Final
Field Sampling Plan Addendum
for
Occidental Chemical Corporation Property and Wastewater Treatment Plant Data Gap 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 2011

Prepared for

U.S. Army Corps of Engineers
Baltimore District

Contract W912DR-06-D-0002
Delivery Order 0009 Modification 03

Prepared by

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Approvers:

[redacted] 22 August 2011

Michael Dorman — Date
Project Manager

[redacted] 18 July 2011

Peter Li, PhD — Date
Program Manager

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 2011

Sandy Staigerwald (EA) Date
Senior Technical Reviewer

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] 20 July 2011

Thomas Bachovchin (ERT) Date
Independent Technical Reviewer

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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 6	Vicinity Shops
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_3	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
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	Wastewater Treatment Plant
µg/L	Micrograms per liter
°C	degrees Celsius

EXECUTIVE SUMMARY

Under contract number W912DR-06-D-0002, Modification 03 to Delivery Order 0009 with the U.S. Army Corps of Engineers (USACE) Baltimore District, ERT has been tasked with conducting additional data gap investigation activities at the Occidental Chemical Corporation Property (OCCP) and the former wastewater treatment plant (WWTP) (EU 7) in support of an ongoing Remedial Investigation (RI) and Feasibility Study (FS) at the former Lake Ontario Ordnance Works (LOOW) site in Niagara County, New York (NY).

The work at OCCP and EU 7 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 3 May 2011. The work being performed at the OCCP will address aerial photographic features (referred to as “anomalies”) previously identified on the OCCP to determine if U.S. Department of Defense (DOD) activities at the property resulted in potential impacts. The anomalies to be investigated at the OCCP have been previously detailed in the *Examination of Historical Aerial Photography – Selected Sites, Former LOOW* (USATEC, 2002) and the *Final Management Action Plan for the Former LOOW, Niagara County, New York* (USACE/EA, 2009). USACE performed site reconnaissance in November 2010 and April 2011 to inspect the anomaly locations identified in the USATEC report and the Final Management Action Plan. Based on USACE inspection of the anomaly locations, nine anomalies were identified and four were recommended for further investigative action. The work being performed at the WWTP will confirm or deny groundwater polycyclic aromatic hydrocarbon (PAH) constituents identified previously during Phase IV RI activities. Data generated from the OCCP activities will be used to supplement previous data and complete an RI report specific to the OCCP. Data generated from the sampling activities at the WWTP will be used to support the feasibility study at the WWTP.

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 additional OCCP and WWTP Data Gap Investigation activities. The associated Quality Assurance Project Plan (QAPP) Addendum (USACE/ERT, 2011a) comprises part two of the SAP. The SAP should be reviewed in conjunction with the other planning documents associated with the investigations, including:

- Quality Assurance Plan (USACE/ERT, 2009a, 2010a, 2011a)
- Site-Specific Safety and Health Plan Addendum (USACE/ERT, 2009b, 2010b, 2011b)
- Radiation Safety Plan Addendum (USACE/ERT, 2009c)
- Field Sampling Plan Addendum (USACE/ERT, 2009d, 2010c)

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, 2009e) and Munitions and Explosives of Concern Support Services Plan Addendum (USACE/ERT, 2009f).

In preparation of the final Phase IV RI, the Human Health Risk Assessment Work Plan (USACE/ERT, 2009g), and Screening Level Ecological Risk Assessment Work Plan (USACE/ERT, 2009h) will be utilized for providing the respective technical approach for determining associated risk.

The investigations covered by this addendum will employ the same sampling and analytical protocols and methods as those utilized in the previous OCCP Data Gap Investigation and Phase IV RI activities in order to maintain consistency of method reproducibility and representativeness of data. Therefore, this document is presented as an addendum to the *Final FSP Addendum for OCCP Data Gap and Lewiston-Porter Central School District (LPCSD) Investigation at the Former LOOW, Niagara County, New York* (USACE/ERT, 2010c) and the *Final FSP Addendum for Phase IV RI/Feasibility Study (FS) at the Former LOOW, Niagara County, New York (USACE/ERT, 2009d)*. However, because sampling locations, number of samples, and sampling rationale differ from those presented in the previous FSP addendum, 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.

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1.0 INTRODUCTION

This FSP is part one of an addendum to the previously approved *Final FSP Addendum for OCCP Data Gap and Lewiston-Porter Central School District (LPCSD) Investigation at the Former LOOW, Niagara County, New York* (USACE/ERT, 2010c) and the *Final FSP Addendum for Phase IV RI/Feasibility Study (FS) at the Former LOOW, Niagara County, New York (USACE/ERT, 2009d)*. The Sampling and Analysis Plan (SAP) is comprised of this *OCCP and Wastewater Treatment Plant Data Gap Investigation FSP Addendum*, herein referred to as "FSP" and the *OCCP and Wastewater Treatment Plant Data Gap Investigation Quality Assurance Project Plan (QAPP) Addendum at the Former LOOW, Niagara County, New York (USACE/ERT, 2011a)*, herein referred to as the "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.

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. 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. 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, 2011b), QAPP Addendum (USACE/ERT, 2011a) and Radiation Safety Plan Addendum (USACE/ERT, 2009c) collectively comprise the Work Plan for the OCCP Data Gap Investigation at the former LOOW.

1.1 Site History

In 1942, the War Department obtained a 7,500-acre parcel in northwestern Niagara County for the construction of a trinitrotoluene (TNT) production facility designated LOOW (Figure 1-1). TNT production, product support and storage occupied 2,500 acres of the eastern parcels. The remaining 5,000 acres were left undeveloped, acting as a buffer zone and allowing for the possible expansion of production. Expansion never occurred and in 1943, after 9 months of operation, LOOW was decommissioned due to excess TNT production at other facilities. The eastern 2,500 acres, which was the production area, was subsequently used by various other agencies of the DOD, including the Air Force and Navy, which later constructed manufacturing plants, Air Force Plant 68 (AFP-68) and the Navy Interim Production Pilot Plant (IPPP) respectively, for high efficiency borane fuels. The Army subsequently used the acreage for the construction of a Nike Missile Base.

In the mid 1940s, 1,500 acres of the southern portion of the former LOOW were transferred to the USACE, Manhattan Engineer District. The Manhattan Engineer District later became the U.S. Atomic Energy Commission (AEC), then the Energy Research and Development Administration (ERDA) and finally the U.S. Department of Energy. During operation, radioactive materials were stored on portions of the 1,500 acres. However, between the 1950s and 1980s, radioactive materials formerly housed on the acreage were consolidated and removed to the current 191-acre Niagara Falls Storage Site (NFSS) area. During the investigations and consolidation, the acreage surrounding the NFSS that was formerly used by the AEC and its predecessor was designated as "Vicinity Properties" (VP) to facilitate the clean up and closure. The NFSS and remaining open VPs are currently being addressed under the Formerly Utilized Sites Remedial Action Program (FUSRAP).

1.1.1 WWTP History

The WWTP was constructed in 1942 to support the LOOW facility and was used to treat wastes from the LOOW sanitary sewer and acid waste lines. The WWTP was comprised of a sewage pump house, venturi vault, Imhoff settling tank, sludge beds, a chlorine contact tank, acid neutralization building, collection tank and final mixing houses, as well as underground utility lines used to convey wastes between these facilities. TNT process wastewater was also diluted at the WWTP. Wastes were discharged to a 30-in. diameter outfall line that exited the WWTP to the west and traversed from the WWTP to the Niagara River. After LOOW activities ceased, the plant was utilized by Air Force Plant 68 (AFP-68), Air Force Plant 38 (AFP-38), the Navy IPPP, the NIKE Base, the Boron-10 Plant (a non-DOD facility), and for disposal of thiocyanate wastes [New York State Assembly Task Force on Toxic Substances (NYSATF) 1981]. AFP-38 operated from approximately 1950-1979 and was used for rocket, missile, and laser research and development. AFP-68 operated from approximately 1957-1959 and was a boron-based high energy fuels research and development project. The former LOOW WWTP was used for treatment of production wastes from both of these facilities. The NIKE Missile Base was operated by the U.S. Army from 1954 to 1966, and the former LOOW WWTP received sanitary wastes from the facility. The Navy IPPP was built in 1956 for the production of type 2 high efficiency fuels. This facility utilized some of the existing TNT production waste lines and the former LOOW WWTP.

In addition to the WWTP, several support shops, referred to as the WWTP Vicinity Shops, were constructed in 1942 just west of the WWTP. The Vicinity Shops included a paint shop, fabrication shop, tool house, electrical shop, and portions of two unloading platforms

The Town of Lewiston acquired the two parcels which comprised the former LOOW WWTP and Vicinity Shops in 1975 (Figure 1-2). The Town WWTP property is bordered by WM property to the north and east, NFSS property to the south, and a National Grid power easement to the west. During the DOE investigation and consolidation of radioactive wastes, the Town of Lewiston property, including the WWTP, was designated VP X. Remediation at VP X included soil removal to a depth of 1.2 ft below ground surface around the structures of the WWTP and near the former railroad track on the southern border of the parcel group (at the NFSS boundary). VP X is currently designated a closed FUSRAP Site (Bechtel National Incorporated (Bechtel), 1992).

Prior to the acquisition of the WWTP land by the Town of Lewiston, a letter was prepared by the State Commissioner of Health outlining the land use restrictions that would be applied to the property in order for the state to approve the land transfer. The restrictions were imposed with the objective of protecting public health and safety and to "minimize danger to life and property from radiation hazards". The restrictions, which currently remain in place, indicate that the property cannot be used for residential purposes, schools, or hospitals, but it can be used for industrial or commercial activities. However, the aforementioned restrictions could be lifted if deemed appropriate by the Department of Health (DOH).

In addition to the above known DOD activities, an evaluation of historic aerial photos identified two anomalies on the property. One of the anomalies, located in the northern region of the Town of Lewiston property, was observed in an aerial photo from 1944. This anomaly was classified as "disturbed ground/scar" and was further described as a possible open storage area [Topographic Engineering Center (TEC), 2002]. The anomaly was not noted in subsequent photos, suggesting that it was not maintained or did not present enough of a physical disturbance to be noted on later photos. The second anomaly was noted in a photo from 1958 and appeared during the timeframe from which the property was being used by the AEC. The second anomaly is located primarily on WM property to the north, but is immediately adjacent to the property boundary with the Town of Lewiston.

1.1.2 OCCP History

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 TNT production area and WWTP (Figure 1-3). 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 and subsequent OCCP Data Gap Investigation.

1.1.3 Previous USACE Investigations Addressing OCCP and WWTP Properties

An ongoing RI is assessing the nature and extent of contamination associated with the former LOOW operations and subsequent DOD operations at AOCs fully eligible for investigation within the approved and ongoing DERP-FUDS HTRW program. During these previous RI phases, formerly used DOD AOCs, including the WWTP and presumed storage area on OCCP, were assessed to determine the appropriateness of combining areas into exposure units (EUs) to facilitate the ongoing risk assessment at the former LOOW. An assessment of proximity, contaminant type and distribution, AOC history, similar terrain/vegetation, and industrial processes was performed to determine how to combine the AOCs into EUs.

On OCCP, the presumed storage area was characterized during the Phase II RI and associated risk assessment and was defined as EU 8 (Figure 1-3) (USACE/EA, 2002).

Two EUs were identified on the Town of Lewiston WWTP parcels (Figure 1-2). EU 6 was identified as the WWTP Vicinity Shops and EU 7 was identified as the WWTP proper. The WWTP Vicinity Shops (EU6) were characterized during the Phase I and II RI and associated risk assessment (USACE/EA, 2002). The Vicinity Shops are not included in the project boundaries for the evaluation of the WWTP, discussed in this FSP. The WWTP was also included in previous investigations, including Phase I of the ongoing RI, but completion of the investigation was postponed, pending decisions on the eligibility of the site for additional evaluation under the ongoing HTRW and/or other FUDS projects.

1.1.3.1 Preliminary Contaminant Assessment (PCA)

A PCA of the WWTP was conducted in 1992 (USACE/Acres 1992), and involved the collection of samples from the pump house, chlorination tank, Imhoff tank, sludge beds, acid neutralization building, collection tank, mixing house, and the west drainage ditch. Samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, and metals. A subset of sludge, sewage, and soil samples were analyzed for explosives. A few VOCs were reported in an aqueous sample from the chlorination tank and in sediment samples from the west drainage ditch, while concentrations were below detection limits for the aqueous samples from the collection tank, acid neutralization building, pump house, and drainage ditch. Two phthalates were also detected in the sediment samples from the west drainage ditch. Elevated concentrations of VOCs, SVOCs (primarily polycyclic aromatic hydrocarbons [PAHs]), PCBs, and metals were reported in the sludge samples. The highest reported concentration of VOCs (497.8 micrograms per kilogram [µg/kg]) was reported in a sample from the pump house. The majority of the reported VOC constituents were benzene, toluene, ethyl benzene, and xylenes. A trace amount of 2,4-dinitrotoluene was reported in the sludge sample from the neutralization building. Trace concentrations of VOCs and SVOCs were also reported in the sewage and sludge samples from the mixing house (USACE/Acres 1992). A detailed description of previous sample results is available for review in the *Preliminary Contamination Assessment Report, Operable Unit No. 2, Volume I of II* (USACE/Acres, 1992).

1.1.3.2 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. Small bermed clearings and ground scars from the timeframe of DOD ownership were visible on the OCCP.

Additionally, historical photos from 1938 through 1956 showed a fenced in area within the southwest portion of the OCCP (the presumed storage area discussed in Section 1.1.2) (TEC, 2002), which may have indicated previous DOD use as a storage area.

The US Army Geospatial Center (AGC), near Alexandria, Virginia, completed an examination of historical aerial photos of 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.

1.1.3.3 Phase I RI

During the Phase I RI, subsurface soil samples were collected from below the 30-in. outfall line, which traverses both the OCCP and LPCSD property. 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 result s of the sample analysis, it was concluded that the results did not indicate an impact from the DOD marker compounds (USACE/EA, 1999).

The WWTP and Vicinity Shops were investigated during the Phase I RI. The RI included collection of surface soil, subsurface soil, and groundwater samples from both areas. Soil samples were field screened for VOCs, PAHs, PCBs, and TNT. PAHs were detected in each of the field screening samples; two of the samples from the WWTP area and two of the samples from the Vicinity Shops area had concentrations of total PAHs that were greater than NY State screening criteria. Other compounds were detected in the screening samples, but not at concentrations of significance.

Three samples from each area were selected for re-screening and laboratory analysis based on the initial field screening results. Boron and lithium were detected in the six confirmation samples, but at concentrations below current screening criteria (2004 Region 9 Preliminary Remediation Goals [PRGs] and 1998 NY State Technical and Operational Guidance). Some metals were detected at elevated concentrations (with respect to NY State criteria) in the samples from the Vicinity Shops area. Explosives were not detected in any of the confirmation samples. One groundwater sample was collected from the WWTP area and one from the Vicinity Shops area. Boron and lithium were detected in each groundwater sample, and the total concentration of boron in the sample from the Vicinity Shops area was greater than the NY State action level. In addition, metals were detected at elevated concentrations in the sample from the Vicinity Shops area. The explosive 1,3,5-trinitrobenze was detected in this sample as well, but at a concentration below NY State criteria. A detailed description of previous sample results is available in the *Report for Phase I Remedial Investigation at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, NY* (USACE/EA, 1999).

The Phase I RI concluded that there were potential PRP impacts at the WWTP, and therefore the area should not be investigated further under the HTRW project. It also concluded that the Vicinity Shops were not impacted by potentially PRPs, and that further evaluation of the elevated polycyclic aromatic PAH concentrations and the boron in groundwater should be conducted.

1.1.3.4 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) VOCs, SVOCs, Target Analyte List (TAL) metals, boron, lithium, pesticides, 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)flouranthene, 2,4,6-trinitrolouene 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 (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 PAHs, explosives, and metals were reported in the surface soil sample collected from beneath the degraded drum and associated contents.

Based on the results of the Phase II RI, the the presumed storage area was included in a human health and screening level ecological risk assessment.

1.1.3.5 Phase III RI

As recommended in the Phase II RI, the underground utilities present at the WWTP and Vicinity Shops were investigated as part of the Phase III RI for the former LOOW. Five types of utilities were present within the WWTP (EU 7) area of the Town of Lewiston property: acid waste lines; drains, pits, and sumps; sanitary sewer lines, wastewater lines, and a small portion of the 30-inch outfall line. Sludge, wastewater, and subsurface soil samples were collected from each line type, and analyzed for VOCs, SVOCs, PCBs, pesticides, and metals. The RI found that the sludge and wastewater in the WWTP Imhoff tank, chlorine tank, and the wooden discharge line from the acid neutralization building were some of the most impacted media at the LOOW facility.

The Phase III RI recommended that a HHRA be completed to evaluate the potential risks from chemicals of potential concern (COPC) associated with the underground lines and drains, pits and sumps.

1.1.3.6 Interim Removal Action for TNT Waste lines

The USACE performed an interim remedial action (IRA) on the TNT waste lines in 1999 (USACE/Radian, 2000). The IRA included removal of portions of the TNT line and cleaning and closing in place other portions of the lines. The portion of the TNT wastes lines on the Town of Lewiston property were cleaned and closed in place. Final administrative closure of the lines will take place as part of a FS once site-specific remedial goals are developed and post IRA confirmatory results can be compared to the remedial goals.

1.2 Project Organization and Responsibilities

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 1-4. 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

The key project team members are provided as Figure 1-4. Additional individuals may be added to the project team as warranted.

<u>Program Manager</u>

[redacted], 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. [redacted] has been the Program Manager for USACE HTRW projects for three years and has been managing USACE projects for over 15 years.

<u>Project Principle for Quality Control</u>

Mr. [redacted] is ERT's Chief Operating Officer and has 30 years experience in government contracting and quality assurance review. As the Project Principle, Mr. [redacted] 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.

<u>Project Manager</u>

Mr. [redacted] 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. Mr. [redacted] 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.

<u>Technical Task/Site Manager</u>

Mr. [redacted] 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.

<u>Field Team Leader</u>

Mr. [redacted] is Project Geologist who will serve as the Field Team Leader, responsible for organizing all field activities related to the OCCP and WWTP Data Gap Investigations, 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.

<u>Project Geologist</u>

Mr. [redacted] 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. Mr. [redacted] 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

Mr. [redacted] will 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

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.
- Performing the GIS and data management tasks.

EA will assist in the development of and will conduct STR reviews of all FSP planning and reporting documents

1.5 Other Subcontractors

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 USEPA Contract Laboratory Staged Electronic Data Deliverable.

1.5.2 Parratt-Wolff, Inc.

Parratt-Wolff 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.

1.5.3 Other Subcontractors

No additional subcontractors are anticipated during investigation activities. If necessary, new contractors will be utilized to ensure that the project quality objectives are maintained.

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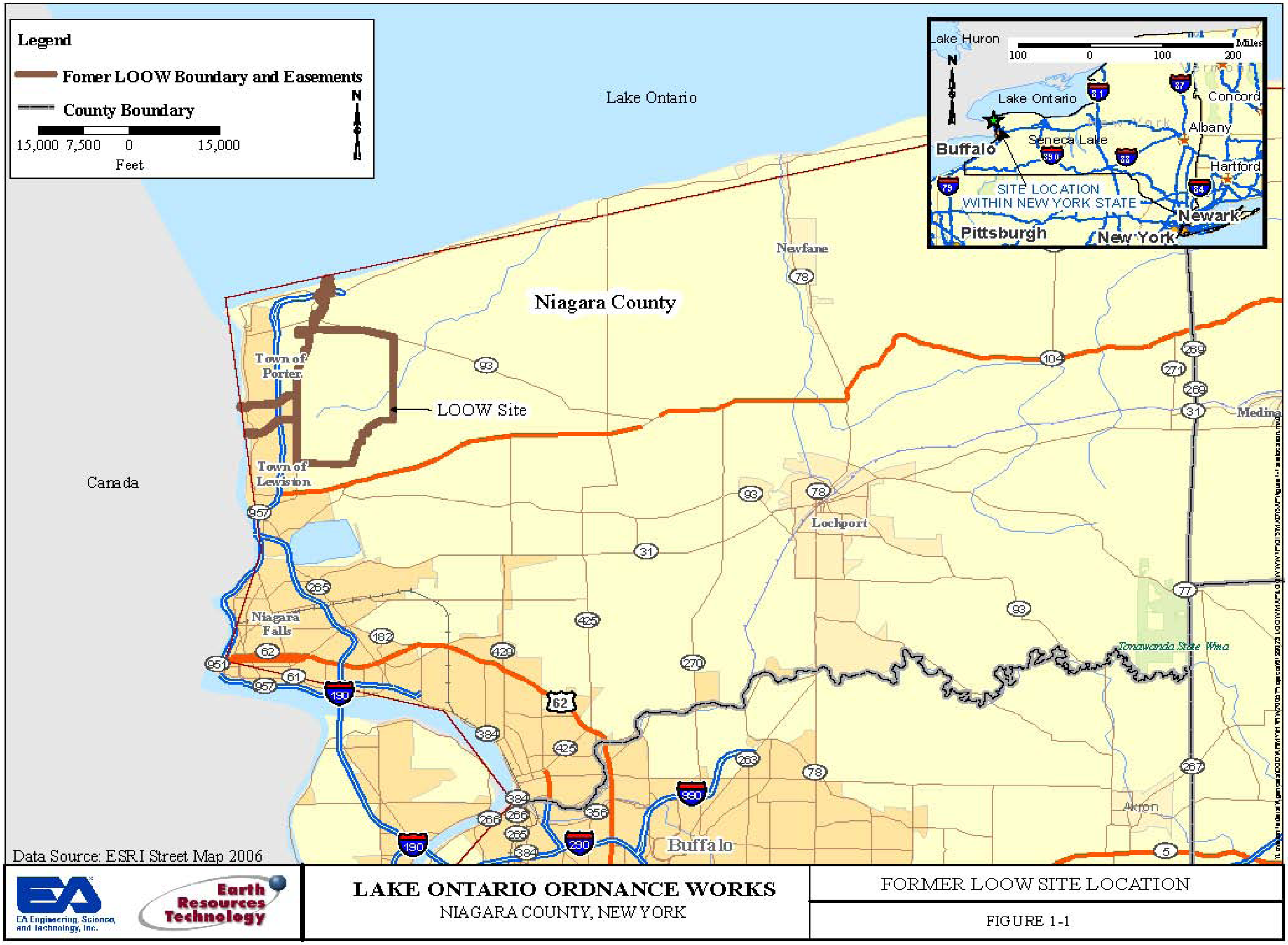

Figure 1-1. Former LOOW Site Location

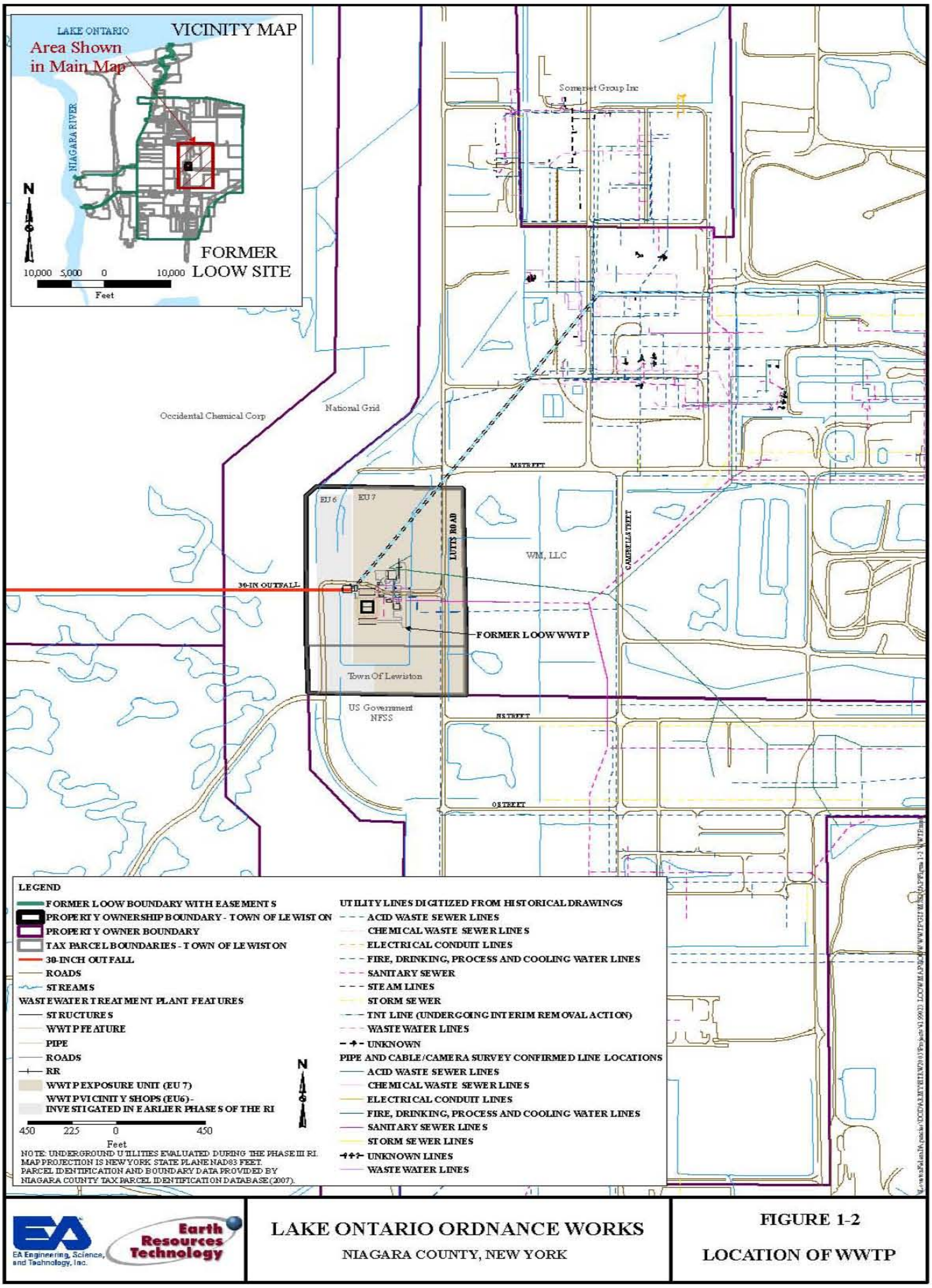

Figure 1-2. Former WWTP Site Location

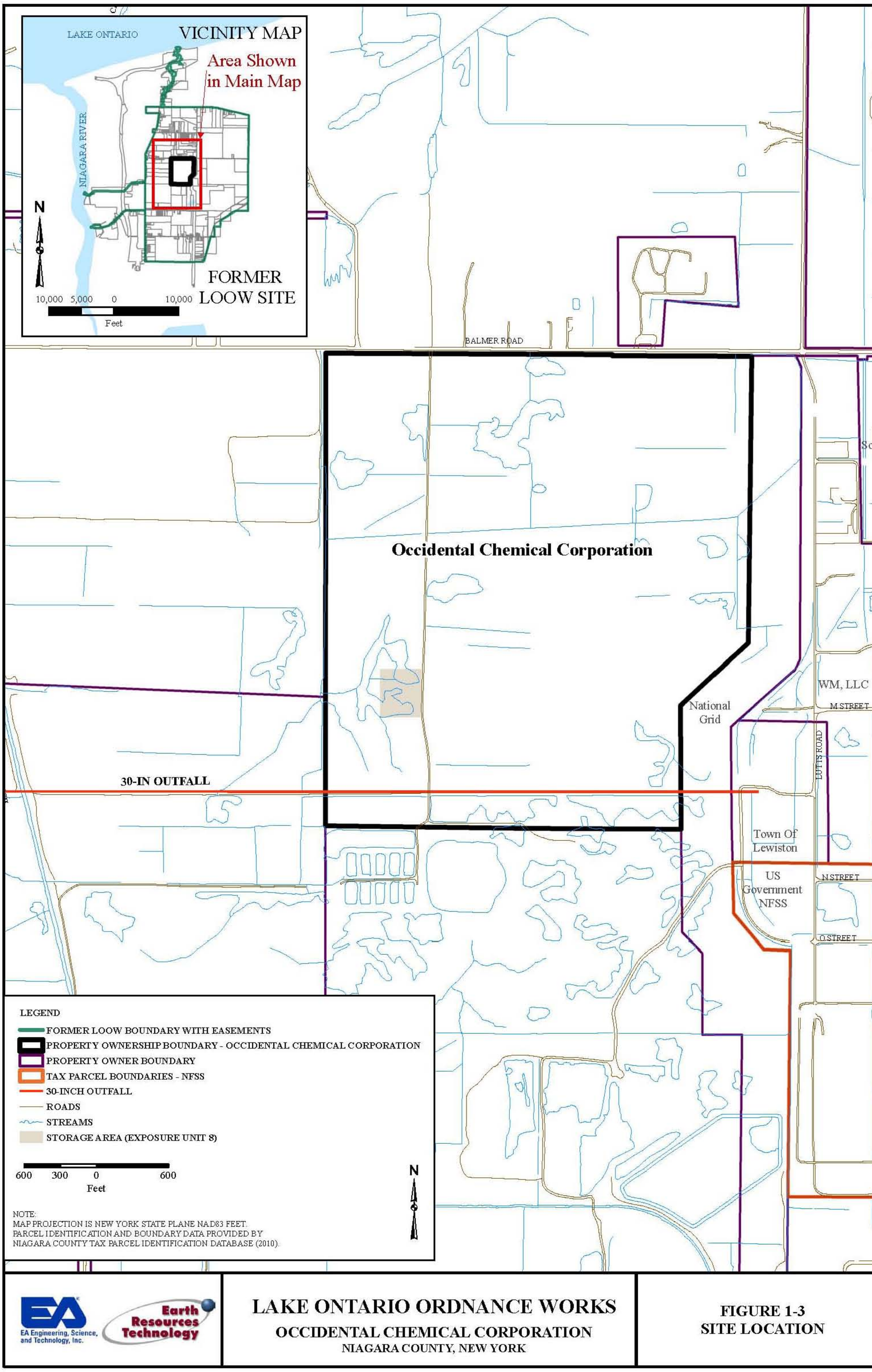

Figure 1-3. Occidental Chemical Corporation Site Location

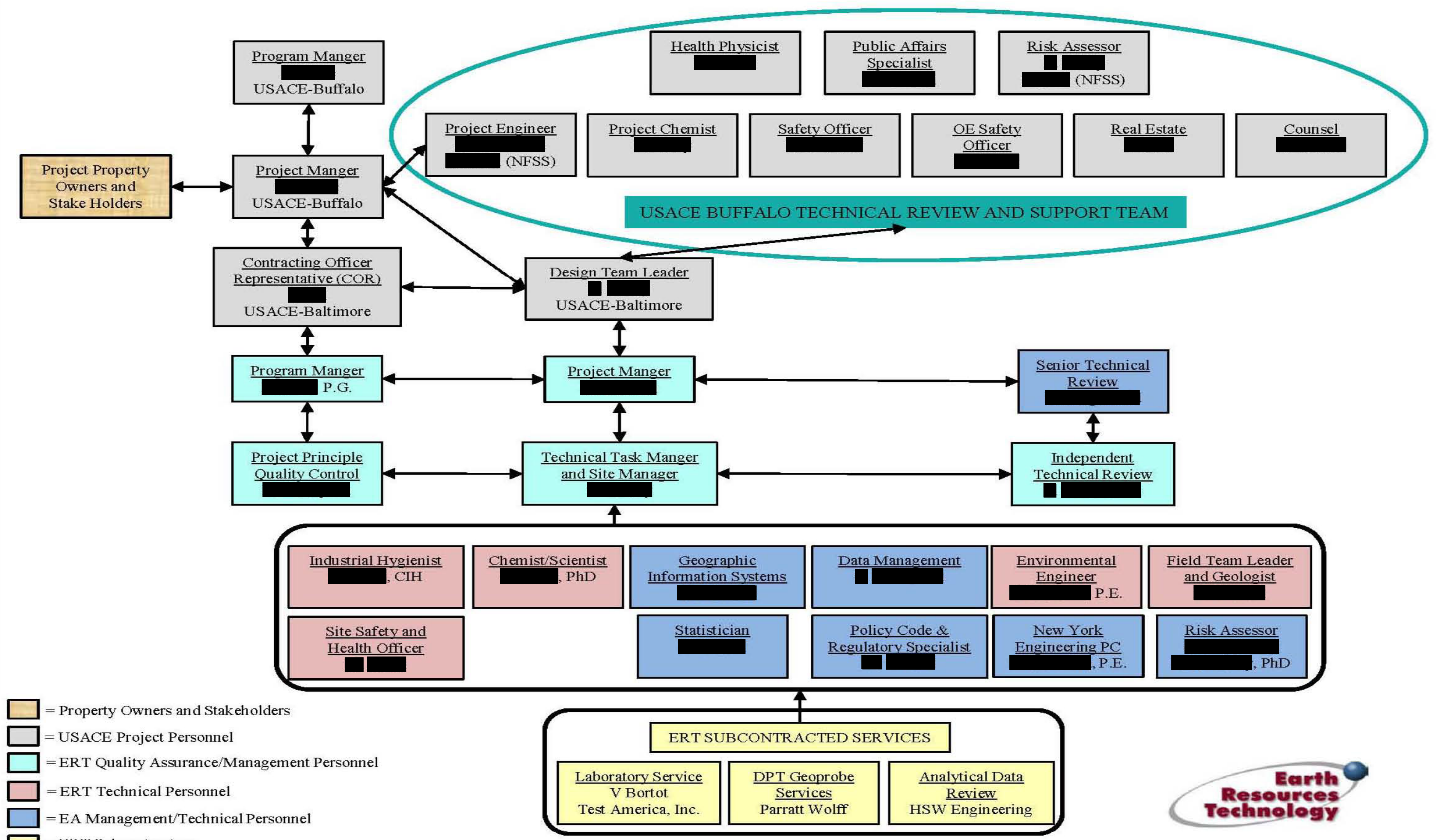

Figure 1-4 – Project Organization Chart

Figure 1-4. Project Organization Chart

2.0 PROJECT SCOPE AND OBJECTIVES

The SAP, inclusive of the FSP and accompanied by the QAPP, presents site-specific sampling locations for the OCCP and WWTP Data Gap 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. A summary of the scope of activities and the proposed field schedule is presented in the following.

Day 1: Mobilization to LOOW

- Travel to the site
- Rental/equipment procurement

Day 2: OCCP

- The ERT and USACE team will inspect the anomalies at Locations 3, 4, and 7 (Figure 5-1), as described in the statement of work, to determine locations for co-located surface and subsurface samples to be collected for laboratory analysis
- Flag sample locations and record geographical positioning system (GPS) coordinates;
    - Two locations to be sampled at Location 3
    - Three locations to be sampled at Location 4
    - Two locations to be sampled at Location 7
- Perform vegetation clearance, as necessary, at the selected sampling locations within Locations 3, 4, and 7
- The ERT and USACE team will perform site reconnaissance to locate Location 2 (pond)
- Upon locating Location 2, collect surface water and sediment samples for laboratory analysis, and record GPS coordinates
- Ship collected samples to the analytical laboratory

Day 3: OCCP

- Location 3
    - Advance borings at the two pre-determined locations and collect co-located surface and subsurface samples for laboratory analysis
    - Confirm GPS locations of the two sampling locations
- Location 4
    - Advance borings at the three pre-determined locations and collect co-located surface and subsurface samples for laboratory analysis
    - Confirm GPS locations of the three sampling locations
- Location 7
    - Advance borings at the two pre-determined locations and collect co-located surface and subsurface samples for laboratory analysis
    - Confirm GPS locations of the three sampling locations
- Ship collected samples to the analytical laboratory
- OCCP Sample Collection Notes

- Each boring will be advanced to native (undisturbed) soil, or 4 ft below ground surface (bgs), whichever is greater
- Surface samples will be collected from 0-1 ft bgs
- Subsurface soil samples will be collected from an interval between 1-4 ft bgs or to native soil, based on the following procedure:
  - Evidence of contamination or fill
  - Boundary between disturbed soil and undisturbed soil
  - Bottom of the boring.
- Unless impacted soil, sediment and surface water are observed, excess material will be returned to its origin (e.g. replaced in the borehole). Therefore investigative derived waste (IDW) will not be accumulated and waste characterization sampling unnecessary.

Day 4: WWTP/Demobilization

- Purge and collect environmental samples from the three existing groundwater monitoring wells at the former WWTP (well IDs C3-WWTP-MW-BP14, -BP15, and -BP15).
- Collect waste characterization sample for the aqueous purge water IDW.
- Ship collected samples to the analytical laboratory
- Demobilization

After demobilization and once characterization sample analysis is complete, accumulated IDW will be removed from the site.

2.1 Project Objectives

2.1.1 WWTP Data Gap Investigation Objectives

The objective of conducting additional groundwater sampling and analysis at the WWTP is to supplement the existing Phase IV RI analytical data and to confirm or deny the presence of groundwater PAH constituents identified during the first round of groundwater sampling at EU 7. PAH concentrations were unable to be adequately confirmed due to laboratory reporting limits (RLs) above the project screening criteria. By analyzing samples for low-level PAHs, the resulting additional analytical data will be used to evaluate whether PAH constituents actually exceed the U.S. Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) (USEPA, 2011). Risk will be re-evaluated based upon the new validated laboratory analytical data.

2.1.2 OCCP Data Gap Investigation Objectives

The objective of conducting the additional OCCP sampling activities is to determine if past DOD activities at previously identified locations (Locations 2, 3, 4 and 7) resulted in potential impacts to surface water, sediment, surface soil and/or subsurface soil. This additional analytical data will be used in coordination with data previously collected during the Phase I RI, Phase II RI, ongoing OCCP Data Gap Investigation and other pertinent historical information. This cumulative data set is intended to complete the characterization of the OCCP.

2.2 Screening Criteria

Although the screening of analytical data is not tasked in the current contract modification, the following information regarding the screening of analytical data as conducted during previous phases of the LOOW RI has been included in this work plan for consistency.

Project activities at the former LOOW are being performed under the Department of the Army DERP-FUDS program and are intended to investigate potential environmental impacts associated with former DOD activities. The former LOOW is not listed on the USEPA National Priorities List (NPL); however, ongoing investigation of the site strictly adheres to the CERCLA process. The NYSDEC provides regulatory and technical guidance for the LOOW project on behalf of NY State and the USEPA.

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, 2011). 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 areas (OCCP and WWTP) will be different, as the purposes of each investigation are also different. Specific criteria for data collected from the WWTP is detailed in the *Field Sampling Plan for Phase IV Remedial Investigation/Feasibility Studies at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, New York* (USACE/ERT, 2009d). Data from the additional sampling at the OCCP will be screened against USEPA RSLs and the NFSS background data.

Federal and State technical guidance documents may be relevant and appropriate for the evaluation of soil and groundwater constituents reported at EU 7. Human health risk-based U.S. EPA RSLs (USEPA 2011) will be used as screening criteria for evaluating reported chemical concentrations in soil and identifying COPC. 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 2009g). The RSLs will be used to screen out areas of sites, exposure pathways, or chemicals from further consideration, assuming certain conditions are present, or to determine that further investigation is warranted at a site. 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 Regional SLs are not intended to be used to represent the cleanup goals for a site and soil concentrations which exceed Regional SLs should not be considered to represent intrinsic risk.

U.S. EPA Soil Screening Level Guidance (USEPA 1996) was used to develop site-specific SLs for the protection of groundwater during the Phase II RI and revised, as appropriate, during the Phase III RI (USACE/EA, 2002, 2008). The derivation is consistent with NYSDEC guidance documents. The protection of groundwater SLs provide a basis for the assessment of the ability of chemicals to leach from the soil and accumulate in groundwater. The protection of groundwater SLs represent a soil concentration below which there is minimum risk of groundwater contamination exceeding target concentrations. The target concentrations in groundwater are typically enforceable drinking water standards that are protective of human health. The NYSDEC TOGS Ambient Water Quality Standards and Guidance Values (NYSDEC 1998) were used as target groundwater concentrations in the establishment of the SLs. Therefore, if soil concentrations remain below impact to groundwater SLs, groundwater concentrations should also remain below NYSDEC TOGS and Guidance Values.

No additional revision to the protection of groundwater RSLs is proposed. A dilution attenuation factor (DAF) of one (negligible) has been used during previous phases of the RI and will continue to be used for the current phase of the RI. The DAF is used to account for concentration reductions through natural attenuation processes including adsorption onto soil, chemical transformations, degradation, and dilution within unaffected groundwater sources. Refer to the previously approved Phase II (USACE/EA, 2002) for a more detailed description of the development of the protection of groundwater SLs.

2.3 Selection of COPCs

Screening of reported concentrations against criteria for assessing potential human health risks from soil, sediment, surface water and groundwater will be performed during reporting and risk assessment tasks of the Occidental Data Gap Investigation and Phase IV RI, respectively. Risk-based screening levels will be used in identification of COPC. Screening levels are medium (i.e., soil, groundwater, etc.) and exposure specific. Identification of COPC for EU 7 (the WWTP) will be determined by comparing the results to the EPA RSLs (USEPA 2008).

U.S. EPA RSLs are available for lead in residential soils. Therefore, the maximum detected lead concentration in soil will be compared to the U.S. EPA residential RSL of 400 milligram/kilogram (mg/kg) (USEPA 2008). The maximum detected lead concentrations in groundwater will be compared to the U.S. EPA action level (AL) of 15 microgram/liter (µg/L) for lead in residential and public drinking water (USEPA 2008).

2.4 Additional Screening Considerations

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 sediment and surface water data collected from the pond.

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.

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3.0 NONMEASUREMENT DATA AQCUISITION

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 geology, hydrology and soil information from other sources
- Site-specific aerial photographs from various sources
- Historical as-built drawings and figures of the WWTP and OCCP

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)

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4.0 PRE-SAMPLING ACTIVITIES

Prior to sample collection, the pre-sampling activities described in the following subsections will be performed. These activities include ensuring the rights-of-entry (ROEs) are valid; conducting meetings, as appropriate, with property owners so they are aware of the possible impacts to site-use; municipal and private utility checks; brush clearance and any other site preparation.

4.1 Rights-of-Entry

It is required that ROEs be obtained prior to the mobilization for the field activities. ROEs have been established for the Town of Lewiston property and all caveats of the agreement are intended to be adhered to. Because of this, ROEs have been reviewed to ensure the agreement is valid and has not expired. A copy of the agreement will be kept onsite during the field activities and referred to as necessary. It is intended to coordinate all site activities with the USACE and the property owner to ensure all parties are aware of ongoing and upcoming activities.

4.2 Pre-Activity Meetings

Prior to beginning intrusive activities on the WWTP property, several meetings will be required. Waste Management (WM) requires personnel scheduled to perform work, or in this case traverse WM property to access the WWTP, to undergo a safety and emergency procedure briefing conducted by WM personnel. These requirements include, but are not limited to, donning of appropriate personal protective equipment (PPE), knowledge of emergency rally points specific to the areas where personnel will be conducting work, and recognition of the WM emergency warning system. 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.

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

The current site owners have indicated that no private utilities have been installed on the properties to their knowledge. As per the previously approved Phase IV RI FSP (USACE/ERT, 2009d), New York One Call will be contacted to perform utility location and mark outs for the property. New York State One-Call performs utility clearance through the Dig Safely New York Program. The phone number for the call-in center is (800) 962-7962. Prior to intrusive activities, requests for utility locations and clearance will be made.

The serialized reference number issued by One-Call will be recorded and maintained as evidence of the clearance request and to assist in referencing specific requests made to utility companies. The Site Manager will ensure that each utility company and potential active line has been appropriately marked.

Utility location services use the following standard color coding system to distinguish line types:

- Electric – Red
- Gas, oil, and/or television – Orange
- Water – Blue
- Sewer – Green
- Temporary Survey marking – Pink

Field personnel will confirm with the Site Manager that all utility clearance has been conducted prior to commencing intrusive activities. If utilities are present within the work area, a minimum of 3-ft distance will be maintained between the marked utility and the intrusive activity. In the event that an active line is encountered, the utility owner and/or New York One-Call will be notified.

4.4 Brush, Vegetation and Other Debris Clearance

Brush clearance may be required to access certain sample locations throughout the OCCP and the WWTP. 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 will be conducted by hand to access sampling locations, as necessary. A sample of site vegetation will be field screened by USACE-Buffalo District staff for radiological impacts exceeding the background as described in the Radiation Safety Plan Addendum (USACE/ERT, 2009c) prior to clearing. If vegetation exhibits radioactivity greater than limits described in the RSP, the ERT and USACE PM will be notified immediately and a decision will be made as to whether the vegetation should be disturbed and managed separately, sampled to confirm radioactivity through laboratory analysis, or remain in place. If elevated radioactive levels are observed, field activities will be suspended until appropriate actions are determined. Brush and vegetation, without detected radiological impacts, that was removed to gain access to sampling locations will be spread on site.

4.5 Cleanup of Suspected ACM

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

5.0 FIELD SAMPLING PLAN

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

OCCP Data Gap Investigation Objectives

- Evaluate four aerial photographic features ("anomalies" identified as Locations 2, 3, 4, and 7) previously identified on the OCCP to determine if previous DOD activities resulted in potential impacts.
- Collect one surface water sample from the pond at Location 2 and analyze the sample for TCL VOCs via USEPA Method 8260B, TCL SVOCs via USEPA Method 8270C, explosives via USEPA Method 8330, PCBs via USEPA Method 8082, and TAL metals, boron and lithium via USEPA Method 6020A/7000 series.
- Collect one sediment sample from the pond at Location 2 and analyze the sample for TCL VOCs via USEPA Method 8260B, TCL SVOCs via USEPA Method 8270C, explosives via USEPA Method 8330, PCBs via USEPA Method 8082, and TAL metals, boron and lithium via U.S. EPA Method 6020A/7000 series. In addition, field measurements will be taken for temperature, conductivity, pH, oxidation-reduction potential, dissolved oxygen and turbidity utilizing a multi-meter (Horiba Model U-52, or similar).
- Collect 14 additional soil samples from anomalies associated with Locations 3, 4, and 7 (7 surface soil samples and 7 subsurface soil samples) and analyze the samples for TCL VOCs via USEPA Method 8260B, TCL SVOCs via USEPA Method 8270C, explosives via USEPA Method 8330, PCBs via USEPA Method 8082, TAL metals, boron and lithium via USEPA Method 6020A/7000 series. Location 3 soil samples will also be analyzed for hexavalent chromium via USEPA Method 7196A.
- If the radiological field screening results are greater than twice the background levels and requested by USACE PM or representative, laboratory analysis for radionuclides will be performed as outlined below:
  - Radium 226 (DOE HASL 300 Ra-006-RC Mod)
  - Gross Alpha and Gross Beta (USEPA 9310 Mod).
  - Gamma Spectroscopy, Isotopic Uranium, Isotopic Plutonium, Isotopic Thorium (DOE HASL 300 A-01-R Mod)
  - Strontium 90 (DOE HASL 300 Sr-03-RC)

WWTP Data Gap Investigation Objectives

- Collect three additional groundwater samples from existing groundwater monitoring wells. Groundwater samples will be analyzed for low-level PAHs via USEPA Method 8270C SIM.
- Confirm or deny the presence of previously identified PAHs in groundwater.

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)

Sampling protocols, or standard operating procedures (SOPs), are provided in Appendix B of this FSP. Surface and subsurface soil samples are co-located at the proposed sample locations. Anomalies and former DOD areas of concern identified evaluating historic photographs and site reconnaissance will be targeted for sample collection and analysis. Sections 5.2 and 5.3 provide additional details concerning sample location and rationale.

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.

Table 5-1. Proposed Analytical Sample Parameters

Sample Program	Sample Matrix					Analytical Samples and Methods							
	Surface Soil	Subsurface Soil	Sediment	Surface Water	Groundwater	TCL VOCs (SW846 8260B)	TCL SVOCs[3] (SW846 8270C)	Explosives (SW846 8330)	PCBs (SW846 8082)	TAL Metals[4] (SW846 6020A)	Boron	Lithium	Radiological[1]
OCCP Data Gap Investigation													
Biased Samples – Occidental Property	7	7	1	1	-	16	16	16	16	16	16	16	1
Field Duplicate (collection frequency of 10% of normal samples)	1	1	1	1	-	4	4	4	4	4	4	4	1
Equipment Rinsate Blanks (frequency of one per day per media per equipment type)	1	1	1	1	-	4	4	4	4	4	4	4	1
Matrix Spike/Matrix Spike Duplicate (MS/MSD) (collection frequency of 5% of normal samples)	1	1	1	1	-	4	4	4	4	4	4	4	1
Trip (1 per cooler containing aliquots for VOC analysis)[2]	1	-	1	-	-	2	-	-	-	-	-	-	-
WWTP Data Gap Investigation													
Biased Samples - WWTP Groundwater MWs	-	-	-	-	3	-	3	-	-	-	-	-	-
Field Duplicate (collection frequency of 10% of normal samples)	-	-	-	-	1	-	1	-	-	-	-	-	-
Equipment Rinsate Blanks (frequency of one per day per media per equipment type)	-	-	-	-	1	-	1	-	-	-	-	-	-
MS/MSD (collection frequency of 5% of normal samples)	-	-	-	-	1	-	1	-	-	-	-	-	-
Trip (1 per cooler containing aliquots for VOC analysis)[2]	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] 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)

[2] 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

[3] Groundwater samples collected at the WWTP will be analyzed for low-level PAHS only via USEPA Method 8270C SIM

[4] surface and subsurface samples collected from Location 3 will also be analyzed for hexavalent chromium via USEPA Method 7196A

5.2 Biased Sampling

Biased sampling has been included in the FSP Addendum and is designed to target historic locations which may constitute a higher potential for impacts. These areas include the known locations of previously identified anomalies 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.

Biased analytical samples will be collected from four locations at the OCCP: Location 2, Location 3, Location 4 and Location 7.

At Location 2, one biased surface water sample and sediment sample will be collected. At Location 3, two biased sampling locations will be allocated, co-located surface and subsurface samples will be collected from each biased location. At Location 4, three biased sampling locations will be allocated, co-located surface and subsurface samples will be collected from each biased location. At Location 7, two biased sampling locations will be allocated, co-located surface and subsurface samples will be collected from each biased location. Each location will be visually inspected for evidence of impacts. If impacts are observed, the biased samples will be collected from the area of visual evidence of potential impacts. If no visual evidence of potential impacts are determined, a location will be selected based on professional judgment and the existing environmental conditions at the location. Table 5-2 below summarizes the sample requirements for each of the identified locations.

Table 5-2. Location Specific Sample Quantity Requirements

Location	Centroid X Coordinate[1]	Centroid Y Coordinate[1]	Type	Quantity	Sample Collection Method
2	1039233.201	1176405.953	Surface Water	1	Direct collection into sample container
			Sediment	1	Disposable scoop
3	1037348.890	1176061.102	Surface Soil/Fill	2	Geoprobe® Macrocore Sampler
			Subsurface Soil/Fill	2	
4	1037392.935	1174726.053	Surface Soil/Fill	3	Geoprobe® Macrocore Sampler
			Subsurface Soil/Fill	3	
7	1037458.944	1173961.767	Surface Soil/Fill	2	Geoprobe® Macrocore Sampler
			Subsurface Soil/Fill	2	

Note: Additional samples may be collected based on field observations
[1] – Centroid X and Y coordinates are provide in NAD 1983 State Plane New York West.

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 (USACE/ERT 2011b). The project-specific target compound and analyte lists are also available in the project QAPP Addendum (USACE/ERT 2011b). 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 FSP Addendum for OCCP Data Gap and Lewiston-Porter Central School District (LPCSD) Investigation at the Former LOOW, Niagara County, New York* (USACE/ERT, 2010c) and established in the ERT Standard Operating Procedures presented as Appendix B of this FSP. 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, groundwater and waste characterization sampling. Direct push drilling (Geoprobe® or equivalent) will be utilized to collect both surface and subsurface soil sample cores. Grab samples will be collected utilizing appropriate hand-held disposable sampling equipment for the sediment, surface soil, subsurface soil and surface water samples, respectively. Groundwater samples collected from the WWTP will be collected using low-flow procedures. 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 composite sampling. 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 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.

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

Surface and subsurface soil samples will be collected from various biased sampling locations at Location 3, 4 and 7 at the OCCP. Figures 5-1 summarizes the sample locations proposed for this investigation. A total of 14 surface and subsurface samples will be collected: co-located surface and subsurface soil samples will be collected from two points at Location 3, co-located surface and subsurface soil samples will be collected from three points at Location 4, and co-located surface and subsurface soil samples will be collected from two points at Location 7. Actual sample locations at each of the locations will be determined based on field observations at the time of the investigation. GPS coordinates for each of the sample locations will be recorded by the field team in North American Datum (NAD) 1983 State Plane New York West and photographic evidence of each sample location will also be recorded.

Surface soil samples will be collected from the interval between 0 – 1 ft bgs. The subsurface soil samples, where borings will be advanced to either the fill/native soil interface or to 4 ft bgs, shall be collected using the following precedence:

- Evidence of contamination or fill
- Boundary between disturbed soil and undisturbed soil
- Bottom of the boring.

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

- Hexavalent chromium (Location 3 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 5-3. Table 5-4 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.

5.4.2.1 Sediment Sampling

Sediment samples will be collected by the sample team using disposal scoops. Once the sample location is determined, the sample team will remove any 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.

5.4.2.2 Direct Push Surface and Subsurface 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 surface and subsurface soil samples. Each boring will be advanced a previously described. 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, using a PID with a10.6 eV lamp (or approved equal) 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 core at the field geologist’s discretion.

Table 5-3. Analytical Parameters, Methods, Preservation and Container Requirements

Sample Matrix	Analytical Parameter	Sample Type[1]	No. of Samples[2]	Analytical Method	Sample Preservation	Holding Time[3]	Sample Container[4,5]
Soil/Sediment	VOCs (TCL)	Grab	15	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/Sediment	PCBs	Grab	15	SW-846 Method 8082	Cool to 4° C	14 days to extraction; 40 days from extraction to analysis	
Soil/Sediment	SVOCs (TCL)	Grab	15	SW-846 Method 8270C	Cool to 4° C	14 days to extraction; 40 days from extraction to analysis	(1) 8-oz glass jar
Soil/Sediment	Metals plus lithium and boron- total (TAL)	Grab	15	SW-846 Method 6020a/7000 Series	Cool to 4° C	28 days to analysis for Hg; 6 months to analysis for other metals	
Soil/Sediment	Explosives	Grab	15	SW-846 Method 8330	Cool to 4° C	14 days to extraction; 40 days from extraction to analysis	(1) 30g glass jar
Soil/Sediment	Hexavalent Chromium	Grab	15	SW-846 Method 7196A	Cool to 4° C	24 hours	4 oz glass jar w/ Teflon lid
Surface water	VOCs (TCL)	Grab	1	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	1	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	1	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	1	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 5-3. Analytical Parameters, Methods, Preservation and Container Requirements

Sample Matrix	Analytical Parameter	Sample Type[1]	No. of Samples[2]	Analytical Method	Sample Preservation	Holding Time[3]	Sample Container[4,5]
Surface water	Metals (TAL) including boron and lithium by Inductively coupled plasma/mass spectroscopy	Grab	1	SW-846 Method 6020a/7000 Series	pH<2 with HNO_3; Cool to 4° C	28 days to analysis for Hg; 6 months to analysis for other metals	(1) 500 mL polyethylene bottle
Groundwater	PAHs (low-level)	Grab	3	SW-846 Method 8270C SIM	Cool to 4° C	7 days to extraction; 40 days from extraction to analysis	(2) 1 liter (L) amber glass bottles
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

Table 5-3. Analytical Parameters, Methods, Preservation and Container Requirements

Sample Matrix	Analytical Parameter	Sample Type[1]	No. of Samples[2]	Analytical Method	Sample Preservation	Holding Time[3]	Sample Container[4,5]
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
Solid Waste/Liquid Waste	Gross Alpha/Beta	Grab	TBD	SW-846 Method 9310m	Cool to 4° C ; HNO_3 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_3 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_3 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_3 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_3 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_3 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 4^0 C; HNO_3 to pH <2	6 months	(1) 1 L polyethylene container

[1] 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.
[2] Actual numbers of samples may vary depending on field conditions, sample material availability, and field observations. Inclusive of environmental samples only and does not assume QA/QC samples. Refer to Table 5-1 for estimates of all samples to be collected.
[3] From date of sample collection
[4] I-Chem Series 300 bottles
[5] 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 5-4. Other Potential Analytical Parameters, Methods, Preservation and Container Requirements for IDW Characterization[1]

Sample Matrix	Analytical Parameter	Sample Type[1]	No. of Samples[2]	Analytical Method	Sample Preservation	Holding Time[3]	Sample Container[4,5]
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_2B (18th edition)	pH<2 with H_2SO_4; Cool to 4° C	28 days to analysis	(1) 100 mL polyethylene container
Liquid Waste	Nitrite	Grab	TBD	Standard Method (SM) 4500-NO_2B (18th 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 5-4. Other Potential Analytical Parameters, Methods, Preservation and Container Requirements for IDW Characterization[1]

Sample Matrix	Analytical Parameter	Sample Type[1]	No. of Samples[2]	Analytical Method	Sample Preservation	Holding Time[3]	Sample Container[4,5]
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

[1] 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.
[2] Actual numbers of samples will depend on other analytical results, sample material availability, and disposal facilities requirements.
[3] From date of sample collection
[4] I-Chem Series 300 bottles
[5] 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

5.4.3 Surface Water Sampling

In order to identify potential surface water impacts within Location 2, one biased surface water sample will be collected from locations along the shoreline of an unnamed pond (See Figure 5-1).

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 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 up-current while collecting the appropriate sample volume and minimize disturbing the bottom sediments.

In some situations, it may be necessary to use containers that do not have preservatives. 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 contained in vials for VOC analysis 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 Total 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 5-3. Table 5-4 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 Groundwater Sampling

In order to confirm or deny previously detected concentrations of PAHs in groundwater at the WWTP, an additional round of three groundwater samples will be collected and laboratory analyzed for low-level PAHs from three existing groundwater monitoring wells (Figure 5-2).

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 5-3. Table 5-4 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.

5.4.4.1 Well Purging

The objective is to ensure collection of a groundwater sample that is representative of the aquifer and not of stagnant water sitting in the well casing. A low-flow purging and sampling procedure will be utilized to avoid intrusion of particulates within the well or from the surrounding formation. Groundwater from each well will be purged until parameters have stabilized. A turbidity level of 10 NTUs or less is the well purging goal, but not an absolute value before sampling as natural groundwater turbidity levels may exceed the established value. Other field parameters including temperature, conductivity, pH, oxidation-reduction potential, and DO will also be monitored. With the exception of turbidity, field measurements will be taken from the flow cell and will be recorded during and after purging, and before sampling. An aliquot for turbidity measurement will be collected prior to flow through cell via a "T" valve or in line sampling port. Field parameters should generally be within ±10 percent for DO and turbidity, ±3 percent for specific conductivity three consecutive readings, at a minimum of two minutes apart, so that it may be determined when the parameters stabilize. Temperature is not an effective parameter to monitor groundwater stabilization due to the potential for groundwater temperature to be influenced by submersible pumps, and therefore although recorded, will not be a determining factor. Depth to water will also be monitored throughout the purging process.

Upon opening each monitoring well, the concentration of ionizable vapors in the headspace will be measured using a PID and water level measurements will be recorded using a decontaminated electronic oil-water interface probe. The depth to product (if present), depth to water, and the total depth will be measured from the top of the marked polyvinyl chloride (PVC) casing. Water level and free product (none anticipated) measurements will first be made and the volume of water in the well determined. The volume of water in the well will be calculated so that the number of well volumes purged and an estimate of the time required to purge the well can be made. Before sampling, the wells will be purged utilizing a low-flow submersible stainless steel pump using dedicated Teflon® or Teflon®-lined polyethylene tubing connected to a flow cell. Very low purging rates are proposed, on the order of 100 ml/minute to 500 ml/minute, to minimize suspension of particulate matter in the well.

The pump will be lowered into the well very carefully to prevent mixing of water and suspension of bottom sediment and subsequent entrainment onto sampling equipment. The pump intake will be placed 4 ft above the bottom of the well. Surging will be avoided. Pumps must be carefully cleaned between wells according to the procedures specified in Section 5.7. It is anticipated that no more than three well volumes will be purged in order for turbidity to reach a minimum and the other parameters to stabilize. Ideally, pumping rates will be at a rate so that no draw-down of the groundwater level occurs (i.e., pumping rate is less than recharge rate). During purging, ERT will actively monitor and track the volume of water purged and the field parameter readings. Data will be recorded in the field logbook. Purge water will be collected and stored in 55-gallon drums until properly characterized.

5.4.4.2 Well Sampling

Once groundwater parameters have stabilized, the flow will be reduced slightly, the flow through cell will be disconnected and a groundwater sample will be collected directly from the pump discharge. Prior to sample collection, the pump rate will be check to insure removal of the flow through cell did not cause an increase in flow rate. All sampling equipment will be cleaned according to the procedures specified in Section 5.8.

Pumping rates for withdrawing the samples will be similar to those followed for well purging.

The samples will be collected in sample bottles (pre-preserved, if appropriate), placed in iced coolers and removed from light immediately after collection. In addition, all sample bottles must be filled to the top so that aeration of the samples during transport is minimized. All bottles will be filled to avoid cascading and aeration of the samples, the goal being to minimize any precipitation of colloidal matter.

5.4.5 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 5-3. Additional analyses that may be required by the disposal facility (to be determined) are listed in Table 5-4. Sampling methods are briefly discussed below.

5.4.5.1 Solid Waste

It is not intended for solid waste to be generated during the sampling event. In the event gross contamination is encountered and solid waste containerized, a composite sample of the containerized solid waste will be collected using disposable scoops

5.4.5.2 Liquid Waste

As indicated by Table 5-4, liquid sampling methods include utilizing dedicated dippers. Dippers are used to collect samples from the surface of the liquid, and are appropriate for wastes that are homogeneous.

5.4.5.3 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.

5.4.6 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 surface water, sediment and soil 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 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.

5.5.2 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 or distilled water;
- Pump Sprayer;

- 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;
- Personal protective equipment (gloves, eyewear);
- 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 Non-Disposable Soil and Sediment Sampling Equipment

For this sampling event, it is intended to utilize strictly dedicated, disposable sampling equipment. Only the cutting shoe of the Geoprobe will not be dedicated for the sample location. Therefore, the cutting show will be decontaminated using the following procedure.

1. Fill a wash basin with potable tap water. Add sufficient soap powder (alconox) or solution (liquinox) 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.
2. 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.
3. Rinse the equipment with tap water in a second basin, using a coarse scrub brush or pressure sprayer to aid in the rinse, if necessary.
4. Rinse the equipment in a third basin, using distilled or deionized water.
5. Allow the equipment to completely air dry on clean polyethylene sheeting.
6. 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.
7. 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.
8. Record the decontamination procedure in the field logbook or on appropriate field form.

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 (if necessary)*	See Table 5-3 and, if additional analyses are required by disposal facility, see Table 5-4.	Containerize, sample for RCRA characteristic wastes, dispose at appropriate permitted facility
Decontamination fluid	See Table 5-3 and, if additional analyses are required by disposal facility, see Table 5-4.	Containerize, sample for RCRA characteristic waste, dispose of at appropriate permitted facility

**It is not expected that solid IDW will be collected, but this information has been included as a contingency.*

5.9 Survey of Sample Locations and Elevations

Sample locations will be surveyed using a hand held GPS unit (Trimble GeoXH™ or similar) with anticipated horizontal and vertical accuracy of +/- 3 ft. The information will be incorporated into figures providing the actual sample locations for both the OCCP and WWTP sites.

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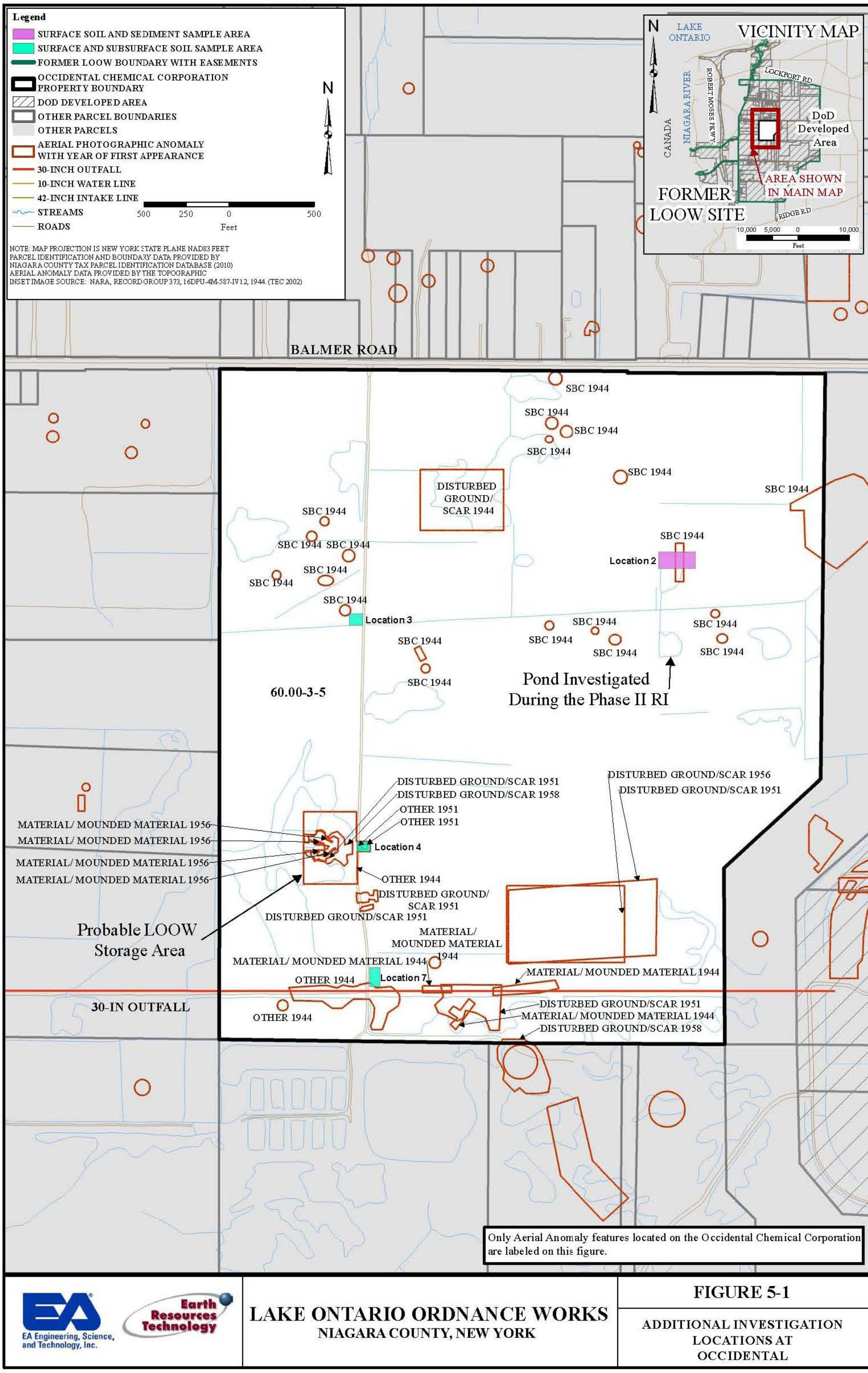

Figure 5-1. Occidental Chemical Corporation Property - Additional Investigation Locations at Occidental

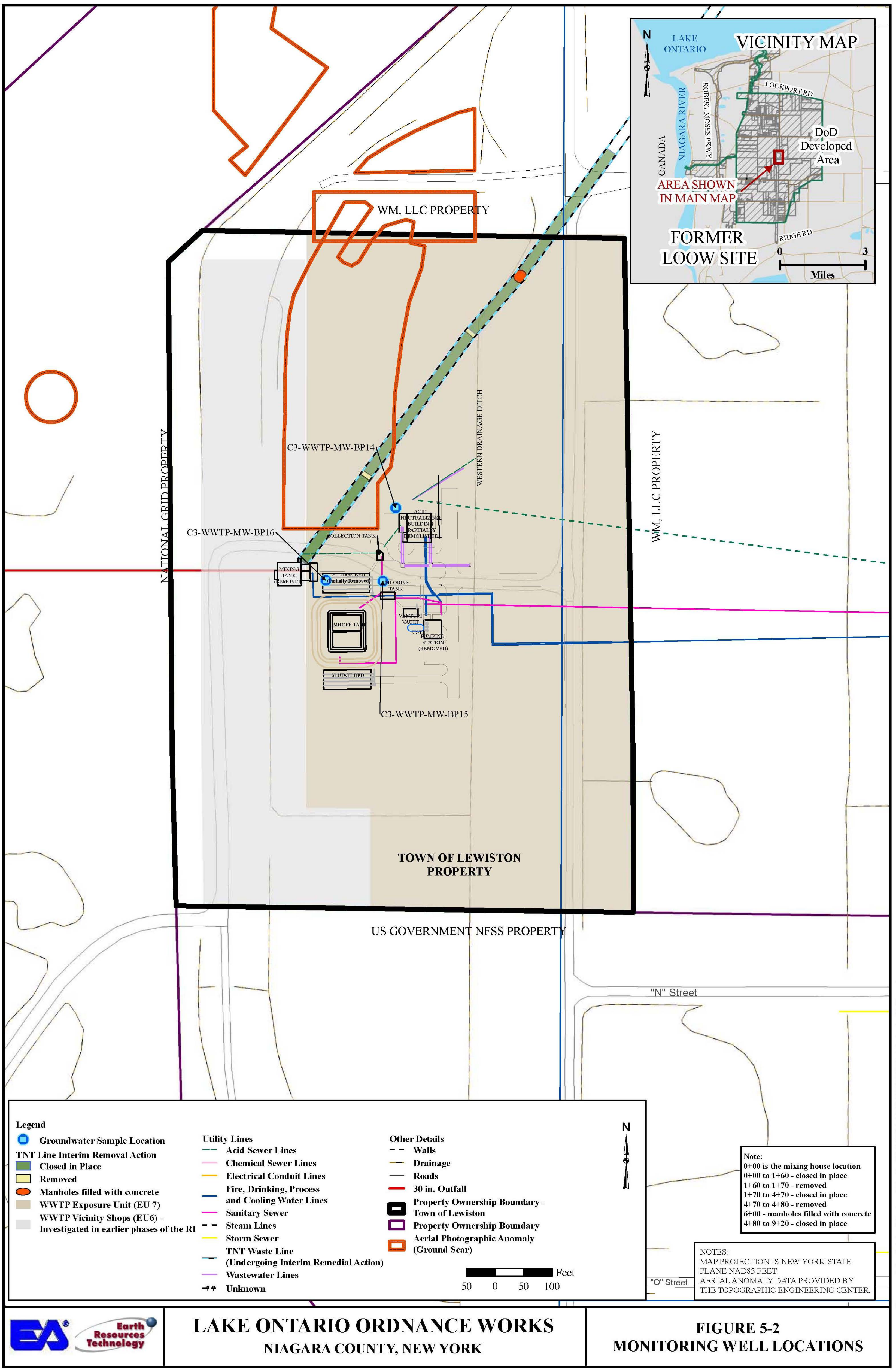

Figure 5-2. WWTP Groundwater Monitoring Well Locations

6.0 SAMPLE MANAGEMENT

Proper sample management includes procedures which dictate sample handling to ensure analysis validity. Certain procedures are considered vital to the qualification of data generated from the collection and analysis of environmental samples. Procedures detailed in the QAPP include proper sample custody, establishment of a chain-of-custody, adherences to a standard sample naming scheme, application of a custody seal and the transfer of custody, and properly packaging and shipment samples to ensure uncompromised delivery to the laboratory.

6.1 Sample Collection Documentation

6.1.1 <u>Field Documentation</u>

Field activity documentation is one of the most important activities that occur in a field sampling task. There is abundant information available for documenting the details of a sampling effort at the time the sampling effort is taking place. It is critical that sufficient detail be provided as it happens or shortly thereafter to allow others not present at the sampling effort to fully comprehend the procedure and conditions at the time of the sampling effort.

The objective of documenting field activities is to ensure that information regarding the field activities is adequately logged and will be acceptable if it is required as evidence in legal proceedings.

Field team members will keep a field logbook to document all field activities. Field logbooks will provide the means of recording the chronology of data collection activities performed during the investigation. As such, entries will be described in as much detail as possible so that a particular situation could be reconstructed without reliance on memory.

The logbook will be a bound notebook with water-resistant pages. Logbook entries will be dated, legible, and contain accurate and inclusive documentation of the activity. The title page of each logbook will contain the following:

- Person to whom the logbook is assigned
- The logbook number
- Project name and number
- Site name and location
- Project start date
- End date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, and names of all sampling team members present will be entered. Each entry of the logbook will be signed and dated by the person making the entry. All entries will be made in permanent ink, signed, and dated and no erasures or obliterations will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark that is signed and dated by the sampler. The correction shall be written adjacent to the error.

Field activities will be fully documented. Information included in the logbook will include, but may not be limited to the following:

- Chronology of activities, including entry and exit times
- Names of all people involved in sampling activities
- Level of personal protection used
- Any changes made to planned protocol
- Names of visitors to the site during sampling and reason for their visit
- Sample location and identification
- Changes in weather conditions
- Dates (month/day/year) and times (military) of sample collection
- Measurement equipment identification (model/manufacturer) and calibration information
- Sample collection methods and equipment
- Sample depths
- Whether grab or composite sample collected
- How sample composited, if applicable
- Sample description (color, odor, texture, etc.)
- Sample identification code
- Tests or analyses to be performed
- Sample preservation and storage conditions
- Equipment decontamination procedures
- QC sample collection
- Unusual observations
- Record of photographs
- Sketches or diagrams
- Signature of person recording the information

Partial pages left in the logbook or log sheets after the completion of daily activities will be crossed out, initialed, and dated. Field logbooks and log sheets will be reviewed on a daily basis by the Field Team Leader. Logbooks will be supported by standardized forms.

6.1.2 Sample Labeling

Immediately upon collection, each sample will be labeled with an adhesive label which includes the date and time of collection, sampler's initials, tests to be performed, preservative (if applicable), and a unique identifier. The following identification scheme will be used:

A. The sample ID number will include the component (identified as "C3" for the Town of Lewiston property), area of concern, matrix, soil, sediment, wastewater, or monitoring well location, along with the sample depth, sample interval, and the depth interval at which it was collected.

The following is a guide for sample identification at the WWTP:

Property:	AOC:	Matrix:	Location:	Sample depth:
C3–	WWTP–	AA–	AN–	NN
Component Number	Unique Site Identifier	Matrix	Sampling Location	Depth

The following is a guide for sample identification at the OCCP:

Property:	AOC:	Matrix:	Location:	Sample depth:
C10–	AA##–	AA–	AN–	NN
Component Number	Unique Site Identifier	Matrix	Sampling Location	Depth

where:

Property = one of the following matrix codes:
C3 (Component 3), which identifies the sample as having been collected at the WWTP (Town of Lewiston property).
C10 (Component 10), which identifies the sample as having been collected on the OCCP

AOC = one of the following matrix codes:
WWTP = Component 3, former LOOW WWTP (Town of Lewiston Property)
AA## = Aerial anomaly location number, where the location number corresponds to Location 02, 03, 04 or 07. For example C10-AA07-SO-03-4 is would represent sample location 3 for aerial anomaly Location 7 on Component 10 (OCCP).

Matrix = one of the following matrix codes:
SO = Surface, semi-surface, and subsurface soils
GW = Ground water (Geoprobe)
SD = Sediment
SL = Sludge
SW = Surface water
MW = Monitoring well (ground water)
WW = Wastewater (from pits or underground lines)

Location = Numeric or alphabetic numeric description indicating the location from which the sample was collected, or, if the sample is a blank, indicates the type of blank collected:

BP## = indicates biased point location number. Note that surface soil samples were collected from two biased point locations during the Phase I RI. Therefore, numbering of biased points for this phase will begin with BP03.
01 = first in a series of sequential sample locations (for example, the first location at aerial anomaly Location 7).
A100 = indicates systematic grid location A100.
AB01 = Ambient blank 1
TB01 = Trip blank 1
RB05 = Rinsate blank 5

Sample depth = Numeric field indicating sample end depth, in feet, with an assumed 0.5 ft interval. For example, -0.5 indicates sample was collected from 0 to 0.5 bgs. 10.5 indicates the sample was collected from 10.0 to 10.5 ft bgs.

Duplicate samples will be labeled as blind duplicates by giving them sample numbers that do not reveal to the parent sample identification. The duplicate designation will be comprised of a concatenation of component, AOC, and matrix followed by "DUP" and sequential duplicate number for that owner/matrix combination. For example, C3-WWTP-SO-DUP3 would represent the third duplicate collected from soil within the WWTP EU on Town of Lewiston property. Duplicate designations and associated parent sample designations will be recorded in the field logbook.

If QA split samples are collected, they will be assigned the same designation as the parent sample, with the addition of a "-QA" as a suffix. Collection of QA split samples will be noted in the field logbook.

MS/MSDs will be noted in the Comments column of the chain-of-custody (COC).

B. The job number will be the number assigned to the particular site.
Example: 3047
C. The analysis required will be indicated for each sample.
Example: TCL VOC
D. Date taken will be the date the sample was collected, using the format: MM/DD/YY.
Example: 6/22/09
E. Time will be the time the sample was collected, using military time.
Example: 14:30
F. The sampler's name will be printed in the "Sampled By" section.
G. Other information relevant to the sample.
Example: Equipment Blank

Example sample label information is presented below:

Client:	ERT
Sample Type:	Grab
Site Name:	WWTP
Date Taken:	6/22/03
Time Taken:	14:30
Sample No:	C3-WWTP-SO-BP04-0.0-0.6
Analysis:	TCL VOC
Preservative:	HCl
Sampler:	John Doe

Job No. ____________________
Client: ____________________
Sample Number ____________________
Date ____________________ Sample Time ____________________
Sample Matrix ____________________
Grab or Composite (explain) ____________________
Preservatives ____________________
Analyses ____________________
Sampler Signature____________________

This sample label contains the authoritative information for the sample..

6.1.3 Sample Custody

Custody is one of several factors that are necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files.

A sample or evidence file is considered to be under a person's custody if

- the item is in the actual possession of a person
- the item is in the view of the person after being in actual possession of the person
- the item was in the actual physical possession of the person but is locked up to prevent tampering - the item is in a designated and identified secure area

6.1.3.1 Field Custody Procedure

Samples will be collected following the sampling procedures documented in Section 5.0 of this Plan. Documentation of sample collection is described in Section 6.1 of this Plan. Sample COC and packaging procedures are summarized below. These procedures will ensure that the samples will arrive at the laboratory with the COC intact.

- The field sampler is personally responsible for the care and custody of the samples until they are transferred or dispatched properly. Field procedures have been designed such that as few people as possible will handle the samples.

- All bottles will be identified by the use of sample labels with sample numbers, sampling locations, date/time of collection, and type of analysis. The sample numbering system is presented in Section 6.1.2 of this Plan.
- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample label because the pen would not function in wet weather.
- Samples will be accompanied by a properly completed COC form. The sample numbers and locations will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents the transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage location.
- All shipments will be accompanied by the COC record identifying the contents. The original record will accompany the shipment, and copies will be retained by the sampler and placed in the project files.
- Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the cooler and covered with clear plastic tape after being signed by field personnel. The cooler will be strapped shut with strapping tape in at least two locations.
- If the samples are sent by common carrier, the air bill will be used. Air bills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody forms since the custody forms will be sealed inside the sample cooler and the custody seals will remain intact.
- Samples remain in the custody of the sampler until transfer of custody is completed. This consists of delivery of samples to the laboratory sample custodian, and signature of the laboratory sample custodian on COC document as receiving the samples and signature of sampler as relinquishing samples.

6.1.3.2 Laboratory Custody Procedures

Samples will be received and logged in by a designated sample custodian or his/her designee. Upon sample receipt, the sample custodian will:

- Examine the shipping containers to verify that the custody tape is intact.
- Examine all sample containers for damage.
- Determine if the temperature required for the requested testing program has been maintained during shipment and document the temperature on the COC records.
- Compare samples received against those listed on the COC.
- Verify that sample holding times have not been exceeded.
- Examine all shipping records for accuracy and completeness.

- Determine sample pH (if applicable) and record on COC forms.
- Sign and date the COC immediately (if shipment is accepted) and attach the air bill.
- Note any problems associated with the coolers and/or samples on the cooler receipt form and notify the Laboratory Project Manager, who will be responsible for contacting the ERT Technical Task Manager.
- Attach laboratory sample container labels with unique laboratory identification and test.
- Place the samples in the proper laboratory storage.

Following receipt, samples will be logged in according to the following procedure:

- The samples will be entered into the laboratory tracking system. At a minimum, the following information will be entered: project name or identification, unique sample numbers (both client and internal laboratory), type of sample, required tests, date and time of laboratory receipt of samples, and field ID provided by field personnel.
- The Laboratory Project Manager will be notified of sample arrival.

The completed COC, air bills, and any additional documentation will be placed in the final evidence file.

6.1.4 Chain-of-Custody Records

COC records are initiated by the samplers in the field. The field portion of the custody documentation should include: (1) the project name; (2) signatures of samplers; (3) the sample number, date and time of collection, and whether the sample is grab or composite; (4) signatures of individuals involved in sampling; (5) if applicable, air bill or other shipping number, and (6) requested analyses and analytical methods, turnaround times, and data deliverable requirements. Sample receipt and log-in procedures at the laboratory are described in Section 6.1.3.2 of this Plan. Analytical samples will be submitted for a standard 21-day turnaround time.

On a regular basis (daily or on such a basis that all holding times will be met), samples will be transferred to the custody of the respective laboratories, via third-party commercial carriers or via laboratory courier service. Sample packaging and shipping procedures, and field COC procedures are described in Sections 6.2 and 6.1.3, respectively, of this plan.

6.2 Sample Packaging

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. This SOP was developed to establish packaging and shipping requirements and guidelines for environmental sample shipping. The term "Environmental Sample" refers to any sample that has less than reportable quantities of any hazardous constituents according to Department of Transportation (DOT) 49 CFR - Section 172.

6.2.1 Required Equipment

- Coolers with return address of ERT office written on inside lid
- Heavy-duty plastic bags
- Plastic zip-top bags, small and large

- Fiber tape
- Duct tape
- Vermiculite and/or packing peanuts
- Bubble Wrap (optional)
- Ice
- COC seals
- Completed COC record or CLP custody records if applicable
- Completed Bill of Lading

6.2.2 Procedures

The following steps must be followed when packing for shipment other than laboratory provided courier:

- Select a sturdy cooler in good repair. Secure and tape the drain plug (inside and outside) with fiber or duct tape.
- Be sure the caps on all bottles are tight (will not leak); check to see that labels and COC records are completed properly.
- Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three volatile organic analysis (VOA) vials may be packed in one bag. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite. It is preferable to place glass sample bottles and jars into the cooler vertically. Due to the strength properties of a glass container, there is much less chance for breakage when the container is packed vertically rather than horizontally.
- Place two to four inches of packing peanuts, bubble wrap, or vermiculite into the bag in the cooler and then place the bottles and cans in the bag with sufficient space to allow for the addition of more packing peanuts, vermiculite, or bubble wrap between the bottles and cans.
- Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place these ice bags on top of and between the samples. Ensure the cooler has the required temperature blank, and, if required, trip blank. Fill all remaining space between the bottles or cans with sealed ice. Securely fasten the top of the large garbage bag with tape (preferably duct tape).
- Place the completed COC Record or the CLP Traffic Report Form (if applicable) for the laboratory into a plastic zip-top bag, tape the bag to the inner side of the cooler's lid, and then close the cooler.
- Fiber tape shall be wrapped around each end of the cooler two times, and completed COC seals affixed to the top opposite sides of the cooler half on the fiber tape so that the cooler cannot be opened without breaking the seal. Complete two more layers with fiber tape; place clear tape over custody seals.

The shipping containers must be marked "THIS END UP" and arrow labels which indicate the proper upward position of the container should be affixed to the cooler. A label containing the name and address of the shipper shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted to be on the outside of the container used to transport environmental samples and shall not be used.

6.3 Documentation of Field Activities

It is essential to detail all field activities associated with the Phase IV RI. Documentation will be the responsibility of each member of the field team. A standard operation procedure for correct field documentation techniques is provided in Attachment B. Bound, hard cover books will be used daily to record typical events during the Phase IV RI. Other documents may be utilized to perform the logging of samples, bore holes, well installation, groundwater sampling and other such activities. If necessary, field memorandums may be typed and distributed to field personnel, members of the project delivery team (PDT) and other pertinent recipients, and will be considered official documentation of the particular event described.

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7.0 FIELD ASSESSMENT/THREE PHASE INSPECTION PROCEDURES

In order to ensure that quality is maintained throughout field activities, a three phase inspection process as described in EM 200-1-3. The three phase quality control process includes a preparatory phase, initial phase and follow-up phase.

7.1 Preparatory Phase

The preparatory phase includes a review of planning documents, work requirements and field sampling DQOs by the project team. The project team will review the scope of work requirements, examine required supplies and equipment, practice and ensure functionality of required equipment, complete a site reconnaissance and review the required sample collection, handlings, and packaging procedures.

7.2 Initial Phase

The initial phase includes 100% review of field tasks during the initial sampling efforts to ensure that activities are being completed in compliance with the finalized planning documents. Instrumentation calibrations will be observed and documented in daily logs.

7.3 Follow-Up Phase

Follow-up inspections will be completed on an as needed basis to ensure compliance with finalized planning documents and contract obligations. The follow-up phase will be used as a tool to review and resolve project issues occurring during the field activities that were not anticipated in the planning documents. Non-conformance memoranda, generated by either USACE oversight or internally by the contractor, may be generated if failures to provide quality field practices and screening analysis continue.

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8.0 NON-CONFORMANCE AND CORRECTIVE ACTIONS

The field team is responsible for identifying non-conformance events. If such an event is identified, the Technical Task Manager will be notified. If the non-conformance event involves safety, the SSHO will be notified. A memorandum with a description of the event will be generated which includes an evaluation of whether the non-conformance event affects the integrity of project objectives. The memorandum will provide draft corrective actions that will be sent to USACE for approval.

Re-sampling and/or reanalysis may be initiated by the PM after consultation with the technical task manager and the USACE. Typical examples of events which may cause resampling or reanalysis include failures to meet the DQOs, improper sampling technique and improper sample handling.

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APPENDIX A
Proposed Procedures for Background Evaluation

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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, Wilcox 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.

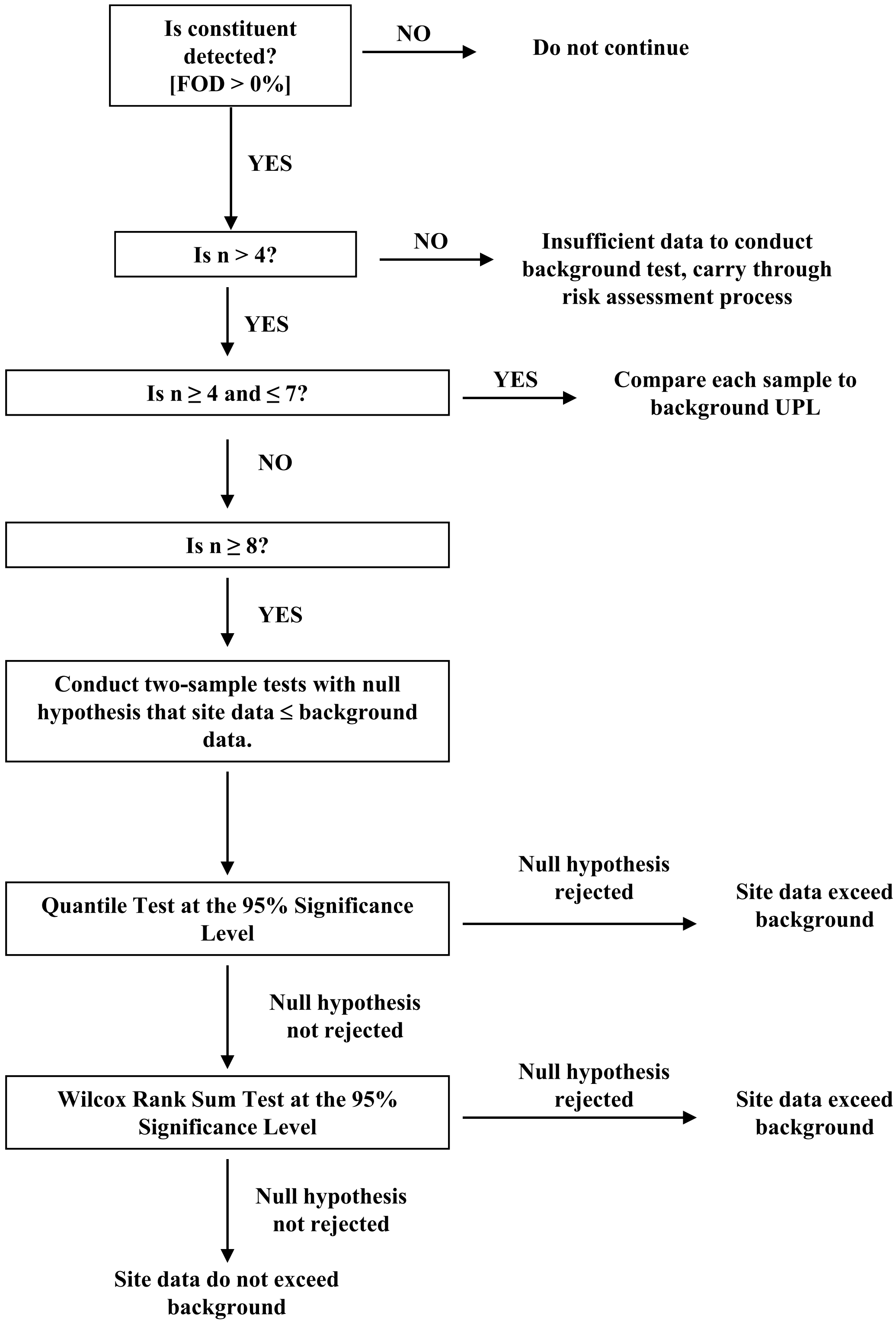

Figure A-1. Decision Tree for Comparison to Background Data, EU 7 - Former LOOW Wastewater Treatment Plant

APPENDIX B
Standard Operating Procedures

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Earth Resources Technology, Inc. Standard Operating Procedure **PREPARING FOR AND CONCLUDING FIELD ACTIVITY**			
Effective Date: **01/22/09**	Version: **001**	SOP#: **ERT SOP-01-1A**	
Approvals			
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA 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:	☐ Relevant project file documents	☐ Wide brimmed hat
	☐ Field book	☐ Caution tape
	☐ Clip board / desk top	☐ Nitrile gloves
	☐ Cell phone and charger	☐ Trash bags
	☐ Safety glasses	☐ Chair and table
	☐ Steel toe boots	☐ Lunch
	☐ Hard hat	☐ Drinking water
	☐ Work plan	☐ Rugged work ware
	☐ Work gloves	☐ Rain Gear
	☐ Hand tools	☐ Site access key
	☐ HASP	☐ Subcontractor contact #
	☐ Paper towels	☐ Power converter
Drilling	☐ PID w/ cal gas	☐ Caution tape
	☐ Water level meter	☐ Measuring wheel
	☐ GPS	☐ USACE manual
	☐ Decon bucket, soap and brush	☐ Macro core holder
	☐ Well log forms	☐ Non-HAZ stickers
	☐ Work plan	☐ Hand auger
Ground water Sampling	☐ Pump	☐ String
	☐ Battery / Generator	☐ Well keys
	☐ Tubing	☐ Carbon bucket
	☐ Multi-meter	☐ Bottle ware + extras
	☐ Bailers	☐ Labels + extras
	☐ Measuring cup	☐ COC
	☐ Stopwatch	☐ Cooler with bubble wrap
	☐ PID w/ cal gas	☐ Ice
	☐ Buckets (3) w/ lids	☐ Ziplock bags
	☐ Decon station	☐ Fishing gear
	☐ Soap and brush	☐ Work plan
	☐ Distilled water	☐ Work order
	☐ DI water	☐ Purge data sheets
	☐ Water level meter	☐ Non-HAZ stickers
Soil Sampling	☐ PID w/ cal gas	☐ Labels
	☐ zip lock bags	☐ Soil sample equipment
	☐ Jars	☐ Hand auger
	☐ Cooler and bubble wrap	☐ Digging Bar
	☐ Ice	☐ Paper towels
	☐ Chain of custody	☐ Trowel

**Highlight as applicable*

Earth Resources Technology, Inc. Standard Operating Procedure **USE OF FIELD LOGBOOKS**			
Effective Date: **01/22/09**	Version: **001**	SOP#: **ERT SOP-01-2**	
Approvals			
Mike Dorman Program Manager [redacted] Signature	1/22/09 Date	R. Russell Ashley, C.P.G. Field QA Manager [redacted] Signature	1/21/09 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, photoioinzation 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 **DECONTAMINATION OF SAMPLING EQUIPMENT**			
Effective Date: **01/22/09**	Version: **001**	**ERT SOP-03-1**	
Approvals			
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA Manager	
[redacted] Signature	1/23/09 Date	[redacted] Signature	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®-coated equipment with 10% nitric acid; rinse stainless steel equipment with 1% hydrochloric acid.
3. Rinse all accessible surfaces, plastic or Teflon®-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 **DECONTAMINATION OF DRILLING AND DIRECT-PUSH EQUIPMENT AND MATERIALS**			
Effective Date: **01/29/09**	Version: **001**	ERT SOP-03-2	
Approvals			
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA Manager	
[redacted]	1/30/09 Date	[redacted] 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 **WELL DEVELOPMENT**			
Effective Date: **01/26/09**	Version: **001**	**ERT SOP-05-4**	
Approvals			
Mike Dorman Program Manager [redacted] Signature	1/26/09 Date	R. Russell Ashley, C.P.G. Field QA Manager [redacted] Signature	1/26/09 Date

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:	Sampling Organization: Earth Resources Technology
Site Name:	Sampler (s):
Project No.:	Screen Interval (feet below ground surface):
Date:	Pump Intake (feet below ground surface):
Well Number:	Purging Device (Pump Type):

Well	PID	DTW	TD	WV	MPV	Start Time	End Time	APV	Observations

PID = photo-ionazation 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 **WELL PURGING – PUMPING METHOD**			
Effective Date: **01/22/09**	Version: **001**	**ERT SOP-05-6**	
Approvals			
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA Manager	
[redacted] Signature	1/23/09 Date	[redacted] Signature	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-Wager 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:

Earth Resources Technology

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:

Earth Resources Technology, Inc. Standard Operating Procedure **MONITORING WELL AND BOREHOLE ABANDONMENT**			
Effective Date: **01/26/09**	Version: **001**	**ERT SOP-05-7**	
Approvals			
Mike Dorman Program Manager [redacted]		R. Russell Ashley, C.P.G. Field QA Manager [redacted]	
Signature	1/26/09 Date	Signature	1/26/09 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 it 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 or 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. Betonite will be used to fill the entire borehole to ground surface. In order to adequately homogenize the hydrated the betonite chips, betonite 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 betonite 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 **SURFACE WATER AND SEDIMENT SAMPLING**			
Effective Date: **01/22/09**	Version: **001**	**ERT SOP-06-1**	
Approvals			
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA Manager	
[redacted] Signature	1/22/09 Date	[redacted] Signature	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 devise 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 provided 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®). 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® 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

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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 **ENVIRONMENTAL SOIL SAMPLING**			
Effective Date: **01/27/09**	Version: **001**	**ERT SOP-06-03**	
Approvals			
Mike Dorman Program Manager [redacted] Signature	1/27/09 Date	R. Russell Ashley, C.P.G. Field QA Manager [redacted] Signature	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® or similar)
5. Stainless Steel Hand Auger
6. Shovel, or Post-Hole Digger
7. Stainless Steel Trowel, Spoon, or Bucket Auger
8. Teflon® or Stainless Steel Spatula
9. Stainless Steel Bowl or Teflon® 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 **INVESTIGATIVE DERIVED WASTE (IDW) MANAGEMENT**			
Effective Date: **01/29/09**	Version: **001**	SOP#: **ERT SOP-06-4**	
Approvals			
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA 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 Dumsters
- 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

TYPE	HAZARDOUS	NON-HAZARDOUS
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

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!

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Earth Resources Technology, Inc. Standard Operating Procedure **LOW-FLOW GROUNDWATER SAMPLING**		
Effective Date: **01/22/09**	Version: **001**	SOP#: **ERT SOP-06-5A**
Approvals		
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA Manager
[redacted] Signature	1/23/09 Date	[redacted] Signature — 1/22/09 Date

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 4º 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®-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 monitorign 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	± 0.2 unit
Specific Conductivity	± 3%
Dissolved Oxygen	± 10% or 0.2 mg/l whichever is greater
Oxidation Reduction Potential	± 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 diltration 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.

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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 Proceduere 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, analyze-free water is passed through a filter and collected into in 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 **PACKAGING AND SHIPMENT OF FIELD SAMPLES**			
Effective Date: **01/27/09**	Version: **001**	SOP#: **ERT SOP-06-7**	
Approvals			
Mike Dorman Program Manager [redacted] Signature	1/28/09 Date	R. Russell Ashley, C.P.G. Field QA Manager [redacted] Signature	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 classified as non-hazardous environmental samples. ERT will not ship any material known to be hazardous. If hazardous material is suspected, the Project Manger 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 filed activities, the project-specific SAP will details 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.

Minimum Sample Label Requirements	
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 of9:54 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 currier.

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 of 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

PROJECT NO.

Attachment 2 – Example Custody Seal

Example Custody Seal

Earth Resources Technology, Inc. Standard Operating Procedure **GROUNDWATER LEVEL MEASUREMENT**			
Effective Date: **01/22/09**	Version: **001**	SOP#: **ERT SOP-07-2**	
Approvals			
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA Manager	
[redacted] Signature	1/22/09 Date	[redacted] Signature	1/22/09 Date

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 contract. 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 move to the side of the casing where the permanent measurement point is marked on the well casing. The measurement is then read and the 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 **BOREHOLE LOGGING**			
Effective Date: **01/22/09**	Version: **001**	SOP#: **ERT SOP-07-3**	
Approvals			
Mike Dorman Program Manager		R. Russell Ashley, C.P.G. Field QA Manager	
[redacted] Signature	1/23/09 Date	[redacted] Signature	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 LITLE 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 MORETHAN 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 PLASTICTY, 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 Consistancy	Thumb Penetration	Average SPT N Blows/ft over 6-18" interval of 24" split spoon
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and fingers when squeezed in hand.	< 2
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 – 4
MEDIUM STIFF	Can be penetrated over ¼ inch by thumb with moderate effort. Molded by strong finger pressure.	4 – 8
STIFF	Indented about ¼ inch by thumb but penetrated only with great effort.	8 – 15
VERY STIFF	Readily indented by thumbnail	15 – 30
HARD	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
VERY LOOSE SAND	4	0 - 15	Easily penetrated with ½" reinforcing rod pushed by hand.
LOOSE SAND	4 – 10	15 – 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 – 30	35 – 65	Penetrated a foot with ½" reinforcing rod driven by 5-lb hammer.
DENSE SAND	30 – 50	65 – 85	Penetrated a foot with ½" reinforcing rod driven by 5-lb hammer.
VERY DENSE SAND	<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

HTRW DRILLING LOG	DISTRICT	HOLE NUMBER
1. COMPANY NAME	2. DRILLING CONTRACTOR	SHEET OF SHEETS

3. PROJECT	4. LOCATION
5. NAME OF DRILLER	6. MANUFACTURERS 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	15. DEPTH GROUND WATER ENCOUNTERED
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME SINCE DRILLING COMPLETED
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS SPECIFY

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEM ANAL	VOC	METALS	OTHERS (SPECIFY)	OTHERS (SPECIFY)	OTHERS (SPECIFY)	21. TOTAL CORE RECOVERY
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHERS (SPECIFY)	23. GEOLOGIST		

LOCATION SKETCH / COMMENTS SCALE:

PROJECT	HOLE NO.

ERT FORM 5056-R

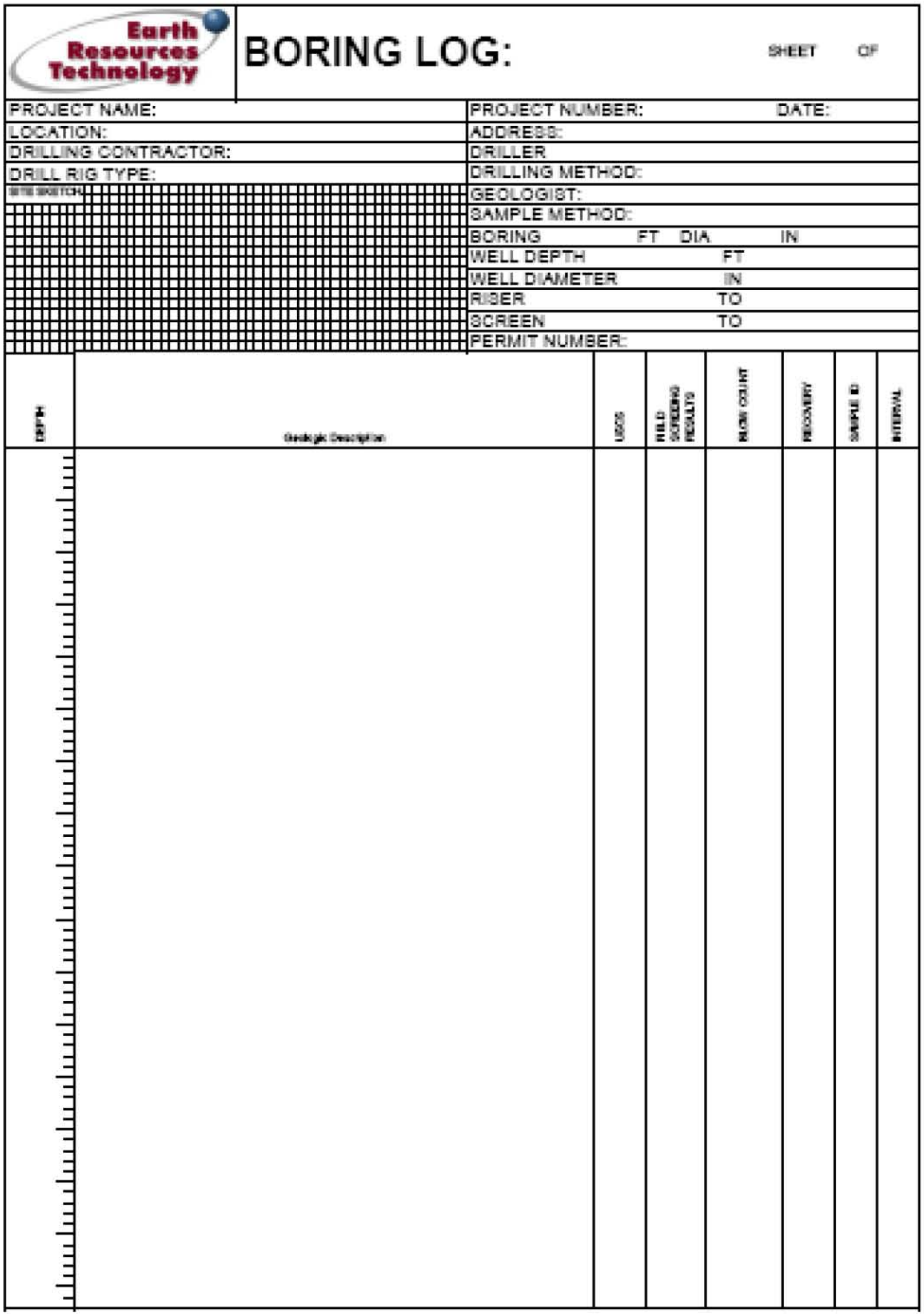
HTRW DRILLING LOG (CONTINUATION SHEET)		HOLE NUMBER
PROJECT	GEOLOGIST	SHEET OF SHEETS

ELEV (FT)	DEPTH	DESCRIPTION OF MATERIAL	FIELD SCREENING RESULTS	GEOTECH SAMPLE	ANALYTICAL SAMPLE	BLOW COUNT	REMARKS

PROJECT	HOLE NO.

ERT FORM 5056A-R

For Non-USACE clientele ERT utilizes *ERT Well Logging Form V4*.



BORING LOG: SHEET OF

PROJECT NAME:	PROJECT NUMBER: DATE:
LOCATION:	ADDRESS:
DRILLING CONTRACTOR:	DRILLER
DRILL RIG TYPE:	DRILLING METHOD:
SITE SKETCH	GEOLOGIST:
	SAMPLE METHOD:
	BORING FT DIA IN
	WELL DEPTH FT
	WELL DIAMETER IN
	RISER TO
	SCREEN TO
	PERMIT NUMBER:

DEPTH	Geologic Description	USCS	FIELD SCREENING RESULTS	BLOW COUNT	RECOVERY	SAMPLE ID	INTERVAL

APPENDIX C
Equipment Operating Manuals

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This document is a confidential company document and is unable to be released.