directly over boring location 10 is accounted for in the first field screening objective discussed previously). A secondary grid will consist of 10 foot spacing between nodes originating from the hot spot location and, resulting in an additional 16 field screen sample locations.

The intent of the field screen sampling approach is to aid in the allocation of analytical soil samples. For this reason, a specific methodology has to be adhered to and is detailed in the following flow chart (see Figure 5-2) to aid personnel in the field in determining the consistent and appropriate approach to evaluating the field screen sampling results and subsequent actions.

The results of the field screen sampling will be used to determine the appropriate location for the collection of sample volumes to be submitted for laboratory analysis. ERT will consult with

USACE PM or designated representative prior to allocating the final sample locations for analytical sample collection. Generally, the analytical soil sample location will be determined to be the negative field screen sample result in each of the cardinal directions (i.e., north, south, east and west) along the exterior of the larger sampling grid. Around the hot spot, samples will be taken either at the 5 ft node around the hot spot, or a location closer to the hot spot, based on field screening results.

#### *5.2.1.2 Biased Analytical Sampling*

Once the extent of the explosives contamination is determined through field screen sampling, soil samples will be collected for the laboratory analysis of explosives, total metals and hexavalent chromium. One surface soil sample and one subsurface soil sample will be collected from the first negative detection of explosives constituents (i.e., non-detect, as determined from the field screen results) in each cardinal direction. For example, if the samples collected from a 10 ft distance from the hot spot indicated the presence of explosives, and no explosives were indicated at the 15 ft interval, the analytical sample would be collected from the 15 ft interval. Surface soil samples will be collected at the interval between 0 and 1 ft bgs and the subsurface soil will be collected at a depth between 1 ft and 6 ft, depending on field screening and observations. The purpose of these samples is to confirm that the full extent of the impact has been delineated. A total of eight samples will be collected within the area of explosives contamination during the Phase I investigation to assist in delineating the distribution of explosives contamination: four around the hot spot (location 10) and four around the perimeter of the larger grid (encompassing locations 3, 4, 5, and 10).

As part of the analysis, each of the above samples would also be analyzed to determine the different forms of chromium present in the surface soil. Each sample would be analyzed for hexavalent chromium and total metals.

As part of this phase, it is also proposed to return to the location of the previously detected highest subsurface chromium concentration (previous sample location 2) and collect one subsurface sample at a depth of 5 to 7 ft and have the sample laboratory analyzed for hexavalent chromium and total metals to confirm the previous analytical data.

It is assumed that 8 soil samples (four surface samples and four subsurface samples) will be collected during Phase I and laboratory analyzed for explosives, total metals, and hexavalent chromium, and 1 subsurface soil sample will be analyzed for hexavalent chromium and total metals only. Samples will be screening for radiological parameters for health and safety purposes. Radiological analytical samples will be collected for health and safety screening if soil levels are greater than 2 times background levels [i.e., 16,000 counts per minute (cpm)]. Explosive samples will be submitted for a maximum 3 day turnaround time, with samples collected on Monday having results available by Friday morning.

The second phase of the analytical sampling would be implemented based on the results of Phase I. The sample team would return to the site to collect additional samples for extent and characterization (primarily explosives). If explosive constituents were not detected in a particular Phase I sample, then the field team would collect a subsequent set of samples, aligned with the grid, and collected at the next inward node (towards the explosives hot spot, location



10). Both a surface and subsurface sample will be collected and submitted for the laboratory analysis of explosives constituents.

Similarly, if explosives are still detected at concentrations exceeding the USEPA RSLs for Residential Soil, then the sampling team would collect an additional analytical sample in the cardinal direction of the detection an additional 10 ft along with the grid system, away from the explosives hot spot location (Location 10). Sample volumes will only be collected from intervals (subsurface or surface) exhibiting detectable levels of explosives above the USEPA RSLs for Residential Soil. It is estimated that up to 16 additional samples may be collected for laboratory analysis of explosives during this phase in order to further refine the extent of the explosives contamination at the site. In addition, to confirm previously reported elevated levels of cadmium in the general area of the hot spot, up to 4 of these samples will be analyzed for total metals.

During Phase II, up to 16 samples (including both surface and subsurface soil) will be collected, plus QA samples. Phase II samples will be analyzed for explosives and if based on the results of the Phase I soil samples, additional analysis for total metals and hexavalent chromium are required, additional analysis will be conducted on up to 16 of the collected soil samples. These samples will be submitted for a standard 21-day turnaround time.

### **5.2.2 Historic Soil Disturbances Biased Sampling – LPCSD**

Based on a review of historic aerial photographs, biased sample locations have been included in this FSP Addendum to address historic soil disturbances on the LPCSD campus. The intent of the sampling approach is to investigate soil disturbances observed in aerial photographs taken of the site from the time period when DOD owned the parcel.

Seven identified locations of mounded material in the northern portion of the campus and one trench (in the northeast) and one pit in the southeastern portion of the campus will be investigated (Figure 5-2). At each location, field reconnaissance will be performed by qualified environmental professionals, including visual identification and the use of field screening tools to assess potential impacts.

Field reconnaissance will also include a determination of the size (as measured in the field) of the anomaly area. Volume calculations will be determined based on field measurements of the anomaly dimensions. The characterization will be used to determine the field screening and analytical sampling approach to each anomaly. Each anomaly (mounded material and trench/pit) will be assessed based upon its estimated volume or square footage into one of two groups. Group A will consist of mounded material that are less than 200 cubic ft in size and pits that are less than 100 square ft in size. Group B will consist of mounded material that are equal to or greater than 200 cubic ft in size and pits that are equal to or greater than 100 square ft in size.

#### **5.2.2.1 Field Screen Sampling**

At each location, field screen sampling will be used for initial assessment of the mounded material and pits. Field screening will primarily consist of the collection and field analysis of samples utilizing DropEx<sup>®</sup> sampling kits. Radiological and photoionization detector (PID) screening will also be conducted for health and safety purposes. The PID will use a 10.6

electron volt lamp, which can detect a wide variety of VOCs; however, VOCs are not expected to be found at the site.

At Group A anomalies, two surface samples will be collected and analyzed for explosive residue using DropEx<sup>®</sup>. Each Group B anomaly will be separated into four quadrants. From each of the quadrants, two surface samples will be collected and analyzed for explosive residue using DropEx<sup>®</sup>. In each instance, the collected sample will be screened with a PID in order to assess the potential for VOC impacts.

#### *5.2.2.2 Analytical Sampling Approach*

Upon completion of field reconnaissance, an analytical sampling strategy will be employed for each anomaly Group. At each Group A anomaly, one boring will be advanced at a location which, based on field observations and field screening, constitutes the greatest likelihood to present impacts. Borings at mounded material will be advanced until the boring reaches the interface of the mounded material and the native ground surface. From each boring, one surface soil sample (0-1 ft bgs) and one subsurface sample (greater than 1 ft bgs) will be collected and submitted for laboratory analysis. The depth of the collected subsurface sample will be from the interval of greatest impact, based on observations and PID readings (see Section 5.4.2). In the absence of impact, the sample will be collected from the interface between the mounded material and the native ground surface (the terminal point of the boring). Borings and subsurface soil samples will be terminated upon reaching a clear transition to both uncontaminated soil and the natural soil sequence. If drilling refusal is encountered three times at a location prior to reaching uncontaminated soil and natural soil sequence, the boring will be terminated and a soil sample collected at the depth of refusal.

Each Group B anomaly will be separated into four quadrants as described below. A single boring will be advanced in each quadrant. Based on the observations of a qualified environmental professional, at a minimum, one surface sample and one subsurface sample from each Group B anomaly will be submitted for laboratory analysis. If field observations indicate the potential for impacts; up to one surface sample and one subsurface sample will be collected from each boring that is advanced in each of the quadrants and submitted for laboratory analysis. In total, up to four surface analytical samples and four subsurface analytical soil samples will be submitted for laboratory analysis from each Group B anomaly. The target depth for surface samples will be 0-1ft bgs and the target depth for the subsurface analytical soil samples will be from the interval of greatest impact, based on observation and PID readings (see Section 5.5.1). In the absence of impact, the sample will be collected from the interface between the mounded material and the native ground surface. Borings and subsurface soil samples will be terminated upon reaching a clear transition to both uncontaminated soil and the natural soil sequence. If drilling refusal is encountered three times at a location prior to reaching uncontaminated soil and natural soil sequence, the boring will be terminated and a soil sample collected at the depth of refusal.

#### **5.2.3 SWDD Biased Sampling – LPCSD**

To assist in investigating the LPCSD property, additional environmental sampling will be conducted along the SWDD, which flows predominantly from southeast to northwest across the campus. Six biased sample locations will be selected along the portion of the SWDD that traverse the LPCSD campus (Figure 5-2). Samples will be collected from the most down-

gradient location (north) to the most up-gradient location (south) along the SWDD in order to minimize potential cross contamination of the collected samples. The intent is to collect the most up-gradient sample from the point at which the SWDD enters the LPCSD campus and the most down-gradient location from a point adjacent to where the SWDD exits the LPCSD campus. The remaining four sample locations will be evenly distributed along the length of the SWDD as it traverses the campus.

At each of the six locations, one sediment sample (0-6 in. bgs), one subsurface soil sample (1ft – 3 ft bgs) and one surface water sample will be collected for laboratory analysis. Based on the depth of the SWDD at the time of sample collection, the samples will be collected as closely to the center of the SWDD as possible, while still providing adequate safety to the field team members collecting the samples.

### **5.3 Summary of Analytical Program**

Environmental samples to be submitted for VOCs, SVOCs, PCBs, total metals (including boron and lithium), and explosives analysis as presented in the QAPP Addendum. The project-specific target compound and analyte lists are also available in the project QAPP Addendum. Section 5.4.5 discusses the proposed quality control samples.

Investigative derived waste (IDW) will also be analyzed for full SW846 Toxicity Characteristic Leachate Procedure (TCLP) and radiological impacts in order to determine the appropriate waste stream and disposal requirements.

Detailed sampling protocols and the analytical program are presented in the following sections. The project QAPP Addendum presents the data quality objectives and required QA/QC samples and rationale for collection.

### **5.4 Field Sampling Procedures**

ERT shall continue the protocols for sampling set forth in the approved *Final Sampling and Analysis Plan for Phase III Remedial Investigation – Underground Lines at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, New York* (USACE/EA, 2006). The sampling procedures shall be conducted in accordance with established technical guidelines, methods, policies and Standard Operating Procedures. The subsections below present an overview of the sampling program procedures.

Environmental sampling for the investigations will include soil, sediment, surface water and waste characterization sampling. Direct push drilling (Geoprobe® or equivalent); however, other drilling methods including hollow-stem auger, mud rotary and drive and wash may also be used if warranted by site conditions. Performing grab or composite sampling by appropriate hand-held sampling equipment will be the preferred method for waste characterization sampling.

#### **5.4.1 Grab/Composite Sampling for Waste Characterization**

Waste characterization of a liquid or a solid can involve grab or composite sampling depending upon the homogeneity and the volume of the waste. Grab sampling consists of collecting discrete samples of a material and submitting each sample for separate analysis. Grab sampling is appropriate for characterizing small quantities of waste as well as waste streams of varying content (e.g., drums of different contents). Composite sampling consists of taking discrete grab

samples of a material and combining them for analysis. Composite sampling generally is appropriate for large volumes of a homogenous waste material, such as a pile of soil or construction debris. The specific number of composite and grab samples largely will depend upon the size and nature of the waste pile (i.e., cubic yards) as well as the analysis required for characterization of the waste.

Grab soil/solid samples will be collected from the material or interval in question by retrieving a volume for analysis using a clean stainless steel, aluminum, or mild steel scoop, trowel, spoon, or bucket auger and placing the soil into the sample container. All parameters except VOCs will be homogenized. Samples for VOCs will be placed directly into the sample container.

Composite samples will be collected in a cleaned stainless steel pan for homogenization and mixing to form the composite. Composite sampling will be performed for the waste characterization of IDW.

#### **5.4.2 Soil Sampling**

In order to define the nature and extent of COPCs and delineate potential impacts, surface and subsurface soil samples will be collected from various biased sampling locations across the OCCP and the undeveloped portion of the LPCSD campus. Figures 5-1 and 5-3 summarize the sample locations proposed for this investigation. From these sampling locations, varying numbers of samples will be field-screened and laboratory analyzed for chemical constituents (as described in Section 5.2).

Proposed sample depths will be based on a review of the historical structure within the area, groundwater elevations, and other pertinent data. There is no way to confirm if the pre-selected sample depths are adequate to accurately characterize potential impacts, therefore field observations will determine the actual depth of subsurface soil samples.

Soil intervals will be examined for staining, discoloration, odors, and debris indicative of contamination (ash, coal fragments, wood chips, cinders, petroleum staining, etc.) Samples for laboratory analysis will be collected from the 6-inch interval most likely to be contaminated, based on PID readings (at the LPCSD campus), discoloration, staining, and the field geologist's judgment (field conditions may require a section longer than 6 inches to make sufficient sample; however this decision will be field-based). The samples will be collected by cutting the soil core in two places with either disposable plastic trowels or a decontaminated steel, stainless steel, or aluminum trowel, spoon, or knife and homogenized in either a disposable plastic container or a decontaminated stainless steel pan before being placed in the sample bottles. VOC samples will be placed directly into the sample containers without homogenization. Samplers will wear phthalate-free gloves such as nitrile (no latex will be used) and will avoid contact of the gloves with the sample. Only properly decontaminated metal instruments will be allowed to touch the sample. If there is insufficient soil volume in the acetate sleeve/split spoon, then this will be made up by attempting a second direct push sleeve at the same depth, or by using the next immediate sample interval above or below this depth, if appropriate. If there is no recovery, then the sample from this depth will be skipped, and drilling will progress to the next depth interval.

Selected discrete soil samples will be collected for the following parameters in the order specified below:

- TCL VOCs (LPCSD only),
- TCL SVOCs (LPCSD only),
- Explosives (LPCSD and OCCP),
- TCL PCBs (LPCSD only),
- TAL Metals (OCCP) plus lithium and boron (LPCSD), and
- Hexavalent chromium (OCCP only)

Analytical parameters, methods, container and preservation requirements for soil, sediment and surface water samples, along with anticipated waste characterization requirements (for IDW disposal) are summarized in Table 5-2. Table 5-3 summarizes other potential analytical parameters, methods container and preservation requirements for the characterization of IDW, which may be required based on the selected disposal facility.

Grab samples will be collected for all samples related to the site investigation. Grab soil/solid samples will be collected from the material or interval in question by retrieving a volume for analysis using a clean disposable trowel/scoop and placing the soil in a clean disposable pan for homogenization before inserting into the sample container. All parameters except VOCs will be homogenized. Soil aliquots for VOC analysis and will be placed directly into the sample container.

Composite samples will be collected in the same manner described above, except that the collected discrete sample volumes will be placed in a clean stainless steel pan and mixed to form the composite. Composite sampling will be performed for waste characterization as necessary.

**Table 5-2. Analytical Parameters, Methods, Preservation and Container Requirements**

Sample Matrix	Analytical Parameter	Sample Type <sup>1</sup>	No. of Samples <sup>2</sup>	Analytical Method	Sample Preservation	Holding Time <sup>3</sup>	Sample Container <sup>4,5</sup>
Soil	VOCs (TCL)	Grab	TBD	SW-846 Method 8260B	Deionized Water/ 4° C (2 vials); Methanol/ 4° C (1 vial)	2 days to prep; 14 days to analysis	3 vials (TerraCore kit)
Soil	PCBs	Grab	TBD	SW-846 Method 8082	Cool to 4° C	14 days to extraction; 40 days from extraction to analysis	(1) 8-oz glass jar
Soil	SVOCs (TCL)	Grab	TBD	SW-846 Method 8270C	Cool to 4° C	14 days to extraction; 40 days from extraction to analysis	
Soil	Metals plus lithium and boron- total (TAL)	Grab	TBD	SW-846 Method 6020a/7000 Series	Cool to 4° C	28 days to analysis for Hg; 6 months to analysis for other metals	
Soil	Hexavalent Chromium	Grab	TBD	SW-846 Method 7196	Cool to 4° C	24 hours	(1) 4 oz glass jar w/ Teflon lid
Soil	Explosives	Grab	TBD	SW-846 Method 8330	Cool to 4° C	14 days to extraction; 40 days from extraction to analysis	(1) 30g glass jar
Surface water	VOCs (TCL)	Grab	TBD	SW-846 Method 8260B	pH<2 with HCl; Cool to 4° C; no headspace	14 days to analysis	(3) 40 milliliter (mL) volatile organic analysis (VOA) vials
Surface water	SVOCs (TCL)	Grab	TBD	SW-846 Method 8270C	Cool to 4° C	7 days to extraction; 40 days from extraction to analysis	(2) 1 liter (L) amber glass bottles
Surface water	PCBs	Grab	TBD	SW-846 Method 8082	Cool to 4° C	14 days to extractions; 40 days from extraction to analysis	(2) 1 L amber glass bottles
Surface water	Explosives	Grab	TBD	SW-846 Method 8330	Cool to 4° C	7 days until extraction; 40 days from extraction to analysis	(1) 1 L amber glass bottles

**Table 5-2. Analytical Parameters, Methods, Preservation and Container Requirements**

Sample Matrix	Analytical Parameter	Sample Type <sup>1</sup>	No. of Samples <sup>2</sup>	Analytical Method	Sample Preservation	Holding Time <sup>3</sup>	Sample Container <sup>4,5</sup>
Surface water	Metals (TAL) including boron and lithium by Inductively coupled plasma/mass spectroscopy	Grab	TBD	SW-846 Method 6020a/7000 Series	pH<2 with HNO <sub>3</sub> ; Cool to 4° C	28 days to analysis for Hg; 6 months to analysis for other metals	(1) 500 mL polyethylene bottle
Liquid Waste	Flashpoint	Grab	TBD	SW-846 Method 1010	Cool to 4° C	None	(1) 100 mL polyethylene container
Solid Waste/Liquid Waste	TCLP VOC	Grab	TBD	SW 846 Methods 1311/8260B	Cool to 4° C; no headspace	14 days to TCLP extraction; 14 days from extraction to analysis	(1) 60 ml VOC vial
Solid Waste/Liquid Waste	TCLP SVOC	Grab	TBD	SW 846 Methods 1311/ 8270C	Cool to 4° C	14 days to TCLP extraction; 40 days from extraction to analysis	(1) 950 mL amber glass jar
Solid Waste/Liquid Waste	TCLP Pesticides	Grab	TBD	SW-846 Methods 1311/8081A	Cool to 4° C	7 days to TCLP extraction; 40 days from extraction to analysis	(1) 950 mL amber glass jar
Solid Waste/Liquid Waste	TCLP Metals	Grab	TBD	SW 846 Methods 1311/ 6010B/7000 Series	Cool to 4° C	Hg: 28 days to TCLP extraction; 28 days from extraction to analysis. Other Metals: 6 months to TCLP extraction; 6 months from extraction to analysis	(1) 500 mL plastic jar
Solid Waste/Liquid Waste	Ignitability	Grab	TBD	SW-846 Method 1010/1030	Cool to 4° C	None specified	(1) 500 mL amber glass jar
Solid Waste/Liquid Waste	Corrosivity	Grab	TBD	SW-846 Method 9045C	Cool to 4° C	As soon as possible (within 3 days of collection)	(1) 500 mL amber glass jar
Solid Waste/Liquid Waste	Reactive cyanide	Grab	TBD	SW-846 Chapter 7, Section 7.3.3	Cool to 4° C; no headspace	As soon as possible (within 3 days of collection)	(1) 500 mL amber glass jar

**Table 5-2. Analytical Parameters, Methods, Preservation and Container Requirements**

Sample Matrix	Analytical Parameter	Sample Type <sup>1</sup>	No. of Samples <sup>2</sup>	Analytical Method	Sample Preservation	Holding Time <sup>3</sup>	Sample Container <sup>4,5</sup>
Solid Waste/Liquid Waste	Gross Alpha/Beta	Grab	TBD	SW-846 Method 9310m	Cool to 4° C ; HNO <sub>3</sub> to pH <2	48 hours to extraction 6 months from extraction to analysis	(1) 1 L polyethylene container
Solid Waste/Liquid Waste	Gamma Spec – Co-60, Zn-65, Cs-137, Cs-134	Grab	TBD	DOE HASL 300 Ga-01-Rm	Cool to 4° C; HNO <sub>3</sub> to pH <2	21 day ingrowth period prior to extraction and 6 months from extraction to analysis	(1) 1 L polyethylene container
Solid Waste/Liquid Waste	Isotopic Uranium	Grab	TBD	DOE HASL 300 A-01-Rm	Cool to 4° C; HNO <sub>3</sub> to pH <2	6 months	(1) 1 L polyethylene container
Solid Waste/Liquid Waste	Isotopic Thorium	Grab	TBD	DOE HASL 300 A-01-Rm	Cool to 4° C; HNO <sub>3</sub> to pH <2	6 months	(1) 1 L polyethylene container
Solid Waste/Liquid Waste	Isotopic Plutonium	Grab	TBD	DOE HASL 300 A-01-Rm	Cool to 4° C; HNO <sub>3</sub> to pH <2	6 months	(1) 1 L polyethylene container
Solid Waste/Liquid Waste	Radium-226	Grab	TBD	DOE HASL 300 Ra-06-RC	Cool to 4° C; HNO <sub>3</sub> to pH <2	6 months	(1) 1 L polyethylene container
Solid Waste/Liquid Waste	Strontium-90	Grab	TBD	DOE HASL 300 Sr-03-RC	Cool to 4° C; HNO <sub>3</sub> to pH <2	6 months	(1) 1 L polyethylene container

<sup>1</sup> For soil samples, a six-inch sampling interval is the preferred sample size; however, sample volume recovery, analytical method requirements, and field conditions can affect the actual sample interval size. For these reasons, the actual sampling interval may change in order to obtain adequate volume.

<sup>2</sup> Actual numbers of samples may vary depending on field conditions, sample material availability, and field observations. Table 5-1 for estimates.

<sup>3</sup> From date of sample collection

<sup>4</sup> I-Chem Series 300 bottles

<sup>5</sup> MS/MSDs require duplicate volume for all parameters for solid matrices; MS/MSDs require triplicate volume for organic parameters for aqueous matrices and duplicate volume for inorganic parameters for aqueous matrices

L = liter

ML = milliliter TBD = To Be Determined

VOA = volatile organic analysis



**Table 5-3. Other Potential Analytical Parameters, Methods, Preservation and Container Requirements for IDW Characterization<sup>1</sup>**

Sample Matrix	Analytical Parameter	Sample Type <sup>1</sup>	No. of Samples <sup>2</sup>	Analytical Method	Sample Preservation	Holding Time <sup>3</sup>	Sample Container <sup>4,5</sup>
Solid Waste	Cyanide	Grab	TBD	SW-846 Method 9012A	Cool to 4° C	14 days to analysis	(1) 300 mL amber glass jar
Solid Waste	Dioxins/Furans	Grab	TBD	SW-846 Method 8280A	Cool to 4° C	30 days to extraction; 45 days from extraction to analysis	(1) 300 mL amber glass jar
Solid Waste	TPH-DRO	Grab	TBD	SW-846 Method 8015B	Cool to 4° C	14 days to extraction; 40 days from extraction to analysis	(1) 300 mL amber glass jar
Solid Waste	Total Organic Halides	Grab	TBD	SW-846 Method 9023	Cool to 4° C; no headspace	28 days to analysis	(1) 2-oz. glass jar
Solid Waste/Liquid Waste	Reactive sulfide	Grab	TBD	SW-846 Chapter 7, Section 7.3.4	Cool to 4° C; no headspace	As soon as possible (within 3 days of collection)	(1) 500 mL amber glass jar
Liquid Waste	Nitrate	Grab	TBD	EPA Method 353.2/SM 4500-NO <sub>3</sub> B (18 <sup>th</sup> edition)	pH<2 with H <sub>2</sub> SO <sub>4</sub> ; Cool to 4° C	28 days to analysis	(1) 100 mL polyethylene container
Liquid Waste	Nitrite	Grab	TBD	Standard Method (SM) 4500-NO <sub>2</sub> B (18 <sup>th</sup> edition)	Cool to 4° C	48 hours to analysis	(1) 100 mL polyethylene container
Liquid Waste	Total Cyanide	Grab	TBD	EPA Method 335.3	pH>12 with NaOH; Cool to 4° C	14 days to analysis	(1) 250 mL polyethylene container
Liquid Waste	Total Dissolved Solids	Grab	TBD	EPA Method 160.1	Cool to 4° C	7 days to analysis	(1) 100 mL polyethylene container
Liquid Waste	Total Petroleum Hydrocarbons	Grab	TBD	EPA Method 418.1	pH<2 with HCl; Cool to 4° C	28 days to analysis	(2) 950 mL amber glass jar

**Table 5-3. Other Potential Analytical Parameters, Methods, Preservation and Container Requirements for IDW Characterization<sup>1</sup>**

Sample Matrix	Analytical Parameter	Sample Type <sup>1</sup>	No. of Samples <sup>2</sup>	Analytical Method	Sample Preservation	Holding Time <sup>3</sup>	Sample Container <sup>4,5</sup>
Liquid Waste	pH	Grab	TBD	EPA Method 150.1	Cool to 4° C	As soon as possible (24 hours to analysis)	(1) 100 mL polyethylene container
Liquid Waste	Amenable cyanide	Grab	TBD	EPA Method 335.2	pH>12 with NaOH; Cool to 4° C	14 days to analysis	(1) 300 mL polyethylene container
Liquid Waste	Hexavalent chromium	Grab	TBD	SW-846 Method 7196A	Cool to 4° C	24 hours to analysis	(1) 500 mL polyethylene container

<sup>1</sup> Table 5-3 is a listing of additional analytical requirements that, based on past experience, may be required by the disposal facility for completion of waste profiles and proper manifesting. Although it is not anticipated that all of these analyses will be required, the final analytical suite for waste characterization will be based on specific facility requirements and will be finalized once initial waste characterization (TCLP and RIC) is completed and a targeted facility is selected.

<sup>2</sup> Actual numbers of samples will depend on other analytical results, sample material availability, and disposal facilities requirements.

<sup>3</sup> From date of sample collection

<sup>4</sup> I-Chem Series 300 bottles

<sup>5</sup> MS/MSDs require duplicate volume for all parameters for solid matrices; MS/MSDs require triplicate volume for organic parameters for aqueous matrices and duplicate volume for inorganic parameters for aqueous matrices

RIC = Reactivity, ignitability, corrosivity

TBD = To Be Determined

TPH-DRO = Total petroleum hydrocarbons –diesel range organics

#### 5.4.2.1 Surface Soil/Sediment Sampling

Surface soil samples will be collected by the sample team using disposal scoops. Once the sample location is determined, the sample team will remove the initial layer of vegetative matter from the location so that the underlying soil is visible. The sample team will then use the scoops to place the soil into a mixing bowl for homogenization. Each sample will be screened using a PID to detect possible organic vapors and with radiological instrumentation as discussed in the RSP. The samples will be examined for staining, discoloration, odors, and debris indicative of contamination. Field screening analysis (PID, radiological, and/or explosives) will be recorded using the approved field management and data collection worksheets.

Once homogenized, the soil will be placed into the appropriate sample container. VOC samples will be collected directly into the sample container using a TerraCore® kit. If subsurface soil samples are co-located with surface soil samples, the surface soil samples may be collected using either a hand auger (at OCCP) or direct push as described below.

At the LPCSD site, along the SWDD, split samples (soil and sediment) may be collected for subsequent radiological analysis by USACE.

#### 5.4.2.2 Direct Push Soil Sampling

A vehicle mounted, hydraulically powered machine using static force and percussion (Geoprobe® or similar) will advance a macro-corer into the subsurface to collect soil samples. Continuous soil samples will be collected to the water table, or to the maximum depth of suspected impact based on a review of the historical structures intended to be investigated. If evidence of grossly impacted soil is encountered, the probes will be advanced to a depth at which soil no longer exhibits such impacts. Geologic descriptions of the soil and field screening results will be recorded in field logs.

Sampling will be performed using four-foot-long macrocore acetate sleeves that will be advanced continuously to the desired depth below the surface. Soil samples from each sleeve will be screened using a radiation screening instruments (see the RSP) and a PID to detect possible organic vapors. Organic vapor screening will be performed by slicing open the acetate sleeve, making a small slice in the soil column with a clean knife or sampling tool, inserting the PID probe and pushing the slice closed, and monitoring the soil for approximately 5 to 10 seconds. This procedure will be repeated at intervals along the soil column at the field geologist's discretion.

#### 5.4.3 Surface Water Sampling

In order to identify potential surface water impacts within the SWDD, additional biased surface water samples will be collected from locations along the portion of the SWDD that traverses the LPCSD campus. Six biased samples will be collected from biased sample locations, co-located with sediment and subsurface soil samples as detailed in section 5.2.2 and 5.4.2 and depicted in Figure 5-3. Samples will be collected from the most down-gradient location to the most up-gradient location along the SWDD in order to minimize potential cross contamination between the collected sample volumes. Split samples may be collected by USACE at these locations, for radiological analysis.

The surface water sample may be collected directly into the sample container when unpreserved dedicated sample containers are being utilized. Surface water volumes collected for analysis requiring preservation will be collected in a dedicated unpreserved sample container and immediately transferred into a dedicated sample container with Teflon® septa or other nonreactive material and the prescribed sample preservative volume. Whenever possible, surface water samples should be collected away from the shore line in order to minimize sediment infiltration into the sample volume. If the water body is not stagnant (i.e., stream, river) the sampler should face upstream while collecting the appropriate sample volume and minimize disturbing the bottom sediments.

In some situations, however, it may be necessary to use the unpreserved vials. For example, if the surface water sample contains a high concentration of dissolved calcium carbonate, there may be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles rendering the sample unacceptable for VOC analysis. In this case, unpreserved vials should be used and arrangements confirmed with the laboratory prior to sampling in order to ensure acceptable receipt of the unpreserved sample volumes.

Surface water sample volumes collected for VOC analysis will be collected ensuring that no bubbles or air space are trapped in the dedicated VOA sample container. Surface water sample volumes collected for VOC analysis will be sufficient to completely fill the dedicated sample container eliminated, when possible, all voids or head space. Sediment sample volumes should be decanted, as possible, to remove excess water

Selected discrete surface water samples will be collected for the following parameters in the order specified below:

- TCL VOCs,
- TCL SVOCs,
- Explosives,
- TCL PCBs, and
- TAL Metals plus lithium and boron

Analytical parameters, methods, container and preservation requirements for soil and groundwater samples, along with anticipated waste characterization requirements (for IDW disposal) are summarized in Table 5-2. Table 5-3 summarizes other potential analytical parameters, methods container and preservation requirements for the characterization of IDW, which may be required based on the selected disposal facility.

#### **5.4.4 Investigation-Derived Waste Characterization Sampling**

IDW classification sampling will be conducted to characterize solid and liquid wastes for the purpose of determining proper off-site disposal. Specific analytical methods for characterization of liquid and solid wastes are listed in Table 5-2. Additional analyses that may be required by the disposal facility (to be determined) are listed in Table 5-3. Sampling methods are presented in Table 5-4 and briefly discussed below.

#### 5.4.4.1 Solid Waste

As indicated by Table 5-4, solid sampling methods include utilizing dedicated stainless steel or Teflon® scoops/shovels, triers, and thieves. Scoops and shovels are the preferred method for sampling solids from piles or containers. Stainless steel triers are similar to a scoop and are used for the collection of a core sample of a solid material. Thieves are long hollow tubes, with an inner tube, and are used for sampling of dry free running solids (e.g., pile of fine sand). To sample solid material at varying depths, a core sampler in conjunction with an auger can be utilized (see Section 5.4.1).

#### 5.4.4.2 Liquid Waste

As indicated by Table 5-4, liquid sampling methods include utilizing dedicated dippers, glass tube samplers, pump and tubing, kemmerer bottles, and Bacon Bomb samplers. Dippers are used to collect samples from the surface of the liquid, and are appropriate for wastes that are homogeneous. Glass tube samplers consist of glass tubes of varying length and diameter used to collect a full-depth liquid sample from a drum or similar container. Pump and tubing (e.g., bladder pump or peristaltic pump) are used to collect liquid samples from a depth (up to approximately 20 ft below grade), and are typically relied upon for sampling subsurface structures, such as underground storage tanks. To minimize the loss of volatile organic components in the liquid, the lowest achievable flow rate is utilized for collecting the sample by this method. Kemmerer bottles and Bacon Bomb samplers are discrete-depth samplers. These samplers are lowered into the liquid and opened to collect a sample at a desired depth.

#### 5.4.4.3 Radiological Analysis for IDW

Under the auspices of DERP-FUDS, environmental samples will not be laboratory analyzed for radiological parameters. Although, due to Wastewater Treatment Plant (EU 7) proximity to areas of previously observed radiological impacts and a review of previous actions taken during activities related to HTRW projects at the former LOOW, radiological analysis will be conducted on IDW generated during Phase IV RI activities. This information will be utilized to select the appropriate waste facility for IDW. Radiological analysis will be conducted for, isotopic plutonium, isotopic thorium and isotopic uranium. In addition, gross alpha/beta and gamma spec analyses will be performed. Media to be sampled and specific analytical methods are provided in Table 5-2. If elevated radioactivity is present in samples collected during Phase IV RI activities, USACE will be contacted immediately and appropriate actions will be determined.

<b>Table 5-4. Sampling Methods Summary for IDW Characterization</b>							
<b>Waste Type/Unit Type</b>	<b>Scoops/ Shovel</b>	<b>Sample Core</b>	<b>Auger</b>	<b>Glass Tubes</b>	<b>Dipper</b>	<b>Pump/ Tubing</b>	<b>Kemmerer Bottle</b>
<b>Solid Waste</b>							
Waste Piles	X	X	X				
Drums	X	X					
Sacks/Bags	X						
<b>Liquid Waste</b>							
Drums				X	X	X	

#### 5.4.5 QC Sample Information

QC samples will include equipment blanks, trip blanks, field duplicates and MS/MSDs.

**Equipment blanks** will consist of deionized water and will be used to check the efficacy of equipment decontamination and potential contamination of the equipment that may cause sample contamination. Equipment blanks will be collected by routing the distilled water through the sampling equipment prior to sample collection. Equipment blanks will be submitted to the laboratory at a frequency of one per 20 samples per matrix per type of equipment being used per parameter, with the exception of TCLP parameters and parameters associated with waste characterization/disposal samples.

**Trip blanks** will consist of distilled deionized water (supplied by the laboratory) and will be used to assess the potential for volatile organic compound contamination of groundwater samples due to contaminant migration during sample shipment and storage. Trip blanks will be transported to the site unopened, stored with the investigative samples, and kept closed until analyzed by the laboratory. Trip blanks will be submitted to the laboratory at a frequency of one per cooler that contains groundwater sample aliquots proposed for VOC analyses.

**Field duplicates and QA splits** are an additional aliquot of the same sample submitted for the same parameters as the original sample. Field duplicates will be used to assess the sampling and analytical reproducibility. QA split samples are also additional aliquots of the same sample, but are sent to a separate laboratory. The USACE may elect to collect QA splits at their discretion. The QA split will be assigned the same designation as the parent sample, with the addition of a “-QA” as a suffix. Duplicate samples will be designated such that the laboratory will not know which sample is the parent to the duplicate. Therefore, duplicates will be assigned a different designation from the “parent” sample. The soil selected for the duplicate and QA split analyses should be homogenized with the parent sample using the coning and quartering method, with the exception of the aliquot for VOC analysis. The VOC aliquot shall be a grab sample collected as closely as possible to the aliquot for VOC analysis collected for the parent sample. The duplicate and QA split samples are considered separate samples, and will be submitted for the same analysis as the parent sample, in the same quantity, bottle type, and using the required preservation techniques. For aqueous samples, field duplicates will be collected by alternately filling sample bottles from the source being sampled. Field duplicates will be submitted at a frequency of one per 10 samples for all matrices and all parameters, with the exception of TCLP parameters and parameters associated with waste characterization/disposal samples. Waste characterization samples will not require collection of field duplicates.

**MSs and MSDs** are two additional aliquots of the same sample submitted for the same parameters as the original sample. The additional aliquots will be spiked by the laboratory with compounds and/or surrogates. Matrix spikes provide information about the effect of the sample matrix on the measurement methodology. MS/MSDs will be submitted at a frequency of one per 20 investigative samples per matrix for organic parameters. MSs will be submitted at a frequency of one per 20 investigative samples per matrix for inorganic parameters.

The frequency and expected number of QC samples is listed in Table 5-1. Preservation and container requirements for QC samples are the same as shown in Table 5-2.

**Temperature Blanks** are aliquots of potable or distilled water sent by the laboratory, typically in plastic containers, to be included in each sample cooler. Upon arrival at the laboratory, the temperature blank will be used by the sample custodian to determine the temperature of cooler.

## **5.5 Sample Preparation and Analytical Procedures**

### **5.5.1 Field Screening Sample Preparation**

Field screening for explosives will be performed on soil samples. DropEx<sup>®</sup> is an liquid-based detection system for the identification of explosives through a series of sequential reactions. The DropEx<sup>®</sup> Kits will be used to provide a rapid environmental screen of soil samples collected at both locations. Nitroaromatics, nitrate esters and nitramines are determined by a series of reactions which differentiates between the concentrations and sets of compounds within the media tested.

Grab soil samples will be collected as described in Section 5.4.2. The homogenized soil will be spread onto the DropEx<sup>®</sup> wipe, or similar, allowing the field screening medium time to react. Field screening analysis will be recorded using the approved field management and data collection worksheets.

To ensure quality and reproducibility of the field screening data, duplicate field screening wipes will be conducted at a rate of one per 20 samples collected. Samples that may be selected for laboratory analysis thereafter will be subject to the sampling quality assurance plan consisting of duplicate samples, field blanks, equipment blanks, trip blanks and MS/MSDs as described in other sections of this FSP Addendum.

At the LPCSD, a limited number of field screened samples will be chosen for laboratory analysis as described in Section 5.2.2. At these locations, a Geoprobe<sup>®</sup>, or similar, will be used to advance a sampling tube to the vadose zone. A discrete, representative sample of surface soil and subsurface soil will be collected and submitted to the laboratory for full suite analysis. Samples for laboratory analysis will be collected based on PID readings, discoloration, staining, and the field screening results.

Samplers will wear phthalate-free gloves such as nitrile (no latex will be used) and will avoid contact of the gloves with the sample. Only clean metal instruments will be allowed to touch the sample.

### **5.5.2 Sample Preparation**

Soil samples will be collected as described in Section 5.4.2 and, packaged and documented as described in Section 6 of this FSP. The procedures have been established based on approved techniques and methods which ensure the highest quality data deliverables.

### **5.5.3 Laboratory Sample Preparation and Analysis**

Laboratory analyses of soil, surface water, sediment, and waste characterization samples will be performed by TA in accordance with QA/QC procedures specified in the *Test America, Inc, Quality Assurance Manual* (TA, 2010), provided as an appendix to the QAPP. Table 5-2 summarizes the proposed analytical methods to be used during this investigation.

## **5.6 Sample Preservation and Containerization**

The analytical laboratory will supply the sample containers for the chemical samples. These containers will be cleaned by the manufacturer to meet or exceed all analyte specifications established in *Specifications and Guidance for Contaminant-Free Sample Containers* (EPA, 1992). Certificates of analysis are provided with each bottle lot and maintained on file to document conformance to EPA specifications. The containers will be pre-preserved, where appropriate (See Table 5-2).

## **5.7 Decontamination of Field Equipment**

This SOP was prepared to direct ERT personnel in the methods for decontamination of field equipment used in hazardous waste investigations. The SOP conforms to "A Compendium of Superfund Field Operations Methods (EPA/540/P-87/001) (USEPA, 1987)," and other pertinent technical publications.

The objective of equipment decontamination is to remove potential contaminants from a sampling device or item of field equipment prior to and between collection of samples for laboratory analysis and limit personnel exposure to residual contamination that may be present on used field equipment.

### **5.7.1 Equipment**

The following equipment may be utilized when decontaminating equipment. Site-specific conditions may warrant the use or deletion of items from this list.

- Alconox, liquinox or other non-phosphate concentrated laboratory grade soap;
- Deionized Water;
- Pump Sprayer;
- 1-Pint Squeeze bottle filled with pesticide-grade hexane;
- 1-Pint Squeeze bottle filled with pesticide-grade methanol;
- 1-Pint Squeeze bottle filled with ten (10) percent nitric acid;
- 1-Pint Squeeze bottle filled with one (1) percent nitric acid;
- Five large plastic wash basins (24 inches by 30 inches by 6 inches deep);
- Two coarse scrub brushes;
- Small wire brush;
- Aluminum foil;
- Polyethylene sheeting;
- Two large capacity barrels;
- All necessary personal protective equipment (gloves, eyewear, tyvek suits);
- Extra quantities of above listed liquids; and
- 4 inch Schedule 40 PVC pipe 4 ft in length with an end cap for decontaminating pump and associated tubing (if needed).



### **5.7.2 Procedures for Soil Sampling Equipment**

Soil sampling equipment, such as split spoon samplers, shovels, augers, trowels, spoons, mixing bowls, and spatulas will be cleaned using the following procedure.

1. Lay out sufficient polyethylene sheeting on the ground or floor to allow placement of the five plastic wash basins and an air drying area. Place wash basins on the polyethylene sheeting.
2. Fill the first wash basin with potable tap water. Add sufficient soap powder or solution to cause suds to form in the basin. Do not use an excessive amount of the soap or rinsing the soap residue off the equipment will be difficult.
3. Using a clean, coarse scrub brush, wash the sampling equipment in the soap solution in the first basin, removing all dirt. Allow excess soap to drain off the equipment when finished.
4. Rinse the equipment with tap water in the second basin, using a coarse scrub brush or pressure sprayer to aid in the rinse, if necessary.
5. If the equipment is being used to sample for metals, rinse the equipment with nitric acid in the third basin. A 10 percent solution is used on stainless steel equipment. A one percent solution is used on all other equipment. If no metals sampling is being performed, this step may be omitted.
6. Spray down the equipment in the third basin, using deionized water.
7. Spray down the equipment in the fourth basin, using pesticide-grade methanol, if sampling for organic compounds is to be performed. If oily, a two-step process using methanol, followed by hexane should be used to remove both water soluble and non-soluble compounds. If no samples for organic compounds are being collected, this step may be omitted.
8. Allow the equipment to completely air dry on clean polyethylene sheeting.
9. Rinse the equipment in the fifth basin, using deionized water.
10. Allow the equipment to completely air dry on clean polyethylene sheeting.
11. Reassemble equipment, if necessary, and wrap completely in clean, unused aluminum foil, shiny side out for transport. Re-use of equipment on the same day without wrapping in foil is acceptable.
12. Allow spent cleaning solutions in the trays to evaporate into the air. If evaporation is not possible, all spent cleaning solutions shall be drummed for disposal along with any other contaminated fluids generated during the field investigation.
13. Record the decontamination procedure in the field logbook or on appropriate field form.
14. If step 8, rinsing with organic solvents, was performed, check the equipment for the presence of residual solvents with a PID or flame ionization detector prior to use. If detection occurs, disassemble the equipment and allow to air dry until no readings are observed, then re-rinse with deionized water.

*Note that if temperature or humidity conditions preclude air drying equipment, sufficient spares should be available so that no item of sampling equipment need be used more than once.*

*Alternatively, the inability to air dry equipment completely prior to reuse should be noted in the field logbook. In this case, additional rinses with deionized water should be used and recorded.*

## 5.8 Management of Investigative Derived Wastes

Containerized IDW will be secured in drums or other leak-proof containers and properly labeled pending appropriate disposal. Containerized waste will be sampled as required by the disposal facility. Typical parameters include Resource Conservation and Recovery Act (RCRA) characteristic waste parameters – ignitability, reactivity, corrosivity and toxicity. Toxicity for solids will be evaluated by the TCLP method. Toxicity for liquid IDW will be evaluated by TCL/TAL analysis using SW846 methods. Results will be compared to characteristic waste action levels prior to determining a disposal method.

Disposal of the waste will be coordinated with the USACE and the disposal facility. The USACE will be considered the generator of wastes accumulated during this investigation. A signatory from the USACE will be designated to sign the waste characterization and disposal manifests prior to disposal.

Table 5-5 summarizes the wastes to be generated during the investigation, as well as the anticipated disposal method.

Table 5-5. IDW Management		
Type of Waste	Proposed Characterization Analyses	Proposed Handling/Disposal
Sampling gloves, coveralls, paper towels, etc.	None	Dispose as municipal waste
Waste soil or solids	See Table 5-2 and, if additional analyses are required by disposal facility, see Table 5-3.	Containerize, sample for RCRA characteristic wastes, dispose at appropriate permitted facility
Decontamination fluid	See Table 5-2 and, if additional analyses are required by disposal facility, see Table 5-3.	Containerize sample for RCRA characteristic waste, dispose of at appropriate permitted facility

## 5.9 Survey of Sample Locations and Elevations

Sample locations and grid nodes will be located using a hand held GPS unit, along with distance measurements from previously surveyed locations (i.e., fence posts or other objects). The information will be incorporated into figures providing the actual sample locations for both the OCCP and LPCSD sites.

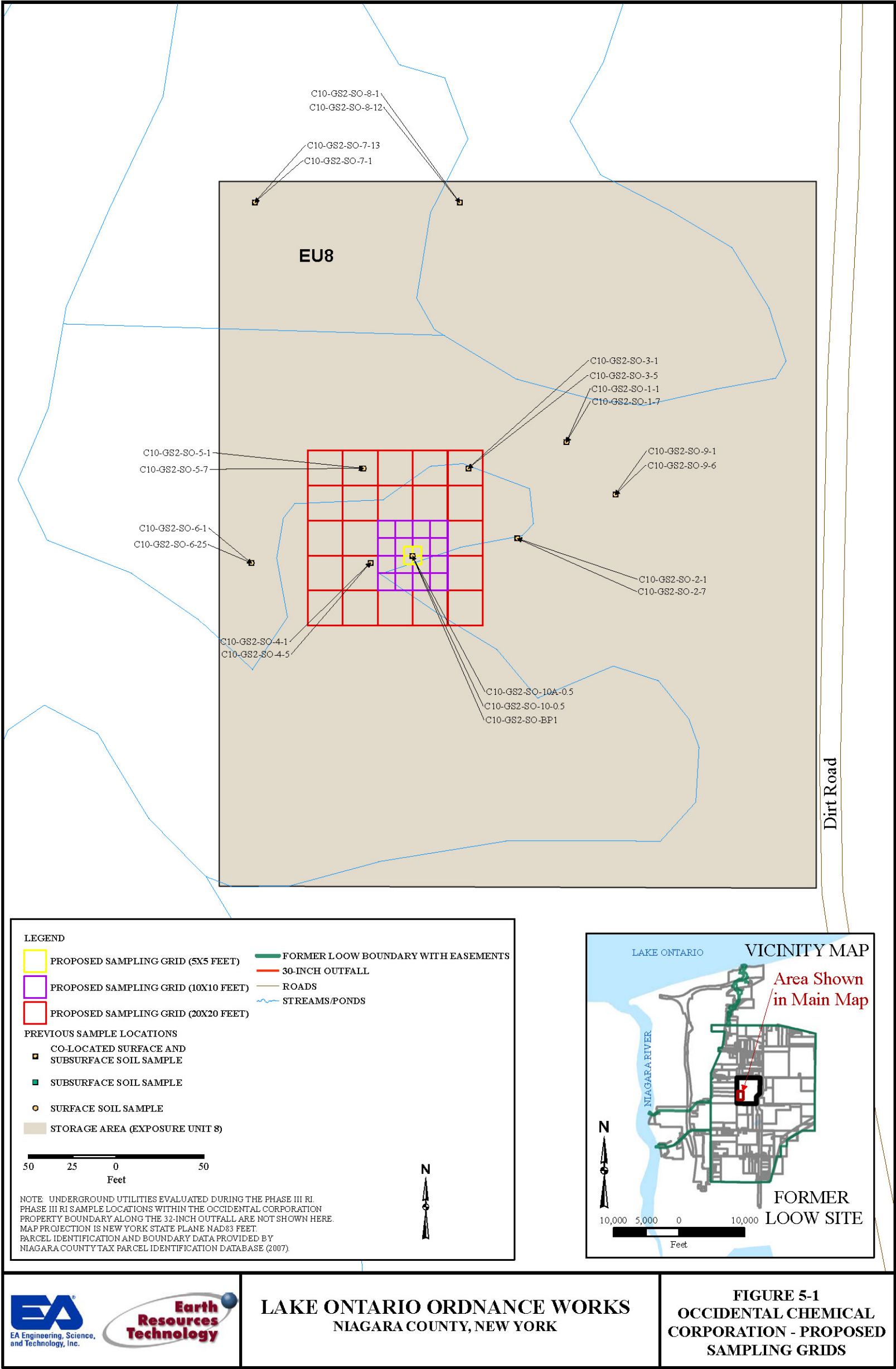


Figure 5-1. Occidental Chemical Corporation Property - Proposed Sampling Grids

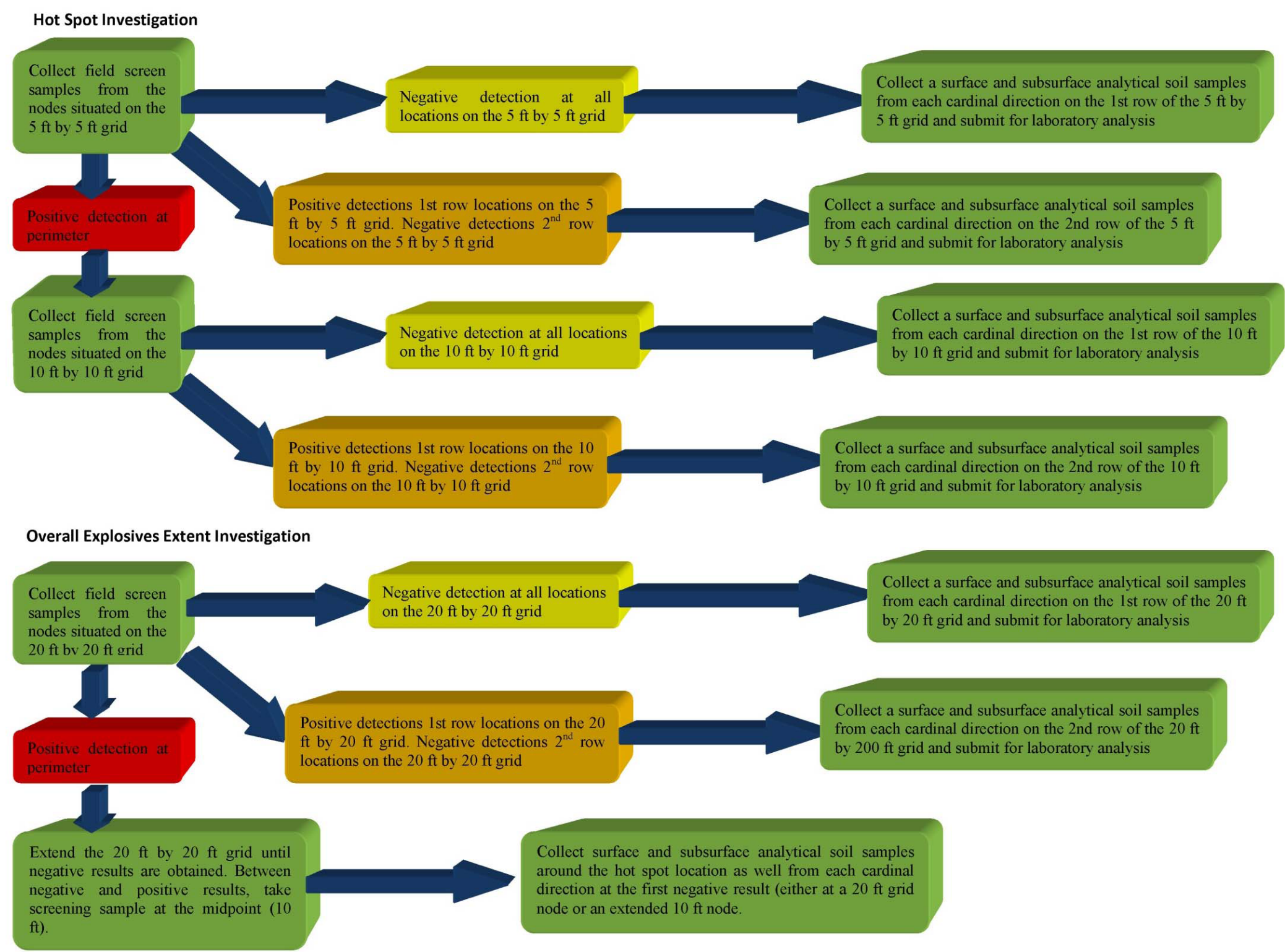


Figure 5-2. Decision Tree for Field Screening for Explosives at OCCP.



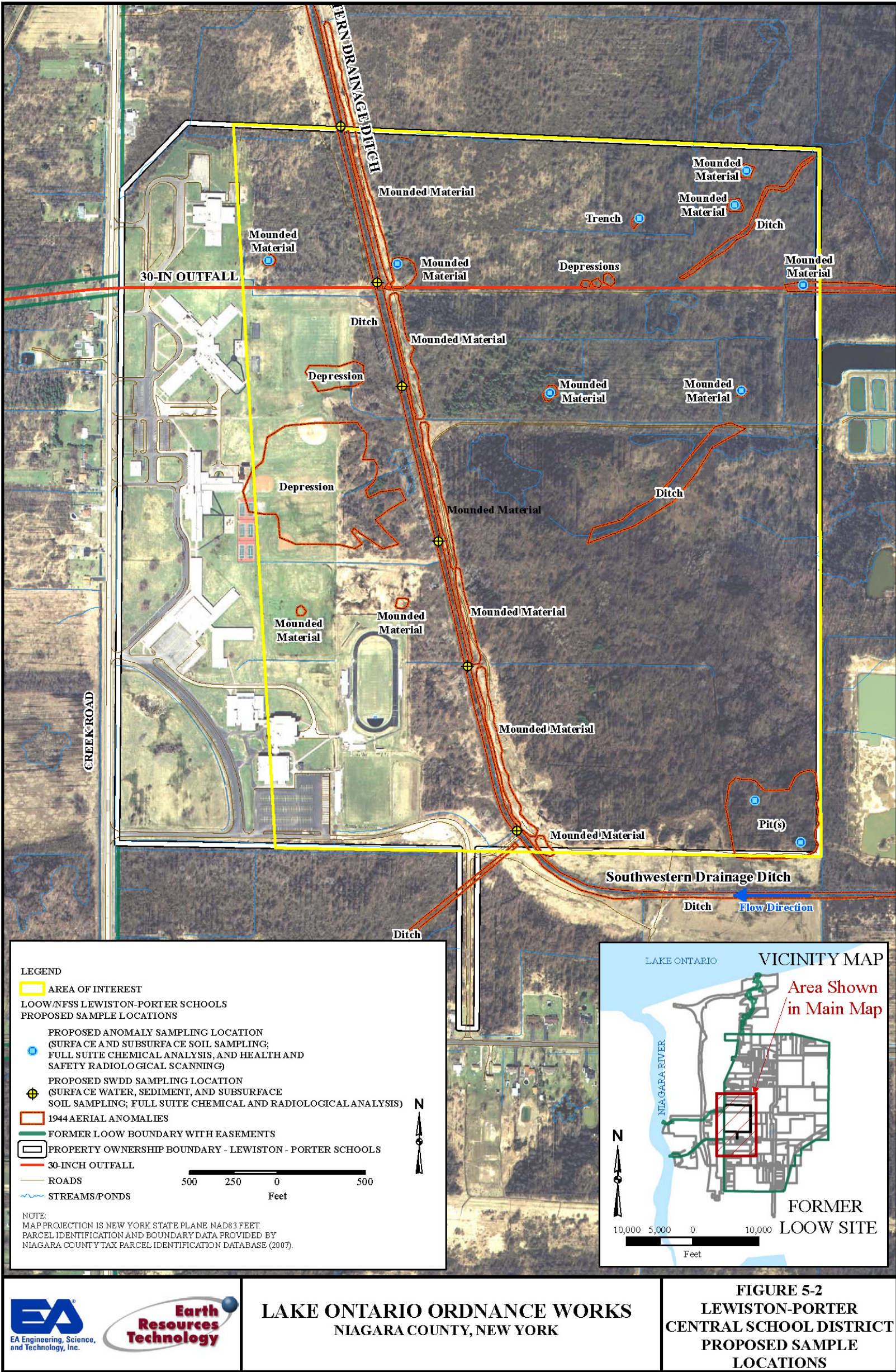


Figure 5-3. Lewiston-Porter Central School District Proposed Sample Locations



## **6.0 SAMPLE MANAGEMENT**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **6.1 Sample Collection Documentation**

#### **6.1.1 Field Documentation**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

#### **6.1.2 Sample Labeling**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

#### **6.1.3 Sample Custody**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

#### **6.1.4 Chain-of-Custody Records**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **6.2 Sample Packaging**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

#### **6.2.1 Required Equipment**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

#### **6.2.2 Procedures**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **6.3 Documentation of Field Activities**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

## **7.0 FIELD ASSESSMENT/THREE PHASE INSPECTION PROCEDURES**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **7.1 Preparatory Phase**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **7.2 Initial Phase**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

### **7.3 Follow-Up Phase**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*

## **8.0 NON-CONFORMANCE AND CORRECTIVE ACTIONS**

*This section of the original Phase IV RI FSP Addendum (USACE/ERT, 2009h) has not been amended.*



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**APPENDIX A**  
**Proposed Procedures for Background Evaluation**

## PROPOSED PROCEDURES FOR BACKGROUND EVALUATION

### Background Soil Evaluation

Background samples were collected during Phases I and II of the RI in order to obtain data representing the general area of the former LOOW that was not impacted by site-specific operations. The background sample collection program included collection of a surface and subsurface soil sample from each of 17 locations (EA 2002). Samples were submitted for analysis of TAL metals, boron, and lithium. A subset was submitted for analysis of PAHs. Although there is the potential for non-DOD, anthropogenic impact from pesticides due to extensive use of the area for agricultural purposes, the background samples were not submitted for pesticide analyses. However, results of the risk assessment conducted during the Phase I and Phase II RI confirmed that pesticides were not driving risk at the LOOW site.

For the Phase IV RI of the WWTP, the background metals data will be used to evaluate whether reported metals concentrations in soil samples are indicative of background and/or anthropogenic concentrations (from non-DOD impact, such as metals from pesticide use in orchards) or were more likely due to impact from site activities associated with DOD site-use.

A test for outliers within the initial inorganic background dataset was performed prior to using the dataset for the background evaluation. Using an inter-quartile test (Iglewicz and Hoaglin, 1993), three results from surface soil samples were identified as potential outliers: selenium within background location BGKD 12, and arsenic and lead within location BKGD 17.

Location BGKD 12 was located within a hunting preserve. Selenium is a component in gun metal and may have been present in higher concentrations due to site use. Location BKGD 17 was located adjacent to a fruit orchard. Lead arsenate has historically been used as a pesticide and may have contributed to the lead and arsenic reported at this location.

Because selenium, arsenic, and lead were reported as outliers and site use suggests that the concentrations may be linked to site use, these three concentrations were removed from the data set prior to use in the background evaluation.

To prepare the Phase IV data for the background evaluation, data from soil samples will be evaluated to determine the number of detected concentrations for each analyte. If the number of detected results is less than 10 (for either the background or the site data set), the data set will be considered too small to perform a robust background evaluation.

For analytes with the number of detects greater than or equal to 10, Wilcoxon Rank Sum and Quantile tests will be performed at the 95% significance level to test the null hypothesis that background data is less than or equal to site data. Figure A-1 illustrates the decision tree for determining if the Phase IV data exceeds background.

**APPENDIX B**  
**Standard Operating Procedures**



Earth Resources Technology, Inc. Standard Operating Procedure <b>PREPARING FOR AND CONCLUDING FIELD ACTIVITY</b>			
Effective Date: <b>01/22/09</b>		Version: <b>001</b>	SOP#: <b>ERT SOP-01-1A</b>
Approvals			
[Redacted] C.P.G. Program Manager		[Redacted] C.P.G. Field OA Manager	
[Redacted] Signature	1/23/09 Date	[Redacted] Signature	1/22/09 Date

## 1.0 PURPOSE

The purpose of this procedure is to outline requirements associated with preparing for and concluding environmental field activities.

## 2.0 SCOPE

This procedure applies to all field activities commencing with the Notice to Proceed and ending with the completion of all project field activities.

It is neither the intent of this procedure to fully detail all actions required for preparing and concluding field activities nor define specific methodology, but rather offer general points to be considered in the preparation and conclusion of field activities. Preparation and conclusion activities are specific to the planned field activities and will be detailed in the project-specific Sample and Analysis Plan.

## 3.0 REQUIREMENTS

In order to efficiently complete field work, specific tasks must be accomplished in an orderly fashion prior to actual field work (preparation) and after field work has been completed (conclusion).

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

For the purpose of this procedure, the Project Manager is responsible for providing the Field Team access to applicable project-specific information, subcontractor support and equipment necessary to complete stated Project Quality Objectives. Project Manager responsibilities include, but are not limited to, locating resources and manufacturers of the proposed equipment, initiating purchaser lease agreements, coordinating site access, coordinating field tasks with associated subcontractors/prime contractors and perform overall task management.

### 4.2 Field Team Leader

The Field Team Leader is responsible for ensuring the Field Team understands all associated field activities and applicable procedures, adheres to the project-specific work plans and successfully completes the field activities. The Field Team Leader is responsible for identifying and obtaining project specific field equipment and tools, appropriate field recording forms and ensuring adequate quantities of supplies. If appropriate, the Field Team Leader is responsible for coordinating necessary subcontractor support. This may include scheduling the receipt of appropriate environmental sample containers, scheduling courier services for analytical samples to the laboratory, etc, as directed by the Project Manager.

The Field Team Leader is responsible for the completion of the Field Activity Preparation Checklist and the Work Order Form. Upon completion, these forms will be reviewed with the Project Manager to ensure accuracy and completeness.

During field activities and at the conclusion of field activities, the Field Team Leader is responsible for performing periodic quality control and quality assurance checks of all environmental sampling procedures and samples obtained, arrange sample shipment to the analytical laboratory, ensure all equipment (both rented and ERT owned) and supplies are accounted for and aptly returned.

#### **4.3 Field Team Members**

The Field Team is responsible for the successful completion of all field tasks as assigned by the Field Team Leader. This will be ensured by the adherence to the project-specific operating procedure and project-specific work plan(s). For the purpose of this procedure, the Field Team will be required to fully understand tasks associated with the project-specific work plan(s). During preparation for field activities, field team members may be directed by the Field Team Leader to aid in the identification and arrangement of necessary activity specific equipment, subcontractor support and information.

### **5.0 EQUIPMENT**

None Specified

### **6.0 PROCEDURE**

#### **6.1 Preparing Field Activities**

Preparation is a process that begins with the Notice to Proceed and ends with the initiation of field activities. Adequate time and effort involved in preparation ensures efficient and effective execution of the work plan and completion of field activities.

The many preparation tasks to be considered include:

- Ordering and procuring items of a specialized nature, including environmental sampling equipment, environmental sample containers, etc.
- Performing a thorough review of the cost proposal to determine if additional items may be needed. This should be discussed with the personnel assigned to field activities.
- Informing personnel of the date, location and activity required to be performed. Instruct personnel as to travel arrangements.
- Locating sources for field purchased items and supplies.
- Establishing an inventory system of disposable and non-disposable items.
- Detailing specific requirements for mobilization of subcontractors to include drilling contractors, analytical laboratories. Activities to be considered include transportation, decontamination, orientation and badging, and initial setup.
- Testing and calibrating all equipment to ensure operational readiness.
- Establishing a field office or field staging areas for materials and IDW.
- Ensuring reliable communications for field personnel during field activities.



## **6.2 Concluding Field Activities**

Terminating field activity includes activities necessary to transfer custody of materials and supplies after completion of field activities. Activities to be considered include:

- Planning for the thorough completion of field activities before conclusion of field activities. Preliminary conclusion efforts may be undertaken, but all materials and supplies necessary for field activities shall be retained until field activities are complete.
- Reviewing records and thoroughly inspecting equipment to ensure all equipment has been decontaminated.
- Adequately packing special equipment, electronic equipment and other non-disposable items for shipment.
- Completing a review of all environmental samples to be delivered to the analytical laboratory. All sample volumes, sample nomenclature, sample labels, specified sample analytics, number of samples, Chain-of Custody forms, packaging of samples and custody seal will be thoroughly reviewed by the Field Team Leader prior to relinquishing environmental samples.
- Completing an inventory review of packaged equipment for shipment.
- Contact applicable rental equipment suppliers, off-rent equipment and document confirmation off-rent number when applicable. Transfer custody of the rental equipment to the rental company or contracted courier.
- Stage and or dispose of all IDW in accordance with federal and state regulations

## **7.0 REFERENCES**

The following documents were referenced during the development of this Standard Operation Procedure:

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York

## **8.0 DEFINITIONS**

None

## **9.0 ATTACHMENTS**

### **9.1 Attachment 1 – ERT Field Activity Preparation Checklist**

Prior to commencing field activities, the field team is required to amass the necessary information and equipment necessary to successfully complete the field activity objectives. To ensure the appropriate equipment has been obtained, the Field Activity Preparation Checklist will be completed and reviewed with the Field Team

## ERT Field Activity Preparation Checklist

### General:

<input type="checkbox"/>	Relevant project file documents	<input type="checkbox"/>	Wide brimmed hat
<input type="checkbox"/>	Field book	<input type="checkbox"/>	Caution tape
<input type="checkbox"/>	Clip board / desk top	<input type="checkbox"/>	Nitrile gloves
<input type="checkbox"/>	Cell phone and charger	<input type="checkbox"/>	Trash bags
<input type="checkbox"/>	Safety glasses	<input type="checkbox"/>	Chair and table
<input type="checkbox"/>	Steel toe boots	<input type="checkbox"/>	Lunch
<input type="checkbox"/>	Hard hat	<input type="checkbox"/>	Drinking water
<input type="checkbox"/>	Work plan	<input type="checkbox"/>	Rugged work ware
<input type="checkbox"/>	Work gloves	<input type="checkbox"/>	Rain Gear
<input type="checkbox"/>	Hand tools	<input type="checkbox"/>	Site access key
<input type="checkbox"/>	HASP	<input type="checkbox"/>	Subcontractor contact #
<input type="checkbox"/>	Paper towels	<input type="checkbox"/>	Power converter

### Drilling

<input type="checkbox"/>	PID w/ cal gas	<input type="checkbox"/>	Caution tape
<input type="checkbox"/>	Water level meter	<input type="checkbox"/>	Measuring wheel
<input type="checkbox"/>	GPS	<input type="checkbox"/>	USACE manual
<input type="checkbox"/>	Decon bucket, soap and brush	<input type="checkbox"/>	Macro core holder
<input type="checkbox"/>	Well log forms	<input type="checkbox"/>	Non-HAZ stickers
<input type="checkbox"/>	Work plan	<input type="checkbox"/>	Hand auger

### Ground water Sampling

<input type="checkbox"/>	Pump	<input type="checkbox"/>	String
<input type="checkbox"/>	Battery / Generator	<input type="checkbox"/>	Well keys
<input type="checkbox"/>	Tubing	<input type="checkbox"/>	Carbon bucket
<input type="checkbox"/>	Multi-meter	<input type="checkbox"/>	Bottle ware + extras
<input type="checkbox"/>	Bailers	<input type="checkbox"/>	Labels + extras
<input type="checkbox"/>	Measuring cup	<input type="checkbox"/>	COC
<input type="checkbox"/>	Stopwatch	<input type="checkbox"/>	Cooler with bubble wrap
<input type="checkbox"/>	PID w/ cal gas	<input type="checkbox"/>	Ice
<input type="checkbox"/>	Buckets (3) w/ lids	<input type="checkbox"/>	Ziplock bags
<input type="checkbox"/>	Decon station	<input type="checkbox"/>	Fishing gear
<input type="checkbox"/>	Soap and brush	<input type="checkbox"/>	Work plan
<input type="checkbox"/>	Distilled water	<input type="checkbox"/>	Work order
<input type="checkbox"/>	DI water	<input type="checkbox"/>	Purge data sheets
<input type="checkbox"/>	Water level meter	<input type="checkbox"/>	Non-HAZ stickers

### Soil Sampling

<input type="checkbox"/>	PID w/ cal gas	<input type="checkbox"/>	Labels
<input type="checkbox"/>	zip lock bags	<input type="checkbox"/>	Soil sample equipment
<input type="checkbox"/>	Jars	<input type="checkbox"/>	Hand auger
<input type="checkbox"/>	Cooler and bubble wrap	<input type="checkbox"/>	Digging Bar
<input type="checkbox"/>	Ice	<input type="checkbox"/>	Paper towels
<input type="checkbox"/>	Chain of custody	<input type="checkbox"/>	Trowel

*\*Highlight as applicable*



Earth Resources Technology, Inc. Standard Operating Procedure <b>USE OF FIELD LOGBOOKS</b>			
Effective Date: <b>01/22/09</b>		Version: <b>001</b>	
SOP#: <b>ERT SOP-01-2</b>			
Approvals			
[Redacted] Program Manager		[Redacted], C.P.G. Field QA Manager	
[Redacted]		[Redacted]	
1/22/09		1/21/09	
Signature		Date	
Date		Signature	
Date		Date	

## 1.0 PURPOSE

The purpose of this procedure is to detail minimum requirements related to maintaining Field Logbooks and recording all field activities within Field Logbooks.

## 2.0 SCOPE

This procedure applies to all Field Logbooks which are required to be maintained onsite during field activities and for the duration of a project.

## 3.0 REQUIREMENTS

Field Logbooks will be initiated at the start of the first field activity. Entries will be made each day that field activities occur related to Earth Resources Technology, Inc. (ERT) or ERT subcontractor activities. A current field logbook will be maintained during the duration of the project. Site activities which are nonconcurring will be recorded in the same dedicated Field Logbook.

The Field Logbook will become part of the permanent project file. Field Logbooks must be maintained properly and to the standard set forth in this procedure because information contained in the Field Logbook may be admitted as evidence in mitigation, as an accurate record of field procedures and/or representative site conditions during the time of field activities. All logbooks will be secured in a reasonable fashion for the duration of the project and filed with related project documents after the completion of the project. Field Logbooks are considered company property, as such will be retained and utilized by ERT personnel exclusively to record the events of field activities associated with ERT projects.

## 4.0 RESPONSIBILITIES

### 4.1 Project Managers

The Field Logbook is issued by the Project Manager to the Field Team Leader or other person responsible for the direction of field activities (i.e., Field Geologist, Sampling Team Leader). Upon completing field activities, the Field Logbook will be returned to the Project Manager's custody that is responsible for reviewing the daily entries and filing the logbook within the permanent project file.

## **4.2 Field Team Leader**

Field Logbooks are issued to the Field Team Leader, or other person responsible for conducting field activities. It is the responsibility of this person to keep the logbook current, detailing all field activities and pertinent information. It is this person's responsibility to properly secure the logbook and return the logbook to the custody of the Project Manager after concluding field efforts.

## **5.0 EQUIPMENT**

The Field Logbook shall have pre-printed numbered pages, be bound in such a way that pages cannot be readily removed, and be constructed of robust and weather resistant material.

## **6.0 PROCEDURE**

### **6.1 General**

The cover and inside cover of each logbook will contain at a minimum the following information:

- Project Identification
- Project number
- Project Manager's name
- Project Manager contact info
- Sequential book number
- Start date
- End date

The spine of the log book shall contain the following information

- Project Identification
- Sequential book number

As appropriate, a table of contents will be compiled on the Table of Contents page with descriptions of field activities and their respective page numbers in chronological order. The Tables of Contents page will be completed after a log book has been filled to capacity and review of the daily entries has been performed by the Project Manager.

Unless prohibited by weather, pens with permanent black ink should be used to record all activities and datum. When weather conditions do not make it conducive to use permanent ink, entries should be made using a non-smear lead pencil. Once removed from wet elements, penciled entries should be repeated with a permanent ink pen to ensure permanency of the entry. No erasures are permitted. Data or other information that has been entered incorrectly will be corrected by drawing a single line through the incorrect entry, initialing (or signing) and dating the lined-through entry. Under no circumstances will the incorrect material be erased, made illegible or obscured so that it cannot be read. The Field Team Leader or his designee will draw a diagonal line and initial at 1) the end of unfilled pages and 2) the end of all entries for each day of field activity. The final recorded information for each daily entry will be the time field personnel exited the site.

## **6.2 Information Required**

The initial entry for each day of field activities at a minimum should include the following information:

- Date
- Day of week
- Purpose of site visit
- Time of arrival onsite
- Weather conditions
- Names and/or initials of all ERT field personnel present
- Names and/or initials of all subcontractors present
- Names of any visitors present and their affiliation

Entries will be recorded in the Field Logbook in real-time chronological order and summarize all site activities. Logbook entries will be recorded in clear concise and legible hand script, should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate.

### **6.2.1 Information Required for Sampling Activities**

- Makes and models of equipment, and identifying numbers
- Equipment calibration procedures performed including concentrations of calibration media
- Equipment decontamination procedures performed
- Equipment nonconformance
- Sampling methodology utilized
- Matrix sampled
- Sample location, when applicable
- Sample ID's
- Sample collection times
- Sample ware, i.e. number of, size, type, and preservative
- Analytical parameters requested to be performed by the contracted laboratory
- Sample custody procedure conducted
- Any deviations from the work plan that occur while conducting field activities
- Relevant Health and Safety conditions
- Notation of use of any activity specific forms utilized

### **6.2.2 Information Required for Soil Boring and Well Installation**

- Name of subcontractor(s)
- Names of the subcontractor(s) personnel
- Drilling methodology utilized
- Location of drilling activities and the duration of drilling (start and completion times).

- Observations made during the recovery of boring cuttings, including visual, olfactory, photoionization detector (PID) readings, volume and geologic descriptors, if necessary.
- Well construction information, including the length of screen and riser, depth interval of filter pack, bentonite, and sealing media, depth of screened interval, and well head protection measures.
- Quantity, type, and name of manufacture of well construction material (i.e. filter sand, bentonite, grout, and well material)
- Quantity and frequency that water was added to the borehole in order to assist boring and well construction
- Depth groundwater was encountered, as applicable.
- Depth to water in completed well.
- Any complications impeding the progress of drilling activities
- Abandonment method if no well is installed in borehole
- Site sketch depicting relevant surface features, project related investigative features, and scale and North arrow if possible.
- Any deviations from the work plan that occur while conducting field activities
- Relevant Health and Safety conditions
- Notation of use of any activity specific forms utilized

Field Logbook entries are not intended to replace data recorded on activity specific data forms such as Well Log Forms, Well Construction Diagram Forms, and Purge Data Sheets. Use of such forms must be noted in the Field Logbook.

## **7.0 REFERENCES**

The following documents were referenced in the development of this Standard Operation Procedure:

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Army Corp of Engineers (USACE), 2001. *Requirements for the Preparation of Sampling and Analysis Plans*. EM 200-1-3. February.

United States Environmental Protection Agency (USEPA), 2007. *Field Branches Quality System and Technical Procedures*. Region 4 Science and Ecosystem Support Division. SESDPROC-010-R3. November

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York.

## **8.0 DEFINITIONS**

None

## **9.0 ATTACHMENTS**

None

Earth Resources Technology, Inc. Standard Operating Procedure <b>DECONTAMINATION OF SAMPLING EQUIPMENT</b>			
Effective Date: <b>01/22/09</b>		Version: <b>001</b>	
<b>ERT SOP-03-1</b>			
Approvals			
[Redacted] Program Manager		[Redacted], C.P.G. Field QA Manager	
[Redacted] Signature		[Redacted] Signature	
1/23/09 Date		1/22/09 Date	

## 1.0 PURPOSE

The purpose of this procedure is to provide reference information on the proper decontamination procedures for sampling equipment used to perform field investigations.

## 2.0 SCOPE

This procedure addresses decontamination of sampling equipment. Decontamination of drilling equipment and other well installation equipment is described in ERT SOP-03-2.

## 3.0 REQUIREMENTS

To ensure that chemical analysis results are reflective of actual constituent concentrations present at sampling locations and to minimize the potential for introducing foreign constituents, equipment used in sampling activities must be properly cleaned and decontaminated. This minimizes or eliminates the potential for cross-contamination between sampling locations and the transfer of media constituents.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that approved decontamination procedures for all chemical sampling and field analytical equipment are detailed in the project-specific Sample and Analysis Plan prior to the actual field effort and that field personnel required to successfully accomplish the task have been properly briefed and trained.

### 4.2 Field Team Leader

The Field Team Leader is responsible for ensuring that sample equipment decontamination procedures utilized during field sampling activities are completed in compliance with this procedure and as detailed in the project-specific Sample and Analysis Plan.

### 4.3 Field Sampling Team

All members of the Field Sampling Team are responsible for implementing appropriate decontamination procedures as detailed in this procedure and the project-specific Sample and Analysis Plan. Such duties may be performed by geotechnical engineers, field technicians, or other qualified field personnel. Decontamination procedures will be documented in the Field Logbook.

## 5.0 EQUIPMENT

The following equipment is necessary for the decontamination of sampling equipment:

- Disposable Nitrile Gloves
- Laboratory-Grade, Non-Phosphate Detergent
- Distilled Water
- Contractor-grade plastic trash bags
- Scrub Brushes
- Multi-stage decontamination station
- Five-gallon clean plastic buckets (minimum of 3)
- Polyethylene sheeting

## 6.0 PROCEDURE

Prior to the collection of samples, equipment used to collect water, soil, sediment, and other samples which makes contact with the sample media will be decontaminated by one of the following methods. Prior to proceeding with decontamination procedures, a decontamination area will be constructed. The minimum requirements for a decontamination area include covering sufficient ground surface area with polyethylene sheeting in order to comfortably conduct all decontamination procedures and minimize conditions resulting in potential cross-contamination. For Method 2 a three-stage/vessel decontamination station should be constructed to progress through the three stages of decontamination. Typically this can consist of clean 5 gallon buckets or other open top vessels or short sections of clean PVC pipe that have been capped on the bottom to retain the decontamination liquids.

*Method 1 -- General decontamination procedure for all sampling equipment:*

1. Wash and scrub with laboratory-grade, non-phosphate detergent all accessible equipment surfaces. This includes all internal surfaces that are readily accessible and may come into contact with the sample media
2. Rinse with approved distilled water.
3. Rinse a second time with approved distilled water.
4. Wrap in new, unused contractor-grade plastic trash bag, or polyethylene sheeting.

*Method 2 -- Decontamination procedure for submersible pumps used to collect groundwater samples for volatile organic compounds:*

1. Wash and scrub all accessible surfaces of submersible pumps with laboratory-grade, non-phosphate detergent diluted with distilled water. This includes all internal surfaces that are readily accessible and may come into contact with the sample media.
2. Rinse with distilled water.
3. Immerse the submersible pump in a container filled with laboratory-grade, non-phosphate detergent diluted with distilled water and energize the pump in order to allow the solution to rinse the inaccessible internal lines and chambers of the pump. Detergent to distilled water ration should be at a minimum of 6 grams/gallon.
4. Submerge the pump, in detergent-free distilled water and re-energize the pump in order to rinse the detergent solution from the inaccessible internal lines and chambers of the pump



5. Repeat Step 4 in additional container of detergent-free distilled water.
6. Rinse the pump with deionized water.
7. Wrap in new, unused contractor-grade plastic trash bag, or polyethylene sheeting.

*Method 3 -- Decontamination procedure for equipment used to collect metal samples only:*

1. Rinse all accessible surfaces of the submersible pump with distilled water.
2. Rinse plastic or Teflon<sup>®</sup>-coated equipment with 10% nitric acid; rinse stainless steel equipment with 1% hydrochloric acid.
3. Rinse all accessible surfaces, plastic or Teflon<sup>®</sup>-coated equipment, and stainless steel equipment with deionized, analyte-free water.
4. Air dry.

### **Bailers and Bailing Line**

An elevated potential for cross-contamination between groundwater sampling points via the use of a common bailer, or its attached line, exists unless strict procedures for decontamination are followed. It is recommended that dedicated disposable bailer and bailing line be used for each sample point. Braided nylon or polypropylene lines may be used with a bailer and discarded after each use. If a non-disposable bailer is used it must be decontaminated using procedures outlined for sampling equipment (*Method 1*) prior to the initial groundwater sample collection and to each succeeding sample collection. After completing sample collection at all sample points, the non-disposable bailer should be decontaminated a final time using procedures outlined in *Method 1*.

### **Sampling Pumps**

Most common sampling pumps are low volume pumps (less than two gallons per minute). These include various types of positive displacement pumps. Pumps that allow air or other gases to contact the groundwater sample will not be used. If pumps are used for collecting groundwater samples at more than one sampling point, the pumps will be decontaminated between each sample location. General procedures to be used for decontamination of sampling pumps are described in *Method 2*.

### **Water Level Indicators**

Water level indicators that consist of a probe which contacts groundwater must be decontaminated using the following method:

- Wash and scrub all accessible surfaces of the probe with laboratory-grade, non-phosphate detergent.
- Wash and scrub the measuring tape portion of the meter with laboratory-grade, non-phosphate detergent.
- Rinse the probe and measuring tape portion of the meter with deionized, volatile-free water.
- Wrap the probe in new unused contractor-grade plastic trash bag.

## Probes

Probes (e.g., pH or specific ion electrodes, geophysical probes, or thermometers) that come in direct contact with the sample will be decontaminated using the procedure described for Water Level Indicators.

## Quality Control Procedures for Decontamination

The effectiveness of field cleaning procedures may be monitored by following quality assurance/quality control procedures (QA/QC) outlined in the project-specific Sampling and Analysis Plan. QA/QC procedures generally consist of collecting periodic equipment blank samples and requesting laboratory analysis for the constituents of concern

### Decontamination Notes:

Care will be taken when choosing the location to decontaminate sampling equipment in order to avoid contact with fugitive dust, fuel, oils, gasoline, organic solvents, or any potential source of contamination. All efforts will be made to conduct the decontamination at or adjacent to the sampling location.

Disposal of all investigative derived wastes generated during decontamination procedures is detailed in ERT SOP-06-4 and deviations from the procedure will be described in the project-specific Sample and Analysis Plan.

## 7.0 REFERENCES

The following documents were referenced in the development of this Standard Operation Procedure:

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Environmental Protection Agency, December 1987. *A Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001.

USEPA, November 1992. *RCRA Ground-Water Monitoring:: Draft Technical Guidance*

United States Environmental Protection Agency, November 1986. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA SW-846, Third Edition.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York

## 8.0 DEFINITIONS

**Negative Contamination** - Occurs when the measured concentration of the analyte is artificially low as a result of volatilization, adsorption, and related losses.

**Positive Contamination** - Occurs when the measured concentration of the analyte is artificially high due to leaching or the introduction of foreign matter into the sample.

**Cross Contamination** - A type of positive contamination caused by the introduction of part of one sample with a second sample during sampling or storage.



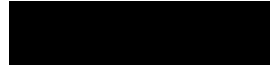

**Detergent** - Standard brand of non-phosphate, laboratory-grade detergent such as Alconox or Liquinox.

**Acid Solution** - A combination of reagent-grade acid and deionized water.

**Solvent** - Pesticide-grade solvent.

**Tap or Potable Water** - Water from an approved municipal water treatment system.

**Deionized Water** - Volatile-free water produced by distillation and procured from an outside party.

Earth Resources Technology, Inc.			
Standard Operating Procedure			
<b>DECONTAMINATION OF DRILLING AND DIRECT-PUSH EQUIPMENT AND MATERIALS</b>			
Effective Date: <b>01/29/09</b>	Version: <b>001</b>	ERT SOP-03-2	
Approvals			
 Program Manager		 , C.P.G. F	
 Signature		1/30/09 Date	 Signature
		1/29/09 Date	

## 1.0 PURPOSE

The purpose of this procedure is to provide reference information on the proper decontamination of drilling and direct-push equipment, and other materials used in conducting subsurface investigations.

## 2.0 SCOPE

This procedure addresses decontamination of drilling and direct-push equipment and associated materials only. Personal decontamination guidelines are present in the project-specific work plan. Decontamination of sampling equipment is described in ERT SOP-03-1.

## 3.0 REQUIREMENTS

To ensure that chemical analysis results are reflective of the actual concentrations present at sampling locations, various drilling and direct-push equipment used in subsurface investigations must be properly cleaned and decontaminated minimizing the potential for cross-contamination and transfer of constituents between subsurface sample locations.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that approved decontamination procedures for all drilling and direct-push equipment used for subsurface investigation are detailed in the project-specific Sample and Analysis Plan prior to the actual field effort and that field personnel required to successfully accomplish the task have been properly briefed and trained.

### 4.2 Field Team Leader

The Field Team Leader is responsible for ensuring that equipment decontamination procedures utilized during field sampling activities are completed in compliance with this procedure and as detailed in the project-specific Sample and Analysis Plan.

### 4.3 Field Team

The Field Team is responsible for performing decontamination procedures in accordance with this procedure and the project-specific work plans. Such duties may be performed by geotechnical engineers, field technicians, or other qualified field personnel. Decontamination procedures will be documented in the Field Logbook.

## 5.0 EQUIPMENT

- Portable Hot Water Pressure Washer
- Portable water supply tank with necessary hose connections
- Insulated Gloves

- Rubber Boots
- Safety glasses
- Potable water
- 6 mil or greater Plastic Sheeting
- Berm Construction Materials
- Liquid Transfer Pump
- 55-Gallon Drums

## **6.0 PROCEDURE**

### **Pressure Washing**

All drilling and direct-push equipment involved in subsurface investigative activities will be decontaminated by heated pressure washing prior to drilling activities at each borehole. Pressure washing will be performed over a designated decontamination area, as described below.

### **Standard Washing Protocol**

All down-hole tooling and materials involved in subsurface investigative activities that come into direct or indirect contact with subsurface material will be decontaminated by a standard washing protocol. Such equipment and materials include augers, drive rods, and drill bits. Decontamination of tooling used to collect samples, such as split spoons and macro cores, will be conducted as per ERT SOP-03-1.

The following general decontamination method will be utilized for drilling and direct-push equipment:

- Place equipment to be washed on an elevated platform inside of the designated decontamination area
- Use a brush or broom to remove heavy soil spoils
- Pressure wash all accessible surfaces using clean potable water
- Allow to air dry
- Handle and transport to next boring location using care to retain the cleanliness of the equipment. When practical transport on new unused polyethylene plastic sheeting.

Pressure washing will be performed over a designated decontamination area, as described below.

Screen and casing (PVC) supplied by the manufacturer that is free of manufacturing markings, residues and labeling, and sealed in plastic will not require decontamination.

### **Designated Decontamination Areas**

A designated decontamination area will be established to contain decontamination wastes and waste waters. The design of the decontamination area may vary but at a minimum must be of adequate size and structural composition to contain decontamination waste. This may consist of a portable damn or self constructed berm, lined with minimum 6-mil plastic. The berm and liner will be assembled in such a way as to contain all liquid IDW generated by the decontamination procedure. The location of the decontamination area will be identified in the project-specific work plan and subject to site conditions.

Liquid IDW will be collected and containerized (i.e. 55-gallon DOT drums, plastic water tote) for eventual disposal at an approved facility in accordance with the project-specific work plan.

## 7.0 REFERENCES

The following documents were referenced in the development of this Standard Operation Procedure:

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Environmental Protection Agency, November 1986. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA SW-846, Third Edition.

United States Environmental Protection Agency (USEPA), 1991. *Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells*. EPA160014-891034. March.

United States Environmental Protection Agency (USEPA), 1992. *RCRA Ground Water Monitoring: Draft Technical Guidance*. November

United States Army Corp of Engineers (USACE), 1994. *Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites*. EM 1110-1-4000. November.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York



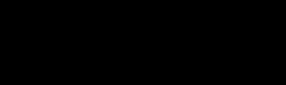
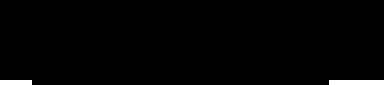
## 8.0 DEFINITIONS

**Cross Contamination** - Type of positive contamination caused by the introduction of part of one sample with a second sample during sampling or storage.

**Detergent** - Laboratory-grade non-phosphate detergent such as Alconox or Liquinox.

**Tap or Potable Water** - Water from an approved municipal water treatment system.

**IDW** – Investigative Derived Waste

Earth Resources Technology, Inc. Standard Operating Procedure <b>WELL DEVELOPMENT</b>			
Effective Date: <b>01/26/09</b>		Version: <b>001</b>	
<b>ERT SOP-05-4</b>			
Approvals			
 Program Manager		 C.P.G. Field QA Manager	
  1/26/09 Signature		  1/26/09 Signature	

## 1.0 PURPOSE

The purpose of this procedure is to define the requirements for developing monitoring wells with the intent to increase permeability around the well screen and ensure a representative groundwater sample can be obtained from the water-bearing zone.

## 2.0 SCOPE

This procedure applies to the development of wells by either bailing or pumping techniques. Development water will be staged onsite in appropriate containers, characterized by laboratory analysis, and handled in accordance with ERT SOP-06-4 and the project-specific Sample and Analysis Plan.

## 3.0 REQUIREMENTS

The purpose of well development is to stabilize and increase the permeability of the filter pack around the well screen, and restore the permeability of the local formation which may have been reduced by drilling and installation operations. The selection of well development methods, well construction and installation details, and the characteristics of the formation in which the well is to be screened, will be detailed in the project-specific Sample and Analysis Plan. Any equipment introduced into the well or in contact with development water will be decontaminated in accordance with ERT SOP-03-1 or ERT SOP-03-02, as applicable.

Typically monitoring wells will be developed by removing a minimum of 3 well volumes and a maximum of 5 well volumes of groundwater from the well. The Field Team Leader will be required to make a visual observation of the resulting groundwater conditions following development and the description will be noted in the Field Logbook. Typical observations include the color, odor, turbidity (non-soluble constituents) and volume of water removed. The purpose for developing a well is not to stabilize groundwater quality indicators, as is typical for environmental sampling and therefore, physical and chemical parameters including temperature, pH, specific conductance and turbidity will not be measured during well development.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that field personnel have been adequately trained and that appropriate well development procedures are detailed in the project-specific Sample and Analysis Plan.

## **4.2 Field Team Leader**

The Field Team Leader is responsible for ensuring that well development activities are performed in accordance with this procedure and the project-specific Sample and Analysis Plan. At the completion of each well development, the Field Team Leader will inspect the resulting water and record the observation in the Field Logbook, including color, odor, turbidity (non-soluble constituents) and volume of water removed, and other information as detailed in the project-specific Sample and Analysis Plan.

## **4.3 Field Team**

The Field Team is responsible for developing monitoring wells in accordance with this procedure and the project-specific Sample and Analysis Plan. Pertinent information will be recorded in the Field Logbook, including the color, odor, turbidity (non-soluble constituents) and volume of water removed from the well, and other information as detailed in the project-specific Sample and Analysis Plan

## **5.0 EQUIPMENT**

- Pump
- Surge blocks and accessory equipment
- Bailers
- Polypropylene Rope for Bailer Line (or approved equal)
- Water Level Indicator
- Photoinonization Detector
- Drums or Mobile Tanks to Contain the Development Water
- Field Logbook
- Well Development Log

## **6.0 PROCEDURE**

### **6.1 Development Methods**

#### **6.1.1 Mechanical Surging**

Operation of a piston-like device termed a surge block affixed to the end of a length of drill rod, or drill stem, is a very effective development method that can be utilized in all diameter of wells, even in stratified formations having variable permeability. The up-and-down plunging action alternately forces water to flow into and out of the well, similar to a piston in a cylinder. The use of a surge block can agitate and mobilize particulates around the well screen. Periods of surging should be alternated with periods of water extraction from the well so that sediment, brought into the well, is removed. Surging should initially be gentle to assure that groundwater can freely enter and exit the well, and that the surge block is not so tight as to damage the well riser or screen. For short well screens (1.6 m (5 ft) or less) set in a homogeneous formation, the surge block does not have to be operated within the screen interval. However, if the screened interval includes constituents of high and low permeability, the block may have to be operated gently within the screened portion of the well.

#### **6.1.2 Pumping**

A commonly used development method consists of removing water from the well using a pump set at a high rate. This over-pumping technique, is generally successful in relatively non-stratified, clean-sand formations. By pumping the well at a rate greater than that used during



sampling events, mobilized particulates may be removed, thereby providing a cleaner well for sampling. Over-pumping may be supplemented with the use of a bottom discharge/filling bailer for removing heavy sediment fines. During development, the pump should periodically be raised and lowered in order to agitate deposited sediments in order to extract sediments suspended in the removed water. A disadvantage of development using a pump is that smaller soil grains of the filter pack may bridge the well screen or filter pack, due to one directional flow of water. To correct this potential problem, over-pumping is often used in conjunction with backwashing or surging.

### **6.1.3 Backwashing**

Backwashing is the process of forcing water down and out of the well through the well screen, causing soil particles to dislodge that may have become wedged in or bridged around the well screen due to over-pumping of the well. Backwashing when supplemented with over-pumping, facilitates the removal of fine-grained materials from the formation surrounding the well. A commonly used backwashing procedure called “rawhiding” consists of starting and stopping the submerged pump intermittently in order to allow water in the well pipe to fall back into the well resulting in rapid changes in the pressure head within the well. If “rawhiding” is to be used, there cannot be a backflow prevention valve in the pump or eductor line. Another method of backwashing is to pump water into the well in sufficient volume to maintain a hydraulic head greater than that in the formation. Water used during this method will be of a known source and chemistry. The impact of foreign water on the local groundwater quality should be evaluated prior to proceeding and, added water should be removed by pumping after development is complete. A minimum of 3 volumes of water should be removed after backwashing with this technique in order to ensure that all added water within the formation has been eradicated. Prior to using this method, local, state, and federal guidance should be reviewed. Do not use this method in cases where the water pumped into the well is potentially contaminated.

### **6.1.4 Bailing**

The use of dedicated disposable bailers is an effective way of manually developing small diameter wells that have a high static water table or are relatively shallow in depth [ $<4.6$  m (20 ft)]. Use of a bailer that has a diameter close to that of the well screen is recommended in order to sufficiently agitate sediments that have settled at the bottom of the well. The bailer should be operated throughout the screened interval. Bottom loading bailers can extract sediment that has settled to the bottom of the well by short rapid up and down motions of the bailer at the bottom of the well which stir up the settled sediments and collect the particulates in the bailer. Bailers used for development should never be left inside the well after development is complete.

## **6.2 Development Procedures**

The development of monitoring wells will be initiated no sooner than 48 hours after or no later than 7 days after the final installation of the monitoring well. For well development by pumping, water from the entire water column will be while periodically raising and lowering the pump intake in order to agitate sediments within the well. Well development will be completed a minimum of 14 days prior to any groundwater sampling occurs. Well development by pump procedures includes:

1. Open and record the condition of the well head in the Field Logbook.
2. Check for volatile organic compounds with a PID immediately after opening the well head and record the reading in the Field Logbook.

3. Measure the depth to the static groundwater level using a groundwater interface probe, or similar, in the well before beginning development. Record the value to the nearest 0.01 foot in the Field Logbook and the Well Development Form. Depth should be recorded from a pre-determined point on the well (typically a notch in the PVC riser).
4. Measure the total depth of the well prior to development by lowering a groundwater interface probe, or similar, to the base of the well. Depth should be recorded from a pre-determined point on the well (typically a notch in the PVC riser). Record the value to the nearest 0.1 foot in the Field Logbook and Well Development Form.
5. Connect the appropriate tubing, electrical supply lines and safety line to the pump and lower the pump into well. The pump should always remain completely submerged in groundwater.
6. Ensure that the effluent tubing connected to the pump is secured in the waste water receptacle (i.e. plastic tote, 55-gallon drum, 5-gallon bucket).
7. Energize the pump and adjust the pumping rate so as to minimize spillage from the effluent tubing to the waste water receptacle. Record the flow/pumping rate.
8. Development will be considered complete when the well water is clear to the unaided eye and a minimum of three times the standing volume of the well (to include the well screen, casing, plus saturated annulus, assuming 30% porosity for the annulus) has been removed.
9. Should the recharge be so slow that the required volume cannot be removed in 48 consecutive hours of development, the water remains discolored, or excess sediment remains after the three to five volume removal; contact the Project Manager for guidance.
10. Measure the total depth of the well after development and the total volume of water removed from the well. Record the value to the nearest 0.1 foot in the Field Logbook and the Well Development Form.

## **6.2 Development Records**

The following information should be recorded in the Field Logbook and/or Well Development Form during development:

1. Date and time of development
2. Start and stop time of development
3. Static water level in the well prior to development
4. Total depth to the bottom of well
5. Volume of water column in well
6. Volume of water to be evacuated for development
7. Description of visual quality of water being removed, including color, odor, turbidity and volume of water removed when the observations were made. At a minimum, a brief description of the water removed should be made after initially starting development and after each well volume of water is removed.
8. Type and size of pump and/or bailer used
9. Description of surge techniques
10. Pumping rate and any changes to the rate after initially setting the pump rate
11. Total volume of water removed.

## 7.0 REFERENCES

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Army Corp of Engineers (USACE), 1994. *Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites*. EM 1110-1-4000. November.

United States Environmental Protection Agency (USEPA), 1991. *Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells*. EPA160014-891034. March.

United States Environmental Protection Agency (USEPA), 1992. *RCRA Ground Water Monitoring: Draft Technical Guidance*. November

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York


## 8.0 DEFINITIONS

**Surging** - Surging is a process in which a plunger-type device called a surge plunger or surge block, is moved up and down within the well screen to force groundwater to alternately flow in and out through the sand pack. This back and forth movement of water facilitates removal of fines from the formation immediately adjacent to the well while preventing bridging (wedging) of sand grains.

## 9.0 ATTACHMENTS

Well Development Log

## GROUNDWATER MONITORING WELL DEVELOPMENT FORM

Client: Site Name: Project No.: Date: Well Number:						Sampling Organization: Earth Resources Technology Sampler (s): Screen Interval (feet below ground surface): Pump Intake (feet below ground surface): Purging Device (Pump Type):			
									
Well	PID	DTW	TD	WV	MPV	Start Time	End Time	APV	Observations

PID = photo-ionization detector



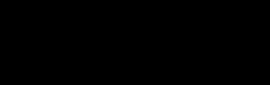
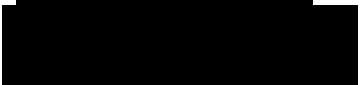
DTW = depth to water (in feet), from TOC

TD = total water depth (in feet), before development/after development

WV = well volume (gallons)

MPV = minimum purge volume (gallons)

APV = actual purge volume (in gallons)

Earth Resources Technology, Inc. Standard Operating Procedure <b>WELL PURGING – PUMPING METHOD</b>			
Effective Date: <b>01/22/09</b>		Version: <b>001</b>	
ERT SOP-05-6			
Approvals			
 Program Manager		 C.P.G. Field QA Manager	
 Signature		 Signature	
1/23/09 Date		1/22/09 Date	

## 1.0 PURPOSE

The purpose of this procedure is to provide general reference information on well purging by a high volume pumping method prior to environmental sampling of groundwater wells. The methods and equipment described are for the purging of water samples from the saturated zone of the substrata.

## 2.0 SCOPE

This procedure applies to purging relatively large volumes of water in a shallow to medium depth well (typically up to 75 feet in total depth).

## 3.0 REQUIREMENTS

The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the monitoring well and to avoid physical or chemical alteration of the water due to purging and sampling techniques. Typically, in between sampling events there will be little or no vertical mixing of stagnant water in the well and stratification will occur. The well water in the screened section may mix with groundwater due to normal hydraulic flow, but stagnant water above the screened section will remain isolated.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that appropriate well purging procedures are established in the project-specific Sample and Analysis Plan and that the field personnel assigned to the activity are properly trained and briefed.

### 4.2 Field Team Leader

The Field Team Leader is responsible for ensuring that the well purging techniques utilized during field activities are in accordance with this procedure and the project-specific Sample and Analysis Plan. When purging is complete, the Field Team Leader is responsible for reviewing data entered into the Filed Logbook and/or the Well Purge Data Forms for accuracy and completeness. Upon completion of this review, the Field Team Leader will transfer custody of the forms and Field Logbook to the Project Manager

### 4.3 Field Team

The Field Team is responsible for purging wells in accordance with this procedure and the project-specific Sample and Analysis Plan. The Field Team will be responsible for purging

wells, performing appropriate physical measurements and observations, recording observations within the Field Logbook and/or Purge Data Sheets and containment of purged water. The Field Team will record pertinent information including amount of water purged, pH, specific conductivity, temperature, and turbidity on the Well Purge Data Form for each well purged. These parameters will be recorded as qualitative data and will not be used for determination of sampling interval.

## **5.0 EQUIPMENT**

The following equipment shall be available for well purging via the pumping method:

- Submersible Centrifugal Pump
- Power Source with GFCI
- Chemically Inert Tubing
- Electronic water level meter (graduated to 0.01 feet)
- Multi-Parameter Water-Quality Meter
- Nitrile gloves
- Photoionization Detector
- 5 gallon receptor buckets for temporary purge water containment
- DOT liquid rated drums for containerization of purge water
- Well Purge Data Form
- Field Logbook
- Graduated vessel
- Timing device (stopwatch)
- Calculator

## **6.0 PROCEDURE**

### **General**

Purge volumes for each well will vary depending on the intent of the monitoring program and the local hydrogeologic conditions. A well will not be sampled until the purging procedure has been followed to completion.

### **Calculations of Well Volume**

To ensure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to determine the volume of standing water in the well column. Calculations shall be recorded in the Field Logbook and the Well Purge Data Forms.

1. If possible, obtain all available information on well construction (location, casing, screens, etc.).
2. Measure and record static water level (depth below ground level or top of casing reference point), per ERT SOP-07-2. If the total well depth is unknown, determine total depth of well using a clean, decontaminated, water level indicator.
3. Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).
4. Calculate the volume of water in the casing

Diameter of Casing or Hole (in)	Gallons per foot of depth	Cubic feet per foot of depth
2	0.163	0.0218
4	0.653	0.0873
6	1.469	0.1963

Water column volume (gallons) = (TD – DTW) x gallons per foot of depth

### Specific Procedure

- Field personnel must always use new nitrile gloves.
- When known, purging and sampling order for multiple wells should proceed from least impacted to most impact in order to limit the potential for cross-contamination between monitoring wells or transfer of constituents.

1. Measure the background for volatile organic compounds (VOCs) using a photoionization detector (PID) then open the well and screen the well head with the PID. If volatile organic compound (VOC) concentrations are equal to or greater than 1000 parts per million (ppm), immediately recap the well and inform the Project Manager. Record the measured PID reading in the Field Logbook and/or the Well Purge Sheet.

*Monitoring head space VOC concentrations is a health and safety requirement and should be instituted at the discretion of the Field Manager and the requirements of the Site Health and Safety Plan.*

2. Measure the depth to water in the well per ERT SOP0-7-2 and record the data in the Field Logbook and/or Well Purge Data Form.
3. Calculate the volume of water in the well. Record this information in the Field Logbook and/or Well Purge Data Form. A minimum of three well volumes will be purged from groundwater monitoring wells prior to sampling unless a well is purged dry. If purging results in drying the monitoring well, the well should be sampled as soon as sufficient volume of groundwater has recovered in the well. Note in the Field Logbook and/or Well Purge Data Form that the well was purged dry and indicate the volume of water removed.
4. Lower the purge pump into the well until it is completely submerged.
5. Place the pump effluent tubing into the receptor container and start the pump in accordance with the pump's operation manual. Record pump rates (if sustainable) and the total volume of water purged from the well.
6. Water quality parameters should be measured at the start of the purging process, after each well volume is removed, and prior to the collection of groundwater samples (minimum of 4 data measurements should be recorded in the Field Logbook and/or the Well Purge Data Sheets) to acquire qualitative data that will help evaluate geochemical characteristics of the aquifer. Measured groundwater quality data should be entered into the Field Logbook and/or Well Purge Data Form.
7. Groundwater samples shall be collected immediately after purging is complete in accordance with ERT SOP-06-5.

8. Whenever the receptor container is three quarters full, the purge water should be transferred to a DOT approved liquids drum, or similar large container, for containerization per ERT SOP-06-4 or disposed of in accordance with the project-specific Sample and Analysis Plan.
9. Carefully withdraw the purge pump from the well after purging is complete, decontaminate the pump in accordance with ERT SOP-03-1
10. Dispose of all investigative derived waste (IDW) items in accordance with ERT SOP-06-4 and the project-specific Sample and Analysis Plan.

## **7.0 REFERENCES**

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Army Corp of Engineers (USACE), 2001. *Requirements for the Preparation of Sampling and Analysis Plans*. EM 200-1-3. February.

United States Environmental Protection Agency (USEPA), 1992. *RCRA Ground Water Monitoring: Draft Technical Guidance*. November.

United States Environmental Protection Agency (USEPA), 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*. Ground Water Forum Issue Paper, EPA/542/S-02/001. May.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York.

## **8.0 DEFINITIONS**

None

## **9.0 ATTACHMENTS**

Well Purge Data Form



# WELL PURGE DATA FORM

SITE: \_\_\_\_\_

FIELD PERSONNEL: \_\_\_\_\_

DATE: \_\_\_\_\_





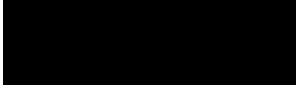
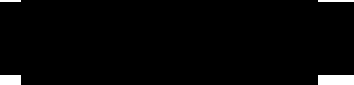
WEATHER: \_\_\_\_\_

	WELL DEPTH: _____	STICK-UP / FLUSH MOUNT
MONITORING WELL: _____	WELL SIZE: _____ Inches	WELL VOLUME: _____ GAL
	2 inch = 0.163 gal/ft    4 inch = 0.653 gal/ft	3 X WELL VOLUME: _____ GAL

PID/FID READINGS	BACKGROUND: _____	PUMP INTAKE DEPTH: _____ ft below TOC	
	BENEATH WELL CAP: _____	DEPTH OF WATER BEFORE PUMP INSTALLATION: _____	ft below TOC

TIME	PURGING	SAMPLING	pH (pH units)		SPECIFIC CONDUCTIVITY (mS/cm)		TURBIDITY (NTU)		DISSOLVED OXYGEN (mg/l)		TEMPERATURE (degrees C)		OXYGEN REDUX POTENTIAL (mv)		PUMPING RATE (ml/min)	DEPTH TO WATER (ft below toc)
			READING	CHANGE	READING	CHANGE	READING	CHANGE	READING	CHANGE	READING	CHANGE	READING	CHANGE		
				NA		NA		NA		NA		NA		NA		

COMMENTS:	TOTAL GAL PURGED:
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Earth Resources Technology, Inc. Standard Operating Procedure <b>MONITORING WELL AND BOREHOLE ABANDONMENT</b>			
Effective Date: <b>01/26/09</b>		Version: <b>001</b>	
ERT SOP-05-7			
Approvals			
 Program Manager		 C.P.G. Field QA Manager	
			
1/26/09		1/26/09	
Signature		Signature	
Date		Date	

## 1.0 PURPOSE

The purpose of this procedure is to describe, in general terms, the principles and methods of properly abandoning a constructed monitoring well or borehole.

## 2.0 SCOPE

This procedure applies specifically to the abandonment of monitoring wells and boreholes with the understanding that compliance with federal or local regulation may require additional actions. Project specific procedural details associated with abandonment will be detailed in the project-specific Sample and Analysis Plan.

## 3.0 REQUIREMENTS

In order to minimize the potential migration of groundwater and soil constituents, at a minimum, the following procedures will be conducted in order to properly abandon intrusions into the subsurface. Abandonment may occur when a borehole or monitoring well has been damaged to such an extent that it is no longer functional, or in the case that a borehole or monitoring well has served its functional purpose and is no longer required. ERT will notify the client of intent to abandon intrusions, as appropriate. ERT primary responsibility will be for the oversight of the abandonment. ERT personnel will properly document the activity within the project Field Logbook. All abandonment records will become part of the permanent project files and any necessary abandonment forms will be forwarded to the applicable authority. A properly licensed driller will be retained for the abandonment of boreholes and wells as outlined below.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that all procedures for properly abandoning a borehole or monitoring well are detailed in the project-specific Sample and Analysis Plans and those activities associated with borehole and monitoring well abandonment are conducted in accordance with the Project Plans and local, state and federal regulations.

### 4.2 Field Team Leader

The Field Team Leader is responsible for ensuring that monitoring wells and boreholes are abandoned in accordance with this procedure and applicable project-specific requirements.

### **4.3 Field Team**

The Field Team is responsible for ensuring that borehole and monitoring well abandonment is conducted in accordance with this procedure and applicable project-specific requirements. The Field Team will document all activities within the Field Logbook.

### **4.4 Contracted Licensed Driller**

The contracted licensed driller will be responsible for the mechanical abandonment of bore holes and wells and certifying the completion of abandonment. Abandonment will be conducted within all applicable municipal, state, and federal regulations.

## **5.0 EQUIPMENT**

- Drilling Rig Equipped with Appropriate Drilling Tools
- Cement, Sand, Bentonite Powder, Bentonite Pellets, or Commercial Hole-Sealing Products

## **6.0 PROCEDURE**

Prior to abandoning a monitoring well in place, all attempts will be made to mechanically remove the monitoring well construction from the borehole. If an abandoned well cannot be removed by mechanical means, it may be grouted with the well screen and casing in place. Each boring or well to be abandoned/decommissioned will be sealed by grouting from the bottom of the boring/monitoring well to the ground surface. Grout will be mixed in a container and consist of cement, water and three to five percent (by weight) bentonite powder. Mixed grout will be introduced by extending a tremie pipe to the bottom of the boring/well (i.e., to the maximum depth drilled/bottom of well screen) and using a mechanical pump, transferred from the mixing container through the tremie pipe and into the boring/well. Grout will be introduced in this fashion until undiluted grout completely fills the boring/well void space. All openings or ungrouted portions of the annular space(s) between an innermost well casing and borehole will be completely filled with grout.

When possible after 24 hours, the Field Team Leader will check the abandoned site for grout settlement. If settlement has occurred, the depression will be filled with grout and rechecked after another 24 hours has passed. Additional grout will be added per the previously described method except that the tremie pipe will be inserted to the top of the competent grout surface. This process will be repeated until firm grout extends from the base of the borehole/well to the ground surface.

Hand-augered boreholes, generally less than 10 feet in total depth may be abandoned using dry flaked bentonite chips and do not require the services of a licensed driller for abandonment. Bentonite will be used to fill the entire borehole to ground surface. In order to adequately homogenize the hydrated bentonite chips, bentonite should be introduced in 2 foot lifts and then hydrating using water. A mixing rod will then be used to ensure an event consistency throughout the lift. Once consistency is ensured, the next two foot lift of dry flaked bentonite chips may be added. This process will be repeated until the grout mixture extends to the ground surface. When possible after 24 hours, the Field Team Leader will revisit the borehole and if settling has occurred, grout will be added as previously described. In some cases, dependent on the

constituents and/or characterization of the auger cuttings, collected cuttings from a hand-augered borehole may be replaced back to the hole.

## 7.0 REFERENCES

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Army Corp of Engineers (USACE), 1994. *Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites*. EM 1110-1-4000. November.

United States Environmental Protection Agency (USEPA), 1991. *Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Well*. EPA160014-891034. March.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York

## 8.0 DEFINITIONS

**Borehole** - For purposes of this procedure only, any hole drilled into the subsurface for the purpose of identifying lithology or installing monitoring wells.

**Contaminant** - Any substance, which if introduced, would degrade the quality of groundwater.

**Grout** - A slurry of cement, clay, or other material impervious to and capable of preventing movement of water. Typically a neat cement grout containing three to five percent bentonite powder by weight.

Earth Resources Technology, Inc. Standard Operating Procedure <b>SURFACE WATER AND SEDIMENT SAMPLING</b>			
Effective Date: <b>01/22/09</b>		Version: <b>001</b>	
<b>ERT SOP-06-1</b>			
Approvals			
<div style="background-color: black; width: 100px; height: 15px; margin-bottom: 5px;"></div> Program Manager		<div style="background-color: black; width: 100px; height: 15px; margin-bottom: 5px;"></div> , C.P.G. Field QA Manager	
<div style="background-color: black; width: 180px; height: 40px; margin-bottom: 5px;"></div> Signature		<div style="background-color: black; width: 180px; height: 40px; margin-bottom: 5px;"></div> Signature	
1/22/09 Date		1/21/09 Date	

## 1.0 PURPOSE

The purpose of this procedure is to define the requirements necessary for environmental surface water and sediment sampling. This procedure describes the methods and equipment commonly used for collecting environmental samples of surface water and sediment samples for either onsite examination and testing, or for laboratory analysis.

## 2.0 SCOPE

Surface water and sediment sampling may be conducted at any site which contains surface drainage, water bodies (i.e. streams, lakes, ponds) or sites located hydraulically down-gradient from surface drainage sites. The collection of concentrated sludge or waste characterization samples from disposal or process lagoons often requires methods, precautions, and equipment different from those described herein. Consequently, specific sampling requirements may be required. Any such modification to these procedures will be specified in the project-specific Sampling and Analysis Plan (SAP).

## 3.0 REQUIREMENTS

Many factors must be considered in developing a sampling program for surface water or sediments, including study objectives; accessibility; site topography, flow, mixing, and other physical characteristics of a water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depends on bottom current or flow characteristics, sediment characteristics (density, size) and geochemical properties (which affect an adsorption/desorption). The project team developing the sampling plan must consider the mixing characteristics of the water bodies and also understand the role of fluvial-sediment transport, deposition, and chemical sorption.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that the procedures described in the project-specific Sample and Analysis Plan, at a minimum meet the requirements set forth in this procedure and those detailed in applicable federal and state guidance documents, and that the field team conducting the sampling are adequately trained and briefed on the prescribed methodology.

## **4.2 Field Team Leader**

The Field Team Leader is responsible for ensuring that surface water and sediment sampling is conducted in accordance with the procedures outlined in this procedure and in the project-specific Sample and Analysis Plan. At a minimum, this may include reviewing the Sample and Analysis Plan for project specific requirements, ensuring that the sampling team is briefed and trained on the project specific requirements, and overseeing the collection and management of the environmental samples.

## **4.3 Field Team**

The Field Team is required to adhere to the sample collection requirements described in this procedure and the project-specific Sample and Analysis Plan. Deviations from these documents must first be consulted with the Field Team Leader and Project Manager. The Field Team is required to properly manage the sample collection and handling process of samples from the point of sample collection to relinquishment of samples to the analytical laboratory or designated courier.

## **5.0 EQUIPMENT**

- Sample Containers
- Thermometer
- Stainless Steel Bowl and Spoon
- Stainless Steel Hand Auger, Shovel, or Spoon
- Filtering Equipment (if analyzing for metals in water)
- Open Tube
- Dip Sampler
- Kemmerer or Van Dorn Sampler
- Hand-Driven Tube Sampler with Liners (Brass or Stainless Steel)
- Decontamination Equipment and Supplies
- Pump

## **6.0 PROCEDURE**

### **General Procedures**

The following section outlines general procedures for collecting surface water and sediment samples. All sampling equipment should be cleaned and decontaminated prior to use in accordance with ERT SOP-03-1.

- Unless specified in the project-specific Sample and Analysis Plan, when sampling surface water and sediments from the same location, surface water samples will always be collected first and sediments second in order to minimize disturbance of sediments and unintentional collection of these disturbed sediments in the surface water samples..
- Samples will always be collected first at the most down-gradient location and progress to the furthest up-gradient location in order to minimize potential cross-contamination or constituent transfer from one sample location to another.

- Sample volumes at each location will first be collected for volatile organic compound (VOC) analysis followed by sample volumes collected for non-volatile organics and inorganics analysis.
- Prior to collecting sediment and/or surface water samples, the sampling device shall be decontaminated in accordance with ERT SOP-03-1. Twigs, leaves, pebbles, and debris that are not components of the matrix of interest will be properly removed by the Field Team using nitrile gloves or stainless steel tongs.
- Sediment sample volumes collected for VOC analysis will be collected directly from the sampler and immediately placed in the dedicated sample container and sealed in order to minimize volatilization. The remaining sample volumes to be collected for analysis will be composited in a stainless-steel bowl and allocated to the dedicated sample containers. Duplicates and split samples shall be collected at the same time as the original sample and in the same analytical sequence.
- Surface water sample volumes collected for VOC analysis will be collected ensuring that no bubbles or air space are trapped in the dedicated volatile organic analysis (VOA) sample container. Sediment sample volumes collected for VOC analysis will be sufficient to completely fill the dedicated sample container eliminated, when possible, all voids or head space. Sediment sample volumes should be decanted, as possible, to eradicate excess water.
- Prior to and after sample volumes are collected at each location, the sampling equipment will be decontaminated in accordance with ERT SOP-03-1.
- As required in the project-specific Sample and Analysis Plan, sample volumes collected for dissolved inorganic parameters in surface waters may be field filtered in accordance with ERT SOP-06-8 or laboratory filtered prior preservation. Surface water sample volumes collected for total inorganic analysis will not be filtered.

### **Water Sampling Techniques**

Surface water sample volumes collected for VOC analysis will first be collected in dedicated unpreserved sample containers and then immediately transferred to dedicated VOA sample containers with Teflon® septa or other nonreactive material and the prescribed volume of hydrochloric acid preservative. Generally, the VOA sample container will be provided by the analytical laboratory containing the prescribed volume of hydrochloric acid preservatives. Preserved samples have a two week holding time, whereas, unpreserved samples have only a seven day holding time. In some situations, however, it may be necessary to use the unpreserved vials. For example, if the surface water sample contains a high concentration of dissolved calcium carbonate, there may be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles rendering the sample unacceptable for VOC analysis. In this case, unpreserved vials should be used and arrangements confirmed with the laboratory prior to sampling in order to ensure acceptable receipt of the unpreserved sample volumes.

#### *Dip Sampling*

A sample may be collected directly into the sample container when unpreserved dedicated sample containers are being utilized. Surface water volumes collected for analysis requiring preservation will be collected in a dedicated unpreserved sample container and immediately transferred into a dedicated sample container with the prescribed sample preservative volume. In



most cases, the analytical laboratory will provide dedicated sample containers with the prescribed sample preservative pre-aliquotted. Whenever possible, surface water samples should be collected away from the shore line in order to minimize sediment infiltration into the sample volume. If the water body is not stagnant (i.e. stream, river) the sampler should face upstream while collecting the appropriate sample volume and minimize disturbing the bottom sediments.

### *Weighted Bottle Sampling*

A grab sample can also be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling within a specific interval within the water column. Several of these samples can be combined to provide a vertical composite. Alternatively, in many cases it is acceptable to use a dedicated sample container to obtain a vertical composite sample. The dedicated sample container can be lowered to the bottom of the desired interval and raised to the top of the desired interval at a uniform rate.

A closed weighted bottle sampler consists of a stoppered glass or plastic bottle, weight and/or holding device, and lines to open the stopper and to lower or raise the bottle. The proper procedure for sampling using this equipment is:

1. Gently lower the closed weighted sampler to the desired depth. Do not prematurely remove the stopper. Air bubbles forming at the surface of the water bottle may indicate that the stopper has opened prematurely. If air bubbles are observed, the sampler should be inspected prior to collecting the sample volume.
2. Disengage the stopper with a sharp tug of the sampler line.
3. Allow the bottle to fill completely, as evidenced by the cessation of air bubbles.
4. Raise the sampler and cap the bottle.
5. Preserve sample, if required, with appropriate preservatives or transfer the sample volume to the dedicated sample container.
6. Decontaminate weighted sample bottle in accordance with ERT SOP-03-1 if it will be used for further sample collection.

### *Pumps*

Pumps which operate by a bellows, diaphragm, or siphon action should not be used to collect samples which will be analyzed for volatile organics because the slight vacuum applied may induce volatilization. In order to avoid contamination of the pump, a liquid trap consisting of a vacuum flask or other vessel to collect the sample should be inserted between the sample inlet hose and the pump.

Tubing used for the inlet hose shall be nonreactive (preferably Teflon<sup>®</sup>). The tubing and liquid trap must be thoroughly decontaminated between uses, per ERT SOP-03-1, or disposed of after a single use.

When sampling, the tubing is weighted and lowered to the desired depth. The sample is then obtained by operation of the pump and subsequently transferred from the trap to the dedicated sample container.

### *Kemmerer/Van Dorn Samplers*

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon<sup>®</sup> coated sampler, a Standard Kemmerer or Van Dorn sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In either case, a "messenger" is sent down the line when the sampler is at the designated depth which causes the rubber stoppers to close, thereby allowing the sample to be contained and raised. The sample is removed through a valve to fill the sample containers.

### **Sediment Sampling Techniques**

Sediment samples are typically collected at the same locations or adjacent to surface water locations. Typically if only one sediment sample is to be collected, the sample locations will be approximately at the center of the water body. This is particularly true for reservoirs that are formed by the impoundment of rivers or streams. Generally, coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center are generally composed of fine-grained materials which may, because of their lower porosity and greater surface area, contain greater concentrations of contaminants. The shape, flow pattern, depth distribution, and water circulation patterns must all be considered when selecting sediment sampling locations. In streams, areas likely to have sediment accumulation (i.e., bends, behind islands or boulders, quiet shallow areas or very deep, low velocity areas) may be sampled while areas likely to show net erosion (i.e., high-velocity, turbulent areas) and suspension of fine solid materials will be avoided. Refer to the project-specific Sample and Analysis plan for the appropriate sample locations for sediments and surface waters.

### *Scoop Samplers*

Stainless steel scoops may be used to collect sediment samples. Scoops have a limited reach of approximately eight feet, if attached to an extension.

### *Dredge Samplers*

A dredge is a vessel that is dragged across the bottom of the surface being sampled, collecting a composite of surface sediments and associated benthic fauna. This type of sampler is used primarily for collecting indigenous benthic fauna rather than samples for chemical analyses. Because the sample is mixed with the overlying water, no pore-water studies can be conducted utilizing dredged samples. Additionally, because the walls of the dredge are typically nets, they act as a sieve and mainly coarser material is trapped, resulting in the loss of fine sediments and water-soluble compounds. Associated sample washing may potentially bias sample results. Typically, sample analysis results from dredge sampling should be considered qualitative since it is difficult to determine the actual surface sampled by the dredge. For these reasons, dredge samplers are not recommended within this procedure.

### *Grab Samplers*

Grab samplers have jaws that close by a trigger mechanism upon impact with the bottom surface. Grab samplers offer the advantage of being able to collect a large amount of material in one sample, but are highly unpredictable in determining sampling depth. Substantial contaminant variation with depth is unlikely in shallow channel areas without direct contamination sources, in areas with frequent ship traffic, or from sediments that are dredged at regular intervals. In these

situations, bottom sediments are frequently re-suspended and mixed, effectively preventing stratification. In such cases, surface grab samples represent the mixed sediment column.

### *Core Samplers*

Core samplers are tubes that are inserted into the sediment by various means to obtain a cylinder or box sample of material at known depths. Corers can be simple, hand-operated devices used by scuba divers, or they can be large, costly, motor-driven mechanisms that can collect samples from great depths. Corers are recommended whenever sampling to depth is required, or when the variation in contamination with depth is of concern. Examples of corers are gravity corers, piston corers, vibra-corers, split-spoon cores, and box core samplers. The choice of corer design depends on factors such as the objectives of the sampling program, sediment volumes required for testing, sediment characteristics, water depth, sediment depth, and currents or tides. Refer to the project-specific Sample and Analysis Plan for the appropriate sample equipment specific to the project objectives

*NOTE: The sample processing area may be located on the water vessel depending on the calmness of the sampling environment (e.g., no waves or current) and available workspace on the sampling platform (e.g., use of a large barge).*

## **7.0 REFERENCES**

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Army Corp of Engineers (USACE), 2001. *Requirements for the Preparation of Sampling and Analysis Plans*. EM 200-1-3. February.

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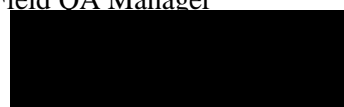
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## **8.0 DEFINITIONS**

**Environmental Sample** - Low concentration sample typically collected offsite and not requiring DOT hazardous waste labeling as a high hazard sample.

**Hazardous Waste Sample** - Medium to high concentration sample (e.g., source material, sludge leachate) requiring DOT labeling and Contract Lab handling as a high hazard sample.

Earth Resources Technology, Inc. Standard Operating Procedure <b>ENVIRONMENTAL SOIL SAMPLING</b>			
Effective Date: <b>01/27/09</b>		Version: <b>001</b>	
<b>ERT SOP-06-03</b>			
Approvals			
 Program Manager		 , C.P.G. Field OA Manager	
 Signature		 Signature	
1/27/09 Date		1/26/09 Date	

## 1.0 PURPOSE

The purpose of this procedure is to outline the general procedures for environmental soil sampling. Soil sampling aids in characterizing substrata, and the nature and extent of soil constituents. Soil samples may be collected at different locations within the horizontal and vertical plane in order to characterize the distribution of constituents within the media

## 2.0 SCOPE

Soil sampling is potentially applicable to any site which characterization of media constituents is necessary. A variety of sampling techniques are available for collection of soil samples. These include split-spoon sampling, collecting auger cuttings, Shelby tube sampling and continuous coring sampling. Split-spoon sampling is the most commonly used technique. The collection of internal quality control checks during soil sampling is specified in the project-specific Sample and Analysis Plan.

## 3.0 REQUIREMENTS

Soil sample collection points should be as close to possible to the proposed location. In most cases accuracy within one foot horizontally is adequate. Specific sampling requirements will be detailed within the project-specific Sampling and Analysis Plan (SAP). Sample locations will be recorded in the Field Logbook and can be accomplished by hand sketching a diagram with measured distances. Record keeping for specific sample locations may be conducted by professional surveys, geographical positioning systems or measuring the distance from site specific permanent/semi-permanent features. The precision of the soil sampling will be determined by the following data quality objectives:

- Sample collection information will be recorded in the Field Logbook and/or Boring Log Form. This will include the sample locations, sample identification (ID), requested analysis and field observations regarding the sample collected.
- Surface/air contact may be minimized by placing the sample in an airtight container immediately after collection.
- Sampling and sample preparation equipment will be decontaminated in accordance with ERT SOP-03-01 prior to and after each sample is collected unless dedicated disposable equipment is used.
- Soil samples collected for volatile organic analytes (VOAs) will be collected and containerized undisturbed, if possible.

- Depth-profile sampling must comply with the above requirements. Care must be taken to prevent cross-contamination, transfer of constituents and misidentification of samples.
- Immediately after containerizing a sample, the sample for laboratory analysis will be labeled in accordance with the project-specific SAP.
- Vertical depth control tolerances are specified in the project-specific Sample and Analysis Plan.

## **4.0 RESPONSIBILITIES**

### **4.1 Project Manager**

The Project Manager is responsible for ensuring that the procedures described in the project-specific SAP, at a minimum meet the requirements set forth in this procedure and those detailed in applicable federal and state guidance documents, and that the field team conducting the sampling are adequately trained and briefed on the prescribed methodology.

### **4.2 Field Team Leader**

The Field Team Leader is responsible for ensuring that soil sampling is conducted in accordance with the procedures outlined in this procedure and in the project-specific SAP. At a minimum, this may include reviewing the SAP for project specific requirements, ensuring that the sampling team is briefed and trained on the project specific requirements, and overseeing the collection and management of the environmental samples.

### **4.3 Field Team**

All members of the Field Sampling Team are responsible for implementing the sampling procedures, including the classification soil and rock samples, collecting soil and rock samples, packing and sealing of soil and rock samples. Such duties may be performed by geotechnical engineers, field technicians, or other qualified field personnel.

## **5.0 EQUIPMENT**

The following pieces of equipment may be needed for the collection of depth-specific soil samples:

1. Drilling Equipment (i.e. mud rotary drill)
2. Split-Spoon Sampling Equipment (typically either 1 3/8" or 2 1/2" I.D.)
3. Shelby Tube Sampling Equipment
4. Direct Push Machine (Geoprobe 6620<sup>®</sup> or similar)
5. Stainless Steel Hand Auger
6. Shovel, or Post-Hole Digger
7. Stainless Steel Trowel, Spoon, or Bucket Auger
8. Teflon<sup>®</sup> or Stainless Steel Spatula
9. Stainless Steel Bowl or Teflon<sup>®</sup> Mixing Board
10. Organic Vapor Monitoring Device (PID)
11. Appropriate Sampling Containers
12. Ziploc-type plastic bags
13. Decontamination Supplies
14. Field Logbook and Field Sampling Forms
15. Knife or chemically inert spatula type instrument
16. Nitrile Gloves

## **6.0 GENERAL PRECAUTIONS**

The following general precautions should be taken when sampling:

- A clean pair of new, disposable nitrile gloves shall be worn at each sampling location and gloves should be donned immediately prior to sampling.
- All work is to be conducted on a clean surface.
- Sample collection, preservation, and method-specific handling procedures outlined in the project-specific SAP will be used for samples collected for laboratory analysis.
- To prevent cross-contamination between samples, all sample containers for a sampling location should be sealed in dedicated plastic bags, especially when the sampled medium is suspected of containing high concentrations of volatile organics.
- Samples of waste or highly contaminated samples should never be placed in the same storage container (ice chest) as environmental samples.
- Wherever possible, one member of the field team should be dedicated to recording all the collection notes, fill out sample labels, field sheets, etc., while the other members collect the required sample volumes. This is especially important when subjective decisions and descriptions are being made.
- Sample collection activities should precede progressively from the suspected least impacted area to the suspected most impacted area.
- Field personnel should take precautions to prevent cross-contamination from sampling equipment. Stainless steel samplers are preferable. All samplers should be properly decontaminated and inspected for visible signs of deterioration before each use or be dedicated and disposed of after each use.
- Adequate field control samples should be collected. Typically field control samples consist of Field Blank Samples and Equipment Blank Samples. Consult the project-specific SAP for details.

## **7.0 PROCEDURES**

### **7.1 Manual Soil Sampling Methods**

#### **General**

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface. The most common interval is 0 to 6 inches, however the data quality objectives of the investigation may dictate another interval, such as 0 to 3 inches for risk assessment purposes. The shallow subsurface interval may be considered to extend from approximately 12-inches below ground surface to a site-specific depth at which sample collection using manual collection methods becomes impractical.



## **Spoons**

Stainless steel spoons may be used for surface soil sampling to depths of approximately 6-inches below ground surface where conditions are generally soft and non-indurated and there is no problematic vegetative layer to penetrate.

### ***Special Considerations When Using Spoons***

- When using stainless steel spoons, consideration must be given to the procedure used to collect the volatile organic compound sample.
- When compositing, make sure that each composite location (aliquot) consist of equal volumes, i.e., same number of equal spoonfuls.
- If a thick, matted root zone is present at or near the surface, it should be removed before the sample is collected

## **Hand Augers**

Hand augers may be used to advance boreholes and collect soil samples in the surface and shallow subsurface intervals. Typically, 4-inch stainless steel auger buckets with cutting heads are used. The bucket is advanced by simultaneously pushing and turning using an attached handle.

### ***Surface Soil Sampling***

When conducting surface soil sampling with hand augers, the auger buckets may be used with a handle alone or with a handle and extensions. The bucket is advanced to the appropriate depth and the contents are transferred to the homogenization container for processing.

### ***Subsurface Soil Sampling***

Hand augers are the most common equipment used to collect shallow subsurface soil samples. Auger holes are advanced one bucket at a time until the sample depth is achieved. When the sample depth is reached, the bucket used to advance the hole is removed and decontaminated following ERT SOP03-1. The clean auger bucket is then placed in the hole and filled with soil to make up the sample and removed. The practical depth of investigation using a hand auger depends upon the soil properties and depth of investigation. In sand, augering is usually easily performed, but the depth of collection is limited to the depth at which the sand begins to flow or collapse. Hand augers may also be of limited use in tight clays or cemented sands. In these soil types, the greater the depth attempted, the more difficult it is to recover a sample due to increased friction and torqueing of the hand auger extensions. At some point these problems become so severe that power equipment must be used.

### ***Special Considerations for Soil Sampling with the Hand Auger***

- Because of the tendency for the auger bucket to scrape material from the sides of the auger hole while being extracted, the top several inches of soil in the auger bucket should be discarded prior to placing the sample in the required sample container.
- Power augers, such as the Little Beaver®, and drill rigs may be used to advance boreholes to depths for subsurface soil sampling with the hand auger. They may not be used for sample collection. When power augers are used to advance a borehole to depth



for sampling, care must be taken that exhaust fumes, gasoline and/or oil do not contaminate the borehole or area in the immediate vicinity of sampling.

## **7.2 Direct Push Soil Sampling Methods**

### **General**

These methods are used primarily to collect shallow and deep subsurface soil samples. Three methods are available for use with either the Geoprobe® or the drill rig adapted with a hydraulic hammer. All methods involve the collection and retrieval of the soil sample within a thin-walled liner. The following sections describe each of the specific sampling methods that can be accomplished using direct push techniques, along with details specific to each method.

### **Large Bore® Soil Sampler**

The Large Bore® (LB®) sampler is a solid barrel direct push sampler equipped with a piston-rod point assembly used primarily for collection of depth-discrete subsurface soil samples. The sample barrel is approximately 30-inches (762 mm) long and has a 1.5- inch (38 mm) outside diameter. The LB® sampler is capable of recovering a discrete sample core 22 inches x 1.0 inch (559 mm x 25 mm) contained inside a removable liner. The resultant sample volume is a maximum of 283 ml. After the LB® sample barrel is equipped with the cutting shoe and liner, the piston-rod point assembly is inserted, along with the drive head and piston stop assembly. The assembled sampler is driven to the desired sampling depth, at which time the piston stop pin is removed, freeing the push point. The LB® sampler is then pushed into the soil a distance equal to the length of the LB® sample barrel. The probe rod string, with the LB® sampler attached, is then removed from the subsurface. After retrieval, the LB® sampler is then removed from the probe rod string. The drive head is then removed to allow removal of the liner and soil sample.

### **Macro-Core® Soil Sampler**

The Macro-Core® (MC®) sampler is a solid barrel direct push sampler equipped with a piston-rod point assembly used primarily for collection of either continuous or depthdiscrete subsurface soil samples. Although other lengths are available, the standard MC® sampler has an assembled length of approximately 52 inches (1321 mm) with an outside diameter of 2.2 inches (56 mm). The MC® sampler is capable of recovering a discrete sample core 45 inches x 1.5 inches (1143 mm x 38 mm) contained inside a removable liner. The resultant sample volume is a maximum of 1300 ml. The MC® sampler may be used in either an open-tube or closed-point configuration. Samples collected for chemical analyses must be collected with the closed-point configuration. If used for collection of soil for stratigraphic descriptions, the open-tubed configuration is acceptable.

### **Dual Tube Soil Sampling System**

The Dual Tube 21 soil sampling system is a direct push system for collecting continuous core samples of unconsolidated materials from within a sealed outer casing of 2.125-inch (54 mm) OD probe rod. The samples are collected within a liner that is threaded onto the leading end of a string of 1.0-inch diameter probe rod. Collected samples have a volume of up to 800 ml in the form of a 1.125-inch x 48-inch (29 mm x 1219 mm) core. Use of this method allows for collection of continuous core inside a cased hole, minimizing or preventing cross-contamination between different intervals during sample collection. The outer casing is advanced, one core

length at a time, with only the inner probe rod and core being removed and replaced between samples. If the sampling zone of interest begins at some depth below ground surface, a solid drive tip must be used to drive the dual tube assembly and core to its initial sample depth.

### **Special Considerations When Using Direct Push Sampling Methods**

- *Liner Use and Material Selection* – Due to the mode of operation, the samples must be collected with a liner. Liners are available in the following materials: stainless steel, brass, cellulose acetate butyrate (CAB), PETG, polyvinyl chloride (PVC) and Teflon®. The required liner material will be specified in the project-specific Sample and Analysis Plan.
- *Sample Orientation* – When the liners and associated sample are removed from the sample tubes, it is important to maintain the proper orientation of the sample. This is particularly important when multiple sample depths are collected from the same push. It is also important to maintain proper orientation to define precisely the depth at which an aliquot was collected. Maintaining proper orientation is typically accomplished using vinyl end caps. Typically orientation is indicated by marking on the exterior of the liner with a permanent marker.
- *Core Catchers* – Occasionally the material being sampled lacks cohesiveness and is subject to crumbling and falling out of the sample liner. In cases such as these, the use of core catchers on the leading end of the sampler may help retain the sample until it is retrieved to the surface. Materials of construction for core catchers must be consistent with the type of liner used, i.e., if stainless steel liners are required, stainless steel core catchers must be used.

## **7.3 Split Spoon/Drill Rig Methods**

### **General**

Split spoon sampling methods are used primarily to collect shallow and deep subsurface soil samples. All split spoon samplers, regardless of size, are basically split cylindrical barrels that are threaded on each end. The leading end is held together with a beveled threaded collar that functions as a cutting shoe. The other end is held together with a threaded collar that serves as the sub used to attach the spoon to the string of drill rod. Two basic methods are available for use, including the smaller diameter standard split spoon, driven with the drill rig safety hammer, and the larger diameter continuous split spoon, advanced inside and slightly ahead of the lead auger during hollow stem auger drilling. The following sections describe each of the specific sampling methods, along with details specific to each method.

### **Standard Split Spoon**

A drill rig is used to advance a borehole to the target depth. The drill string is then removed and a standard split spoon is attached to a string of drill rod. Split spoons used for soil sampling must be constructed of stainless steel and are typically 2.0-inches OD (1.5-inches ID) and 18-inches to 24-inches in length. Other diameters and lengths are common and may be used if constructed of the proper material. After the spoon is attached to the string of drill rod it is lowered into the borehole. The drill rig safety hammer is then used to drive the split spoon into the soil at the bottom of the borehole. After the split spoon has been driven into the soil, filling the spoon, it is

retrieved to the surface, where it is removed from the drill rod string and opened for sample acquisition.

### **Continuous Split Spoon**

The continuous split spoon is a large diameter split spoon that is advanced into the soil column inside a hollow stem auger. Continuous split spoons are typically 3-inches to 5- inches in diameter and either 5-feet or 10-feet in length, although the 5-foot long samplers are most common. After the auger string has been advanced into the soil column a distance equal to the length of the sampler being used it is returned to the surface. The sampler is removed from inside the hollow stem auger and the threaded collars are removed. The split spoon is then opened for sampling.

### **Special Considerations When Using Split Spoon Sampling Methods**

Always discard the top several inches of material in the spoon before removing any portion for sampling. This material normally consists of borehole wall material that has sloughed off of the borehole wall after removal of the drill string prior to and during inserting the split spoon.

## **7.4 Shelby Tube/Thin-Walled Sampling Methods**

### **General**

Shelby tubes, also referred to generically as thin-walled push tubes or Acker thin-walled samplers, are used to collect subsurface soil samples in cohesive soils and clays during drilling activities. In addition to samples for chemical analyses, Shelby tubes are also used to collect relatively undisturbed soil samples for geotechnical analyses, such as hydraulic conductivity and permeability, to support hydrogeologic characterizations at hazardous waste and other sites.

### **Shelby Tube Sampling Method**

A typical Shelby tube is 30-inches in length and has a 3.0-inch OD (2.875 ID) and may be constructed of steel, stainless steel, galvanized steel, or brass. They also typically are attached to push heads that are constructed with a ball-check to aid in holding the contained sample during retrieval. If used for collecting samples for chemical analyses, it must be constructed of stainless steel. If used for collecting samples for standard geotechnical parameters, any material is acceptable. To collect a sample, the tube is attached to a string of drill rod and is lowered into the borehole, where the sampler is then pressed into the undisturbed clay or silts by hydraulic force. After retrieval to the surface, the tube containing the sample is then removed from the sampler head. If samples for chemical analyses are needed, the soil contained inside the tube is then removed for sample acquisition. If the sample is collected for geotechnical parameters, the tube is typically capped, maintaining the sample in its relatively undisturbed state, and shipped to the appropriate geotechnical laboratory.

## **7.5 General Sample Handling for Intact Soil Cores**

1. Expose or remove the core from the sampling device.
2. Use a knife or spatula type instrument to remove any slough or cuttings that may have fell into the hole above the sampling depth

3. Use a knife or spatula to cut the core lengthwise. Successive passes should be done until the core is cut halfway. The core is then pried apart the rest of the way revealing a fresh face not smeared by the knife.
4. Once split apart any layering or structures should be noted.
5. Collect and containerize the environmental sample for laboratory analysis following the methodology specified in the project-specific SAP.
6. Describe the samples and record the description on the Borehole Logging Form in accordance with ERT SOP-07-3..
7. If samples are collected for laboratory analysis verify that samples have been properly labeled and stored as specified in the project-specific SAP.
8. This sampling procedure is repeated at appropriate intervals in accordance with the project-specific SAP.
9. Soil IDW generated by soil sampling and drilling activities will be disposed of according to ERT SOP 06-4 as prescribed in the project-specific SAP.
10. All sampling equipment, including internal components, will be decontaminated prior to use, between sampling events, and prior to demobilization.

## **8.0 COMPOSTING AND SPLITTING SAMPLES**

### **Compositing Samples**

Compositing is the process of physically combining and homogenizing several individual soil aliquots of the same volume or weight. Compositing samples provide an average concentration of contaminants over a certain number of sampling points. Compositing dilutes high-concentration aliquots; therefore, detection limits should be reduced accordingly. If the composite area is heterogeneous in concentration and its composite value is to be compared to a particular action level, then that action level must be divided by the total number of aliquots making up the composite for accurate determination of the detection limit.

### **Splitting Samples**

Splitting samples (after preparation) is performed when multiple portions of the same samples are required to be analyzed separately. Fill the sample containers simultaneously with alternate spoonfuls of the homogenized sample

## **9.0 REFERENCES**

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## 10.0 DEFINITIONS

**Auger Cuttings** - Soil brought to the surface by the action of the augers as they are screwed into the ground.

**Hazardous Waste Sample** - Medium to high concentration sample (e.g., source material, sludge, leachate) requiring DOT labeling and Contract Lab handling as a high hazard sample.

**Shelby Tube Sampler** - A thin-walled metal tube is used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from two to five inches in outside diameter and 18 to 54 inches in length. A stationary piston device is included in the sampler to reduce sampling disturbance and increase sample recovery.

**Split-Spoon Sampler** - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. This device can be driven into resistant (consolidated) materials using a drive weight mounted on the drilling rig. A standard split-spoon sampler, used for performing standard penetration tests, is two inches in outside diameter and 1 3/8 inches in inside diameter. This standard spoon typically is available in two common lengths, providing either 20 inch or 26 inch internal longitudinal clearance for obtaining 18 inch or 24 inch long samples, respectively. A five-foot long split-spoon sampler is also available.

**Continuous Core Sampler** - A steel tube, which may be split in half and held together by threaded collars or may be one piece. The sampler is usually five or ten feet in length and three to five inches in diameter. This device may be driven ahead of hollow-stem augers or may be driven into the soil by vibrational and/or rotary action.



Earth Resources Technology, Inc. Standard Operating Procedure <b>INVESTIGATIVE DERIVED WASTE (IDW) MANAGEMENT</b>			
Effective Date: <b>01/29/09</b>		Version: <b>001</b>	SOP#: <b>ERT SOP-06-4</b>
Approvals			
[Redacted] C.P.G. Program Manager		[Redacted] C.P.G. Field OA Manager	
[Redacted] Signature	1/29/09 Date	[Redacted] Signature	1/28/09 Date

## 1.0 PURPOSE

The purpose of this procedure is to provide general and specific considerations and procedures for use in managing investigation derived waste (IDW) generated during the course of environmental site investigation activities.

## 2.0 SCOPE

The procedure is applicable to ERT personnel involved in managing IDW generated during environmental site investigations. This procedure includes guidance on what constitutes IDW, and how to properly minimize, identify, characterize, stage and dispose of IDW.

## 3.0 REQUIREMENTS

To help minimize health and safety hazards associated with handling IDW, common sense, good judgment, and compliance with the protocols of this procedure and associated federal and state Regulations are essential.

Proper safety precautions must be observed when managing IDW. Refer to the project-specific work plan and to ERT's Health and Safety Plan (HASP) for guidance on necessary safety precautions.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that all activities involving IDW are properly managed and executed in accordance with federal and state regulation. The Project Manager is also required to ensure that all field personnel involved with the management of IDW are properly trained and made aware of the associated hazards.

### 4.2 Field Team Leader

The Field Team Leader is responsible for ensuring all IDW management precautions detailed in this procedure and the project-specific work plans are followed. The Field Team Leader is also responsible for ensuring that the Field Sampling Team manages all IDW in accordance with applicable project-specific requirements, federal and state regulation. Prior to leaving a site after completing field activities for a given day, the Field Team Leader is responsible for properly labeling and securing all IDW to be staged onsite, or ensure that all IDW has been removed from the site.



### **4.3 Field Sampling Team**

The Field Sampling Team is responsible for minimizing the amount of IDW generated for containerization, properly labeling and staging IDW, and for the overall safe conduct of drum opening, sampling, and labeling operations when IDW is containerized in drums.

If any unexpected results (i.e. environmental releases) occur, the Field Sampling Team must inform the Project Manager immediately. Together with the Health and Safety Officer and outside assistance, if necessary, the most prudent course of action will be acted upon.

### **4.4 Health and Safety Officer**

The Health and Safety Officer is responsible for safety of all on-site operations, alerting the Field Sampling Team of any potentially unsafe conditions, and halting work if on-site personnel or off-site public health is threatened.

## **5.0 EQUIPMENT**

- 55-Gallon Drums
- Roll-Off Dumpsters
- Nitrile Gloves
- Contractor-Grade Plastic Bags
- Non-Hazardous Waste Labels
- Hazardous Waste Labels
- Sharpie Pens
- Drum Dolly
- Drum Opening Equipment (i.e. bung wrench)
- PID
- Personal Protective Equipment as specified in the project-specific work plan.
- Spill Control Equipment
- Containment Equipment
- 6-Mil Plastic Sheeting
- Soil and Water Sampling Equipment
- Field Logbook

## **6.0 PROCEDURES**

### **6.1 Types of IDW**

Materials which constitute IDW include, but are not limited to:

- Personnel protective equipment (PPE) - This includes disposable coveralls, gloves, booties, respirator canisters, splash suits, etc.
- Disposable equipment and items - This includes plastic ground and equipment covers, aluminum foil, conduit pipe, composite liquid waste samplers, disposable bailers, disposable tubing, broken or unused sample containers, sample container boxes, tape, etc.
- Soil cuttings from drilling and/or hand augering.



- Drilling mud or water used for mud or water rotary drilling.
- Groundwater obtained through well development or well purging.
- Cleaning fluids such as detergents and wash water.
- Packing and shipping materials.

Table 6-1 lists the types of IDW commonly generated during field investigations and the current disposal practices that should be followed. For the purpose of determining the ultimate disposition of IDW, it is typically distinguished as being either hazardous or non-hazardous. This determination is based on either clear regulatory guidance or subsequent laboratory analysis.

## **6.2 IDW Minimization**

By implementing a flexible field investigation plan that utilizes real-time data, the Field Team can optimize sample locations and numbers of samples collected in order to adequately characterize a site. The use of a phased approach to site investigations can also result in less IDW generation and more accurate constituent delineation.

Early investigation phases may be nonintrusive and may be performed using geophysics or aerial photography. Subsequent phases may be performed with minimally intrusive techniques such as direct push technology (DPT).

For permanent monitoring wells requiring multiple rounds of investigation, utilization of dedicated sampling equipment can reduce IDW. Low flow sampling techniques can also be an effective way of minimizing the generation of purge water. This technique assures groundwater parameters stabilize prior to sampling (representative of the aquifer) and eliminates the need to remove multiple volumes of well groundwater prior to sampling.

Advance planning should be used not only to minimize the quantities of IDW generated, but also to avoid generation of RCRA regulated wastes and the generation of wastes subject to land disposal restrictions.

- Use of RCRA regulated solvents should be replaced by power washing, steam cleaning, or use of non-RCRA solvents whenever possible.
- Boring sizes should be as small as possible to accomplish the specific task.

## **6.3 IDW Containerization**

Depending on the type of IDW and extent of contamination, IDW may be staged onsite for subsequent characterization and disposal in:

- Contractor bags – typical for non-hazardous PPE and disposable sampling equipment
- Steel 55-gallon DOT-approved drums – typical for low volumes of soil and purge water, potentially hazardous PPE and hazardous IDW
- Roll-off dumpsters – typical for large volumes of hazardous and non-hazardous soil

**Table 6-1. Typical IDW and Appropriate Management**

<b>TYPE</b>	<b>HAZARDOUS</b>	<b>NON-HAZARDOUS</b>
PPE-Disposable	Containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to Field Office for disposal in dumpster.
PPE-Reusable	Decontaminate as per SESDPROC-205, if possible. If the equipment cannot be decontaminated, containerize in plastic 5- gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Decontaminate as per ERT SOP03-1
Soil Cuttings	Containerize in DOT-approved container with tight-fitting lid. Identify and leave onsite with permission of site operator, otherwise arrange with program site manager for testing and disposal. Containerize in a 55-gallon steel drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in a 55-gallon steel drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.
Groundwater	Containerize in DOT-approved container with tight-fitting lid. Identify and leave onsite with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.
Decontamination Water	Containerize in DOT-approved container with tight-fitting lid. Identify and leave onsite with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.
Disposable Equipment	Containerize in DOT-approved container or 5-gallon plastic bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.
Trash	NA	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.

*\*\* These materials may be placed on the ground if doing so does not endanger human health or the environment or violate federal or state regulations.*

## **6.4 Management of Non-Hazardous IDW**

Disposal of non-hazardous IDW will be addressed in the project-specific Sampling and Analysis Plan. Disposable non-hazardous IDW may be placed into municipal dumpsters. Disposal of non-hazardous IDW such as drill cuttings, purge or development water, decontamination wash water, drilling mud, etc., will be specified in the approved project-specific Sampling and Plan. These materials must be staged in dedicated containers and not be placed into general trash dumpsters. The minimum requirements for managing non-hazardous IDW include:

- Non-hazardous liquid and soil/sediment IDW will be containerized for proper disposal when possible immediately upon generations, but at a minimum, prior to concluding site activity for the day.
- Soap and water decontamination fluids and rinsates of such cannot be placed in any water bodies and must be collected and disposed of properly.
- The collection, handling and proposed disposal method must be specified in the approved study plan or QAPP.

## **6.5 Management of Hazardous IDW**

Management and disposal of hazardous or suspected hazardous IDW will be specified in the approved project-specific Sampling and Analysis Plan. Hazardous IDW must be disposed as specified in USEPA regulations. These wastes must be treated and disposed of at an appropriately licensed waste treatment facility. IDW determined to be hazardous waste, must be properly contained and labeled. Hazardous IDW may be stored on the site for a maximum of 90 days before it must be manifested and shipped to a permitted treatment or disposal facility. Generation of hazardous IDW must be anticipated, if possible, to allow arrangements for proper containerization, labeling, transportation and disposal/treatment in accordance with USEPA regulations. Most routine field activities will not produce hazardous IDW.

At a minimum, all hazardous IDW must be containerized and secured prior to leaving the site on a given day. Proper handling and disposal will be arranged prior to commencement of field activities and detailed in the project-specific Sampling and Analysis Plan.

## **6.6 Labeling Waste Containers**

Immediately upon containerizing IDW, the container will be labeled with generator information, emergency contact information, IDW source and applicable characterization (non-hazardous or hazardous). If the IDW must be sampled in order to complete characterization, the container will be labeled as pending characterization using a non-hazardous label, with applicable generator and emergency contact information. Upon complete characterization, containerized IDW will be labeled with updated applicable information and appropriate non-hazardous label (Attachment 1) or hazardous label (Attachment 2). If it is determined by analytical procedure that the waste contained is hazardous, then a hazardous waste label shall be immediately filled out to completion and affixed to the container replacing the nonhazardous placard.

## **6.7 IDW Characterization**

After the IDW has been containerized, it must be characterized in order to determine what disposal methods are applicable. Generally, PPE and other materials used for environmental sampling (i.e., dedicated tubing, dedicated bailers, nitrile glove) will not need to be characterized via laboratory analytics. If analytical sampling requirements are required, requirements will be

detailed in the project-specific Sampling and Analysis Plan. Characterization should determine the following:

- Is the IDW a RCRA hazardous waste?
- Is the IDW a hazardous or toxic substance under any other statute such as CERCLA, CWA, etc.?
- Is the IDW a non-hazardous?

Determining whether IDW constitutes RCRA hazardous waste will determine if:

- Land disposal restrictions apply
- The waste can be managed onsite
- The waste must be disposed of in a RCRA Subtitle C (hazardous waste) facility
- The waste can be disposed of in a RCRA Subtitle D (nonhazardous waste) facility.

Characterization involves sampling, laboratory analysis, and analytical data review.

## 7.0 REFERENCES

The following documents were utilized in the creation of this Standard Operation Procedure:

Cassic, J.A., et al., 1985. *Guidance Document for Cleanup of Surface Tank and Drum Sites*. Prepared for Office of Emergency and Remedial Response, USEPA, Washington, DC under Contract No. 68-01-6930.

IT Corporation, December 1988. *Hazardous Waste Operations and Emergency Response*, IT Corporation, Knoxville, Tennessee.

Martin, F.M., Lippitt, J.M., Prothero, T.G., 1987. *Hazardous Waste Handbook for Health and Safety*, Butterworth Publishers, p. 167-177.

NUS Corporation, 1983. *Operating Guidelines Manual*.

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Environmental Protection Agency (USEPA), 2007. *Management of Investigative Derived Waste*. SESDPROC-202-R1.

United States Environmental Protection Agency (USEPA), 2000. *Soil Sampling*. U.S. EPA Environmental Response Team, SOP 2012. February.

United States Army Corp of Engineers (USACE), 2001. *Requirements for the Preparation of Sampling and Analysis Plans*. EM 200-1-3. February.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York

## 8.0 DEFINITIONS

**Drum** - Any container used to store hazardous materials in a quantity less than 60 U.S. gallons.

**Hazardous Materials** - Any substance capable of producing deleterious health effects, upon any form of skin contact, inhalation or ingestion by animals or humans.

**Investigation-Derived Waste (IDW)** - IDW is a subset of remediation wastes. IDW is waste that is generated in the process of investigating or examining an actual or potentially contaminated site. It includes solid and hazardous waste, media (including groundwater, surface water, soils, and sediments) and debris that contain *listed* hazardous wastes or exhibit a characteristic of a hazardous waste. It includes media and debris that is not hazardous but is contaminated with hazardous constituents. Not all IDW is hazardous waste.

## **9.0 ATTACHMENTS**

Attachment 1 – Example Non-Hazardous Waste Label

Attachment 2 – Example Hazardous Waste Label

**Attachment 1**  
**Example Non-Hazardous Waste Label**



The image shows a standard non-hazardous waste label. It has a green background with white text. The top half features the words "NON-HAZARDOUS WASTE" in large, bold, white capital letters, slanted diagonally. Below this, on the left, is the text "SOLID WASTE EXCLUDED FROM REGULATION UNDER 40CFR 261.4 (b)". On the right, there is a white rectangular box containing the heading "GENERATOR INFORMATION: (optional)" followed by four lines for "SHIPPER", "ADDRESS", "CITY, STATE, ZIP", and "CONTENTS:". At the bottom of the label, the words "NON-HAZARDOUS WASTE" are printed again in green capital letters. A small footer at the very bottom reads "GWMV REV.11-1-02 Printed by Labelmaster, An American Labelmark Co., Chicago, IL 60646 (800) 621-5908".

**NON-HAZARDOUS WASTE**

SOLID WASTE EXCLUDED  
FROM REGULATION UNDER  
40CFR 261.4 (b)

GENERATOR INFORMATION: (optional)

SHIPPER \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY, STATE, ZIP \_\_\_\_\_

CONTENTS: \_\_\_\_\_

**NON-HAZARDOUS WASTE**

GWMV REV.11-1-02 Printed by Labelmaster, An American Labelmark Co., Chicago, IL 60646 (800) 621-5908

**Attachment 2**  
**Example Hazardous Waste Label**



**HAZARDOUS  
WASTE**

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.  
IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY  
AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

GENERATOR INFORMATION:

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_ PHONE \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

MANIFEST TRACKING NO. \_\_\_\_\_ ACCUMULATION START DATE \_\_\_\_\_

EPA ID NO. \_\_\_\_\_ EPA WASTE NO. \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

**HANDLE WITH CARE!**

STYLE WMB

LABELMASTER® (800) 621-5808 www.labelmaster.com



Earth Resources Technology, Inc. Standard Operating Procedure <b>LOW-FLOW GROUNDWATER SAMPLING</b>			
Effective Date: <b>01/22/09</b>		Version: <b>001</b>	
SOP#: <b>ERT SOP-06-5A</b>			
Approvals			
<div style="background-color: black; width: 100px; height: 15px; margin-bottom: 5px;"></div> Program Manager		<div style="background-color: black; width: 100px; height: 15px; margin-bottom: 5px;"></div> , C.P.G. Field QA Manager	
<div style="background-color: black; width: 200px; height: 30px; margin-bottom: 5px;"></div> <div style="display: flex; justify-content: space-between;"> <span>1/23/09</span> <span>1/22/09</span> </div> <div style="display: flex; justify-content: space-between;"> <span>Date</span> <span>Date</span> </div>		<div style="background-color: black; width: 200px; height: 30px; margin-bottom: 5px;"></div> <div style="display: flex; justify-content: space-between;"> <span>Signature</span> <span></span> </div>	

## 1.0 PURPOSE

The purpose of this procedure is to obtain groundwater samples that are representative of the source from which they are taken and minimize the sampler's exposure to groundwater contaminants using low flow purging techniques. The methods and equipment described are for the collection of groundwater samples from the saturated zone of the substrata.

## 2.0 SCOPE

This procedure provides information on proper equipment and techniques for low flow ground water sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described should be followed whenever applicable, noting that site-specific conditions and project-specific work plans, may require adjustments in methodology.

## 3.0 REQUIREMENTS

Generally, sampling can be initiated upon parameter stabilization during low flow purging. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. The sampling flow rate may remain at the established low flow purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles or loss of volatiles due to extended residence time in the tubing.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that the procedures described in the project-specific Sampling and Analysis Plan (SAP), at a minimum meet the requirements set forth in this procedure and those detailed in applicable federal and state guidance documents, and that the field team conducting the sampling are adequately trained and briefed on the prescribed methodology.

### 4.2 Team Leader

The Field Manager is responsible for ensuring that groundwater sampling is conducted in accordance with the procedures outlined in this procedure and in the project-specific SAP. At a minimum, this may include reviewing the SAP for project specific requirements, ensuring that the sampling team is briefed and trained on the project specific requirements, and overseeing the collection and management of the environmental samples.

### 4.3 Field Team

The Field Team is required to adhere to the sample collection requirements described in this procedure and the project-specific SAP. Deviations from these documents must first be consulted with the Field Team Leader and Project Manager. The Field Team is required to

properly manage the sample collection and handling process of samples from the point of sample collection to relinquishment of samples to the analytical laboratory or designated courier.

## **5.0 EQUIPMENT**

Sample containers will conform to EPA regulations for cleanliness and analysis specific preservation. Ideally, sample withdrawal equipment should be completely inert, economical, easily decontaminated or dedicated disposable able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well purging and sample collection.

The following pieces of equipment may be needed to collect groundwater samples:

- Sample Containers
- Nitrile Gloves
- Coolers for Sample Shipping and Cooling
- Ice to keep samples under 4° Celcius (No blue ice or other forms of ice packs should be used)
- Zip-loc type reclose able plastic bags for sample segregation and wet ice containment
- Appropriate Packing Cartons, Filler, and cushioning material
- Labels
- Clear Packing Tape
- Chain-of-Custody Documents
- Stopwatch
- Graduated Cylinder
- Multi parameter meter.
- Flow through cell with fitting adapters, typically a Horiba U-22 with flow through cell
- Photoionization Detector (PID), or similar instrument with calibration gas
- Appropriate Keys (for Locked Wells)
- Tape Measure
- Water-Level Indicator
- Appropriate Sampling Gloves (Nitrile)
- Purge data forms
- Multi-tool
- Folding table
- Plastic Trash Bags (contractor grade/heavy mil)
- Polyethylene sheeting
- Indelible Marking Pens
- Black, Permanent Ink Pens
- Submersible Pump with controller

Sample specific tubing such as Teflon®, Polyethylene and Polypropylene (tubing type shall be selected based on specific site requirements and must be chemically inert to groundwater being sampled)

- Teflon<sup>®</sup>-Coated Wire, Stainless Steel Single Strand Wire, Polypropylene Monofilament Line, or One-Quarter Inch Nylon Rope and Tripod-Pulley Assemble (if necessary)
- Minimum of three 5 gallon buckets
- Decontamination material (distilled water, deionized, analyte free water, Alconox or Liquinox, isopropanol, where applicable)
- Multi-stage decontamination station

## **6.0 PROCEDURE**

To be useful and accurate, a groundwater sample must be representative of the particular saturated zone of the substrata being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of analysis in order to minimize any changes in water chemistry.

Sampling of multiple wells at a single site will always begin with the suspected least impacted well and progress sequentially to the suspected most impacted well, if known, unless project plans specify otherwise. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., containing iron, methane, sulfides) parameters will be sampled first. If an in-line device is used to monitor water quality parameters, it must be disconnected or bypassed during sample collection. Field filtering of samples may be required for certain types of samples. If so, these samples volumes will be collected last.

Methods for low flow purging of monitoring wells prior to sampling include the use of low-flow pumps capable of maintaining flow rates of between 0.1 L/min and 1 L/Min. Procedures described in the following section will be used for purging wells prior to sampling. All water purged prior to sampling will be managed, containerized or treated and discharged, as indicated in the project-specific work plan.

The primary limitations to the collection of representative groundwater samples including, mixing of stagnant water within the monitoring well and representative groundwater from the local aquifer; disturbance and resuspension of settled solids within the monitoring well or in close proximity to the screen; introduction of atmospheric gases or degassing during sample handling and transfer, or inappropriate use of a vacuum sampling device.

### **6.1 Sampling Approach**

General low-flow sampling techniques will consist of the following procedures and be consistent with the project-specific SAP.

### **6.2 Sampling Methods**

The collection of a groundwater sample is made up of the following sequential steps:

#### **6.2.1 Monitoring Well Access**

Access the monitoring well head and screen with PID for volatile compounds. When practical, clean plastic sheeting should be placed on the ground at each sample location to prevent or minimize contaminating sampling equipment by accidental contact with the ground surface. A folding/portable table can aid in the management of samples and equipment during the purging process.

#### **6.2.2 Measure Groundwater Level**

Measure the static groundwater level in the monitoring well per ERT SOP-07-2 with a water-level indicator and/or interface probe. Calculate the groundwater volume within the well using the acquired data and well construction details.

### **6.2.3 Install Submersible Pump**

Lower the submersible pump, safety cable, tubing and electrical lines slowly (in order to minimize disturbance) into the water column to the approximate midpoint of the groundwater zone to be sampled. Refer to the Sampling and Analysis Plan or ERT Sampling Work Order for specific sampling depth. In cases where this information is not available, the field sampler will provide criteria used for selecting the sampling depth and keep this record in the field logbook. Where possible the pump intake will be staged at least two feet above the bottom of the monitoring well, in order to minimize disturbance of particulates present within the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well. Connect tubing attached to the submerged pump to the influent on the flow-through cell. Secure additional tubing to the effluent plug on the flow-through cell and allow for enough slack so that the effluent tubing can reach the dedicated purge water container.

### **6.2.4 Measure Groundwater Level**

Before starting pump, the groundwater level will be measure once again and recorded in the field logbook. If a data recording pressure transducer is being utilized, initialize the starting condition.

### **6.2.5 Purge Well**

All wells will be purged of stagnant water prior to sampling to ensure that the collected groundwater sample is representative of the target groundwater aquifer.

#### *6.2.5.1 Initial Low Stress Sampling Event*

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Gauge any associated change in the groundwater level. Adjust pump speed accordingly until there is little or no groundwater level drawdown (typically less than 0.25 feet). If the minimal drawdown that can be achieved exceeds 0.25 feet but remains stable, continue purging until groundwater quality field parameters have stabilized. Monitor and record the groundwater level and pumping rate every three to five minutes during purging. Record any pumping rate adjustments (both time and flow rate) made while purging. Pumping rates should be reduced to the minimum required to minimize drawdown and to stabilize groundwater quality indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is less than the lowest extraction rate capabilities of the submersible pump and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recharged sufficiently to collect the appropriate volume needed for all sample analysis. Regardless if the groundwater quality indicators have stabilized, monitoring wells which have been completely dewatered during purging may be sampled as soon as the groundwater recharges to a volume adequate to collect the appropriate sample volume. Ideally the intake should not be moved during this recovery period. If circumstances do not allow for this, equipment may be removed and the well

may be sampled within a 24 hour period without re-purging the well. Samples may then be collected even though the indicator field parameters have not stabilized.

#### 6.2.5.2 Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practical, the intake depth and final pump extraction rate from previous sample event(s). Perform purging operations as above.

### 6.2.6 Monitor Indicator Field Parameters

During well purging, groundwater quality indicator parameters should be monitored using the Horiba U-22 with flow through cell, or similar, every three to five minutes or as specified in the Sample and Analysis Plan. During the early phase of purging, groundwater quality indicators may be very erratic. Purging is considered complete and sampling may commence when all pH, specific conductivity, dissolved oxygen, and oxygen reduction potential have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

Parameter	Stabilization Criteria
pH	$\pm 0.2$ unit
Specific Conductivity	$\pm 3\%$
Dissolved Oxygen	$\pm 10\%$ or 0.2 mg/l whichever is greater
Oxidation Reduction Potential	$\pm 20$ mv

*Note: The field measurement of temperature and conductivity are not reliable indicators for differentiating between “stagnant” and native formation water due to the fact that each can be influenced by the operation of the mechanical pump. They will not be utilized as stabilization parameters; however their measurements will be recorded.*

All recorded groundwater quality indicator data will be acquired using a Horiba U-22 with flow through cell. Transparent flow-through cells are preferred as they allow field personnel to monitoring the accumulation of particulates, free product or other foreign objects within the cell. Accumulation of such constituents within the cell may affect measurements of groundwater quality indicator field parameter values. If the requires cleaning during purging operations, purging may continue. Disconnect the influent tubing from the flow through cell over the container dedicated for purge water and arrange so that the purge water will discharge directly into the dedicated container. After cleaning, the flow-through cell may be reintroduced to the purge line. In order to ensure accurate data, monitoring probes within the flow through cell must be continuously submerged in purge water.

### 6.2.7 Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through cell. In order to do so, connect a by-pass assembly or disconnect the influent tube from the flow-through cell. Volatile organic compound (VOC) samples will be collected first and placed directly into laboratory certified volatile organic analysis (VOA) sample containers. All sample containers will be filled by allowing the groundwater from the discharge tubing to flow gently down the inside of the sample container with minimal turbulence. During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch

(inside diameter) tubing be used to help insure that the sample tubing remains water filled. Preserve filtered water sample immediately. Label each sample as collected and cover with clear packing tape in order to maintain the integrity of the label. At a minimum, all sample labels will include the sample ID, sample time and date, the samplers ID and the requested analysis. Secure samples per ERT SOP-06-7.

*Note: filtered groundwater samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health risk calculations.*

### **6.2.8 Post Sampling Activities**

After collection of the samples, in some cases the pump tubing may be dedicated to the well for resampling (by securely hanging the tubing inside the well), decontaminated, or properly discarded. If sample tubing is to be dedicated to the monitoring well, it must be secured in such a fashion as to not allow for the tubing to fall into the well. Every attempt will be made to clear objects from the monitoring well if inadvertently introduced to the well and noted in the appropriate field logbook.

Secure the well head and protective cover.

### **6.3 Collection of Split Samples or Field Duplicates**

Whenever field duplicates are collected or samples are split with another organization the additional samples for identical analyses will be collected along with the original sample (i.e., containers for all volatile organic analyses will be filled first and together, all semi-volatiles together and in proper sequence, and so forth until all sample parameters are in the proper containers).

### **6.4 Sample Containers**

For most samples and analytical parameters, either glass or plastic containers are satisfactory. ERT SOP-06-7, Packaging and Shipment of Field Samples, describes the required sampling containers and shipment methods for various analytes and media.

### **6.5 Preservation of Samples and Sample Volume Requirements**

Sample preservation techniques and volume requirements depend on the type and concentration of constituent and type of analysis to be performed. The project-specific Sample and Analysis Plan will detail sample preservation and volume requirements constituents to be sampled for during the field activities.

### **6.6 Field Filtration**

Field collection and preparation of groundwater samples may include some form of filtration. Field filtration must occur immediately upon or during collection. The recommended method of filtration is via the use of a disposable in-line filtration module (2.0 micron filter for metals and 0.30 micron filter for gross alpha/gross beta). Pressure provided by the dedicated pump will be used to force groundwater through the in-line filter and into the sample container. Prior to using the in-line filter, the filter should be pre-rinse distilled water. Samples for organic analyses should never be filtered. Refer to ERT SOP 06-8 for detailed procedures for field dilution of groundwater samples.

### **6.7 Handling and Transporting Samples**

After collection, samples should be handled as minimally as possible. Samples will be staged in an controlled environment not to exceed 4°C. This can be achieved by placing the samples in a



dedicated refrigerator or cooler with zip-lock bags filled with natural ice. Steps should be taken to ensure that ice melt does not cause sample containers to be submerged and thus introduce the possibility of cross-contaminated or affecting the sample label integrity. All sample containers will be enclosed in dedicated plastic bags to prevent cross-contamination. Sample packing and transportation requirements are described in ERT SOP-06-7.

### **6.8 Sample Holding Times**

Holding times, allowed time between sample collection and analysis for routine samples, are provided in the project-specific Sample and Analysis Plan. This information should be reviewed by the Field Team prior to the start of sampling activities to ensure sample analysis occurs within the allotted timeframe.

### **6.9 Records**

Records will be maintained for each sample that is taken within the dedicated field logbook. The record will include the sample location, total well depth, depth to groundwater, observed groundwater quality indicators, pumping rates, data and time of sample collection and any other applicable data.

### **6.10 Chain-of-Custody**

Chain-of-custody procedures are necessary for adequate sample handling. ERT SOP-06-7 details the requirements for appropriate completion of a chain-of-custody.

## **7.0 REFERENCES**

The following documents were utilized in the creation of this Standard Operation Procedure:

Nielsen, D.M., Nielsen G., 2006. *The Essential Handbook of Ground-Water Sampling*, CRC Press L.L.C., Boca Raton, Florida.

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Army Corp of Engineers (USACE), 2001. *Requirements for the Preparation of Sampling and Analysis Plans*. EM 200-1-3. February.

United States Environmental Protection Agency (USEPA), 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedure*. Ground Water Issue, EPA/540/S-95/504. April.

United States Environmental Protection Agency (USEPA), 1996. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water samples from Monitoring Well*. Region I, SOP: GW0001. Revision 2. July.

United States Environmental Protection Agency (USEPA), 2007. *Field Branches Quality System and Technical Procedures*. Region 4 Science and Ecosystem Support Division. SESDPROC-301-R1.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York.

## **8.0 DEFINITIONS**



**Equipment/Rinse/Rinsate Blanks** - A sample that is collected by pouring over or running analyte-free water through the sample collection equipment after decontamination and before sample collection. The sample is collected in the appropriate sample container with the proper preservative, identical to the samples. This represents background contamination resulting from the field equipment, sampling procedure, sample container, preservative, and shipment.

**Environmental Sample** - Low concentration sample typically collected offsite and not requiring DOT hazardous waste labeling as a high hazard sample.

**Field Blank** - In the field, analyte-free water is collected into a sample container with preservatives. The sample containers are the same lot used for the environmental samples. This evaluates contamination introduced from the sample container(s) with applicable preservatives. Field blanks are not used for volatile samples.

**Field Replicates/Duplicates** - Two or more samples collected at the same sampling location. Field replicates should be samples collected side by side or by collecting one sample and immediately collecting the second sample. Field replicates represent the precision of the whole method, site heterogeneity, field sampling and the laboratory analysis.

**Field Split Samples** - Two or more representative subsamples taken from one environmental sample in the field. Prior to splitting, the environmental sample is homogenized to correct for sample heterogeneity that would adversely impact data comparability. Field split samples are usually analyzed by different laboratories (inter-laboratory comparison) or by the same laboratory (intra-laboratory comparison). Field splits are used to assess sample handling procedures from field to laboratory and laboratory's comparability.

**Filter Blank** - In the field, analyte-free water is passed through a filter and collected into the appropriate sample container. The filter blank is then preserved. This procedure is identical to the sample collection.

**Hazardous Waste Sample** - Medium to high concentration sample (e.g., source material, sludge leachate) requiring DOT labeling and Contract Lab handling as a high hazard sample.

**Laboratory Quality Samples** - Additional samples will be collected for the laboratory's quality control: matrix spike, matrix spike duplicate, laboratory duplicates, etc.

**Shipping Container Temperature Blank** - A water sample provided by the laboratory that is transported to the laboratory to measure the temperature of the samples in the cooler.

## 9.0 ATTACHMENTS

Low-Flow Groundwater Sampling Form

# LOW FLOW SAMPLING DATA SHEET

SITE: \_\_\_\_\_

FIELD PERSONNEL: \_\_\_\_\_

DATE: \_\_\_\_\_



WEATHER: \_\_\_\_\_

WELL DEPTH: \_\_\_\_\_

STICK-UP / FLUSH MOUNT

MONITORING WELL: \_\_\_\_\_

WELL SIZE: \_\_\_\_\_ Inches

WELL VOLUME: \_\_\_\_\_ GAL

2 inch = 0.163 gal/ft    4 inch = 0.653 gal/ft

PID/FID READINGS

BACKGROUND: \_\_\_\_\_

PUMP INTAKE DEPTH: \_\_\_\_\_ ft below TOC





BENEATH WELL CAP:

DEPTH OF WATER BEFORE PUMP INSTALLATION: \_\_\_\_\_ ft below TOC

TIME	PURGING	SAMPLING	pH (pH units)		SPECIFIC CONDUCTIVITY (mS/cm)		TURBIDITY (NTU)		DISSOLVED OXYGEN (mg/l)		TEMPERATURE (degrees C)		OXYGEN REDUX POTENTIAL (mv)		PUMPING RATE (ml/min)	DEPTH TO WATER (ft below toc)
			READING	CHANGE	READING	CHANGE	READING	CHANGE	READING	CHANGE	READING	CHANGE	READING	CHANGE		
				NA		NA		NA		NA		NA		NA		
Stabilization			± 0.2		± 3%		± 10% or <10 NTU		± 10% or 0.2 mg/L		± 3%		± 20 mV			

COMMENTS: \_\_\_\_\_

GAL PURGED: \_\_\_\_\_

Earth Resources Technology, Inc. Standard Operating Procedure <b>PACKAGING AND SHIPMENT OF FIELD SAMPLES</b>			
Effective Date: <b>01/27/09</b>		Version: <b>001</b>	
SOP#: <b>ERT SOP-06-7</b>			
Approvals			
 Program Manager		 , C.P.G. Field QA Manager	
 Signature		 Signature	
1/28/09 Date		1/27/09 Date	

## 1.0 PURPOSE

The purpose of this procedure is to define the requirements necessary for sample packaging and information to be included on sample labels and chain-of-custody (COC) records used in sample transfer from field personnel to the analytical laboratory.

## 2.0 SCOPE

This procedure applies to the packaging, shipping and documentation of samples being collected during field activities and transferred contracted laboratory for analysis. Specifically, this document outlines shipping and sample documentation procedures in accordance with the U.S. Department of Transportation (DOT) guidance and regulation. This procedure is applicable to all environmental samples collected for delivery to analytical laboratories; however, this procedure does not take precedence over federal, state or project-specific requirements for sample management and delivery to the analytical laboratory.

## 3.0 REQUIREMENTS

Careful packaging, shipping and documentation are essential to insure that collected samples are received undamaged and authenticated by the contract analytical laboratory.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for providing project-specific guidelines within the Sampling and Analysis Plan (SAP) for the proper handling and management of environmental samples, and ensuring that the field team is properly trained in the appropriate procedures. Upon completion of the sample accusation and COC completion, the Project Manager is responsible for reviewing the collected samples and the completed COC for accuracy.

### 4.2 Field Team Leader

The Field Team Leader is responsible for ensuring that samples are properly packaged, labeled, documented on the COC and shipped to the contracted analytical laboratory in accordance with this procedure and within the project-specific SAP. The Field Manager will also ensure that proper sample management techniques are followed for the entire duration that samples are in the custody of ERT personnel.

### 4.3 Field Team

The Field Team is responsible for implementing packaging, labeling, documenting and shipping requirements detailed in this procedure and the project-specific SAP.

## 5.0 EQUIPMENT

- Cooler
- Packing Tape
- Bubble Pack
- Sampling Gloves
- Heavy Duty Plastic Trash Bags
- Inert absorbent material/matting
- COC
- Pen, Black Ink
- Ziploc-type Plastic Bags
- Permanent Felt Tip Marker
- Shipping documents
- Right-side-up and Fragile Placarding
- Custody Seals
- Natural Ice
- Temperature Blanks

## 6.0 PROCEDURE

### 6.1 Sample Packaging and Shipping

Typically, samples collected for shipment to analytical laboratories will be classified as non-hazardous environmental samples. ERT will not ship any material known to be hazardous. If hazardous material is suspected, the Project Manager will be notified and appropriate accommodation will be made to transfer the sample media from the site. If hazardous material is expected to be encountered during field activities, the project-specific SAP will detail the proper procedures for handling the hazardous media.

### 6.2 Packaging

Environmental samples will be packaged following the procedure outlined below:

- Conduct a “bottle count” to ensure correct sample volumes for the analytical procedures requested, correct number of samples, and that information on each sample label matches the COC and complies with the project-specific SAP.
- Line shipping cooler with plastic trash bag
- Line bottom of cooler with inert absorbent material/matting.
- Tape drain plug closed (if applicable).
- Place doubled-bagged wet ice on the bottom of the lined shipping cooler. Enclose temperature blank in bagged ice, sufficiently protected from breakage.
- Place inert cushioning material on top of ice.
- Check to ensure that sample lids are tightened to prevent leakage and with enough headspace (except VOC containers with a septum lid) to compensate for any pressure and temperature changes during shipment (approximately 10 percent of the volume of the container).
- Segregate samples from sample points into separate Ziploc-type plastic bags to minimize the potential for cross contamination and contact with any liquid generated from melting ice.
- Arrange samples within the cooler as to minimize contact between breakable sample containers.
- Fill any void spaces between samples with inert cushioning material.
- Place double-bagged ice on top of the samples.
- Close plastic bag lining cooler and tape shut.

- Place signed Chain-of-Custody form into Ziploc-type plastic bag and affix to inside of lid of the shipping cooler with packing tape. In the instances of multiple coolers for a single Chain-of-Custody place photo copies of original COC in Ziploc-type bag in each additional cooler.
- Tape the lid of the shipping cooler shut including around the edge where the lid contacts the body.
- Place COC seals across the threshold where the cooler lid contact the body of the shipping cooler, or as detailed in the project specific SAP.
- Tape down any movable external handles.
- Affix shipping documents to the lid.
- When multiple coolers are shipped during a single event they should be numbered sequentially on the exterior (1 of 3 etc.) so that the receiving facility would be aware of any irregularities in shipment.
- "THIS SIDE UP" or "THIS END UP" and "FRAGILE" placards and upward-pointing arrows should also be affixed on the outside of the cooler.

#### **6.2.1 Shipping Papers**

No DOT shipping papers are required for the transport of non-hazardous environmental samples. However, appropriate COC forms must be included with the shipment.

#### **6.2.2 Transportation**

There are no DOT restrictions on mode of transportation for non-hazardous environmental samples.

### **6.3 Chain-of-Custody Guidelines**

A properly completed COC ensures that handling and shipment of environmental samples has been conducted in a defensible and scientific manner. COC procedures track environmental samples from the time and place it is first obtained to the analytical laboratory. These procedures also provide an auditable trail of evidence the samples pass from the custody of one individual to another. In addition, procedures for consistent and detailed records facilitate the admission of evidence under Rule 803(b) of the Federal Rules of Evidence (P.L. 93-575).

COC procedures, record keeping, and documentation are an important in ensuring the quality of sample analytical results. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

#### **6.3.1 Sample Identification**

The following information shall be recorded in the Field Logbook when samples for laboratory analysis are collected:

- unique sample number
- source of sample (including name, location, and sample type)
- time of collection
- number of samples collected
- types of sample container
- preservative used
- analysis required

- field observations (include pH, temp, depth to water) when applicable
- equipment used to make physical measurements and collect samples
- calibration data for equipment used

### **6.3.2 Sample Labels**

Samples, other than in-situ measurements, are removed and transported from the sample location to a contracted analytical laboratory or other location for analysis. Before transport, however, the collected sample volume is often divided into various containers for particular analytical procedures. Each subsample will be containerized and preserved in accordance with the project-specific SAP.

Each sample container will have a dedicated sample label identifying the sample. The following table describes the minimum sample label requirements.

<b>Minimum Sample Label Requirements</b>	
Field Sample No.	The unique sample number identifying this sample as prescribed by the Work Plan, SAP and/or QAPP
Project Name	Name
Project No.	ERT Project number
Date	A six-digit number indicating the month, day, and year of sample collection; e.g., 12/21/85
Time	A four digit number indication the 24-hour time of collection (for example: 0954 of 9:54 a.m., and 1625 is 4:25 p.m.)
Media Type	Water, Soil, etc.
Method Type	Grab or Composite
Analysis	Method of analysis for the laboratory
Preservation	Type of preservative
Collector's Initials	Initials of the sampler

Once the required information is entered onto the label and affixed to the sample container, clear packing tape should be placed over the label to maintain the integrity of the label.

### **6.3.3 Chain-of-Custody Procedures**

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

### **6.3.4 Field Custody Procedures**

1. Samples are collected as described in the project-specific SAP. Care must be taken to ensure that the sample identification on the label exactly matches sample identification on the COC.
2. Field personnel collecting the environmental samples are responsible for the care and custody of the samples collected until they are properly transferred to a predetermined staging area, the custody of another Field Team member, or the custody of a carrier.
3. Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions.

### **6.3.5 Transfer of Custody and Shipment**

Samples are accompanied by a COC Record Form. When transferring the possession of samples, both the individual relinquishing and receiving the samples will sign, date, and note the time of transfer on the COC. The COC documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory.

Typically the COC is filled out in its entirety as follows:

1. Enter project specific information (i.e. project number and name, Contract Lab case No. or SAS No.). For each sample, record the applicable Sample Identification, date and time of sample collection, the sampler, preservation information, type of sample (composite/grab), number of containers transferred and the requested analytical parameters.
2. Sign, date, and enter the time under "Relinquished by" entry.
3. Ensure the person receiving the sample signs for the "Received by" entry, or enter the name of the carrier (e.g., UPS, Federal Express) under "Received by".
4. Record the bill-of-lading or Federal Express air bill number under "Remarks or Reason for Change of Custody", if appropriate.
5. Place the original (top, signed copy) of the Chain-of-Custody Recorded Form in the appropriate sample shipping package. Retain a copy with field records.

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

Common carriers (FedEx and UPS) will not accept responsibility for handling COC Forms, necessitating the package of the COC Record in the sample container (enclosed with the other documentation in a plastic zip-lock bag secured to the lid of the shipping cooler). As long as custody forms are secured inside the sample shipping container and the custody seals are intact, commercial carriers are not required to sign off on the custody form.

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

## **7.0 REFERENCES**

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Army Corp of Engineers (USACE), 2001. *Requirements for the Preparation of Sampling and Analysis Plans*. EM 200-1-3. February.

United States Environmental Protection Agency (USEPA), 1992. *RCRA Ground Water Monitoring: Draft Technical Guidance*. November



United States Environmental Protection Agency (USEPA), 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Region 4. November.

United States Environmental Protection Agency (USEPA), 2007. *Field Branches Quality System and Technical Procedures*. Region 4 Science and Ecosystem Support Division. SESDPROC-209-R1. November.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York

## 8.0 DEFINITIONS

**Carrier** - A person or firm engaged in the transportation of passengers or property.

**Chain-of-Custody Form** - A Chain-of-Custody Form is a printed form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to the subsequent custodian. Attachment 1 shows a typical Chain-of-Custody Form. Chain-of-Custody Form is a controlled document. One copy of the form must be retained in the project file.

**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 your custody if:

- You possess the sample.
- It is in your view, after being in your physical possession.
- It was in your physical possession and then you locked it up to prevent tampering.
- You have designated and identified a secure area to store the sample

**Environmental Sample** - A low concentration sample typically collected offsite and not requiring DOT hazardous waste labelling as a high hazard sample.

**Marking** - Applying the descriptive name, instructions, cautions, weight, or specification marks or combination thereof required to be placed outside containers of hazardous materials.

**Packaging** - The assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements of 49 CFR 172, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank car tanks.

**Placard** - Color-coded, pictorial sign depicting the hazard class symbol and name to be placed on all four sides of a vehicle transporting certain hazardous materials.

**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.

## 9.0 ATTACHMENTS

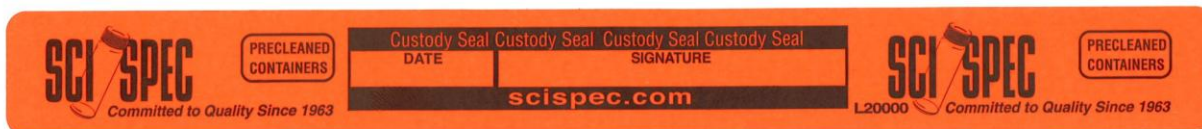
1 – Example Chain of Custody Form

2 – Example Custody Seal

## Attachment 1-Example Chain of Custody Form

[illegible]

## Attachment 2 – Example Custody Seal



## Example Custody Seal

Earth Resources Technology, Inc. Standard Operating Procedure <b>GROUNDWATER LEVEL MEASUREMENT</b>			
Effective Date: <b>01/22/09</b>		Version: <b>001</b>	
SOP#: <b>ERT SOP-07-2</b>			
Approvals			
<div style="background-color: black; width: 100px; height: 15px; margin-bottom: 5px;"></div> Program Manager		<div style="background-color: black; width: 100px; height: 15px; margin-bottom: 5px;"></div> C.P.G. Field QA Manager	
<div style="background-color: black; width: 150px; height: 30px; margin-bottom: 5px;"></div> Date		<div style="background-color: black; width: 150px; height: 30px; margin-bottom: 5px;"></div> Signature	
1/22/09		1/22/09	

## 1.0 PURPOSE

The purpose of this procedure is to provide general reference information and technical guidance on the measurement of static groundwater.

## 2.0 SCOPE

This procedure gives overall technical guidance for obtaining groundwater level measurements in monitoring wells frequently conducted in conjunction with groundwater sampling events.

## 3.0 REQUIREMENTS

Groundwater level measurements can be made in monitoring wells, private or public water wells, peizometers, open boreholes, or test pits (after stabilization). Groundwater measurements will not be made in boreholes with drilling rods or auger flights present, as applicable. If a groundwater elevation measurements must be take while objects are present, the value is assumed to be an estimated groundwater level. If groundwater sampling activities are to occur, groundwater level measurements will be conducted prior to well purging or sampling.

## 4.0 RESPONSIBILITIES

### 4.1 Field Team Leader

The Field Team Leader is responsible for obtaining valid groundwater level measurements in accordance with this procedure. All collected data will be reviewed by the Field Team Leader for accuracy and transferred to the Project Manger for inclusion in the project file.

### 4.2 Field Team

The Field Team is responsible for obtaining valid groundwater level measurements in accordance with this procedure and will be properly trained in the use of necessary equipment. The Field Team is responsible for conducting groundwater level measurements in accordance with the project-specific requirements in the Sampling and Analysis Plan (SAP).

## 5.0 EQUIPMENT

The equipment used to gauge groundwater level may include the following:

- Electronic Water Level Indicator (graduated to 0.01 feet)
- Interface probe (graduated to 0.01 feet)
- Portable Photoionization Detector (PID)
- Deionized Water and phosphate-free soap for decontamination of the Water Level Indicator and/or Interface Probe
- Field Logbook

## 6.0 PROCEDURE

- Initial monitoring of the well headspace and breathing zone concentrations using a PID shall be evaluated by field personnel to determine required levels of protection.
- All groundwater level measurements shall be made to the nearest 0.01 foot, and recorded in the Field Logbook.
- A clearly-established reference point of known altitude, which is normally identified by a mark along the upper edge of the inner well casing or a small notched cut into the well casing, will be used as the dedicated measuring point for gauging groundwater levels. If a survey mark is absent, field personnel will determine to the best of their ability the highest point on the casing and make an indelible mark with a permanent marker or create a distinguishable notch in the well casing for future gauging activities. The absence of the mark and associated corrective action will be reported to the Project Manager and recorded in the Field Logbook.
- Soon after a monitoring or groundwater observation well has been installed and the groundwater level has stabilized, the date and time of the gauging, the initial depth-to-water and total depth of the well will be measured and recorded in the field logbook.
- Cascading water within a borehole can cause false readings. Non-aqueous phase liquid layers may also cause problems in determining the true water level in a well by artificially depressing the true potentiometric surface of the groundwater.
- All groundwater level measurements collected from a site should be obtained in the shortest possible time in order to minimize variations in groundwater elevations caused by external forces (i.e. tidal influences, precipitation events).

### 6.1 Water Level Measuring Techniques

Water level measurements will follow this sequence:

1. Check the operation of recording equipment above ground. This can be accomplished by filling a container with water and slowly lowering the probe into the water. If the probe recognizes the water interface, the measurements from the monitoring well can be assumed to be accurate.
2. All groundwater level measurement devices will be decontaminated in accordance with ERT SOP-03-1 prior to and after use at each location to prevent cross-contamination between monitoring wells.
3. Slowly lower the water level indicator into the well until static water is encountered. Once encountered raise the indicator out of the water and slowly reestablish contact with the groundwater surface. Repeat this process as necessary in order to accurately record the groundwater depth to within 0.01 feet.

Record all information specified below in a Field Logbook:

- If non-aqueous phase liquids (both LNAPL and DNAPL) are suspected to be present an interface probe will be used to determine the presence and thickness of any measurable layers. Measurements will be recorded to the nearest 0.01 foot.
- If NAPL is not anticipated, an electronic water level meter can be used to measure the groundwater level and will be recorded to the nearest 0.01 foot.

- Record date and time, well number, depth to water, depth to non-aqueous phase liquids (if present), total depth, well diameter, and volume of standing water column in the well in the field logbook. Recording this data in a table format facilitates easier evaluation and transference of data from the Field Logbook.

## **6.2 Water Level Measuring Devices**

### **6.2.1 Electronic Water Level Indicators**

These devices consist of a spool of flat plastic tape with encased electrical wires connected to a contact probe at the end. When the probe comes in contact with the water, an electrical circuit is closed and a light, and/or buzzer attached to the spool will signal the contact. In conditions where there is oil on the water, ground water with high specific conductance, water cascading into the well, or turbulent water surface in the well, measuring with an electric sounder may be difficult.

For accurate readings, the probe shall be lowered slowly into the well. The electric tape is graduated on the tape surface to 0.01 feet. Once the device signals the depth to water the tape should be moved to the side of the casing where the permanent measurement point is marked on the well casing. The measurement is then read and recorded in the Field Logbook.

### **6.2.2 Interface Probe**

Interface probes work similar to electronic water level meters except that there are an additional set of electrical contacts on the tip of the contact probe. The conductivity of non-aqueous-phase liquids, such as petroleum products, differs from ground water. The interface probe is sensitive to the conductivity difference and when the probe contacts non-aqueous phase liquids the probe emits a unique audible alert indicating the presence of such a liquid. The tape is graduated to 0.01 feet.

## **7.0 REFERENCES**

The following documents were utilized in the creation of this Standard Operating Procedure:

Fetter, C.W., 1988 *Applied Hydrogeology* Prentice Hall, Inc., Upper Saddle River, New Jersey.

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

United States Environmental Protection Agency (USEPA), 2007. *Field Branches Quality System and Technical Procedures*. Region 4 Science and Ecosystem Support Division. SESDPROC-105-R1.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York

## **8.0 DEFINITIONS**

**Artesian Conditions** - A common condition in a confined aquifer in which the water level in a well completed within the aquifer rises above the top of the aquifer.

**Confined Aquifer** - An aquifer confined between two low permeability layers (aquitards).

**Equipotential Line** - A contour line on the potentiometric surface or water table showing uniform hydraulic head levels. Equipotential lines on the water table are also called water table contour lines.

**Flow Line** - A line indicating the direction of groundwater movement within the saturated zone. Flow lines are drawn perpendicular to equipotential lines.

**Flow Net** - A diagram of groundwater flow, showing flow lines and equipotential lines.

**Piezometric Head** - The height to which water will rise in a cased well.

**Potentiometric Surface** - A surface which is defined by the levels to which water will rise in cased wells which are screened in a specified zone of an unconfined aquifer or in a confined aquifer.





**Unconfined (water table) Aquifer** - An aquifer in which the water table forms the upper boundary.

**Water Table** - A surface in an aquifer where groundwater pressure is equal to atmospheric pressure and below which all strata are saturated with water.

## 9.0 ATTACHMENTS

None



Earth Resources Technology, Inc. Standard Operating Procedure <b>BOREHOLE LOGGING</b>			
Effective Date: <b>01/22/09</b>		Version: <b>001</b>	
SOP#: <b>ERT SOP-07-3</b>			
Approvals			
 Program Manager		 , C.P.G. Field QA Manager	
 Signature		 Signature	
1/23/09 Date		1/22/09 Date	

## 1.0 PURPOSE

The purpose of this procedure is to define the minimum requirements for field logging of boreholes and environmental samples. Consequently, the major objectives of this plan are to provide a uniform set of guidelines that will aid in developing consistency among media descriptions and sample techniques. The importance of accurate, complete, clear and concise logs cannot be overemphasized.

## 2.0 SCOPE

This procedure applies to descriptions of the standard techniques used for logging boreholes and logging soil/rock samples.

## 3.0 REQUIREMENTS

Careful field documentation and sample description is necessary to ensure that logging is done in a consistent manner.

## 4.0 RESPONSIBILITIES

### 4.1 Project Manager

The Project Manager is responsible for ensuring that field personnel have been trained in the use of this procedure ensuring consistency in logging methodology between Field Personnel and compiling the boring logs for inclusion into a field report.

### 4.2 Field Team Leader

The Field Manager/Field Team Leader is responsible for ensuring that borehole logging methods detailed in this procedure are followed and that consistency between descriptive nomenclatures from various logs for a site are accurate. The Field team Leader is responsible for reviewing logs for completeness and accuracy.

### 4.3 Field Team

The Field Team is responsible for accurately recording (logging) pertinent information regarding geologic materials encountered during the boring operations.

## 5.0 EQUIPMENT

The following is a list of required and optional equipment necessary for borehole logging.

### 5.1 Required Equipment

1. Clipboard
2. Soil Boring Forms (Attachment 4)
3. Photoionization Detector (PID) with calibration gas
4. Field Logbook
5. Folding Rule or Tape Measure (calibrated to 0.01 foot)

6. Color Chart
7. Water Level Indicator
8. Copy of Drilling Contract
9. Waterproof Permanent Marking Pen
10. Sample Jars or Bags

## **5.2 Optional Equipment**

1. Hand Lens X10
2. Brunton Compass
3. Pocket Penetrometer
4. Equipment Pouch
5. Flagging Tape
6. Cooler and Water Bottles
7. Flashlight
8. Rock Hammer
9. Acid Bottle
10. Digital Camera

## **6.0 PROCEDURE**

### **6.1 Recording Data**

Borehole information that is required for inclusion in the Field Logbook is detailed in ERT SOP-01-2. In addition to information recorded in the Field Logbook, it is required that soil logging data be recorded on a pre-printed boring-specific log (Attachment 4). This activity is done to provide a clear and concise record of borehole lithology.

### **6.2 Information to be Gathered During Borehole Logging**

Frequency and detail of borehole logging will be detailed in the Sample and Analysis Plan. When conducting discreet sampling, the first recorded data for each sample should be the recovery of soil from the core of split spoon. Recovery will be recorded in inches using a tape measure. When measuring recover, attention must be made to disregard “sluff” that typically precedes the actually sample volume. Secondly, a photoionization detector (PID) reading should be taken from a minimum of three locations long the core sample and recorded in the field logbook. Finally, a description of the geologic unit(s) should be detailed including moisture, constituents, odor, color, and other such descriptors. Careful attention to detail should be made in regards to changes in homogeneity of a sample. Features potentially related to impacts should also be noted such as odor, staining and PID readings. The description of lithologic samples should include color, material description, moisture content, and consistency of the sample or unit. These characteristics should be described according to guidelines given in the attachments. Soil sampling will be performed in accordance with ERT SOP-06-3 and the sampling intervals noted on the log form. Samples screened with a PID are to have the concentrations noted in the appropriate section of the log form, corresponding to the sample interval.

### **6.3 Logging Guidelines**

For accuracy and consistency, boring log descriptions should generally be completed in the following order. Refer to the listed attachments for guidance.

1. Color. Color should be described using a Munsell color chart, and the colors listed in the chart only. If the colors in the sample are variable, adjectives such as "mottled" or

"banded" may be used as appropriate (See Attachment 2). In the written description, the color should be given first with the first letter capitalize.

2. Material Description. Material description is the written description of the material being sampled or observed. In the written description the color (capitalized) is followed by the soil components from most prevalent (capitalized) to least. Refer to Attachment 2 for guidance on soil description procedures.

For example – Brown coarse to fine sand, little Clayey Silt, some (-) medium to fine (+) Gravel.

3. Description of mineralogy may be included in the material description and should be as simple as possible and, above all, accurate. Relatively common mineralogic descriptions may be used as adjectives:
  - Arkosic
  - Calcareous
  - Feldspathic
  - Glauconitic
  - Micaceous
4. Moisture Content. If the drilling method permits, the moisture content of the sample (moist, damp or wet) should be noted. Refer to the attachments for guidance.
5. Consistency. Consistency is the density or strength of the soil. See Attachment 3.
6. USCS Classification. See Attachment 1.

## **7.0 REFERENCES**

The following documents were utilized in the creation of this Standard Operation Procedure:

Compton, R. R., 1985. *Manual of Field Geology*, John Wiley and Sons, Inc., New York.

Folk, R. L., 1968. *Petrology of Sedimentary Rocks*, Hemphills Bookstore, Austin, Texas, **p. 170**.

Lewis, D. W., 1984. *Practical Sedimentology*, Van Nostrand Reinhold Company, Inc., New York, New York.

Pettijohn, F. J., 1975. *Sedimentary Rocks*, Harper & Row, New York.

Sanders, L. L., 1998. *Manual of Field Hydrogeology*, Prentice Hall, Inc., Upper Saddle River, New Jersey.

Weight, W. D., Sonderegger, J. L., 2001. *Manual of Applied Field Hydrogeology*, McGraw-Hill, New York

## 8.0 DEFINITIONS

This section provides information that is commonly used in borehole sample descriptions (also see Section 9.0 Attachments).

**Bedding** - Existence of beds or layers (strata), laminae, or other tabular and essentially horizontal units.

**Cohesive** - Having the capacity to stick together or adhere together. In effect, the cohesion of soil is that part of its shear strength which does not depend on interparticle friction.

**Color** - Described using a Munsell color chart, and only colors listed in that chart should be used. If the colors in the sample are variable, adjectives such as "mottled" or "banded" may be used as appropriate.

**Conchoidal** - Shell-like surface form produced by fracture of a brittle material.

**Consistency** - Density or strength of the soil, and is a primary factor in engineering investigations (see Attachment 9.3).

**Fabric** - Orientation of the particles composing a soil or rock.

**Friable** - Easily crumbled.

**Grading** - Degree of mixing size classes in a sedimentary material. Well graded implies uniform distribution from coarse to fine; poorly graded implies lack of uniformity in size or lack of continuous distribution (also see sorting).

**Grain Size** - Size of particles within a rock or a soil sample (see Attachment 2).

**Moisture** - Degree of wetness of a soil, i.e. moist, damp and wet.

**Plasticity** - Property of a material which enables it to undergo permanent deformation without appreciable volume change or elastic rebound, and without rupture.

**Slickensides** - Polished and striated (scratched) surface that results from friction along a fault plane. Apparent slickensides can sometimes be created during the drilling process.

**Soil Classification** - See Attachment 1.

**Texture** - Geometric aspects of the component particles of a soil or rock, including size, shape, and arrangement.

## 9.0 ATTACHMENTS

- 1 USCS Classification
- 2 Definition of Soil Components
- 3 Field Observations for Determining Soil Consistency
- 4 Boring Log Forms

## Attachment 1

### USCS Classification

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAIN SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO.200 SIEVE SIZE	GRAVEL AND GRAVELY SOILS MORE THAN 50% OF COARSE RETAINED IN NO.4 SIEVE	CLEAN GRAVELS LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS, GRAVEL SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES APPRECIABLE AMOUNT OF FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO.4 SIEVE	CLEAN SAND LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES APPRECIABLE AMOUNT OF FINES	SM	SILTY-SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO.200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC			PT	PEATS, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

## Attachment 2

### Definition of Soil Components

GRANULAR MATERIAL	SIZE DESCRIPTION	SIZE	GRANULAR MATERIAL	SMALLEST DIAMETER OF ROLLED THREADS
BOULDERS		> 23 cm (9 in)	Silt	none
COBBLES		7.6 cm (3 in) - 23cm (9 in)	Clayey SILT	6 mm (1/4 in)
GRAVEL	COARSE	25 mm (1 in) - 76 mm (3 in)	SILT and CLAY	3mm (1/8 in)
	MEDIUM	9.5 mm (0.375 in) - 25 mm (1 in)	CLAY and SILT	1.5 mm (1/16 in)
	FINE	2 mm (0.08 in) - 9.5 mm (0.375 in)	Silty Clay	0.8 mm (1/32 in)
SAND	COARSE	0.59 mm - 2 mm	CLAY	0.4 mm (1/64 in)
	MEDIUM	0.25 mm - 0.59 mm		
	FINE	0.074 mm - 0.25 mm		

### Attachment 3

#### Field Observations for Determining Soil Consistency

##### Clay

Clay Consistency	Thumb Penetration	Average SPT N Blows/ft over 6-18" interval of 24" split spoon
<b>VERY SOFT</b>	Easily penetrated several inches by thumb. Exudes between thumb and fingers when squeezed in hand.	< 2
<b>SOFT</b>	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 – 4
<b>MEDIUM STIFF</b>	Can be penetrated over ¼ inch by thumb with moderate effort. Molded by strong finger pressure.	4 – 8
<b>STIFF</b>	Indented about ¼ inch by thumb but penetrated only with great effort.	8 – 15
<b>VERY STIFF</b>	Readily indented by thumbnail	15 – 30
<b>HARD</b>	Indented with difficulty by thumbnail.	> 30

##### Sand

SOIL TYPE	Average SPT N Blows/ft over 6-18" interval of 24" split spoon	RELATIVE DENSITY %	FIELD TEST
<b>VERY LOOSE SAND</b>	4	0 - 15	Easily penetrated with ½" reinforcing rod pushed by hand.
<b>LOOSE SAND</b>	4 – 10	15 – 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
<b>MEDIUM DENSE SAND</b>	10 – 30	35 – 65	Penetrated a foot with ½" reinforcing rod driven by 5-lb hammer.
<b>DENSE SAND</b>	30 – 50	65 – 85	Penetrated a foot with ½" reinforcing rod driven by 5-lb hammer.
<b>VERY DENSE SAND</b>	<50	85 - 100	Penetrated only a few inches with ½" reinforcing rod driven by 5-lb hammer.



## **Attachment 4**


### **Boring Log Forms**

*NOTE: Earth Resources Technology currently utilizes two different formats of boring log forms. The determination as to which form will be utilized is based on the clientele of the contract being executed.*

*ERT Form 5056 is modeled after the United States Corp of Engineers ENG Form 5056-R and ENG Form 5056A-R and is used when operating under USACE contract.*

HTRW DRILLING LOG				DISTRICT		HOLE NUMBER	
1. COMPANY NAME			2. DRILLING CONTRACTOR			SHEET      SHEETS OF	
3. PROJECT				4. LOCATION			
5. NAME OF DRILLER				6. MANUFACTURE DESIGNATION OF DRILL			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT			8. HOLE LOCATION				
			9. SURFACE LOCATION				
			10. DATE SAMPLED		11. DATE COMPLETED		
12. OVERBURDEN THICKNESS			13. DEPTH GROUND WATER ENCOUNTERED				
13. DEPTH DRILLED INTO ROCK			14. DEPTH TO WATER AND ELAPSED TIME SINCE DRILLING COMPLETED				
14. TOTAL DEPTH OF HOLE			15. OTHER WATER LEVEL MEASUREMENTS SPECIFY				
16. GEOTECHNICAL SAMPLES		DISTURBED		UNDISTURBED		18. TOTAL NUMBER OF CORE BORES	
20. SAMPLES FOR CHEM ANAL		VOC		METALS		OTHERS (SPECIFY)	
						21. TOTAL CORE RECOVERY	
22. DISPOSITION OF HOLE		BACKFILLED		MONITORING WELL		OTHERS (SPECIFY)	
						23. GECLOGIST	
LOCATION SKETCH / COMMENTS							
SCALE:							
PROJECT						HOLE NO.	

ERT FORM 5056-R

HTRW DRILLING LOG (CONTINUATION SHEET)							WELL NUMBER
PROJECT			WELL LOGIST			SHEET OF SHEETS	
BLE (FT)	DEPTH	DESCRIPTION OF MATERIAL	FIELD SCREENING RESULTS	EXOTIC SAMPLE	ANALYTICAL SAMPLE	BLOW COUNT	REMARKS
							
PROJECT						WELL NO.	

ERT FORM 5056A-R

**For Non-USACE clientele ERT utilizes *ERT Well Logging Form V4*.**

11

**APPENDIX C**  
**Equipment Operating Manuals**

# MiniRAE 2000

## Portable VOC Monitor PGM-7600



## OPERATION AND MAINTENANCE MANUAL


(Document No.: 011-4001-000)

Revision E, May 2005



## **ATTENTION!**

### **For European Applications**

- A. C€ 0575  II 1G/2G  
DEMKO 03 ATEX 0204759X  
Eex ia IIC T4**
- B. Recharge batteries only in non-hazardous locations.**
- C. Do not connect external cable to serial interface jack in hazardous locations.**
- D. Use RAE Systems Adapter P/N 500-0072 for connection to communication port and charging jack only in a non-hazardous area.**



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## **WARNING**



**- Do NOT proceed before reading -**

**This manual must be carefully read by all individuals who have or will have the responsibility for using, maintaining, or servicing this product.**

The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

### **CAUTION!!**

**To reduce the risk of electric shock, turn off power before removing the monitor cover. Disconnect the battery before removing sensor module for service. Never operate the monitor while the cover is removed. Remove monitor cover and sensor module only in an area known to be non-hazardous.**

**The model PGM-7600 equipment is classified as to intrinsic safety for use in class I, division 1, groups A, B, C, D, or non-hazardous locations only.**

# Special Notes

-1-

**When the MiniRAE 2000 Monitor is taken out from the transport case and turned on for the first time, there may be some residual organic or inorganic vapor trapped inside the detector chamber. The initial PID sensor reading may indicate a few ppm. Enter an area known to be free of any organic vapor and turn on the monitor. After running for several minutes, the residual vapor in the detector chamber will be cleared and the reading should return to zero.**

-2-

**The battery of the MiniRAE 2000 monitor will discharge slowly even if it is turned off. If the monitor has not been charged for 5-7 days, the battery voltage will be low. Therefore, it is a good practice to always charge the monitor before using it. It is also recommended to fully charge the monitor FOR AT LEAST 10 HOURS before first use. See Section 7 for more information on battery charging and replacement.**

## **WARNINGS**

**STATIC HAZARD:** Clean only with damp cloth.

**For safety reasons this equipment must be operated and serviced by qualified personnel only. Read and understand instruction manual completely before operating or servicing.**

**Use only RAE Systems battery packs, part nos. 012-3050, 012-3051 or 012-3052. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous locations.**

**The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service.**

**For maximum safety, the accuracy of the MiniRAE 2000 should be checked by exposing it to a known concentration calibration gas before each day's use.**

## **AVERTISSEMENTS**

**DANGER RISQUE D'ORIGINE ELECTROSTATIQUE:**  
**Nettoyer uniquement avec un chiffon humide.**

**Pour des raisons de sécurité, cet équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.**

**Utiliser seulement l'ensemble de batterie RAE Systems, la référence 012-3050, 012-3051 au 012-3052. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsèque. Ne charger les batteries que dans emplacements désignés non-dangereuse.**

**La calibration de tous les instruments de RAE Systems doit être testée en exposant l'instrument à une concentration de gaz connue par une procédure d'étalonnage avant de mettre en service l'instrument pour la première fois.**

**Pour une sécurité maximale, la sensibilité du MiniRAE 2000 doit être vérifiée en exposant l'instrument à une concentration de gaz connue par une procédure d'étalonnage avant chaque utilisation journalière.**

## 1. GENERAL INFORMATION

**MiniRAE 2000** Portable VOC Monitor (Model PGM 7600) is a compact monitor designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It monitors Volatile Organic Compounds (VOC) using a Photo-Ionization Detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas discharge lamp. Features are:

- **Lightweight and Compact**
  - Compact, light weight (19 oz.) and rugged design
  - Built-in sample draw pump
- **Dependable and Accurate**
  - Up to 10 hours of continuous monitoring with rechargeable battery pack
  - Designed to continuously monitor VOC vapor at ppm levels
- **User Friendly**
  - Preset alarm thresholds for STEL, TWA, low and high level peak values. Audio buzzer and flashing LED display are activated when the limits are exceeded.
- **Datalogging Capabilities**
  - 15,000 point datalogging storage capacity for data download to PC

**MiniRAE 2000** consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged ABS + PC case with a backlit 1 line by 8 character dot matrix LCD and 3 keys to provide easy user interface.




## 1.1 General Specifications

Table 1.1

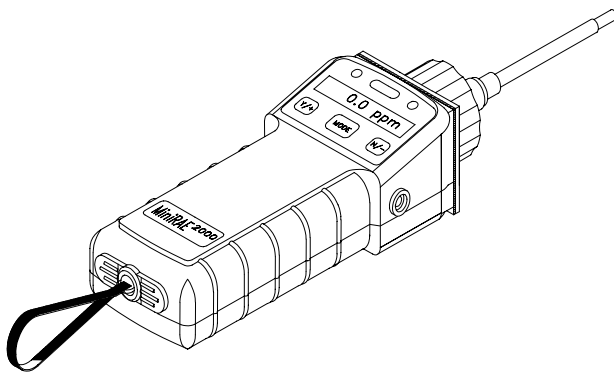
<b>Portable VOC Monitor Specification</b>	
Size:	8.2"L x 3.0"W x 2.0"H
Weight:	19.5 oz with battery pack
Detector:	Photo-ionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 4.8V /1250 mAH Rechargeable Nickel Metal Hydride battery pack (snap in, field replaceable)
Battery Charging:	10 hours charge through built-in charger
Operating Hours:	Up to 10 hours continuous operation
Display:	1 line by 8 characters 5x7 dot matrix LCD (0.4" character height) with LED back light automatically in dim light
Range, Resolution & Response time ( $t_{90}$ ):	
Isobutylene (calibration gas)	
	0-99 ppm                      0.1 ppm 2 sec
	100-1,999 ppm 1.0 ppm    2 sec
	2000-10,000 ppm 1.0 ppm 2 sec
Measurement Accuracy (Isobutylene):	
	0 – 2000 ppm: $\pm 2$ ppm or 10% of reading.
	> 2000 ppm: $\pm 20\%$ of reading
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Built-in 102 VOC gases
Calibration:	Two-point field calibration of zero and standard reference gas
Calibration Memory:	
	Store up to 8 separate calibration, alarm limits and span value
Inlet Probe:	Flexible 5" tubing
Keypad:	1 operation key and 2 programming keys

## GENERAL INFORMATION

Direct Readout:	Instantaneous, average, STEL and peak value, battery voltage and elapsed time
Intrinsic Safety:	UL & cUL Class 1, Division I, Group A,B,C,D, Temperature Code T3C (US & Canada); <b>CE</b> 0575  II 1G DEMKO 02 ATEX 0204759 Eex ia IIC T4 (Europe)
EM Interference:	No effect when exposed to 0.43 W/cm <sup>2</sup> RF interference (5 watt transmitter at 12 inches)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Survey or Hygiene mode
Alarm:	90 dB buzzer and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure.
External Alarm:	Optional plug-in pen-size vibration alarm or remote alarm
Alarm Mode:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on data logged information
Datalogging:	15,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC through RS-232 port
Sampling Pump:	Internally integrated. Flow rate: 450-550 cc/min.
Temperature:	0° to 45°C (32° to 113°F)
Humidity:	0 % to 95 % relative humidity (non-condensing)
Housing:	ABS + PC, conductive coating, splash and dust proof, will withstand 1 meter drop test with rubber boot
Attachment:	Wrist strap, rubber boot and belt clip

## 2. OPERATION OF MINIRAE 2000

The MiniRAE 2000 Portable VOC Monitor is a compact Monitor designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It gives real time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment the MiniRAE 2000 is preset with default alarm limits and the sensor is pre-calibrated with standard calibration gas. However, the user should test the instrument and verify the calibration before the first use. After the monitor is fully charged and calibrated, it is ready for immediate operation.



**Figure 2-1 MiniRAE 2000**

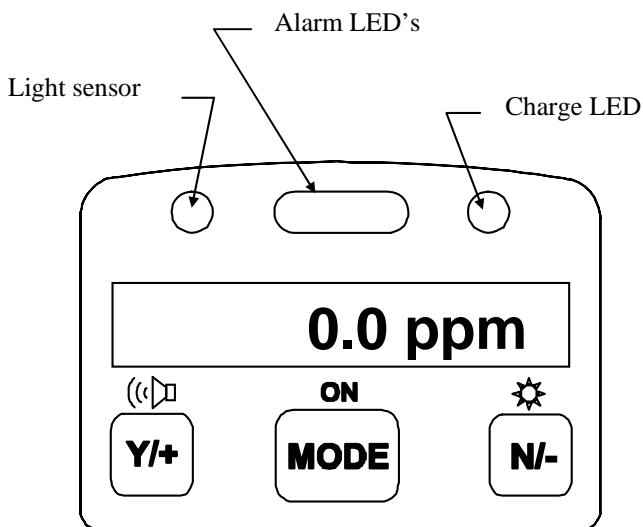
## **2.1 Physical Description**

The main components of the MiniRAE 2000 Portable VOC monitor include:

- Three keys for user to interact with the monitor: 1 operation key and 2 programming keys for normal operation or programming of the monitor
- LCD display with back light for direct readout and calculated measurements
- Buzzer and red LED's for alarm signaling whenever the exposures exceed preset limits
- Wrist strap
- Charge contact for plugging directly to the charging station
- Gas entry and exit ports
- Serial communication port for PC interface
- External alarm and analog output port
- Protective rubber cover

## 2.2 Keys and Display

Figure 2.2 shows the LCD display and the keypad on the front panel of the monitor. The function of the 3 keys during normal operation are summarized below:



**Figure 2-2 LCD Display and Keypad**

### Key Function in Normal Operation

**[MODE]** -Turn on/off the power\* and step through menu items

**[N/-]** -Toggle on/off the back light, negative acknowledge, decrease value

**[Y/+]** -Start measurement, positive acknowledge, increase value

\* Pressing and holding **[MODE]** key for 5 seconds turns off the power to the monitor. Monitor will beep once per second and display countdown timer during power-down sequence. Press **[MODE]** key momentarily to step through menu items. To save time, press any key during message scrolling to skip to the end of the message.

## 2.3 Power On/Off

**To turn on** the MiniRAE 2000 portable VOC monitor, press [MODE] key for one second and release. The audio buzzer will beep once and the air pump will turn on. The display will show “ON!..” and then “Ver n.nn” to indicate the unit’s current firmware version number. Next displayed are the serial number, the model number, Operating mode, current date and time, unit internal temperature, gas selected, high low, STEL, TWA/AVG alarm limits, battery voltage, and shut off voltage. Also displayed are internal mode settings such as User mode, Alarm mode, datalog time remaining and log periods in the respective order.

**To turn off** the MiniRAE 2000 portable VOC monitor, press and hold the [MODE] key for 5 seconds. The monitor will beep once per second during the power-down sequence with a count down timer showing the number of remaining seconds. The message “Off!..” flashes on the LCD display and the display will go blank indicating that the monitor is turned off.

### **Data protection during power off**

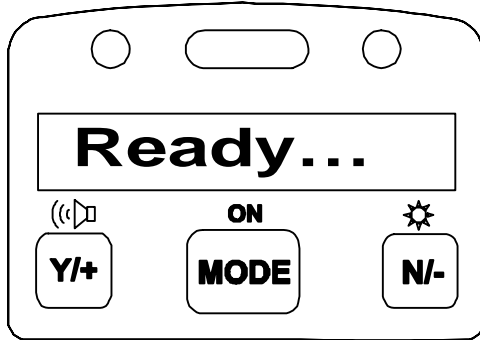
When the monitor is turned off, all the current real time data including last measured value are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost. While the power is off, the real time clock will continue to operate until the battery is completely drained (usually in 4-5 days without any charging). If the battery is completely drained or is disconnected from the monitor for more than 30 minutes, the real time clock will be lost. In this case, the user needs to enter the real time clock information again, as described in Section 4, or send the PC clock during configuration through the PC communication.

## 2.4 Operation

The **MiniRAE 2000** VOC monitor has two operation modes: **Survey** and **Hygiene** mode. The **Survey mode** allows the user to manually start and stop the monitoring/measuring operation and display certain exposure values. In the **Hygiene mode**, the monitor runs continuously after the monitor is turned on. Refer to Section 4.7.1 for switching between the two modes.

### 2.4.1 Survey Mode

After the monitor is turned on, it runs through the start up menu. Then the message “**Ready...**” is displayed (see figure below).



At this point, the user has two options:

1. Step through the Main Menu.
2. Take a measurement.

Press the [**MODE**] button to step through the Main Menu. Press the [**Y/+**] button to proceed to take a measurement.



### **The Main Menu**

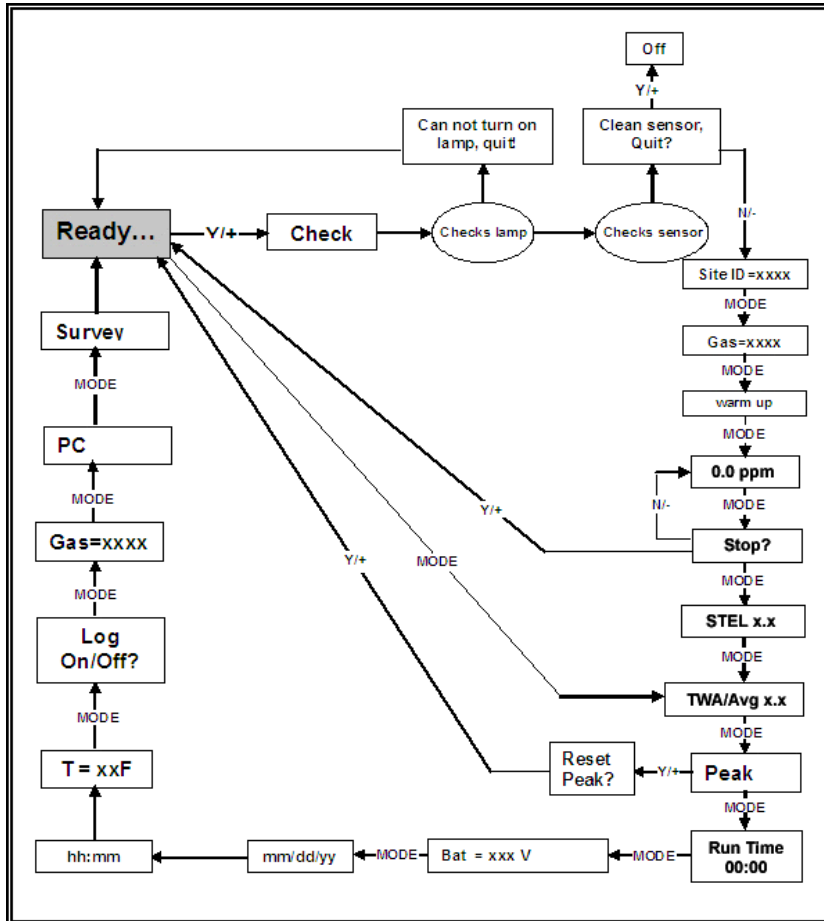
Press the **[MODE]** button to enter the Main Menu. Press the **[Y/+]**, **[MODE]** or **[N/-]** as indicated in the flow chart below to step through the Main Menu. The PID sensor and pump are turned off during this time.

The Main Menu functions are:

- **Ready...**
- **Check**
- **Site ID = xxxx**
- **Gas = xxxx**
- **Warm up**
- **X.x ppm**
- **Stop?**
- **TWA/Avg x.x ppm**
- **STEL x.x ppm**
- **Peak x.x ppm**
- **Run time hh:mm**
- **Bat = X.XV**
- **Mm/dd/yy**
- **hh:mm**
- **T = xxxF [date, time and temperature (°C or °F)]**
- **Log On/Off?**
- **PC Comm?**
- **Survey**

These functions are arranged in a “round robin” order. To select a specific function, press the button as shown below until the desired function appears.

## Main Menu



### **The Main Menu Functions**

- **Ready...:** Indicates that the monitor is ready to take a measurement or to step through the Main Menu. Press the [Y/+] button to advance to taking a measurement (read “Taking a Measurement” on Page 2-12 for details).

Note: The **Ready...** screen is skipped if the menu is cycled through while a measurement is running.

- **Check...:** This message displays while the system is checking the lamp and the sensor. If the lamp test succeeds, the system will progress to checking the sensor. If the lamp test does not succeed, the display will read **Can not turn on lamp, quit!**

- **Can not turn on lamp, quit!:** This message displays when the lamp does not turn on. The system will automatically return to **Ready...** allowing the user to test the lamp again. If the lamp fails a second time, turn the monitor off and refer to Section 7.2 “**PID Sensor & Lamp Cleaning / Replacement**”.

- **Clean Sensor, Quit?:** This message displays when the sensor requires cleaning. Press the [Y/+] button to turn the monitor off and clean the sensor. Press the [N/-] button and the system will progress to the **Site ID = xx**

- **Site ID = xxxx:** This display shows the Site ID and indicates that the monitor is about to start taking measurements (read “Taking a Measurement” for details)

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **Gas = xxxx:** This display identifies the gas to be measured and indicates that the monitor is about to take a measurement (read “Taking a Measurement” for details)

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **x.x ppm:** (read “Taking a Measurement” for details)

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **TWA/Avg:** Displays (in ppm) the Time Weighted Average (TWA) or the Average since the start of the measurement. The average is recalculated every minute.
- **STEL:** Displays the Short Term Exposure Limit.
- **PEAK:** Displays (in ppm) the highest instantaneous reading since the start of the measurement. If [Y/+] is pressed while the peak reading is displayed, the unit will ask **Reset Peak?**. If [Y/+] is pressed again, the peak value will be cleared and the display will return to the **Ready...** message or instantaneous reading. The peak reading is automatically reset when a new measurement is started by pressing [Y/+] from the **Ready...** screen.
- **Run time hh:mm:** The duration of the current measurement period.
- **Bat = X.XV:** The current battery voltage.

Note: A fully charged battery pack should show 4.8 volts or higher. When the battery voltage falls below 4.4 volts, a flashing “**Bat**” will appear as a warning message. At that point, you have 20-30 minutes of run time remaining. When the battery voltage falls below 4.2 volts the monitor turns off automatically.

- **Mm/dd/yy:** The current date.
- **hh:mm:** The current time (24-hour format)

- **T = xxxF:** The internal unit temperature in degrees Fahrenheit. (see Section 4.7.13 to change temperature units)
- **Log on/Off?:** Allows the user to start datalogging of the current measurement. A superscript “L” flashes in the ppm measurement display when datalogging is on. This screen is not shown when datalogging is disabled or when the monitor is not operating in manual start/stop mode.
- **PC Comm?:** This function enables the user to upload data from the MiniRAE 2000 to a Personal Computer (PC) or send/receive configuration information between a PC and the MiniRAE 2000. Press [MODE] to return to **Ready...** .

To communicate with a PC, connect the monitor to the serial port of a PC and start the MiniRAE 2000 application software. Press the [Y/+] button and the LCD displays “**pause monitor, ok?**” Press the [Y/+] button one more time, and the display shows “**Comm...**” The monitor is now ready to receive commands from the PC.

- **Survey:** This function displays the Current Operating Mode (**Survey** or **Hygiene**).

### **Taking a Measurement**

There are two ways to start a measurement.

1. Operating in Hygiene mode.
2. Manually start and stop measurement in Survey mode.

To start a measurement in Hygiene mode, please refer to Section 4.7.1, “**Change Operation Mode**”. To start a measurement in Survey Mode, the MiniRAE 2000 monitor must first be in the “Ready...” mode. This is the mode to which the monitor normally powers up.

### **Measurement phases**

1. Ready
2. Start measurement
3. Measurement display and datalogging
4. Stop measurement

#### **Ready**

The display reads **Ready...** indicating the unit is ready to start a measurement.

#### **Start Measurement**

Press the [Y/+] button to start the check cycle (see above), and then the measurement cycle.

After completing the **Check** cycle, the display will show the **Site ID** and then the **Gas** selected for measurement. The pump will start and the reading will be displayed. The **Peak** and **Average** values will be automatically reset to zero.

#### **Measurement Display and Datalog**

Instantaneous readings of the gas concentration in parts per million (ppm) are updated every second. A flashing superscript **L** is displayed when datalogging is on. Datalog information is saved only after one full datalog period is completed.

### **Stop Measurement**

Press the **[MODE]** button and the display shows Stop? Press **[N/-]** to continue measurement and **[Y/+]** to stop the measurement and datalog event. The pump stops automatically when measurement is stopped. Peak and average values for the current measurement can be read in idle mode until a new measurement is started.

### **Automatic Increment of Site ID**

Every time a measurement is taken, the site ID will be incremented by one automatically in Survey mode.

### **Variable Alarm Signal**

In Survey Mode, if the measurement exceeds the low alarm limit, the buzzer and flashing alarm are activated and will beep/flash once per second. The alarms will increase in frequency as the gas concentration approaches the high alarm limit reaching 8 times per second when the high alarm has been exceeded.

Press **[Y/+]** key to clear if latching alarm.

## 2.4.2 Hygiene Mode

In Hygiene Mode, the unit will continuously taking measurements, once the power is turned on. After the initial start-up sequence displaying the current monitor settings, the LCD displays the instantaneous readings.

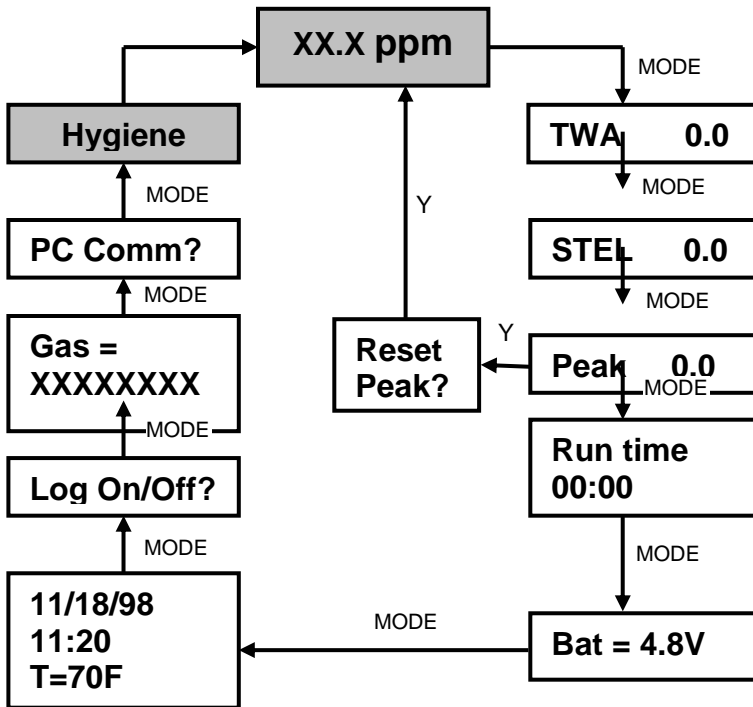
The Hygiene operation menu displays include:

- **Real time readings in ppm**
- **Current TWA/Avg, STEL and Peak values (see Section 4.6.6)**
- **Run time**
- **Current battery voltage**
- **Date, time and temperature**
- **Log on/off?**
- **Gas name**
- **PC communication?**
- **Hygiene**

Detailed description of most of these displays are the same as Section 2.4.1.



## HYGIENE MODE MAIN MENU



To choose a specific display, press the **[MODE]** key one or more times until the desired display appears, or the **[Y/+]** key where indicated with a Y.

**Note:** To get back to instantaneous reading from any of the above display, press **[MODE]** key repeatedly until the “XX.X ppm” display appears.

## **2.5 Alarm Signals**

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings: Low, High, TWA and STEL). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn the user of the alarm condition.

In addition, the MiniRAE 2000 will alarm if one of the following conditions occurs: battery voltage falls below a pre-set voltage level (4.4 V), failure of UV lamp, pump stall, or when the datalog memory is full. When the low battery alarm occurs, there will be approximately 20-30 minutes of operating time remaining. When the battery voltage falls below 4.2 V, the monitor will turn off automatically.

### Alarm Signal Summary:

Condition	Alarm Signal
Gas exceeds “High Alarm” limit	3 beeps/flashes per second
Gas exceeds “Low Alarm” limit	2 beeps/flashes per second
Gas exceeds “TWA” limit	1 Beeps/flashes per seconds
Gas exceeds “STEL” limit	1 Beeps/flashes per seconds
Pump failure	3 beeps/flashes per second plus “Pump” message on LCD
PID lamp failure	3 beeps/flashes per second plus “Lamp” message on LCD
Low battery	1 flash per second, 1 beep per minute plus “Bat” message on LCD
Memory full	1 flash per second plus “Mem” message on LCD

### Alarm Signal Testing:

Under normal non-alarm conditions, it is possible to test the MiniRAE 2000 LED and buzzer in Special Diagnostic Mode (see Section 8 for details).

## 2.6 Preset Alarm Limits and Calibration

The MiniRAE 2000 portable VOC monitor is factory calibrated with standard calibration gas, and is programmed with default alarm limits. There are 102 gas settings stored in the library. Some examples of calibration and alarm limits are shown below. Refer to Section 4 on programming procedures for selecting a different gas, perform a calibration or set new alarm limits.

### Factory Calibration and Preset Alarm Limits

Cal Gas	Cal Span	unit	Low	High	TWA	STEL
Isobutylene	100	ppm	50	100	100	250
Hexane, n-	100	ppm	500	750	500	750
Xylene, m-	100	ppm	100	150	100	150
Benzene	5	ppm	2	5	5	2
Styrene	50	ppm	20	40	20	40
Toluene	100	ppm	50	100	50	100
Vinyl Chloride	10	ppm	5	10	5	10
Custom	100	ppm	50	100	50	100

## **2.7 Integrated Sampling Pump**

The MiniRAE 2000 portable VOC monitor includes an integrated sampling pump. This is a diaphragm type pump that provides a 500-600 cc per minute flow rate. Connecting a Teflon or metal tubing with 1/8 inch inside diameter to the gas inlet port of the MiniRAE 2000, this pump can pull in air samples from 200 feet away horizontally, or 90 feet vertically, at about 3 feet per second flow speed.

The pump turns on when a measurement is started, and turns off when the sample is manually stopped in Survey mode or when the unit is turned off from Hygiene Mode.

If liquid or other objects are pulled into the inlet port filter, the monitor will detect the obstruction and shut down the pump immediately. The alarm will be activated and a flashing error message “Pump” will be also displayed on the LCD display.

The user should acknowledge the pump shut off condition by clearing the obstruction and pressing the [Y/+] key to re-start the pump.

The pump stall threshold is set in the special Diagnostic Mode (Section 8).

## 2.8 Back Light

The LCD display is equipped with an LED back light to assist in reading the display under poor lighting conditions. Pressing and holding the [N/-] key for one second in normal operation can turn on the backlight. The backlight can be turned off by pressing [N/-] a second time. If the [N/-] key is not pressed, the back light will be turned off automatically after a pre-programmed time-out period to save power.

In addition, the ambient light is sensed and the back light will be turned on automatically if the ambient light is below a threshold level. The back light is turned off automatically when the ambient light exceeds the threshold level.

See Section 8 for instructions on how to set the light threshold level.

**Note:** The LED backlight consumes about 20-30% of the total average current, when the instrument is idle or not taking a measurement.

## **2.9 Datalogging**

During datalogging, the MiniRAE 2000 Portable VOC monitor flashes a superscript “L”, on the display to indicate that datalogging is enabled. The monitor stores the time stamp, sample number, and measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information are stored: user ID, site ID, serial number, last calibration date, and alarm limits. All data are retained (even after the unit is turned off) in non-volatile memory so that it can be down loaded at a later time to a PC.

### **Datalogging event**

When Datalogging is enabled, measurement readings are being saved. These data are stored in “groups” or “events. A new event is created and stored each time the monitor is turned on, or a configuration parameter is changed, or datalogging is interrupted (e.g. Communication with PC during Hygiene mode). Information, such as start time, user ID, site ID, gas name, serial number, last calibration date, and alarm limits will be recorded.

### **Datalogging sample**

After an event is recorded, the unit records a shorter form of the data. This data contains: the sample number, time (hour/minute) and gas concentration.

### **3. OPERATION OF ACCESSORIES**

The accessories for the MiniRAE 2000 include:

- An AC Adapter (Battery Charger)
- Alkaline battery holder
- Water Trap Filter

Optional Accessories:

- Dilution Fitting
- Calibration adapter
- Calibration regulator and Flow controller
- Organic Vapor Zeroing kit



### 3.1 Standard Kit and Accessories

#### 1) AC Adapter (Battery Charger)

#### **WARNING**

**To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.**

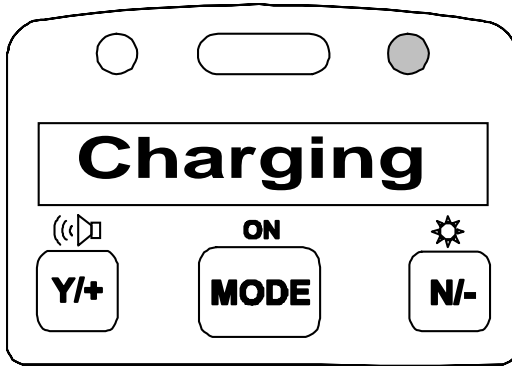
**Ne charger les batteries que dans emplacements designés non-dangereuses.**

A **battery charging circuit** is built into the MiniRAE 2000 monitor. It only needs a regular AC to 12 V DC adapter (wall mount transformer) to charge the monitor.

To charge the battery inside the MiniRAE 2000 monitor:

1. Power off the Monitor.
2. Connect the AC adapter (or the optional automotive charging adapter) to the DC jack on the MiniRAE 2000 monitor. If the unit was off, it will automatically turn on.
3. The first message displayed will be “Deep discharge?” The unit will ask this question for three times. If the user wants to discharge the battery pack, affirm this query with the [Y/+] key, otherwise the unit will move on to the charge mode directly.

4. While charging, the display message will alternate between “Charging” and “Bat=x.xV” (x.x is the present battery voltage). The LED should be red in color when charging.



5. When the battery is fully charged, the LED will change from red to green and the message “Fully charged” will appear on the display. After the battery is fully charged, the unit will enter the “trickle charge” mode. In which, the red LED will turn on for several seconds every minute, to maintain the full charge.

A completely discharged MiniRAE 2000 monitor will be charged to full capacity within 10 hours. The battery will be drained slowly even if the monitor is turned off. If the monitor has not been charged for 7-10 days, the battery voltage will be low.

The factory-supplied battery is designed to last for 10 hours of normal operation (no alarm, no back light condition), for a new battery under the best condition. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), the battery capacity will be reduced significantly.

### **2) Alkaline Battery Holder**

An alkaline battery holder is supplied with each MiniRAE 2000. It accepts four AA size alkaline batteries and can be used in place of the Ni-MH or Ni-Cd battery pack to provide approximately 12-14 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Ni-Cd or Ni-MH battery pack.

To install the adapter, remove the cover of the battery compartment. Remove the Ni-Cd or Ni-MH battery pack from the battery compartment and replace with the alkaline battery adapter. Replace the battery compartment cover.

The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the monitor.

**Note:** The AA Alkaline battery adapter supplied by RAE Systems Inc. is intrinsically safe!

### **3) Water Trap Filter**

The water trap filter is made of PTFE (Teflon<sup>®</sup>) membrane with a 0.45 micron pore size to prevent water from being sucked into the sensor manifold, which would cause extensive damage to the monitor. It will also remove any dust and other particles from entering the monitor and prolong the operating life of the sensor. To install the water trap, simply insert it to the front of the inlet tube of the MiniRAE 2000 monitor.

## 3.2 Optional Accessories

### 1) Dilution Fitting

The user may wish to install a dilution fitting on the inlet to dilute the gas samples. One application for a dilution fitting is to measure organic gas when the concentration exceeds the upper limit of the sensor range.

Make sure to set the dilution ratio in the programming mode (see Section 4.7.9) so that the correct gas reading will be displayed when the dilution fitting is used.

**WARNING: To use a dilution fitting, the user must have the monitor located in a clean atmosphere outside the confined space and use a remote access probe or Tygon tubing to measure the gas concentration inside the confined space.**

### 2) Calibration Adapter

The calibration adapter for the MiniRAE 2000 is a simple 6-inch Tygon tubing with a metal adapter on one end. During calibration, simply insert the metal adapter into the regular gas inlet probe of the MiniRAE 2000 and the tubing to the gas regulator on the gas bottle.

### **3) Calibration Regulator and Flow Controller**

The Calibration Regulator and Flow controller is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the MiniRAE 2000 monitor during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a Demand-flow Regulator or a Tedlar gas bag may be used to match the pump flow precisely.

### **4) Organic Vapor Zeroing kit (Charcoal filter)**

The Organic Vapor Zeroing Kit is used for filtering organic air contaminants that may affect the zero calibration reading. To use the Organic Vapor Zeroing Kit, simply connect the filter to the inlet port of the MiniRAE 2000.

## **4. PROGRAMMING OF MINIRAE 2000**

The MiniRAE 2000 Monitor is built with a microcomputer to provide programming flexibility. Authorized users can recalibrate the monitor, change the alarm limits, change site ID, user ID, lamp type, and real time clock, etc.

Programming is menu-driven to provide intuitive end-user operation. The display shows the menu options and the key pad used for menu selection and data entry.

## 4.1 Programming Mode

The programming mode allows the users to change the setups in the monitor, calibrate the monitor, modify the sensor configuration and enter user information, etc. The programming mode has four menu items. Each menu item includes several sub-menus to perform additional programming functions. Appendix A shows a more detailed menu tree structure.

### Programming Menu

Calibrate/Select Gas?

Change Alarm Limits?

Change Datalog?

Change Monitor Setup?

Once inside the programming mode, the LCD will display the first menu. Each subsequent menu item can be viewed by pressing the [N/-] repeatedly until the desired menu is displayed. To enter the sub-menu of a particular menu, press [Y/+] key, the sub-menu will be displayed.

**Return to Operation mode:** To exit the programming mode and return to operation, press the [MODE] key once at any of the programming menu displays.

## 4.2 Keys for Programming Mode

The three keys perform a different set of functions during the programming mode as summarized below.

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed momentarily or exit data entry mode when pressed and held for 1 second
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question
[N/-]:	Decrease alphanumerical value for data entry or deny (no) for a question



### 4.3 Entering into Programming Mode

1. Turn on the MiniRAE 2000 monitor and wait for the **“Ready..”** message or the instantaneous reading display **“0.0 ppm”** message displayed.
2. Press and hold down both **[N/-]** and **[MODE]** keys for three seconds to enter programming mode. This delay is to prevent the user from entering programming mode by accident.
3. The first menu item **“Calibrate/select Gas?”** will be displayed.
4. Release both **[MODE]** and **[N/-]** keys simultaneously to start the programming mode
5. Press **[N/-]** key to scroll to the next menu item of the programming menu. Press **[Y/+]** key to select the displayed menu item.

The following Sections 4.4 - 4.7 describe the details of each menu options.

## 4.4 Calibrate and Select Gas

### WARNINGS

**The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service for the first time.**

**For maximum safety, the accuracy of the MiniRAE 2000 should be checked by exposing it to known concentration calibration gas before each day's use.**

In the first menu of the programming mode, the user can perform functions such as calibration of the MiniRAE 2000 Monitor, select default cal memories, and modify cal memories (see Table 4.4).

Table 4.4

Calibrate/Select Gas Sub-Menu
Fresh Air Cal?
Span Cal?
Select Cal Memory?
Change Span Value?
Modify Cal Memory?
Change Correction Factor?

Calibrating the MiniRAE 2000 monitor is a two-point process using “fresh air “ and the standard reference gas (also known as span gas). First a “Fresh air” calibration, which contains no detectable VOC (0.0 ppm), is used to set the zero point for the sensor. Then a standard reference gas that contains a known concentration of a given gas is used to set the second point of reference.

**Note:** The span value must be set prior to calibrating for fresh air or span.

The user can store calibrations for up to 8 different measurement gases. The default gas selections are as follows:

- Cal Memory #0.....Isobutylene
- Cal Memory #1.....Hexane
- Cal Memory #2.....Xylene
- Cal Memory #3.....Benzene
- Cal Memory #4.....Styrene
- Cal Memory #5.....Toluene
- Cal Memory #6.....Vinyl Chloride
- Cal Memory #7.....Custom?

Memory #0 functions differently than the other 7 memories. For Memory #0, isobutylene is always the calibration gas. When the gas is changed in Memory #0 to one of 100 other preprogrammed chemicals or to a user-defined custom gas, a correction factor is applied to all the readings. During calibration, the unit requests isobutylene gas and displays the isobutylene concentration immediately following calibration, but when the unit is returned to the normal reading mode, it displays the selected gas and applies the correction factor.

The other 7 cal memories require the same calibration gas as the measurement gas. These memories may also be modified to a preprogrammed chemical or to a user-defined custom gas. In the gas library, only the gases that can be detected by the installed UV lamp will actually be displayed. Note that although the correction factor for the new gas will be displayed and can be modified, this factor is not applied when Memories #1-7 are

used. Therefore the factor will not affect the readings in these memories.

Once each of the memories has been calibrated, the user can switch between the calibrated gases by changing the cal memory without the need to recalibrate. Or the user can switch the measurement gas in Memory #0 and the appropriate correction factor will automatically be applied without the need to recalibrate. If the gas is changed in Memories #1-7, it is necessary to recalibrate.

To change a default gas from the list above to a library or custom gas, first go to Select Cal Memory (Section 4.4.3) and then proceed to Modify Cal Memory (Section 4.4.5) to enter the desired gas. If the desired compound does not appear in the preprogrammed library, the user can use the Custom\_VOC entry in the library, or the name and correction factor of any of the existing compounds can be changed as described in Section 4.4.5. A list of some 300 correction factors is given in Technical Note 106, available at the website [www.raesystems.com](http://www.raesystems.com).

### **4.4.1 Fresh Air Calibration**

This procedure determines the zero point of the sensor calibration curve. To perform a fresh air calibration, use the calibration adapter to connect the MiniRAE 2000 to a “fresh” air source such as from a cylinder or Tedlar bag (option accessory). The “fresh” air is clean dry air without any organic impurities. If such an air cylinder is not available, any clean ambient air without detectable contaminant or a charcoal filter can be used.

1. The first sub-menu shows: “Fresh air Cal?”
2. Make sure that the MiniRAE 2000 is connected to one of the “fresh” air sources described above.
3. Press the [Y/+] key, the display shows “zero in progress” followed by “wait..” and a countdown timer.

After about 15 seconds pause, the display will show the message “update data...zeroed... reading = X.X ppm...” Press any key or wait about 20 seconds, the monitor will return back to “Fresh air Calibration?” submenu.

### **4.4.2 Span Calibration**

This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar Bag, or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the MiniRAE 2000 Monitor, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

Before executing a span calibration, make sure the span value has been set correctly (see next sub-menu).

1. Make sure the monitor is connected to one of the span gas sources described above.
2. Press the [Y/+] key at the “Span Cal?” to start the calibration. The display shows the gas name and the span value of the corresponding gas.
3. The display shows “Apply gas now!” Turn on the valve of the span gas supply.

4. Display shows “wait.... 30” with a count down timer showing the number of remaining seconds while the monitor performs the calibration.
5. To abort the calibration, press any key during the count down. The display shows “Aborted!” and return to “Span Cal?” sub-menu.
6. When the count down timer reaches 0, the display shows the calibrated value.

**Note:** The reading should be very close to the span gas value.

7. During calibration, the monitor waits for an increased signal before starting the countdown timer. If a minimal response is not obtained after 35 seconds, the monitor displays “No Gas!” Check the span gas valve is on and for lamp or sensor failure before trying again.
8. The calibration can be started manually by pressing any key while the “Apply gas now!” is displayed.
9. After a span calibration is completed, the display will show the message “Update Data Span Cal Done! Turn Off Gas.”
10. Turn off the flow of gas. Disconnect the calibration adapter or Tedlar bag from the MiniRAE 2000 Monitor.
11. Press any key and it returns back to “Span Gas Cal?”

### 4.4.3 Select Cal Memory

This function allows the user to select one of eight different memories for gas calibration and measurement. For Memories #1-7, the calibration and measurement gas is the same and no correction factor is applied. For Memory #0, the calibration gas is always isobutylene and the measurement gas may be different, in which case the correction factor for that gas is automatically applied. The default gas selections are listed in Section 4.4

1. “Select Cal Memory?” is the third sub-menu item in the Calibration sub-menu. Pressing the [Y/+] key, the display will show “Gas =” gas name followed by “Mem # x?”
2. Press [N/-] to scroll through all the memory numbers and the gas selections respectively. Press [Y/+] to accept the displayed Cal Memory number.
3. After the [Y/+] key is pressed, the display shows “Save?” Press [Y/+] key to save and proceed. Press [N/-] to discard the entry and advance to the next sub-menu.
4. If the gas in a newly selected Cal Memory number is not calibrated, the display shows “CF= x.xx”. A correction factor with the value “x.xx” will be applied.
5. If the gas of a newly selected cal memory number has been calibrated previously, the display shows “Last calibrated xx/xx/xx”.



#### 4.4.4 Change Span Value

This function allows the user to change the span values of the calibration gases.

1. “Change Span Value?” is the fourth sub-menu item in the Calibration sub-menu
2. Press [**Y/+**], display shows the gas name and the span value. A cursor will blink at the first digit of the Span value. To modify the span gas value, go to Step 3. Otherwise, press and hold the [**MODE**] key for 1 second to accept the previously stored span gas value and move to the next sub-menu.
3. Starting from the left-most digit of the span gas value, use the [**Y/+**] or [**N/-**] key to change the digit value and press [**MODE**] key momentarily to advance to next digit. Repeat this process until all digits are entered. Press and hold the [**MODE**] for 1 second to exit.
4. The display shows “Save?” To accept the new value, press the [**Y/+**] key. Press the [**N/-**] key or the [**MODE**] key to discard the change and move to the next sub-menu.

### 4.4.5 Modify Cal Memory

If the current cal memory number selected is not memory 0, users will be prompted whether to modify the settings of the selected cal memory. Press **[Y/+]** to modify the cal memory and **[N/-]** to go to the next sub-menu.

Once **[Y/+]** is pressed the LCD display will show the current memory number, current Gas selected and prompt user for acceptance of current gas selected.

1. Press **[N/-]** to modify the gas selection if desired. Or press **[Y/+]** key to skip the change of gas selection, and proceed to the next sub-menu.
2. After pressing **[N/-]**, display shows “Copy gas from library?” Press **[Y/+]** to accept or **[N/-]** for the next sub-menu, “Enter Custom gas?”
3. In the “Copy gas from library” submenu, use **[Y/+]** and **[N/-]** keys to scroll through the selections in the library. Press **[MODE]** key momentarily to select the gas. The display shows “Save?” Press **[Y/+]** to save or **[N/-]** to discard the changes and proceed to next sub-menu.
4. In the Custom gas sub-menu, the user can enter the gas name. Press the **[Y/+]** or **[N/-]** key to cycle through all 26 letters and 10 numerals. Press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all digits (up to 8 digits) of the custom gas name is entered.

Press and hold the **[MODE]** key for 1 second to exit the name entry mode. The display will show “Save?” Press **[Y/+]** to save the entry, or **[N/-]** to discard the changes.

### 4.4.6 Change Correction Factor

This function allows the user to change the Correction Factor of the standard calibration gas (only for Cal Memory #0).

1. “Change Correction Factor?” is the sixth sub-menu in the Calibration sub-menu.
2. Press **[Y/+]** key. Display shows the gas name, then the correction factor.

A cursor blinks at the left-most digit of the correction factor. If user wants to modify the correction factor, go to Step 3. Otherwise, press and hold the **[MODE]** key for 1 second to accept the previously stored correction factor value and return to the first sub-menu of the calibrate/select gas menu.

3. Starting from the left-most digit of the correction factor, use **[Y/+]** or **[N/-]** key to change the digit value and press **[MODE]** key momentarily to advance to the next digit, the cursor will move to the next digit to the right. Repeat this process until all digits are entered. Press and hold the **[MODE]** for 1 second to exit.
4. The display shows “Save?” To confirm the new value, press **[Y/+]** to accept the change. Press **[N/-]** or **[MODE]** to discard the change and return to the first sub-menu, Calibrate and Select Gas.

## 4.5 Change Alarm Limits

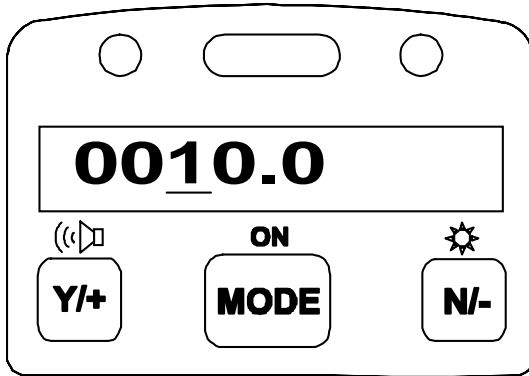
In this menu, the user can change the high and low alarm limits, the STEL limit and the TWA limit (see Table 4.5 below). Press the [Y/+] key and the display shows the current gas selected followed by the first sub-menu item below.

Table 4.5

<b>Alarm Limit Sub-Menu</b>
Change High Alarm limit?
Change Low Alarm limit?
Change STEL limit?
Change TWA limit?

1. Scroll through the Alarm Limit sub-menu using the [N/-] key until the display shows the desired limit to be changed, e.g., "High limit?", "STEL limit?", etc.

2. Press the [**Y/+**] key to select the desired limit and the display shows a flashing cursor on the left-most digit of the previously stored alarm limit.



3. To modify this limit value, use the [**Y/+**] or [**N/-**] key to change the digit value and press the [**MODE**] key momentarily to advance to the next digit. The flashing digit will move to the next digit to its right. Repeat this process until the new limit value is entered. Press and hold the [**MODE**] key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows “Save?” Press [**Y/+**] to accept the new value and move to the next sub-menu. Press [**N/-**] to discard the changes and move to the next sub-menu.

### 4.5.1 Change Low Alarm Limit

The second sub-menu item in the Alarm Limit sub-menu allows the user to change the Low Alarm limit. The LCD displays “Low limit?” To change Low Alarm limit, press **[Y/+]** key, or Press **[N/-]** key advance to next sub-menu in Table 4.5.

1. Press **[Y/+]** and the display will show a flashing cursor on the left-most digit of the previously stored Low alarm limit.
2. To modify this limit value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to its right. Repeat this process until the new limit values is entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press **[Y/+]** to accept the new value and move to the next sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

### 4.5.2 Change STEL Limit

This sub-menu item allows the user to change the STEL limit. The display shows “STEL limit?”

1. Press the **[Y/+]** key and the display will show a flashing cursor on the left-most digit of the previously stored STEL limit.
2. To modify this limit value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values is entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press **[Y/+]** to accept the new value and move to the next sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

### 4.5.3 Change TWA Limit

This sub-menu item allows the user to change the TWA limit. The LCD displays “TWA limit?”

1. Press [**Y/+**] and the display will show a flashing cursor on the left-most digit of the previously stored TWA limit.
2. To modify this limit value, use the [**Y/+**] or [**N/-**] key to change the digit value and press the [**MODE**] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values is entered. Press and hold the [**MODE**] key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press [**Y/+**] to accept the new value and move to the next sub-menu. Press [**N/-**] to discard the changes and move to the next sub-menu.



## **4.6 Change Datalog**

The MiniRAE 2000 monitor calculates and stores the concentration and ID of each sample taken. In the datalog sub-menu, a user can perform the tasks and functions shown below.

### **Datalog Sub-Menu**

Reset Peak/Minimum?

Clear Data?

Change Data Period?

Change Average Type?

### 4.6.1 Reset Peak

This function will reset the peak and minimum stored in the data memory. Note: this function will not clear the STEL or TWA data.

1. “Reset Peak?” is the first sub-menu item in the Datalog sub-menu (Table 4.6).
2. Press the **[Y/+]** key to reset the Peak/Minimum Values. The display shows “Are You Sure?”
3. Pressing the **[Y/+]** key again will reset the values. The display shows “Peak/Minimum Cleared” and moves to the next submenu.
4. Press the **[N/-]** or **[MODE]** key to exit without resetting the values and move to the next sub-menu.

### 4.6.2 Clear Data

This function will erase all data stored in the non-volatile datalog memory. Note: This function does not change STEL, TWA, Peak, Minimum and run time values, which are stored in the regular data memory.

1. “Clear Data?” is the third sub-menu item in the Datalog sub-menu.
2. Press the [Y/+] key to clear the datalog memory. The display shows “Are you sure?”
3. Press the [Y/+] key again to confirm erasure of all the datalog memory.
4. Press the [N/-] or [MODE] key to exit without clearing the datalog memory and move to the next datalog sub-menu.

### 4.6.3 Change Data Period

The datalog period can be programmed from 1 to 3,600 seconds (1 hour).

1. “Change Data Period?” is the fifth sub-menu item in the Datalog sub-menu.
2. Press the **[Y/+]** key and the display shows “Datalog Period = XXXX” with the left-most digit flashing, where “XXXX” is the previously stored data log period.
4. To modify this period, starting from the left-most digit, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 4 digits of the new period are entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
5. If there is any change to the existing value, the display will show “Save?” Press **[Y/+]** to accept the new value or **[N/-]** to discard the changes and move to the next sub-menu.

### 4.6.4 Change Average Type

The user can select either an 8-hour Time Weighted Average (TWA) or a running Average. The running average is simply the average of all instantaneous (1-second) readings since the measurement was started. This average may increase or decrease with time depending on the readings. The TWA is a cumulative value used to estimate the fraction of the 8-hour limit to which the user has been exposed since the start of the measurement. This value can only increase or remain constant, never decrease. Refer to Technical Note 119 for more information on how TWA is calculated.

1. “Change Average Type?” is the sixth sub-menu in the Datalog sub-menu.
2. Press the [Y/+] key to enter the function.
3. The display will show “Running Average?” or “Time Weighted Average?” depending on the current average type.
4. Press [N/-] key to toggle between the average types. Press [Y/+] key to select the displayed average type.
5. If there is any change to the existing setting, the display shows “Save?” Press [Y/+] to save the change. Press [N/-] or [MODE] to discard the change and return to the first sub-menu.

## 4.7 Change Monitor Setup

Several monitor specific variables can be changed in this menu. The following is a list of configuration data that can be modified by the user.

Monitor Setup Sub-Menu	Diagnostic Mode
Change Operation Mode?	“
Change Site ID?	Change Unit ID?
Change User ID?	Change Host ID?
Change Alarm Mode?	“
Change User Mode?	“
Change Date?	“
Change Time?	“
Change Lamp?	“
Change Pump Duty Cycle?	“
Change Unit?	“
Change Dilution Ratio?	“
Change Output?	“
Change DAC Range?	“
Set Temperature Unit?	“

### 4.7.1 Change Operation Mode

MiniRAE 2000 supports two operation modes: Survey and Hygiene mode.

**Survey mode:** Manual start/stop of measurements and display of certain exposure values.

**Hygiene mode:** Automatic measurements, running and datalogging continuously and calculates additional exposure values.

1. “Change Op Mode?” is the first sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key and the display shows the current user mode: “Op Mode = *current mode*?”
3. Press the [Y/+] key to accept the currently displayed operation (Op) mode. Press [N/-] to toggle to the other operation mode. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. When changing Op mode from Hygiene to Survey, the display shows the additional message “Warning! Exit Hygiene?” to prevent accidental exit from Hygiene mode. Press the [Y/+] key to acknowledge.
5. If there is any change to the existing setting, the display will show “Save?” Press the [Y/+] key to accept or the [N/-] key to discard and move to the next sub-menu.

**Note:** If a new Op Mode is saved, the display shows “Op Mode changed!!!” when exiting the programming mode.

### 4.7.2 Change Site ID

The user can enter an 8-digit alphanumeric site ID in the programming mode. This site ID will be included in the datalog report.

1. “Change Site ID?” is the second sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the **[Y/+]** key and the display shows the current site ID: “Site ID = xxxxxxxx” with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to cycle through all 26 letters and 10 numerals. Press **[MODE]** momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new site ID are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode.
5. If there is any change to the existing site ID, the display shows “Save?” Press the **[Y/+]** key to accept the new site ID. Press the **[N/-]** key to discard the change and move to the next sub-menu.



### 4.7.3 Change User ID

The user can enter an 8-digit alphanumeric user ID in the programming mode. This user ID will be included in the datalog report.

1. “Change User ID?” is the third sub-menu item the Monitor Setup menu.
2. Press the **[Y/+]** key and the display shows the current user ID: “User ID = xxxxxxxx” with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to cycle through all 26 letters and 10 numerals. Press **[MODE]** momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new user ID are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode.
5. If there is any change to the existing user ID, the display shows “Save?” Press the **[Y/+]** key to accept the new user ID. Or press the **[N/-]** key to discard the changes and move to the next sub-menu.

### 4.7.4 Change Alarm Mode?

There are two different alarm modes: **Latched** and **Automatic Reset** (Auto Reset) in the MiniRAE 2000 that can be selected from the programming menu.

1. “Change Alarm Mode?” is the fourth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key; the display shows the current alarm mode.
3. Press the [Y/+] key to accept the currently displayed alarm mode. Press [N/-] key to toggle to the other alarm mode. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing setting, the display will show “Save?” Press [Y/+] to save the change. Press [N/-] or [MODE] to discard the change and move to the next sub-menu.

### 4.7.5 Change User Mode

There are two different user modes: **Display** and **Program** that can be selected from the programming menu.

1. “Change User Mode?” is the fifth sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key; the display shows the current user mode selected.
3. Press the [Y/+] key to accept the currently displayed user mode. Press [N/-] key to toggle to the alternate user modes. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection, the display shows messages “Program change” and “Are you sure?” Press [Y/+] to confirm the change or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

**CAUTION:** If the user mode is changed to **Display** mode, the user can no longer enter the programming mode. Therefore, the user can not change the user mode back to **Program** mode in normal mode.

To restore the user mode back to **Program** mode, turn the unit off and back on in Diagnostic Mode. Next enter Program mode by holding the [MODE] and [N/-] keys for three seconds. Enter the password at the prompt (the default is 0000). Once program mode is entered, go to the “Change Monitor Setup” / “Change User Mode” and change the mode back to **Program**.

An alternative way to change Display mode back to Program mode is through the PC and the ProRAE-Suite software.

### 4.7.6 Change Date

The MiniRAE 2000 monitor is equipped with a real time clock (RTC). The user can enter the correct date and time (see 4.7.7) for the real time clock.

1. “Change Date?” is the sixth sub-menu item in the Monitor Setup menu.
2. Press [**Y/+**] and the display shows the current date “mm / dd / yy” with the left most digit of the date flashing.
5. To modify this value, use the [**Y/+**] or [**N/-**] key to change the digit value and press the [**MODE**] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the [**MODE**] key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows “Save?” Press [**Y/+**] to confirm the new value or press [**N/-**] or [**MODE**] to discard the changes and move to the next sub-menu.

### 4.7.7 Change Time

To change the time in the RTC of the MiniRAE 2000:

1. “Change Time?” is the seventh sub-menu item in the Monitor Setup menu.
2. Press [**Y/+**] and the display shows the current time in the 24-hour format “hh : mm” with the left most digit of the time flashing.
3. To modify this value, use the [**Y/+**] or [**N/-**] key to change the digit value and press the [**MODE**] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the [**MODE**] key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows “Save?” Press [**Y/+**] to confirm the new value or press [**N/-**] or [**MODE**] to discard the changes and move to the next sub-menu.

### 4.7.8 Change Lamp

There are three UV lamps with different photon energies available for the PID sensor: **9.8 eV**, **10.6 eV** and **11.7 eV**. The user can select any one of the lamps from the programming mode.

1. “Change Lamp Type?” is the eighth sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the **[Y/+]** key; the display shows the current PID lamp selection.
3. Press the **[Y/+]** key to accept the currently displayed lamp. Press **[N/-]** key to scroll through the sub-menu for other lamp selections. Press **[MODE]** to exit this sub-menu and return to the next sub-menu in Table 4.7.
4. If there is any change to the existing selection, the display will show “Save?” Press **[Y/+]** to save the new selection or press **[N/-]** or **[MODE]** to discard the change and return to the next sub-menu in Table 4.7.

### 4.7.9 Change Unit

User can change the display and datalog unit from parts per million (ppm) to milli-gram per cubic meter ( $\text{mg/m}^3$ ).

1. “Change Unit?” is the ninth sub-menu item in the Monitor Setup sub-menu.
2. Press the [Y/+] key, the display should show the current unit “Display Unit = ppm?” or “Display Unit =  $\text{mg/m}^3$ ?”
3. Press [Y/+] key to accept the currently displayed unit. Press [N/-] key to toggle to the other unit. Press [MODE] key to exit this sub-menu.
4. If there is any change to the existing selection, press [Y/+] to confirm the new selection or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

#### **Caution:**

1. **The correction factor in the gas library is calculated based on “ppm” unit. If “mg” unit is selected, the built-in correction factor library is not valid.**
2. **No automatic conversion between “ppm” and “ $\text{mg/m}^3$ ” reading is performed by the monitor.**
3. **When the unit name is changed from “ppm” to “mg”, the unit must be recalibrated with the span gas concentration entered in  $\text{mg/m}^3$ . The converse rule applies when the unit is changed from “mg” to “ppm”.**

### 4.7.10 Change Dilution Ratio

If a dilution system is used upstream of the MiniRAE 2000 inlet port, the user can enter the dilution ratio (from 1 to 10) to compensate the readings. The unit will then display the actual concentration of the gas before dilution. The dilution ratio should be 1 in normal operation where no dilution gas is applied to the sample gas. Dilution improves accuracy and linearity when the concentrations are above a few thousand ppm.

1. “Change Dilution Ratio?” is the tenth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key; the display shows the current dilution ratio: “Dilution Ratio = xx” with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to increase or decrease the value of the digit. Press **[MODE]** momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until both digits of the new dilution ratio are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode and move to the next sub-menu.
5. If there is any change to the existing dilution ratio, the display shows “Save?” Press **[Y/+]** to confirm the new value or press **[N/-]** or **[MODE]** to discard the changes and move to the next sub-menu.



### 4.7.11 Change Output?

There are two different external output options: DAC (Analog output) and Alarm in the MiniRAE 2000 that can be selected from the programming menu. The alarm output can be used to connect to the optional vibration alarm (vibrator) only. The analog output, which is proportional to the gas concentration, can be connected a chart recorder or can be queried by a computer to download data in real time (see Technical Note 141).

1. “Change External Output?” is the eleventh sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key and the display shows the current output option selection: “Output = DAC?”
3. Press the **[Y/+]** key to accept the currently displayed output option. Press **[N/-]** to change to the other external option: “Output = Alarm?” Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection the display will show “Save?” Then, press **[Y/+]** to save the change, press **[N/-]** to go back to Step 2, or press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.

### 4.7.12 Change DAC Range?

There are four different DAC (Digital-to-Analog Conversion) range values available in the **MiniRAE 2000: 20, 200, 2000 and 10K ppm**. The maximum 2.5V DC analog signal output from the unit will represent the range value chosen. (See for analog signal output connection.)

1. “Change DAC Range?” is the twelfth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key, the display shows the current DAC Range value: “DAC Range = 2000 ppm?”
3. Press the **[Y/+]** key to accept the currently displayed value. Press **[N/-]** to scroll through the sub-menu for other range values. Press **[MODE]** to exit this sub-menu and return to the first sub-menu in Table 4.7.
4. If there is any change to the existing selection, press the **[Y/+]** key and the display will show “Save?” Press the **[Y/+]** key to save the change or press the **[N/-]** key to discard and return to the first sub-menu in Table 4.7.

### 4.7.13 Set Temperature Unit?

The temperature display can be switched between Fahrenheit and Celsius units.

1. “Set Temperature Unit?” is the thirteenth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key, and the display shows the current setting: “Temperature Unit = Fahrenheit?”
3. Press the **[Y/+]** key to accept the currently displayed value. Press **[N/-]** to select the sub-menu “Temperature Unit = Celsius?” Press **[MODE]** to exit this sub-menu and return to the first sub-menu in Table 4.7.
4. If there is any change to the existing selection, press the **[Y/+]** key and the display will show “Save?” Press the **[Y/+]** key to save the change and return to the first sub-menu in Table 4.7 or press the **[N/-]** key to discard and return to Step 3..

## 4.8 Exit Programming Mode

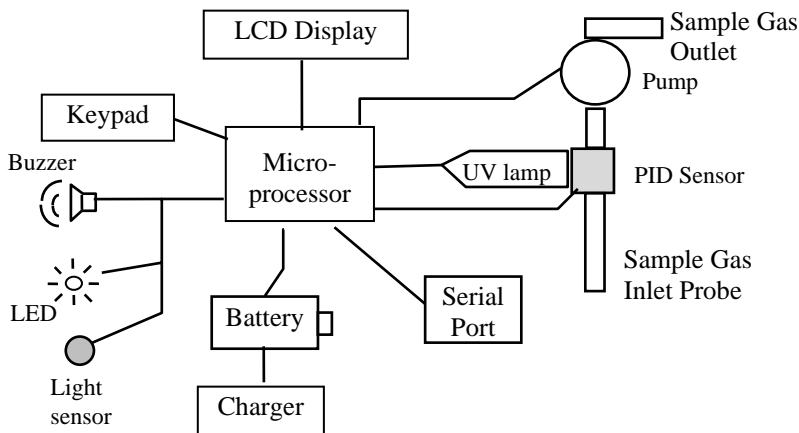
1. To exit programming mode from the first tier menu level, press the **[MODE]** key once.
2. To exit programming mode from 2nd tier sub-menu, press the **[MODE]** key twice.
3. To return to programming mode, press and hold down both the **[MODE]** and **[N/-]** keys for 3 seconds.

## 5. THEORY OF OPERATION

The MiniRAE 2000 monitor uses a newly developed electrodeless discharge UV lamp as the high-energy photon source for the PID. As organic vapors pass by the lamp, they are photo-ionized and the ejected electrons are detected as a current. The PID sensor with a standard 10.6 eV lamp detects a broad range of organic vapors. A lamp with high photon energy (e.g. 11.7 eV) will measure the more kinds of compounds, whereas low photon energies (e.g. 9.8 eV) are selective for easily ionizable compounds such as aromatics. In principle, any compound with an ionization energy lower than that of the lamp photons can be measured.

The PID sensor for the MiniRAE 2000 monitor is constructed as a small cavity in front of the UV lamp. A diaphragm pump draws the gas sample into the sensor and then pumps it out through the side of the instrument.

**Figure 5-1 MiniRAE 2000 Block Diagram**



A single chip microcomputer is used to control the operation of the alarm buzzer, LED, pump and light sensor. It measures the sensor readings and calculates the gas concentrations based on calibration to known standard gases. The data are stored in non-volatile memory so that they can be sent to a PC for record keeping. RS-232 transceivers provide a serial interface between the monitor and the serial port of a PC. An LCD display consisting of a single row of eight alpha/numeric characters is used to display the readings. The user interacts with the monitor through three keys on the front panel keypad.

A rechargeable NiMH, NiCd battery, or an alkaline battery pack powers the monitor.

## 6. MAINTENANCE

The major maintenance items of the MiniRAE 2000 are:

- Battery pack
- Sensor module
- PID lamp
- Sampling pump
- Inlet connectors and filters

**Note: Maintenance should be performed by qualified personnel only.**

**NOTE: The printed circuit board of the monitor is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the monitor. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.**

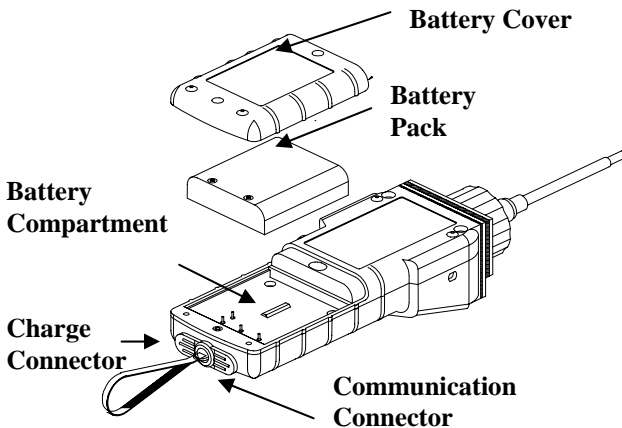
## 6.1 Battery Charging and Replacement

When the display shows a flashing message “Bat”, the battery requires recharging (see Section 3.1 for Battery charging). It is recommended to recharge the MiniRAE 2000 monitor upon returning from fieldwork. A fully charged battery runs a MiniRAE 2000 monitor for 10 hours continuously. The charging time is less than 10 hours for a fully discharged battery. The built-in charging circuit is controlled by the micro-controller to prevent over-charging. The battery may be replaced in the field (in area known to be non-hazardous) if required.

### WARNING

**To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non- hazardous. Remove and replace battery only in area known to be non-hazardous.**

### Replacing Battery Pack



**Figure 6-1 Battery Replacement**

1.



Turn off the power of the MiniRAE 2000.

2. Unscrew the two battery compartment screws, located on the bottom of the monitor, and remove the cover.
3. Remove the battery pack from the battery compartment.
4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment
5. Close the battery cover and tighten the two screws.

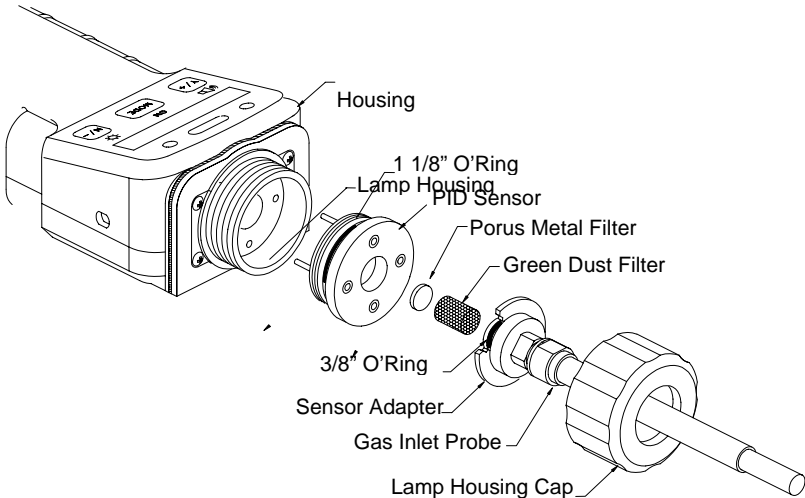
### **Replacing Alkaline Battery Adapter**

1. Insert four fresh AA size alkaline batteries into the alkaline battery holder. Make sure that the polarity of the batteries is correct.
2. Follow the same procedure as described above to replace the battery holder.

**Note:** The internal charging circuit is designed to prevent charging to alkaline batteries.

## 6.2 PID Sensor & Lamp Cleaning/Replacement

The sensor module is made of several components and is attached to the lamp-housing unit as shown in Figure 7-2.



**Figure 7-2 Sensor Components**

**Note:** Normally the cleaning procedure is not needed. Clean the PID sensor module, the lamp and the lamp housing only when one of the following happened:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to air moisture.
3. A chemical liquid has been sucked into the unit and damaged the unit.

Use of the water trap filter will help prevent contamination and accidentally drawing liquid into the sensor.

To access the sensor components and lamp, gently unscrew the lamp-housing cap, remove the sensor adapter with the gas inlet probe and the metal filter all together. Then hold the PID sensor and pull straight out to avoid bending the electrical pins on the sensor (see Figure 7-2). A slight, gentle rocking motion helps release the sensor.

### **To clean the PID sensor:**

Place the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly. Never touch the electrodes of the sensor by hand.

Also use a methanol-soaked cotton swab to wipe off the lamp housing where it contacts the sensor when the sensor is installed.

Turn over the sensor so that the pins point up and the sensor cavity is visible. Examine the sensor electrodes for any corrosion, damage, or bending out of alignment. The metal sensor electrode “fingers” should be flat and straight. If necessary, carefully bend the sensor fingers to ensure that they do not touch the Teflon portions and that they are parallel to each other. Make sure that the nuts on the sensor pins are snug but not overtight. If the sensor is corroded or otherwise damaged, it should be replaced.

### **To clean lamp housing or change the lamp:**

### **To clean lamp housing or change the lamp:**

If the lamp does not turn on, the monitor will display an error message to indicate replacement of the lamp may be required.

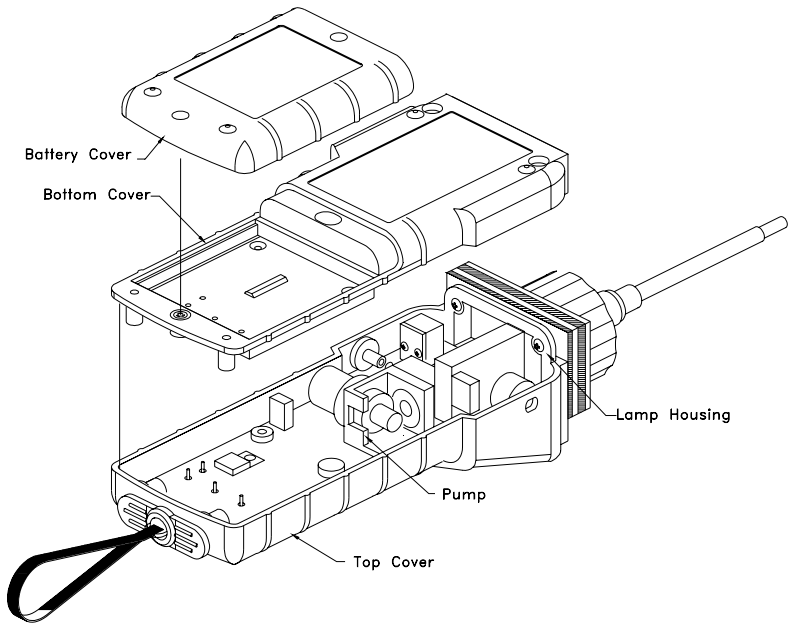
1. If the lamp is operational, clean the lamp window surface and the lamp housing by wiping it with GC grade methanol using a cotton swab using moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Never use water solutions to clean the lamp. Dry the lamp and the lamp housing thoroughly after cleaning.

**CAUTION: Never touch the window surface with the fingers or anything else that may leave a film. Never use acetone or aqueous solutions.**

2. If the lamp does not turn on, remove the lamp from the lamp housing. Place the lamp O-ring onto the new lamp. Insert the new lamp, avoiding contact with the flat window surface.
3. Reinstall the PID sensor module.
4. Tighten the Lamp Housing Cap.
5. If the lamp type has been changed, adjust the lamp type setting in the programming mode (Section 4.7.8).

## 6.3 Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump. When checking the pump flow, make sure that the inlet connector is tight and the inlet tubing is in good condition. Connect a flow meter to the gas inlet probe. The flow rate should be above 450 cc/min when there is no air leakage.



**Figure 7-3 Sampling Pump**

### **Pump Replacement**

1. Turn off the MiniRAE 2000 power.
2. Open the battery cover, remove the battery pack, and carefully unscrew the six screws to open the bottom cover.
3. Unplug the pump from the PCB. Unscrew the two screws that hold the pump assembly to the PCB. Disconnect the Tygon tubing that connects the pump to the gas inlet port and gas outlet port.
4. Insert a new pump assembly. Connect the Tygon tubing to the gas inlet port. Plug the pump connector back into the PCB and screw down the pump assembly to the board.
5. Replace the bottom cover and tighten the six screws. Reconnect the battery pack. Replace the battery pack and its cover.

## 6.4 Turning on the UV Lamp

The UV lamp is made of a glass envelope and a UV window (salt crystal) on one end of the envelope. The inside of the lamp is filled with low pressure gases. To turn on the lamp, a high voltage electric field is applied from the outside of the glass envelope. The molecules inside the lamp are ionized and produce a glow discharge that generates the UV light. The MiniRAE 2000 has a built-in sensing mechanism to monitor the status of the UV lamp and display a “Lamp” error message if it is not on.

If the UV lamp has not been used for a long period of time ( $> 1$  month) or is cold, it may become slightly harder to turn on. If such a condition occurs, the “Lamp” message will appear in the monitor display during the power on sequence. This phenomenon is more significant in 0.25” UV lamps used in ToxiRAE and MultiRAE Plus products, because of the relatively small lamp size. To solve this problem, simply turn on and off the monitor a few times and the lamp should turn on. After the UV lamp is turned on for the first time, it should be easier to turn on the UV lamp next time.

It is possible that the UV lamp is actually on when the lamp error message appears. This is because when the lamp becomes old, the internal threshold level to detect lamp failure may have shifted and cause a false alarm. To eliminate such possibility, simply check to see the UV lamp is actually on. This can be done easily by removing the sensor cap and observing the glow light of the UV lamp in a dark place. The user can also feed the monitor with calibration gas and observe if the sensor reading changes. If the reading changes significantly with the gas, the UV lamp is actually on.

A possible failure mechanism for the UV lamp is a leak developed along the seal of the glass envelope. When such condition occurs, the lamp will become very hard or impossible to turn on and will need to be replaced.

## 7. TROUBLESHOOTING

To aid the user in diagnosing the monitor, a special diagnostic mode can be used displays critical, low level parameters. Section 7.1 describes the operation of the diagnostic mode. Section 7.2 summarizes the frequently encountered problems and suggested solutions. By turning on the MiniRAE 2000 monitor in diagnostic mode and by using the troubleshooting table in Section 7.2, the user can usually correct the problem without having to return the monitor for repair.

### **WARNING**

**This function should be used by qualified personnel only! The diagnostic mode allows the user to set several low-level parameters that are very critical to the operation of the monitor. Extra care should be taken when setting these parameters. If the user is not familiar with the function of these parameters and sets them incorrectly, it may cause the monitor to shut down or malfunction.**



## 7.1 Troubleshooting Table

Problem	Possible Reasons & Solutions
Cannot turn on power after charging the battery	<b>Reasons:</b> Discharged battery. Defective battery. Microcomputer hang-up.  <b>Solutions:</b> Charge or replace battery. Disconnect, then connect battery to reset computer.
No LCD back light	<b>Reasons:</b> Trigger level too low, the current mode is not user mode, and the mode does not support automatic turn on back light.  <b>Solutions:</b> Adjust trigger level. Verify the back light can be turned on in user mode. Call authorized service center.
Lost password	<b>Solutions:</b> Call Technical Support at +1.408 .752 .0723 or +1. 888 .723 .4800
Reading abnormally High	<b>Reasons:</b> Dirty sensor module. Dirty water trap filter. Excessive moisture and water condensation.  <b>Solutions:</b> Clean sensor module and lamp housing. Replace water trap filter. Blow dry the sensor module.
Buzzer Inoperative	<b>Reasons:</b> Bad buzzer.  <b>Solutions:</b> Call authorized service center.

## TROUBLESHOOTING

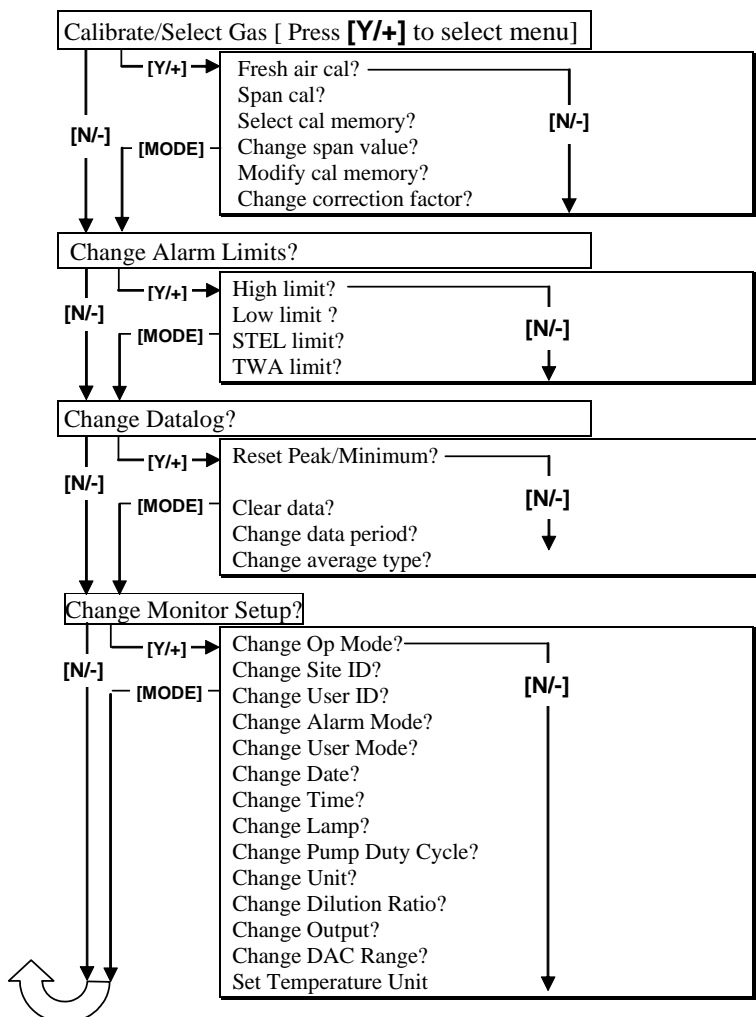
---

Inlet flow too low	<p><b>Reasons:</b> Pump diaphragm damaged or has debris. Flow path leaks.</p> <p><b>Solutions:</b> Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Replace pump or diaphragm.</p>
“Lamp” message during operation	<p><b>Reasons:</b> Lamp drive circuit. Weak or defective PID lamp, defective.</p> <p><b>Solutions:</b> Turn the unit off and back on Replace UV lamp</p>
Full scale measurement in humid environment	<p><b>Reasons:</b> Dirty or wet sensor.</p> <p><b>Solutions:</b> Clean and dry sensor and lamp housing. Adjust sensor fingers to ensure not touching Teflon. Use water trap filter.</p>
Reading abnormally low	<p><b>Reasons:</b> Incorrect calibration. Low sensitivity to the specific gas. Weak or dirty lamp. Air leakage.</p> <p><b>Solutions:</b> Calibrate the monitor. Replace sensor. Clean or replace lamp. Check air leakage.</p>

## APPENDIX A. QUICK REFERENCE GUIDE

Press [N/-] and [MODE], simultaneously, for 3 seconds, to enter Programming Mode. Press [MODE] to return to Survey Mode.

### PROGRAMMING MODE





---

## RAE Systems, Inc. Contact Information

**Main Office:** 3775 N. First St.  
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**Fax:** 408-952-8480

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**Email:** [RaeSales@raesystems.com](mailto:RaeSales@raesystems.com)

**Website:** [www.raesystems.com](http://www.raesystems.com)

**Technical Service:** 888-723-4800  
[Tech@raesystems.com](mailto:Tech@raesystems.com)

### Special Note

If the monitor needs to be serviced, contact either:

1. The RAE Systems distributor from whom the monitor was purchased; they will return the monitor on your behalf.
2. The RAE Systems Technical Service Department. Before returning the monitor for service or repair, obtain a Returned Material Authorization (RMA) number for proper tracking of your equipment. This number needs to be on all documentation and posted on the outside of the box in which the monitor is returned for service or upgrade. Packages without RMA Numbers will be refused at the factory.



# USER GUIDE

## GPS Pathfinder® Pro series





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# USER GUIDE

## **GPS Pathfinder® Pro series**

Version 1.00  
Revision A  
May 2005





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### Patents

The GPS Pathfinder Pro series is protected under the following USA patents:  
5,187,450, 5,311,149, 5,345,244, 5,402,450, 5,493,588.

### Release Notice

This is the May 2005 release (Revision A) of the GPS Pathfinder Pro series User Guide. It applies to version 1.50 of the GPS Pathfinder Pro series receivers (ProXT and ProXH receivers).

### Hardware Limited Warranty

Trimble Navigation Limited warrants that this hardware product (the "Product") will perform substantially in accordance with published specifications and be substantially free of defects in material and workmanship for a period of one (1) year starting from the date of delivery. The warranty set forth in this paragraph shall not apply to software products.

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This Trimble software product, whether provided as a stand-alone computer software product, built into hardware circuitry as firmware, embedded in flash memory, or stored on magnetic or other media, (the "Software") is licensed and not sold, and its use is governed by the terms of the relevant End User License Agreement ("EULA") included with the Software. In the absence of a separate EULA included with the Software providing different limited warranty terms, exclusions and limitations, the following terms and conditions shall apply. Trimble warrants that this Trimble Software product will substantially conform to Trimble's applicable published specifications for the Software for a period of one (1) year, starting from the date of delivery.

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Trimble's sole liability and your exclusive remedy under the warranties set forth above shall be, at Trimble's option, to repair or replace any Product or Software that fails to conform to such warranty ("Nonconforming Product") or refund the purchase price paid by you for any such Nonconforming Product, upon your return of any Nonconforming Product to Trimble in accordance with Trimble's standard return material authorization procedures.

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Note: The above limited warranty provisions may not apply to products or software purchased in the European Union. Please contact your Trimble dealer for applicable warranty information.

### Notices

#### USA

Class B Statement – Notice to Users. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. Contains FCC ID Q23104001. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.
- Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.



#### Canada

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of the Canadian Department of Communications. Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de Classe B prescrites dans le règlement sur le brouillage radioélectrique édicté par le Ministère des Communications du Canada.

#### Europe

This product has been tested and found to comply with the requirements for a Class B device pursuant to European Council Directive 89/336/EEC on EMC, thereby satisfying the requirements for CE Marking and sale within the European Economic Area (EEA). Contains Infineon radio module ROK 104001. These requirements are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential or commercial environment.



#### Australia and New Zealand

This product conforms with the regulatory requirements of the Australian Communications Authority (ACA) EMC framework, thus satisfying the requirements for C-Tick Marking and sale within Australia and New Zealand.



## Trimble and the Environment

At Trimble, we recognize the importance of minimizing the environmental impacts of our products. We endeavor to meet your needs, not only when you purchase and use our products, but also when you are ready to dispose of them. That is why Trimble is actively pursuing, and will continue to pursue, the expanded use of environmentally friendly materials in all its products, and why we have established a convenient and environmentally friendly recycling program.

As Trimble makes additional recycling facilities available for your use, we will post their locations and contact information to our Recycling Instructions web page.

For product recycling instructions and more information, please go to [www.trimble.com/environment/summary.html](http://www.trimble.com/environment/summary.html).

### Europe

To recycle Trimble WEEE (Waste from Electrical and Electronic Equipment), do one of the following:

- call +31 497 53 2436, and ask for the WEEE Associate
- mail a request to:  
Trimble Europe BV  
c/o Menlo Worldwide Logistics  
Meerheide 455521 DZ Eersel, NL



### Taiwan - Battery Recycling Requirements

The product contains a removable Lithium-Ion battery. Taiwanese regulations require that waste batteries be recycled.



## End User License Agreement

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# Safety and Warnings

## Battery Safety

The rechargeable Lithium-ion battery that is used in the GPS Pathfinder® Pro series receivers (the ProXT™ and ProXH™ receivers) is supplied partially charged. Charge the battery completely (see [Charging the Battery, page 10](#)) before using it for the first time. If the battery has been stored for longer than six months, charge it before use (see [Storage, page 32](#)).

See also [Disposing of the battery, page 8](#).



---

**WARNING** – Do not damage the rechargeable Lithium-ion battery. A damaged battery can cause an explosion or fire, and can result in personal injury and/or property damage. To prevent injury or damage:

- Do not use or charge the battery if it appears to be damaged. Signs of damage include, but are not limited to, discoloration, warping, and leaking battery fluid.
  - Do not expose the battery to fire, high temperature, or direct sunlight.
  - Do not immerse the battery in water.
  - Do not use or store the battery inside a vehicle during hot weather.
  - Do not drop or puncture the battery.
  - Do not open the battery or short-circuit its contacts.
- 



---

**WARNING** – Avoid contact with the rechargeable Lithium-ion battery if it appears to be leaking. Battery fluid is corrosive, and contact with it can result in personal injury and/or property damage.

To prevent injury or damage:

- If the battery leaks, avoid contact with the battery fluid.
  - If battery fluid gets into your eyes, immediately rinse your eyes with clean water and seek medical attention. Do not rub your eyes!
  - If battery fluid gets onto your skin or clothing, immediately use clean water to wash off the battery fluid.
- 



---

**WARNING** – Charge and use the rechargeable Lithium-ion battery only in strict accordance with the instructions. Charging or using the battery in unauthorized equipment can cause an explosion or fire, and can result in personal injury and/or equipment damage.

To prevent injury or damage:

- Do not charge or use the battery if it appears to be damaged or leaking.
  - Charge the Lithium-ion battery only in a Trimble product that is specified to charge it. Be sure to follow all instructions that are provided with the battery charger.
  - Discontinue charging a battery that gives off extreme heat or a burning odor.
  - Use the battery only in Trimble equipment that is specified to use it.
  - Use the battery only for its intended use and according to the instructions in the product documentation.
-



---

**WARNING** – When the battery is charged outside the receiver, the contacts may become very hot and there is a risk that you could burn yourself on the exposed metal.

---

## AC Adaptor Safety

An international AC adaptor kit is provided with the GPS Pathfinder Pro series receivers.



---

**WARNING** – To use AC adaptors safely:

- Use only AC adaptors intended for the ProXT and ProXH receiver. Using any other external power source can damage your product and may void your warranty.
  - Make certain that the input voltage on the adaptor matches the voltage in your location.
  - Make certain that the adaptor has prongs compatible with your outlets.
  - AC adaptors are designed for indoor use only. Avoid using the AC adaptor in wet outdoor areas.
  - Unplug the AC adaptor from power when not in use.
  - Do not short the output connector.
- 

## Magnetic mount

The GPS Pathfinder Pro series receiver can be mounted on top of a magnetic mount and placed on top of a vehicle.



---

**WARNING** – If you mount a GPS Pathfinder Pro series receiver on top of a vehicle, make sure that the retaining screw is firmly fastened. If the receiver detaches during travel, it could seriously injure you and other road users.

---

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# Introduction

Welcome to the *GPS Pathfinder Pro series User Guide*. This manual describes how to use a Trimble® GPS Pathfinder® Pro series receiver (a ProXT™ or ProXH™ receiver).

The GPS Pathfinder Pro series receivers are high-performance GPS receivers. They have an integrated antenna and receiver, a user-removable battery, and Bluetooth® wireless technology for connectivity with field computers.

## Related information

Sources of related information include the following:

- Help - the GPS Controller software that is provided with the receivers has built-in, context-sensitive help that lets you quickly find the information you need.

For more information on other software and hardware, refer to the documentation provided with the product as well as the product pages on the Trimble website at [www.trimble.com/product.shtml](http://www.trimble.com/product.shtml).

- For more information on GPS, go to [www.trimble.com/gps](http://www.trimble.com/gps).
- For more information on Bluetooth wireless technology, go to [www.bluetooth.com](http://www.bluetooth.com).
- Trimble training courses – consider a training course to help you use your GPS system to its fullest potential. For more information, go to the Trimble website at [www.trimble.com/training.html](http://www.trimble.com/training.html).

## Technical assistance

If you have a problem and cannot find the information you need in the product documentation, go to the Trimble technical support website ([www.trimble.com/support\\_trl.asp](http://www.trimble.com/support_trl.asp)), which contains extra support documentation.

If you cannot find the information you need, you can purchase Priority Support by going to [www.trimble.com/mgis\\_rqst\\_home.asp](http://www.trimble.com/mgis_rqst_home.asp). If you already have Priority Support, you can also use this link to request support from your Trimble Dealer.

## Your comments

Your feedback about the supporting documentation helps us to improve it with each revision. E-mail your comments to [ReaderFeedback@trimble.com](mailto:ReaderFeedback@trimble.com).



# Getting Started with a GPS Pathfinder Pro series Receiver

This section describes how to set up and get started with a GPS Pathfinder Pro series receiver.

## What's in the box?

When you receive a GPS Pathfinder Pro series receiver, check that you have received all the components, as detailed on the packing list, see [Figure 1.1](#).

The standard components are shown below. Depending on the system that you have purchased, you may have received additional components.

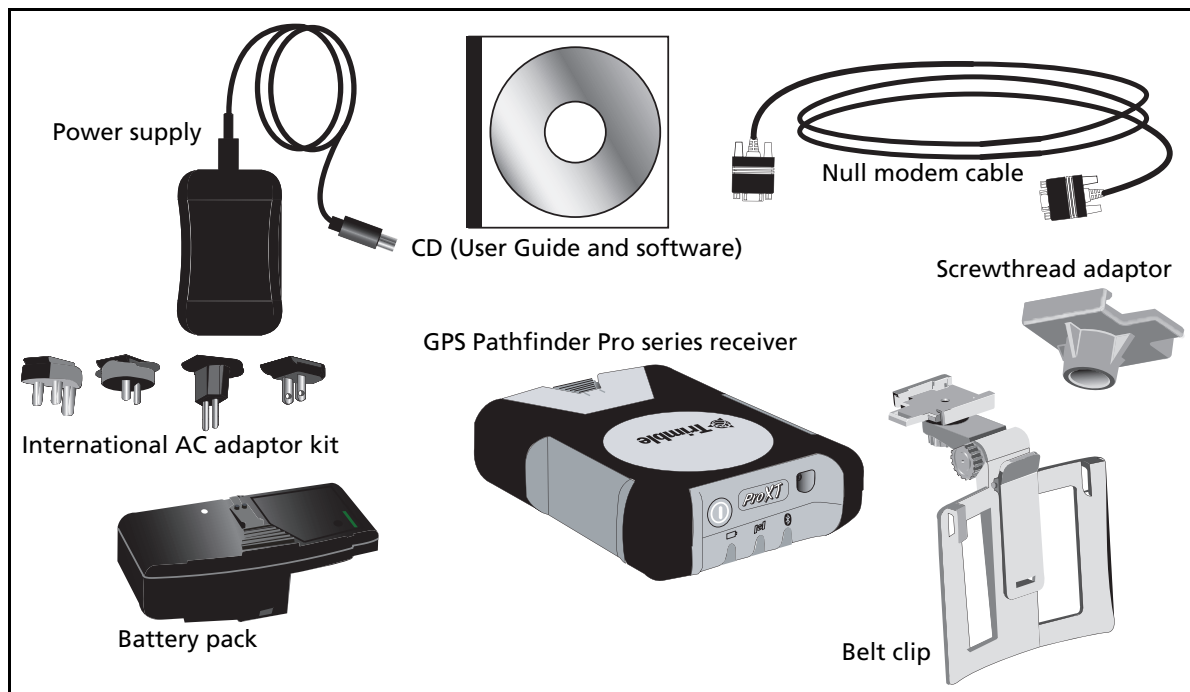


Figure 1.1 GPS Pathfinder Pro series receiver components

Inspect all contents for visible damage (scratches or dents). If any components appear damaged, notify the shipping carrier. Keep the shipping and packaging material for the carrier's inspection.

## Accessories

The following optional accessories are available:

- Backpack
- Range pole
- Range pole bracket
- Zephyr™ GPS antenna kit
- External patch antenna with 1.5 meter cable
- External patch antenna with 5 meter cable
- Hard carry case
- Serial port splitter cable
- Spare battery pack
- Spare belt clip
- Spare screwthread adaptor
- Spare power supply and adaptor kit

For more information, go to the Trimble website at [www.trimble.com/](http://www.trimble.com/).

## Software provided with the receiver

### GPS Controller software

The GPS Controller software runs on a desktop or field computer and enables you to:

- configure a GPS Pathfinder Pro series receiver's GPS settings, for example PDOP, Elevation, and Signal-to-Noise ratio masks
- configure the GPS Pathfinder Pro series receiver to use real-time DGPS sources
- configure the GPS Pathfinder Pro series receiver to output NMEA data
- view status information about the GPS Pathfinder Pro series receivers, satellites, and real-time correction sources
- view satellite prediction information in the field to help you plan your data collection session

See also the *GPS Controller Software Quick Reference Guide*.

## Installing the GPS Controller software

To install the GPS Controller software on an office computer or field computer, follow the installation instructions provided on the *GPS Pathfinder Pro series CD*.

The software provided with the receivers will run on the following Microsoft platforms:

- Microsoft® Windows Mobile™ 2003 software (or later)
- Windows® CE .NET version 4.0 or later
- Windows 2000
- Windows XP Home, Professional, and Tablet PC Edition

## Bluetooth Activation Manager

The GPS Pathfinder Pro series receivers are shipped with Bluetooth wireless technology activated. The Bluetooth Activation Manager runs on the desktop only and enables you to:

- deactivate the Bluetooth radio in a GPS Pathfinder Pro Series receiver to prevent it being accidentally turned on in the field.
- deactivate the Bluetooth radio on a GPS Pathfinder Pro series receiver if you have to turn it off due to the country or area in which you are working
- reactivate the Bluetooth radio if it has been deactivated

**Note** – Once you reactivate Bluetooth, turn on the receiver and then turn on the Bluetooth radio. For more information, see [Turning on or turning off the Bluetooth radio independently of the receiver, page 14](#).

## Installing the Bluetooth Activation Manager

Follow the installation instructions provided on the *GPS Pathfinder Pro series CD*.

This utility runs only on a desktop computer.

## Software used with the GPS Pathfinder Pro series receiver

You can use the following software with the GPS Pathfinder Pro series receivers:

- TerraSync™ software, version 2.50 or later
- GPS Analyst™ extension for ESRI ArcGIS software, version 1.10 or later
- GPSCorrect™ extension for ESRI ArcPad software, version 1.10 or later
- GPS Controller software, version 2.00 or later
- NMEA applications
- Applications developed with the GPS Pathfinder Tools SDK, version 2.00 or later

## Parts of the GPS Pathfinder Pro series receivers

The hardware features of a GPS Pathfinder Pro series receiver are shown in [Figure 1.2](#) and [Figure 1.3, page 6](#).



Figure 1.2 Top view of a GPS Pathfinder Pro series receiver

Feature	Description
Integrated GPS receiver and antenna	Integrated SBAS receiver EVEREST™ multipath rejection technology <b>ProXT</b> - L1 internal antenna and receiver <b>ProXH</b> - L1 internal antenna, L1/L2-aided GPS receiver using H-Star™ technology
Integrated Bluetooth radio	Cable-free connections to a range of Bluetooth-enabled field computers
Power button	Press to turn on or turn off the receiver and the Bluetooth radio (if enabled)
External antenna connection	Connect to the optional external antenna
LED status lights	Power, GPS, and Bluetooth



Figure 1.3 Bottom view of a GPS Pathfinder Pro series receiver

Feature	Description
Accessory interface	Common interface to accessories (belt clip or range pole)
Serial port	Serial (COM) connection to a field computer or real-time source. Contains two bi-directional serial ports (requires a splitter cable)
Power - battery connector	Charge the battery in or out of the receiver
Rechargeable Lithium-ion battery	User-replaceable - no tools required All-day operation with GPS and Bluetooth wireless technology Own LED (not shown) shows charging status when the battery is charged outside the receiver.

## Using a GPS Pathfinder Pro series Receiver

To start using a GPS Pathfinder Pro series receiver, complete the following steps:

1. Charge the rechargeable Lithium-ion battery (see [page 10](#)).
2. Install the GPS Controller software on your office computer and/or field computer.
3. Turn on the receiver and the Bluetooth radio (see [page 13](#)).
4. Mount the receiver (see [page 16](#)).
5. Connect the receiver to a field computer (see [page 20](#)).
6. Connect the receiver to a real-time device, if required (see [page 23](#)).
7. Collect GPS data (see [page 25](#)).

# Batteries and Power

## Introduction

The GPS Pathfinder Pro series receivers use a rechargeable Lithium-ion battery that is user replaceable. Additional battery packs can be carried and quickly changed in the field.

When fully charged, the internal battery of the receiver provides enough power for a full working day.

The rechargeable Lithium-ion battery is supplied partially charged. Use the AC power adaptor to charge the battery completely before using it for the first time. If the battery has been stored for longer than six months, charge it before use. See [Charging the Battery, page 10](#).

## Safety warnings

### Battery safety



**WARNING** – Do not damage the rechargeable Lithium-ion battery. A damaged battery can cause an explosion or fire, and can result in personal injury and/or property damage. To prevent injury or damage:

- Do not use or charge the battery if it appears to be damaged. Signs of damage include, but are not limited to, discoloration, warping, and leaking battery fluid.
- Do not expose the battery to fire, high temperature, or direct sunlight.
- Do not immerse the battery in water.
- Do not use or store the battery inside a vehicle during hot weather.
- Do not drop or puncture the battery.
- Do not open the battery or short-circuit its contacts.



**WARNING** – Avoid contact with the rechargeable Lithium-ion battery if it appears to be leaking. Battery fluid is corrosive, and contact with it can result in personal injury and/or property damage.

To prevent injury or damage:

- If the battery leaks, avoid contact with the battery fluid.
- If battery fluid gets into your eyes, immediately rinse your eyes with clean water and seek medical attention. Do not rub your eyes!
- If battery fluid gets onto your skin or clothing, immediately use clean water to wash off the battery fluid.



**WARNING** – Charge and use the rechargeable Lithium-ion battery only in strict accordance with the instructions. Charging or using the battery in unauthorized equipment can cause an explosion or fire, and can result in personal injury and/or equipment damage.

To prevent injury or damage:

- Do not charge or use the battery if it appears to be damaged or leaking.
  - Charge the Lithium-ion battery only in a Trimble product that is specified to charge it. Be sure to follow all instructions that are provided with the battery charger.
  - Discontinue charging a battery that gives off extreme heat or a burning odor.
  - Use the battery only in Trimble equipment that is specified to use it.
  - Use the battery only for its intended use and according to the instructions in the product documentation.
- 

### AC adaptor safety

An international adaptor kit is provided with the GPS Pathfinder Pro series. This is used to charge the battery both in and out of the receiver.



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**WARNING** – To use AC adaptors safely:

- Use only AC adaptors intended for the GPS Pathfinder Pro series. Using any other external power source can damage your product and may void your warranty.
  - Make certain that the input voltage on the adaptor matches the voltage in your location.
  - Make certain that the adaptor has prongs compatible with your outlets.
  - AC adaptors are designed for indoor use only. Avoid using the AC adaptor in wet outdoor areas.
  - Unplug the AC adaptor from power when not in use.
  - Do not short the output connector.
- 

### Disposing of the battery

Discharge the Lithium-ion battery before disposing of it.

When disposing of the battery, be sure to do so in an environmentally sensitive manner. Adhere to any local and national regulations concerning battery disposal or recycling. See [Trimble and the Environment, page iii](#)

## Removing and replacing the battery

The GPS Pathfinder Pro series has a replaceable Lithium-ion battery.

To remove the battery:

1. Turn off the receiver (press and briefly hold the Power button).
2. Firmly press the ridges on both sides of the battery (1) and then pull the battery out of the cavity (2), see [Figure 1.4](#).



Figure 1.4 Removing the battery



To replace the battery:

- Align the battery and then push it carefully into the battery cavity. The spring clip holds the battery in position. See [Figure 1.5](#).

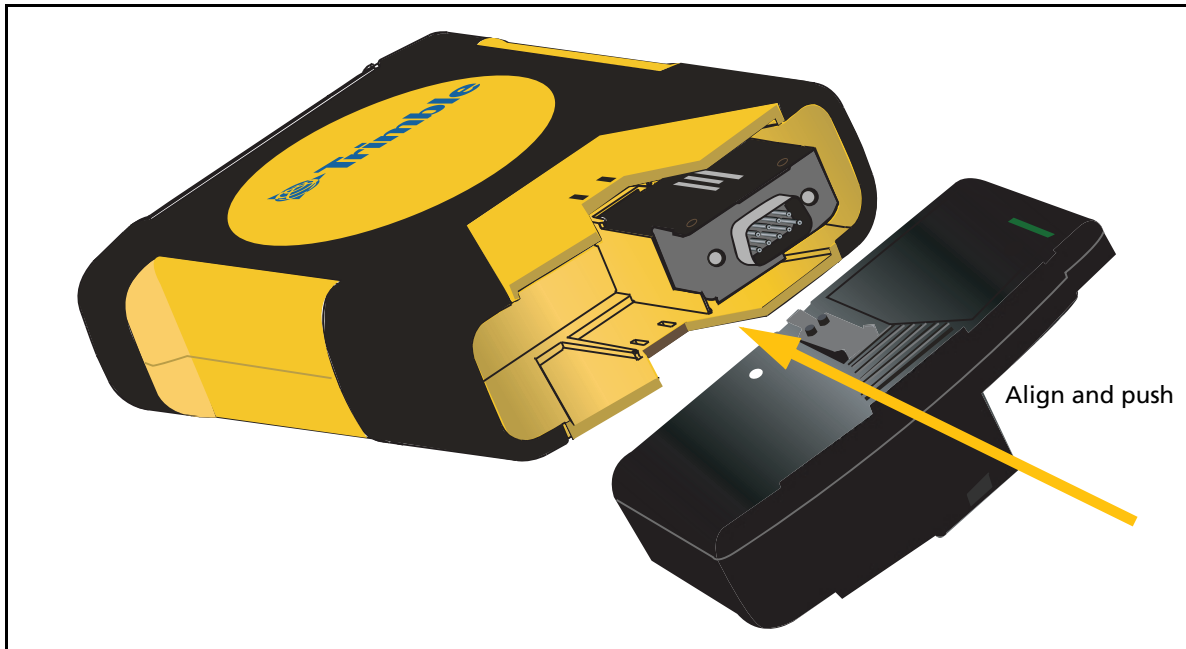


Figure 1.5 Replacing the battery

**Note** – If you accidental short the battery’s output terminals together, the battery will shut down for self-protection, and the output voltage will be zero. To reset the battery, plug it into the wall charger for a few moments to supply current, which resets the internal protector.

## Charging the Battery

The battery takes approximately five hours to charge fully. You can charge the battery while it is in the receiver, or you can remove the battery and charge it out of the receiver.

**Note** – Trimble recommends that you charge the battery in the receiver with the receiver switched on. If the receiver is on, the battery reporting is recalibrated at the end of the charging process.

### Charging the battery in the receiver

1. Insert the battery into the receiver.
2. Turn on the receiver.

3. To connect the battery to power, plug one end of the power connector into the battery connector, and use the appropriate wall plug adaptor to connect the power supply to mains power. See [Figure 1.6](#).
4. Charge the battery fully until it is running on external power.  
The power LED will be solid amber when the battery is fully charged and running on external power.
5. Disconnect the power adaptor.



Figure 1.6 Charging the battery

## Charging the battery out of the receiver



**WARNING** – When the battery is charged outside the receiver, the contacts may become very hot and there is a risk that you could burn yourself on the exposed metal.

1. Connect the battery to power. Plug one end of the power connector into the battery connector and use the appropriate wall plug adaptor to connect the power supply to mains power.
2. Charge the battery fully until it is running on external power.  
The power LED will be solid amber when the battery is fully charged and running on external power.

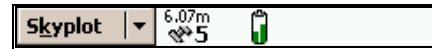
**Note** – The battery has its own LED which flashes when charging, and then becomes solid when fully charged. See [Power status](#) (see page 12).

3. Disconnect the power adaptor.
4. To replace the battery, align the battery and then push it carefully into the battery cavity. The spring clip holds the battery in position.

## Power status

There are three indicators of the power status of the receiver:

- The power LED on the front of the receiver, see [Status information, page 14](#).
- The battery icon in the status bar of the field software (for example the GPS Controller or TerraSync software or the Trimble GPSCorrect extension for ESRI ArcPad software).



The left half of the battery icon indicates the charge level of the receiver battery (the right half indicates the charge level of the field computer battery).

- When the receiver battery is fully charged, the left half of the battery icon appears green. The level of green drops as the battery charge level drops.
- When the receiver battery level is low, the left half of the battery is yellow.
- When the receiver battery level is critical, the left half of the icon is red and the icon flashes.
- The LED on the battery pack. This LED is only visible when the battery is removed from the receiver.

The battery pack LED status modes are as follows:

Mode	Status
Long flash <sup>1</sup>	Charging
On	Fully charged and on external power
Off	No status shown when the charger is not connected.

<sup>1</sup>Long flash - one flash per second

## Conserving power

The battery can usually operate for a full day without recharging. However, if you are away from the office for an extended period, you may require a spare battery pack.

To conserve battery power as much as possible:

- Use the software or the Power button to turn off the receiver when it is not in use.
- Turn off the integrated Bluetooth radio whenever you are not using it ([see page 14](#)).

# General Operation

If you use Bluetooth wireless technology to connect to the receiver, then you must use the Power button to turn on and turn off the receiver.

## Turning on the receiver and the Bluetooth radio

Do one of the following:

- Press the Power button briefly, see [Figure 1.7](#). If you use Bluetooth wireless technology to connect to the receiver, you must use this method.
- Use the software (for example GPS Controller or TerraSync software) installed on your field computer to turn the receiver on. For details, refer to the software documentation.

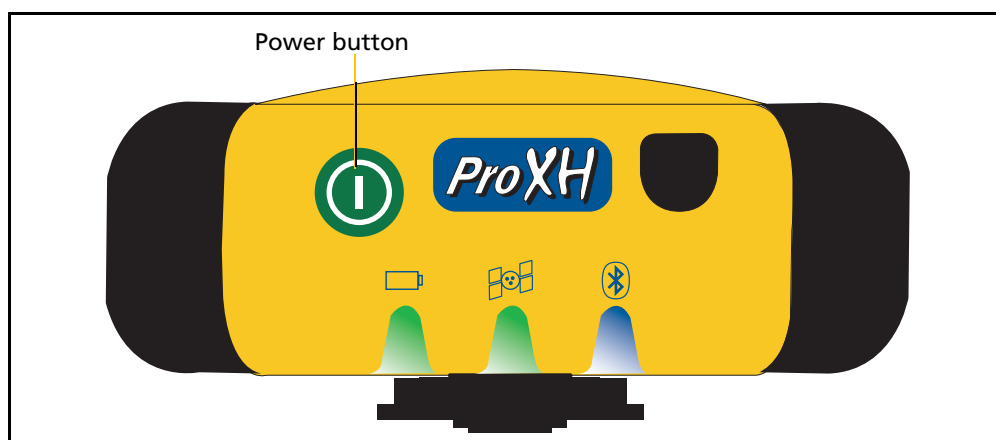


Figure 1.7 Front panel - Power button

On startup, the three LEDs on the front panel should light up briefly. If they do not light up, check that the battery is installed correctly and is charged. After startup, the LED patterns show the [Status information \(see page 14\)](#) of the receiver.

When you first receive the GPS Pathfinder Pro series receiver, the Bluetooth radio is activated by default. If the receiver is turned on, the Bluetooth radio is on and ready to be used. If the Bluetooth radio is **deactivated**, the Bluetooth LED will not be lit after startup, and you must first activate the radio, see [Bluetooth Activation Manager, page 4](#).

When the receiver is turned off and back on again, the Bluetooth radio will be in the same state it was in before the power was turned off. For example if the Bluetooth radio was turned off when the receiver was turned off, then when the receiver is turned back on, the radio will still be off.

## Turning off the receiver and the Bluetooth radio

Do one of the following:

- Press and hold the Power button briefly. If you use Bluetooth wireless technology to connect to the receiver, you must use this method.
- Use the software (for example GPS Controller or TerraSync software) installed on your field computer to turn off the receiver. For details refer to the software documentation.

**Note** – If a GPS Pathfinder Pro series receiver is connected to a field computer with a cable, and has been turned on or off by the software, you can still use the Power button to independently turn on or turn off the receiver.

## Turning on or turning off the Bluetooth radio independently of the receiver

If the receiver is turned on, press the Power button and hold it for 5 seconds to turn on or turn off the Bluetooth radio.

**Note** – If you toggle Bluetooth off, this turns off the radio, but does not deactivate Bluetooth. For more information, see [Bluetooth Activation Manager, page 4](#).

## Status information

When you turn the receiver on, the Power, GPS, and Bluetooth LEDs on the front panel light up as the receiver starts up, see [Figure 1.8](#).

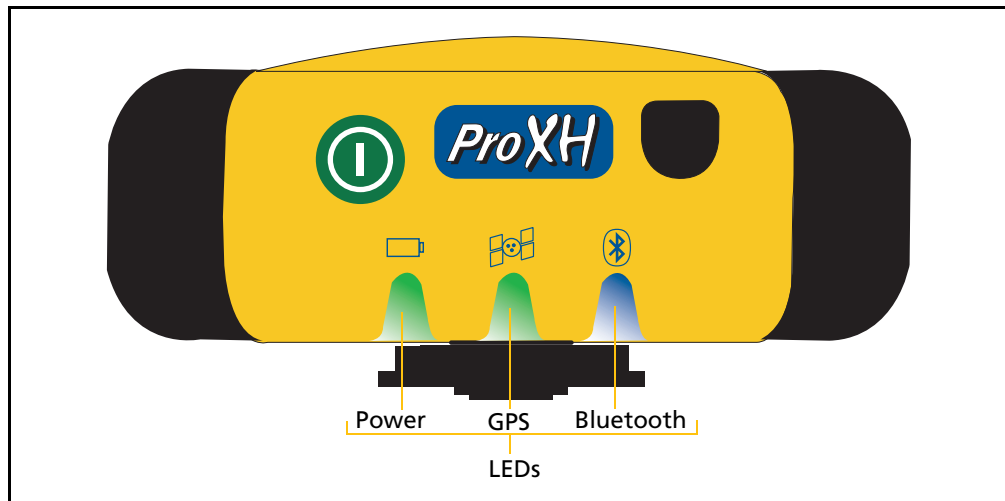


Figure 1.8 Front panel - LEDs

During operation, the LEDs provide the following status information:

LED	Color	Mode	Status
<b>Power</b>	Green	Solid	Good
	Red	Short flash <sup>1</sup>	Low
	Amber	Short flash	Charging
	Amber	Solid	Fully charged and on external power
<b>GPS</b>	Green	Long flash <sup>2</sup>	Generating positions
	Green	Rapid flash <sup>3</sup>	Too few satellites or poor geometry
<b>Bluetooth</b>	Blue	Waiting heartbeat flash <sup>4</sup>	Activated and waiting
	Blue	Long flash	Activated and connected
	Blue	Off	Bluetooth has not been activated or has been turned off
	Blue	Toggle flash <sup>5</sup>	Bluetooth toggled on and off event

<sup>1</sup> Short flash - one flash ever three seconds

<sup>2</sup> Long flash - one flash per second

<sup>3</sup> Rapid flash - two flashes per second

<sup>4</sup> Waiting heartbeat flash - one flash every three seconds

<sup>5</sup> Toggle flash - five short flashes over two seconds

*The battery also has an LED, which is visible only if the battery is charged out of the receiver. See [Power status, page 12](#).*

# Mounting the GPS Pathfinder Pro series Receiver

The receiver has an accessory interface that enables you to mount the receiver on a range of equipment, and easily change between them.

The receiver can be mounted:

- on a screwthread adapter (a standard accessory, provided with the GPS Pathfinder Pro series receiver) for use on a backpack, range pole, or vehicle magnetic mount
- on a belt clip (a standard accessory, provided with the GPS Pathfinder Pro series receiver)
- on the side of a range pole, with a Zephyr antenna on top of the pole

## Mounting the receiver on top of a backpack, range pole or magnetic mount



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**WARNING** – If you mount a GPS Pathfinder Pro series receiver on top of a vehicle, make sure that the retaining screw is firmly fastened. If the receiver detaches during travel, it could seriously injure you and other road users.

---

***Note** – The rangepole bracket contains an insert, which can be reversed to allow the bracket to attach to 1" or 1 1/4" diameter poles.*

1. Make sure that the insert in the rangepole bracket is the correct size to allow the bracket to be used with 1" or 1 1/4" diameter poles.
2. Attach the screw thread adaptor to the pole on a backpack, range pole, or magnetic mount.
3. Slide the receiver onto the screwthread adaptor, see [Figure 1.9](#).

4. If you are mounting the receiver onto a vehicle roof, make sure that the retaining screw is firmly fixed.

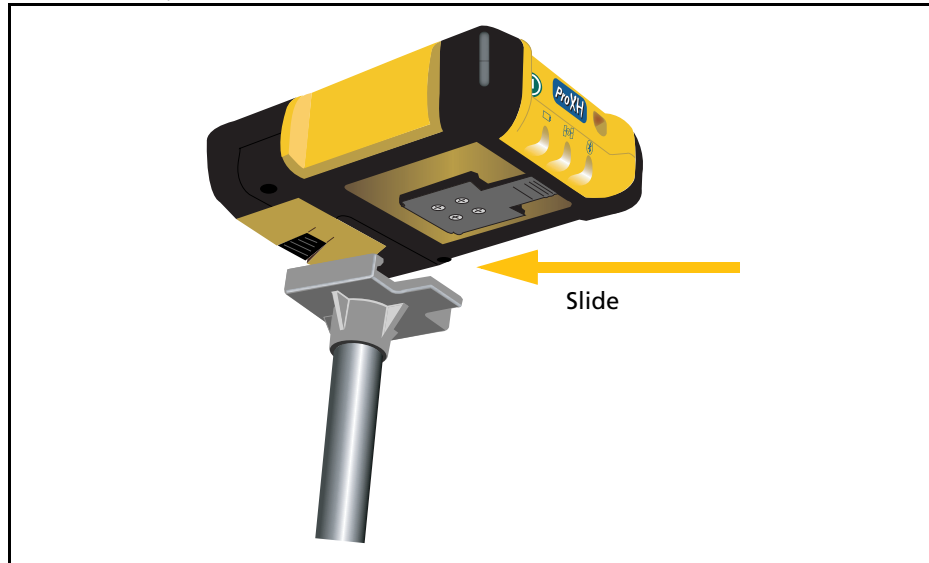


Figure 1.9 Mounting the receiver onto the screwthread adaptor

To unclip the receiver, lift the tab of the accessory interface to release the receiver and then slide the receiver off the mounting attachment.

## Mounting the receiver on the belt clip

If you use the internal antenna, you can mount the receiver horizontally with the antenna facing toward the sky. If you use the external patch antenna, you can mount the receiver vertically.

1. Position the belt clip for vertical or horizontal use.
2. Slide the receiver onto the belt clip.

To unclip the receiver, lift the tab of the accessory interface to release the receiver and then slide the receiver off the mounting attachment.

## Mounting the ProXH receiver on the side of a range pole with the Zephyr Antenna

1. Fix the range pole bracket to the side of the range pole.
2. Slide the receiver onto the bracket.



3. Attach the Zephyr antenna to the top of the pole and then connect the antenna cable to the antenna and the receiver, see [Figure 1.10](#).

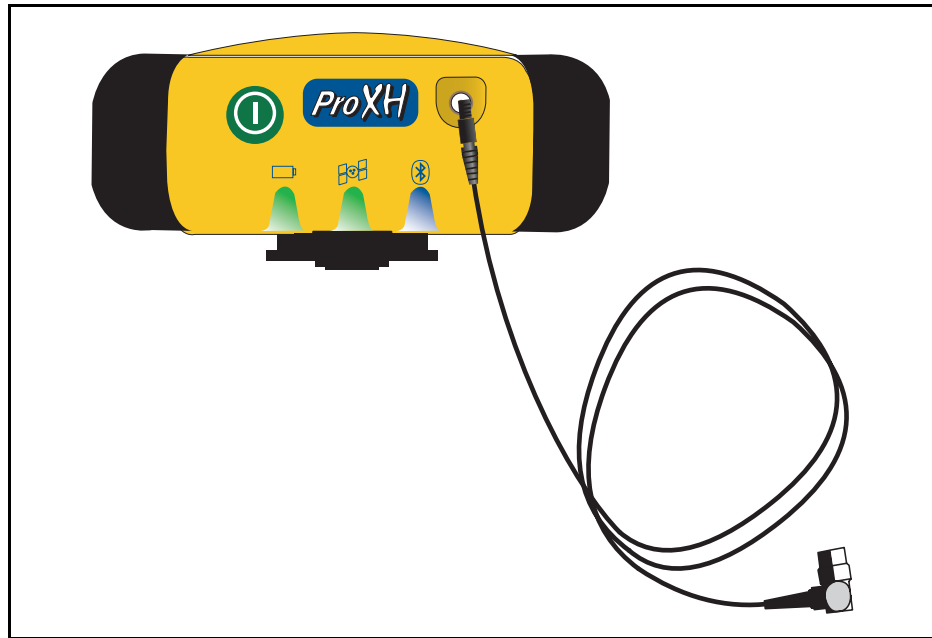


Figure 1.10 Attaching the external antenna

To unclip the receiver, lift the tab of the accessory interface to release the receiver and then slide the receiver off the mounting attachment.

# Connecting the GPS Receiver

You can connect devices to a GPS Pathfinder Pro series receiver using Bluetooth wireless technology, or through the serial port, or by a combination of the two methods. To access both receiver serial ports, use a splitter cable. Connection options are as follows:

Receiver port	Description
Port 1 (serial cable)	TSIP (default), NMEA, or RTCM
Port 2 (splitter cable)	NMEA (out) or RTCM (in) These settings are Off by default
Bluetooth Port 1	NMEA or TSIP
Bluetooth Port 2	NMEA or TSIP

Note the following:

- You cannot have more than one TSIP or RTCM connection.
- To configure the receiver to output NMEA on port 1, use the GPS Controller software.
- To configure the receiver to use RTCM on port 1 when you use Bluetooth wireless technology, use the GPS Controller or TerraSync software, or the GPScorrect extension.

## Connecting to the GPS Receiver with Bluetooth Wireless Technology

Bluetooth wireless technology is an industry standard specification that eliminates the need for cables between Bluetooth-enabled mobile devices. See [Figure 1.11, page 20](#).

To communicate using a Bluetooth connection, a field computer (a *client*) scans the Bluetooth radio frequency to discover other Bluetooth devices. Once it discovers a *host* (for example a GPS receiver), the client selects the service that it will use. A service defines what type of information can be transferred to or from the host, and how to transfer it.

The GPS Pathfinder Pro series receivers use an integrated Bluetooth radio to establish a short-range wireless connection to a Bluetooth-enabled field computer that is within range. The receivers support only a serial port profile (SPP). When you first receive the GPS Pathfinder Pro series receiver, the Bluetooth radio is activated by default. If the receiver is turned on, the receiver is on and ready to be used. This means that a Bluetooth-enabled field computer can connect to a GPS Pathfinder Pro series receiver.

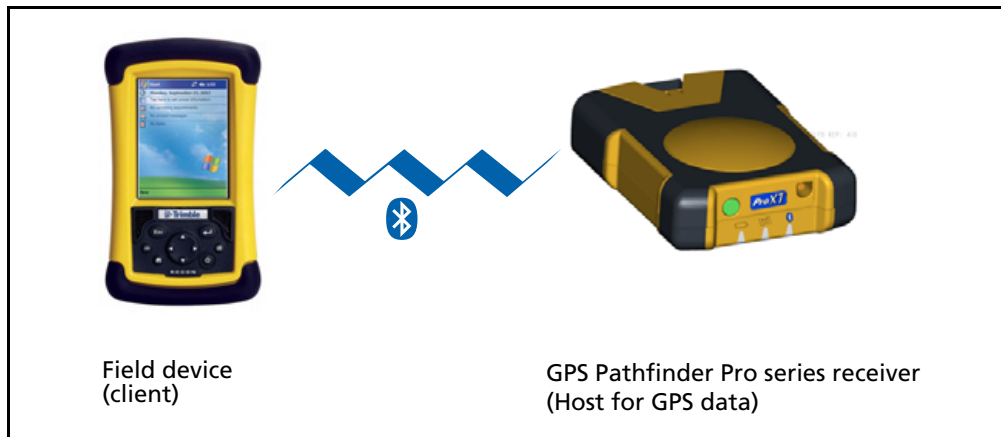


Figure 1.11 Bluetooth wireless connection

### Setting up the Bluetooth radio

On the field computer, configure the computer to not require authentication or secure connection. The receiver cannot exchange a password during connection to authenticate, bond, or pair devices.

Make a note of the field computer's COM port that you use for this connection.

### Connecting to the receiver

**Note** – Before you can start using Bluetooth technology, you must ensure that it is set up on your field computer or office computer. Use the Bluetooth Manager software provided with your field or office computer to set up the serial port connections on your field or office computer.

On the field computer:

1. Scan for devices.
2. Select the Pro series receiver from the list of devices.
3. Depending on the software that is running on your computer, you may need to select the service to connect to. The Pro series receivers offer two Bluetooth ports for NMEA or TSIP. If required, double-click to access the list of services.
4. As required, confirm the connection to the device and the service.

Once you establish this connection between the field computer and the receiver, configure the field software to use the connection. The Bluetooth LED shows that Bluetooth technology is connected to the port but you must set the software to use this connection and data.

## Field software (Bluetooth connection)

1. Open the field software.
2. Select the COM port assigned on the field computer for this Bluetooth connection.
3. If required, select NMEA or TSIP.
4. Connect to the receiver.

**Note** – Unless the software is a TSIP application, the system automatically outputs NMEA.

**Note** – If you use Bluetooth technology to connect to the receiver, then you must use the Power button to turn on and turn off the receiver.

For more information, refer to the documentation for your software.

## Multiple Bluetooth connections

You can connect to both Bluetooth ports on the receiver but you cannot have more than one TSIP connection.

## Connecting to the GPS Receiver using a Serial Port

You can connect devices to a GPS Pathfinder Pro series receiver using the serial port. To access both receiver serial ports, use the optional splitter cable, which contains two bi-directional ports.

1. Make sure that you have all the required accessories to enable a serial connection. If you are using a splitter cable, make sure that it is connected to the correct port.
2. To connect to the receiver TSIP or NMEA serial port, connect the system as shown in [Figure 1.12](#) to [Figure 1.14](#).
  - a. Connect the null-modem cable supplied with your receiver (or the custom serial cable supplied with your field computer) into the serial (COM) port of the office computer or field computer.
  - b. Select the appropriate COM port on your field computer.



---

**CAUTION** – Using a null modem cable to provide NMEA output from port 2 of a GPS Pathfinder Pro series receiver can cause serial communications to jam on some field computers. The communications problem can cause the field computer to slow down or stop responding. To provide NMEA output to another device, Trimble recommends that you connect the optional NMEA/RTCM splitter cable (P/N 55443-00) to the receiver, connect the receiver to the field computer and then enable NMEA output.

---

**Note** – If you use the software to turn on the receiver, then you can use the software **or** the Power button to turn off the receiver. If you used the Power button to turn on the receiver, and then used the software to connect or disconnect the receiver, you must use the Power button to turn off the receiver.

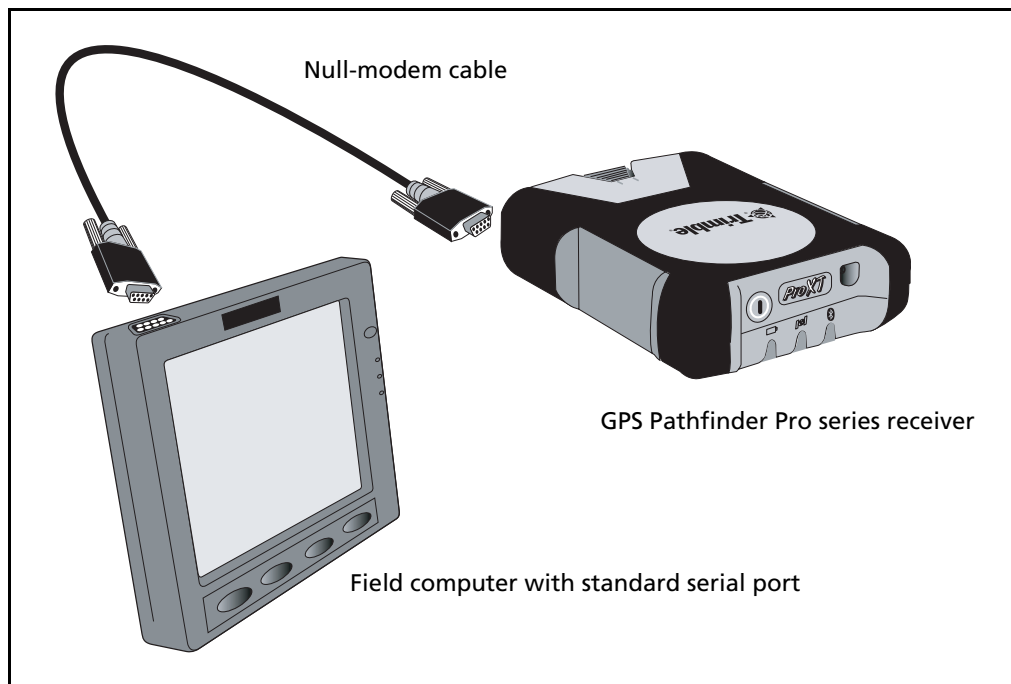


Figure 1.12 Connecting a GPS Pathfinder Pro series receiver to a field computer with a standard serial port

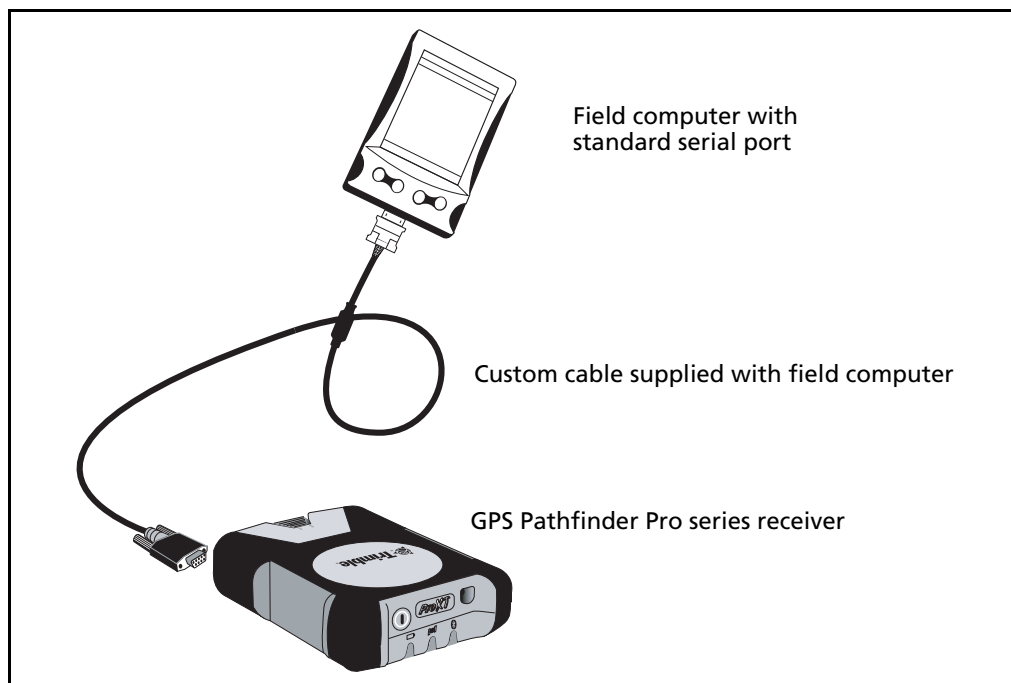


Figure 1.13 Connecting a GPS Pathfinder Pro series receiver to a field computer with a custom serial port

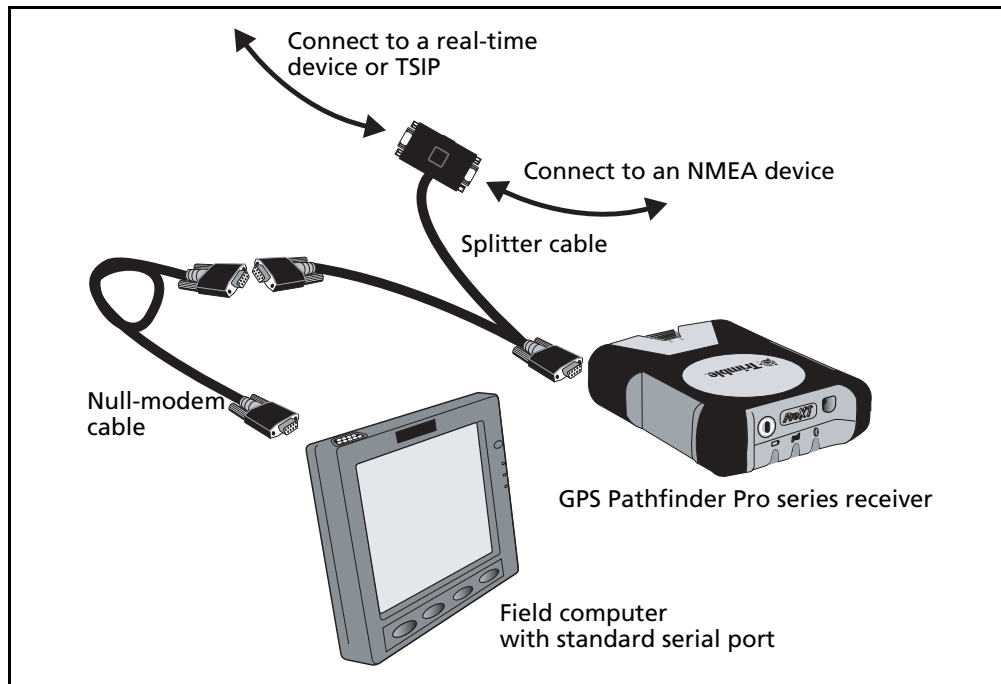


Figure 1.14 Connecting a GPS Pathfinder Pro series receiver to a field computer using a serial port splitter cable



### Field software (serial connection)

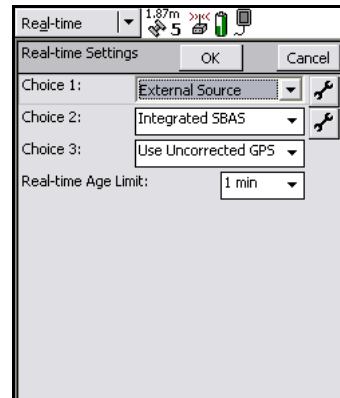
The settings on the field software are similar to those made when connecting to a field computer using Bluetooth wireless technology. See [Field software \(Bluetooth connection\)](#), page 21.

## Connecting a real-time device to the GPS receiver

You can configure the receiver to use RTCM from an external source on port 1 (serial cable) if you are using Bluetooth wireless technology to connect to your field computer, or on port 2 (splitter cable) if you are using a serial connection to your field computer.

1. Make sure that you have all the required accessories to enable a serial connection.
2. Do one of the following:
  - If you are using Bluetooth wireless technology, connect the serial cable between the device and port 1 on the receiver.
  - Connect the serial cable between the device and the Data In port on the splitter cable's port 2.

3. In the GPS Controller or TerraSync software, or the GPSCorrect extension:
  - a. Select Setup from the Status list button.
  - b. Tap **Real-time Settings**. The *Real-time Settings* form appears.
  - c. In the *Choice 1* field, select External Source.
  - d. To open the *External Source Settings* form, tap the setup button  next to the *Choice 1* field.
  - e. In the *Connections Method* field of the *External Source Settings* form, select Receiver Port.
  - f. To open the *Receiver Port Settings* form, tap the setup button  next to the *Port* field.
  - g. Select the port to which your real-time device is connected:
    - Port 1 (serial), if connecting directly with a null modem cable
    - Port 2 (splitter), if connecting to the Data In port on the splitter.
4. Configure the Baud rate, parity, stop bits, and flow control as required for the real-time source.
5. Tap **OK**.



# Collecting GPS Data

## What is GPS?

The Global Positioning System (GPS) is a satellite-based positioning system operated by the U.S. Department of Defense (DoD). A constellation of operational NAVSTAR satellites orbit the earth every 12 hours, providing worldwide, all-weather, 24-hour time and position information.

For more information about GPS concepts, refer to the *Mapping Systems General Reference* at [www.trimble.com/gps/](http://www.trimble.com/gps/).

This section provides information on using GPS in an application:

- [GPS COM Ports, page 25](#)
- [Configuring a GPS Application, page 25](#)
- [Getting a Clear View of the Sky, page 26](#)
- Configuring GPS quality control settings to suit your requirements and the current GPS conditions, see [GPS Quality Control with the GPS Controller Software, page 26](#)
- Using mission planning to identify the best times of the day for working with GPS, see [Planning a data collection session, page 28](#)
- [Using Real-time Corrections from other sources, page 29](#)

## GPS COM Ports

The GPS Pathfinder Pro series receivers have four COM ports for communicating with software field computers or external devices. Each port is used for a particular type of communication, but some protocols can be used on different ports. The Bluetooth radio and the serial ports can be used concurrently to output NMEA data.

For more information on which protocols can be used on each port, see the table on [page 19](#).

## Configuring a GPS Application

Irrespective of whether you are using Bluetooth or a serial port connection, you must select the appropriate COM port on your field computer for the connection you require. See [Field software \(Bluetooth connection\), page 21](#) or [Field software \(serial connection\), page 23](#).



## Getting a Clear View of the Sky

To receive signals from GPS satellites, the receiver must have a clear view of the sky. The internal antenna is located under the Trimble logo. You do not have to have the receiver perfectly level, but keep the antenna facing upward, not downward or sideways.

Anything that blocks light also blocks signals. Satellite signals can be blocked by people, buildings, heavy tree cover, large vehicles, or powerful transmitters. GPS signals can go through leaves, plastic, and glass, but these all weaken the signal.

Although the receiver can be used on a belt clip, you will achieve better results when you mount the receiver on a backpack or rangepole, as this will give the receiver a better view of the sky.

## GPS Quality Control with the GPS Controller Software

**Note** – *The GPS Controller software duplicates the status and setup features of the TerraSync software and the GPSCorrect extension for ESRI ArcPad software. If one of these applications is installed on your field computer, it can be used instead of the GPS Controller software. Version 2.00 of the GPS Controller software also enables you to output NMEA data from the receiver.*

By default, the receiver is configured to receive satellite signals in most conditions. To check the current GPS status, or to configure the GPS receiver, connect your field computer using the GPS Controller software, which is provided with the receiver.

The GPS Controller software also includes a Plan section for mission planning (see [page 28](#)) and a Real-time section for configuring and monitoring real-time correction sources.

Use the graphical Skyplot section, see [Figure 1.15](#), or the Satellite Info section to view detailed GPS information, and to adjust the quality and yield of the GPS positions you are receiving. Use the GPS slider to select predefined settings, or configure customized settings.

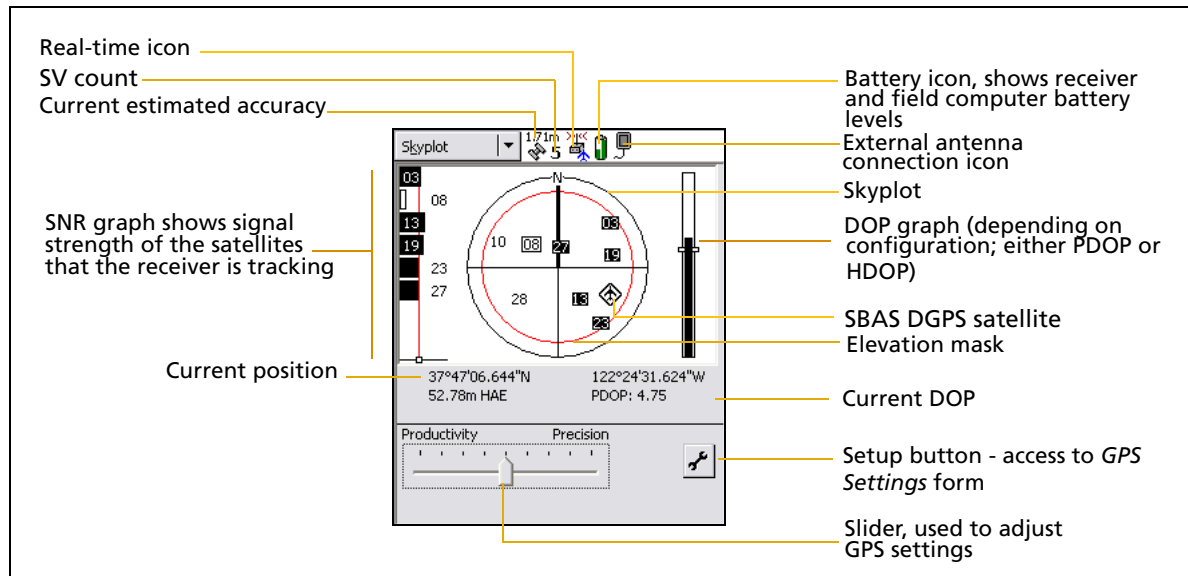


Figure 1.15 Details on the Skyplot screen


For more information on the software used on your field computer, refer to the documentation for that application.

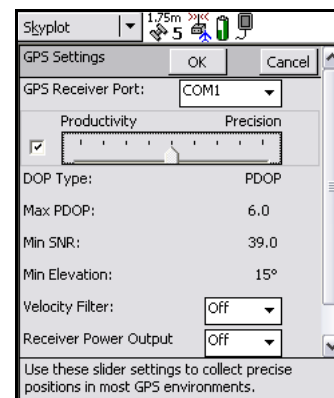
## GPS Settings form

Use the *GPS Settings* form in the GPS Controller software to configure the settings you require for GPS positions in either Slider or Custom mode.

You can also use the GPS Controller software to configure the receiver to use velocity filtering or to output NMEA data.

To open the *GPS Settings* form, do one of the following:

- Tap **GPS Settings** in the Setup section.
- Tap  in the Skyplot section, Satellite Info section, or Plan section.



## Configuring GPS settings in Slider mode

Select the slider check box. The slider control appears on the GPS slider, and some fields in the form become read-only. The values in these fields change as the slider control position changes.

The GPS slider is the same as the slider in the Setup area of the Skyplot and Satellite Info sections. If you change the slider control position in the *GPS Settings* form, it also changes in the Setup area.

## Configuring GPS settings in Custom mode

Clear the slider check box. The slider control disappears from the GPS slider, and the remaining fields change to editable numeric fields. To specify the required GPS settings, enter values in these fields.

## Configuring velocity filtering

You can use velocity filtering to smooth GPS positions when collecting lines or areas in high multipath environments. To apply velocity filtering, you must:

- configure Velocity Filtering to Auto on the *GPS Settings* form
- use real-time corrections, or collect data with SuperCorrect set to On in the TerraSync software or GPSCorrect extension

## Configuring the receiver to output NMEA data

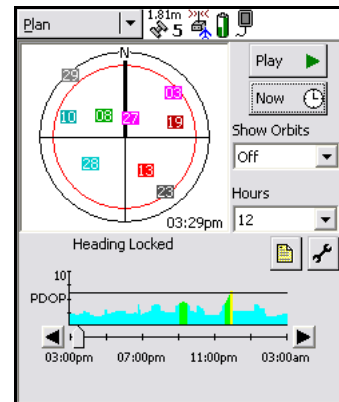
You can configure the receiver to output NMEA data on the serial port, including Port 2 when using the splitter cable, or with Bluetooth wireless technology. You can also configure the serial port settings, the types of messages to output, and the output interval.

## Planning a data collection session

To maximize productivity, plan GPS data collection around the times of the day when satellite geometry is best.

The GPS Controller software has a Plan section with an animated skyplot and DOP (satellite geometry) graph for your position for the next 12 hours.

In the Plan section, you can check the planning skyplot as you play a session, then use the timeline to zoom in on times when geometry is poor. As you adjust GPS settings, the Plan section is updated, so you can see the effect of different quality control settings.



**Note** – If TerraSync software or the GPSCorrect extension for ArcPad is installed, you can use the planning feature in that application instead of in GPS Controller software.

## Using Satellite Based Augmentation System (SBAS) corrections

The GPS Pathfinder Pro series receivers have an integrated SBAS receiver that uses WAAS (Wide Area Augmentation System), or EGNOS (European Geostationary Navigation Overlay System) correction messages to improve GPS accuracy.

The receiver tracks the following by default in Auto mode:

- WAAS satellites between 40° West and 180° West, and between 10° North and 90° North.
- EGNOS satellites between 40° West and 60° East, and between 10° North and 90° North.

**Note** – You can use the default zones, or configure the receiver to use particular SBAS satellites in the Integrated SBAS Satellite form (select GPS Controller / Setup / Real-time Settings). Refer to the GPS Controller Software Quick Reference Guide.

## Using Real-time Corrections from other sources

You can use corrections from an external correction source, such as an external beacon receiver, or a DGPS radio, directly into the receiver's serial ports, or you can connect a mobile phone to a field computer and pass the corrections onto the receiver.

Use the GPS Controller software to set up and monitor the real-time input source that you want to use (see [page 24](#)).

**Note** – If the TerraSync software or the GPScorrect extension for the ESRI ArcPad software is installed, configure real-time settings in that application instead of in the GPS Controller software.

## Antennas

The GPS Pathfinder Pro series receivers contain an internal antenna, which is suitable for use in most conditions. You can also connect an external patch antenna if you wear the receiver on the belt clip, or when you work in a vehicle. When you collect H-Star data with a ProXH receiver, you can connect an external Zephyr antenna for improved accuracy.

## Accuracy

The GPS Pathfinder Pro series receivers are high performance GPS receivers that calculate very accurate GPS positions. The GPS Pathfinder ProXT receiver provides reliable submeter (RMS) positioning with both real-time and postprocessed differential correction. The GPS Pathfinder ProXH receiver with H-Star technology provides postprocessed accuracies of subfoot (30 cm RMS) or eight inches (20 cm RMS) when used with a with an optional Zephyr antenna. In real-time, the ProXH receiver delivers submeter (RMS) accuracy. For more information about H-Star technology, refer to the white paper at [www.trimble.com/PathfinderProXH\\_WP.asp](http://www.trimble.com/PathfinderProXH_WP.asp).

**Note** – RMS means that approximately 63% of the positions are within the specified value.

## Factors that affect accuracy

The accuracy that you obtain from your GPS Pathfinder Pro series receiver depends on several factors, including:

- Receiver type (ProXT or ProXH)
- Number of visible satellites
- Multipath
- Position Dilution of Precision (PDOP)
- Signal-to-Noise Ratio (SNR)
- Satellite elevations
- Occupation time at a point
- Data collection and postprocessing techniques
- Type of antenna

## Differential GPS positioning techniques

Differential GPS (DGPS) requires two or more receivers. One receiver, called the reference station, is located at a known point to determine the GPS measurement errors and compute corrections to these errors. An unlimited number of mobile GPS receivers, commonly called rovers, collect GPS data at unknown locations within the vicinity of the reference station. Errors common at both the reference and rover receivers are corrected with DGPS either in real time or during postprocessing.

The following differential GPS positioning techniques can be used with the GPS Pathfinder Pro series receivers:

- Real-time DGPS - in real-time DGPS, the reference station calculates and broadcasts the error for each satellite as each measurement is received, permitting rover users to immediately see differentially corrected data.

Real-time DGPS sources include external beacon and radio sources, as well as Satellite Based Augmentation Systems (SBAS) such as WAAS in the US and EGNOS in Europe, and Virtual Reference Station (VRS<sup>®</sup>) systems. SBAS and VRS systems use multiple reference stations in a network to calculate the DGPS corrections which are then delivered to the user from a Geostationary satellite (SBAS) or from a radio or cell phone (VRS).

- Postprocessed DGPS - in postprocessed DGPS, measurements from the reference station are logged to a computer so that users can download the correction files and differentially correct their data on return to the office.

Postprocessed DGPS typically uses only one reference station, however, when differentially correcting data collected with ProXH receivers with H-Star technology logging enabled, you can select multiple reference stations to correct the file against for improved accuracy.

- Postprocessed real-time DGPS - postprocessed DGPS positions are generally more accurate than DGPS positions obtained in real time. If you collect SuperCorrect records, or H-Star data with the ProXH receiver, as well as GPS positions using the TerraSync software or the GPSCorrect extension, or applications developed using the GPS Pathfinder Tools SDK, you can postprocess your files in the GPS Pathfinder Office software or the GPS Analyst extension to improve accuracy.

The accuracy using postprocessed real-time DGPS is the same as for postprocessed DGPS (see the previous section).

***Note** – For more information about GPS and DGPS, review the All About GPS tutorial on the Trimble website at [www.trimble.com/gps](http://www.trimble.com/gps).*

### Factors that affect postprocessed DGPS accuracy

Postprocessed differential correction improves the accuracy of GPS positions. In addition to general factors that affect accuracy, there are other factors that affect the accuracy of postprocessed DGPS positions including:

- Distance between reference station and rover receivers
- Receiver type at reference station
- Accuracy of the reference station position
- The logging interval at the reference station
- The reference station uses the correct antenna

### Factors that affect real-time DGPS accuracy

Real-time DGPS offers similar accuracies to postprocessed GPS. However, in addition to the factors listed under [Factors that affect real-time DGPS accuracy \(see page 31\)](#), there are other factors that affect the accuracy of real-time DGPS positions, including:

- Update rate of the corrections
- Corrections based on a different datum

## Resetting GPS

The GPS Controller and TerraSync software, and the GPSCorrect extension all have options to reset the receiver to:

- delete the almanac
- delete information stored on the last known position
- restart the receiver
- reset the GPS receiver to factory defaults

# Caring for and Storing the GPS Pathfinder Pro series receivers

## Servicing

If the receiver requires servicing, contact your support provider.

## Cleaning

Keep the outer surface, the external antenna port, and the serial port free of dirt and dust.

To clean the GPS Pathfinder Pro series receiver, wipe it with a clean dry cloth.

## Storage

If you are not going to use the receiver for some time, charge the battery to approximately 30% and then turn off the receiver.

To use the receiver after storage, turn on the receiver and then:

1. Fully recharge the battery in the receiver, ***with the receiver turned on***, see [Charging the Battery, page 10](#).
2. Check that the Bluetooth radio is activated and on, see [Turning on the receiver and the Bluetooth radio, page 13](#).





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