Sampling and Analysis Plan

Final

Balance of Plant Operable Unit Field Investigation

Niagara Falls Storage Site
Lewiston, New York

Contract No. W912QR-12-D-0023
Delivery Order No. DN01

Prepared by:
URS Group, Inc.

[redacted]

For:
U.S. Army Corps of Engineers (USACE)
Buffalo District
Buffalo, New York

US Army Corps of Engineers®
Buffalo District

November 2012

Balance of Plant Operable Unit Field Investigation
Niagara Falls Storage Site
Lewiston, New York
Sampling and Analysis Plan
Volume 1 – Field Sampling Plan

DRAFT

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6 November 2012
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- [x] New Plan
- [ ] Title Change
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INTRODUCTION

This Sampling and Analysis Plan (SAP) describes activities to be completed during the Balance of Plant (BOP) operable unit field investigation at the Niagara Falls Storage Site (Site), Lewiston, New York.

This document was prepared by URS Group, Inc. (URS) in partial fulfillment of the requirements of Contract W912QR-12-D-0023, Delivery Order DN01. Technical oversight responsibilities for the tasks described in this document will be provided by the U.S. Army Corps of Engineers (USACE), Buffalo District.

This SAP consists of **two components**: a **Field Sampling Plan (FSP)**, which follows, and a **Quality Assurance Project Plan (QAPP)**, included under a separate cover.

The FSP covers the overall objectives of the investigation, outlines the tasks to be completed, and provides guidance and procedures to be followed while completing the effort.

The QAPP describes data quality objectives to be applied, the analytical methods and measurements, quality assurance/quality control protocols for the work efforts, and the data assessment procedures for the evaluation and identification of any data limitations.

Volume 1
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LIST OF ACRONYMS

AEC	U.S. Atomic Energy Commission
ASTM	American Society for Testing and Materials
BOP	Balance of Plant
bgs	Below Ground Surface
CFR	Code of Federal Regulations
cm/sec	centimeters per second
CWM	Chemical Waste Management
COC	Contaminant of Concern
CO	Contracting Officer
CQC	Contractor Quality Control
DOE	Department of Energy
DQCR	Daily Quality Control Report
DNAPL	Dense Non-aqueous Phase Liquid
EM	Electromagnetic or Engineering Manual
EU	Exposure Unit
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
GIS	Geographical Information System
GPS	Global Positioning System
HDPE	High Density Polyethylene
HSO	Health and Safety Officer
HTRW	Hazardous, Toxic and Radioactive Waste
IWCS	Interim Waste Containment Structure
IDW	Investigation-Derived Waste
LOOW	Lake Ontario Ordnance Works
LWBZ	Lower Water-Bearing Zone
m	meter
MGP	Manufactured Gas Plant
mm	millimeter
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAD	North American Datum
NaI	Sodium Iodide
NAPL	Non-Aqueous Phase Liquid
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NFSS	Niagara Falls Storage Site
NRC	Nuclear Regulatory Commission
OU	Operable Unit
PM	Project Manager
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal

RI	Remedial Investigation
ROD	Record of Decision
RPP	Radiation Protection Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SOW	Scope of Work
SSHO	Site Safety and Health Officer
TSC	Temporary Storage Container
UWBZ	Upper Water-Bearing Zone
U-235	Uranium-235
U-238	Uranium-238
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This document was prepared by URS Group, Inc. (URS), in partial fulfillment of the requirements of Contract 912QR-12-D-0023, Task Order 0001. Technical oversight responsibilities for the tasks described in this document will be provided by the U.S. Army Corps of Engineers (USACE), Buffalo District.

URS will conduct a Balance of Plant Operable Unit field investigation at the Niagara Falls Storage Site (Site). This Field Sampling Plan (FSP) presents the overall objectives of the investigation, outlines the tasks to be completed, and provides guidance and procedures to be followed while completing the effort.

1.1 Site Description

The Niagara Falls Storage Site (NFSS), located at 1397 Pletcher Road in the Town of Lewiston (Figure 1), represents a portion of the former Lake Ontario Ordnance Works (LOOW) that was used by the USACE Manhattan Engineer District (MED) and U.S. Atomic Energy Commission (AEC) to store radioactive residues and other materials beginning in 1944. Nearly all the radioactive residues sent to the NFSS originated from uranium processing activities conducted for MED and AEC at the Linde Air Products facility in Tonawanda, New York, the Mallinckrodt Chemical Works refinery in St. Louis, Missouri, and the Middlesex Sampling Plant in Middlesex, New Jersey.

Radiological constituents of concern at NFSS include isotopic uranium, isotopic thorium, and radium-226/228. Other constituents that occur on-site in lesser amounts include daughter products of the uranium series (Uranium-238 [U-238]) and, to some extent, the actinium series (Uranium-235 [U-235]).

1.2 Site Geology

The geology of the NFSS is presented below, from shallowest to deepest:

- Surficial Soils and Fill - The surficial soil at the NFSS consists of a loose to medium dense, brown to yellowish silt with organic matter. Gravel and sands are generally encountered and are dispersed randomly throughout the unit. Thicknesses of surficial deposits vary from 0 to 1.5 meters (0 to 5 feet), with an average range of 0.3 to 0.6 meters (1 to 2 feet).

- Brown Clay Unit - The Brown Clay Unit, also known as the “Upper Clay Till” or the “Brown Clay Till”, is a brownish or reddish, poorly sorted, brown silty clay till deposit indicative of a ground moraine. The thickness of the unit varies from 1.8 to 7 meters (6 to 23 feet). The consistency of the upper clay till ranges from medium soft to hard with plasticity increasing with depth. Thin sand and silt seams, pockets and lenses are common in the basal portion of the unit.

  The sand, gravel, and silt lenses in the basal portion of this unit average 0.3 to 1.5 meters (1 to 5 feet) in thickness and the lateral extent and thickness of these lenses vary abruptly. These intermittent sand lenses likely represent glaciofluvial deposits and are generally vertically and horizontally discontinuous. When saturated, these lenses, pockets and/or seams are most likely not hydraulically interconnected and do not represent a continuous water-bearing zone or aquifer. The sand and gravel in the lenses are usually moist to saturated and vary from loose to dense. Occasional extensive deposits of sand and gravel 5.3 to 6.1 meters (17.5 to 20 feet) in thickness occur within the Brown Clay Unit.

  Permeability tests indicate that the horizontal permeability of the brown clay unit ranges from approximately 3×10^{-2} to 7×10^{-9} centimeters per second (cm/sec). Typical values are between 1×10^{-5} to 1×10^{-7} cm/sec.

- Gray Clay Unit - The Gray Clay Unit, also known as the “Glacio-Lacustrine Clay Unit”, is of

lacustrine origin. Post depositional erosion is evident from channels (depressions) along the upper surface of this unit. These depressions are intermittently filled with the coarser-grained sand and gravel of the Brown Clay Unit. Based on boring logs, the channel-fill deposits are not widespread and not representative of a contiguous lithologic unit. These channel deposits are also described above in the description of the Brown Clay Unit. The Gray Clay Unit occasionally grades vertically to a silt and sand mixture. Gravel is dispersed throughout the unit, as are lenses of fine to medium-grained sand. Sand and gravel become the primary constituents near the base of the unit. The overall consistency of the unit ranges from soft to medium soft, with clay portions being slightly to highly plastic. The clay is generally wet and sand lenses are wet to saturated.

The thickness of the Gray Clay Unit varies from less than 1.5 to 9.1 meters (5 to 30 feet) and it is the thickest unconsolidated unit on site. Based on laboratory tests, the average permeability of the Gray Clay Unit is reported as 7.34×10^{-8} cm/sec.

- Sand and Gravel Unit - The Sand and Gravel Unit, also referred to as "Alluvial Sand and Gravel", consists of clean sand to mixtures of sand, gravel, and silt. The unit is thought to be glaciofluvial in origin, is normally wet to saturated, and exhibits loose to medium relative density. In general, the thickest portions of the unit are present where depressions occur in the bedrock.

  The Sand and Gravel Unit is approximately 0.9 to 2.1 meters (3 to 7 feet) in thickness and occurs 4.6 to 8.5 meters (15 to 28 feet) below ground surface (bgs). The horizontal permeability of the Sand and Gravel Unit ranges from 1.3×10^{-3} to 9×10^{-6} cm/sec. Note: At some locations, a Middle Silt Till Unit splits the Gray Clay Unit or where the lower portion of the Gray Clay Unit is absent the Middle Silt Till overlies the Sand and Gravel Unit. The Middle Silt Till was reported at the Chemical Waste Management (CWM) property but has not been found at the NFSS. The Middle Silt Till Unit may consist of zones of coarse to fine sand and traces of gravel, but dense gray silt is dominant. The horizontal permeability of the Middle Silt Till Unit was reported as 3×10^{-6} cm/sec and the vertical permeability was 1×10^{-7} cm/sec.

- Red Silt Unit - The Red Silt Unit, referred to as the "Basal Red Till", consists of angular fragments of bedrock in a sandy silt matrix that suggests that this is a lodgement till. The Red Silt Unit is composed of clayey gravelly silt with lesser amounts of sand. Gravel is dispersed throughout the unit and consists of both rounded and angular fragments of bedrock. This unit is generally dry to moist, over consolidated, and ranges from medium to very dense. The Red Silt Unit varies in thickness from 0 to 2.1 meters (0 to 7 feet). The top of the Red Silt Unit varies across the site from a minimum of 5.1 meters (17 feet) bgs to a maximum of 13.7 meters (45 feet) bgs. The base varies from 6.7 to 14.9 meters (22 to 48.73 feet) bgs. The horizontal permeability of the Red Silt Unit is reported as 4×10^{-8} cm/sec and the vertical permeability is 3×10^{-8} cm/sec.

- Queenston Formation - The Queenston Formation is the uppermost bedrock unit beneath the site and consists of brownish red shale, siltstone, and mudstone. The top 1.8 to 3.7 meters (6 to 12 feet) of the Queenston Formation are moderately weathered, fractured and more permeable than lower portions of the formation. The Queenston Formation is typically encountered 9.75 to 14.9 meters (32 to 49 feet) bgs. The horizontal permeability of the unweathered portion of the Queenston Formation ranges from 2.3×10^{-4} to 2×10^{-7} cm/sec.

1.3 Site Hydrogeology

There are two water-bearing zones at the NFSS. The uppermost unit is the upper water-bearing zone (UWBZ) in the Brown Clay Unit. The second unit is the lower water-bearing zone (LWBZ) in the Red

Silt and Sand and Gravel Units and upper weather portion of the Queenston Formation. The Gray Clay Unit acts as an aquitard between these units.

Groundwater flow in the UWBZ and LWBZ is to the northwest.

1.4 Reference Documents

This project will be performed in accordance with the Scope of Work (SOW) and the following documents:

- American Society for Testing and Materials (ASTM) D6914 – 04E1, Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices
- "Report of the Results for the Remedial Investigation of Underground Utility Lines Formerly Used by the Department of Defense, Lake Ontario Ordnance Works (LOOW)"
- Uniform Federal Policy (UFP) QAPP
- USACE EM 385-1-1, 15 September 2008, Safety and Health Requirements Manual
- USACE ER 385-1-92 (1 May 2007) Safety and Occupational Health Requirements for Hazardous, Toxic and Radioactive Waste (HTRW) Activities
- USACE ER 385-1-80 (30 June 2010) Ionizing Radiation Protection
- USACE EM 385-1-80 (30 May 1997) Radiation Protection Manual
- USACE EM 385-1-1 Section 25 Excavation and Trenching
- USACE EM-1110-35-1 Management Guidelines for Working with Radioactive and Mixed Waste
- USACE EM 1110-1-1804 Geotechnical Investigations
- USACE EM 1110-1-4000 Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites (1 November 1998)
- USACE EM 1110-1-1003 (July 1, 2003) NAVSTAR Global Positioning System Surveying
- USACE EM 1110-1-1005 (January 1, 2007) Control and Topographic Surveying
- USACE EM 1110-1-1802 (August 31, 1995) Geophysical Exploration for Engineering and Environmental Investigations
- USACE document Policies, Guidance and Requirements for Geospatial Data and Systems, ER-1110-1-8156 (September 1995)
- USDOL OSHA 29 Code of Federal Regulations (CFR) 1926 Safety and Health Regulations for Construction
- USDOL OSHA 29 CFR 1910 Occupational Safety and Health Standards
- USDOL OSHA 29 CFR 1910.120 or 1926.65 HAZWOPER Standard
- UFGS-01 35 26 (February 2012) Governmental Safety Requirements
- UFGS-01 35 29.13 (January 2008) Health, Safety, and Emergency Response Procedures for Contaminated Sites
- US Nuclear Regulatory Commission (NRC) 10 CFR Part 20 Standards of Protection Against Radiation
- USACE Engineering Form ENG 5056 - HTRW Drilling Log
- 29 CFR 1926 Subpart P, Safety and Health Regulations for Construction, Excavations
- EPA 540/G-91/009 Management of Investigation-Derived Wastes During Site Inspections
- EP-200-1-2 Process and Procedures for Resource Conservation and Recovery Act (RCRA) Manifesting
- Spatial Data Standard for Facilities, Infrastructure and Environment (SDSFIE) 3.0 Gold

2.0 PROJECT UNDERSTANDING

2.1 Project Objectives

During development of the RI, the NFSS was divided into 18 exposure units (EU). Figure 2 presents the overall site layout. An EU is defined as the geographic area in which a future receptor (for purposes of the baseline risk assessment) is assumed to work or live, and where a receptor may be exposed to site-related contaminants.

The objectives of this field investigation in support of the BOP Operable Unit (OU) Feasibility Study (FS) are to:

- Delineate groundwater contamination in EUs 1, 2, 4, and 10
- Identify the source of increasing uranium concentrations in groundwater in well OW11B
- Eliminate potential preferential pathways for off-site migration of groundwater contaminants via pipelines
- Evaluate potential groundwater contamination along the 0.25-meter (10-inch) water line near the southeast corner of the IWCS and eliminate the 0.25-meter (10-inch) water line as a potential preferential pathway.
- Manage/sample/dispose of existing Investigation-Derived Waste (IDW) and IDW that will be generated during the field investigation.

2.2 Areas of Investigation

2.2.1 Delineation of Groundwater Contamination in EUs 1, 2, 4, and 10

The areas of dissolved total uranium groundwater contamination in the UWBZ in EUs 1 and 2, EU 4, and EU 10 are fairly well delineated. However, additional monitoring wells are required in these areas to better define the limits of contamination.

Part of the UWBZ groundwater in EU 4 is contaminated with dense non-aqueous phase liquid (DNAPL) that consists of tetrachloroethene and its degradation products. Additional monitoring wells are required in both the UWBZ and LWBZ to complete the delineation of that contamination.

2.2.2 Excavation of Investigative Trenches in the Vicinity of Well OW11B

Over the past several years, groundwater analytical data for well OW11B has shown increasing concentrations of uranium. Based on USACE's review of soil and groundwater data collected near well OW11B, no source for this uranium in groundwater has been identified; however, several areas are suspect due to the nature of former activities in the area. These include a decontamination pad and associated grit chamber, a former railroad bed, and several pipelines.

To investigate these potential sources, several trenches will be excavated, visually observed, and scanned for evidence of contamination. In addition, soil and groundwater samples will be collected.

2.2.3 Excavation and Plugging of Underground Utilities

An abandoned 0.25-meter (10-inch) water line is located near the southeast corner of the IWCS and trends from the southwest to the northeast. Based on historical information, this water line is constructed of ductile iron and is situated approximately 2.4 meters (8 feet) below grade. To eliminate the potential that this line is providing a preferential pathway for groundwater contaminants, it will be excavated, cut, and plugged.

Several underground utilities, including the abandoned 0.25-meter (10-inch) water line and an abandoned 0.457-meter (18-inch) to 0.762-meter (30-inch) sanitary line, leave the site to the north and to the east. To eliminate the possibility that these utility lines provide preferential pathways for off-site migration of site contaminants, along with process water and fire water lines that are likely co-located within the pipe trenches, these lines will be excavated, cut, and plugged. One manhole (Manhole 41) associated with a sanitary line also will be plugged.

2.3 Project Organization

The proposed project team, shown in the attached Organization Chart (Figure 3), consists of staff from our Buffalo, New York, office with health physicist support from our Oak Ridge, Tennessee, and Salt Lake City, Utah, offices. The project team is familiar with many of USACE's requirements and concerns, which will enable the work to be performed immediately, efficiently, safely and in accordance with USACE's policies and procedures.

The project will be managed out of our Buffalo office by [redacted] In addition to [redacted] the following presents a list of key personnel that will work on the project:

TABLE 1

Key Project Personnel

Name	Title
[redacted]	Program Manager
[redacted]	Project Manager
[redacted]	URS Quality Assurance (QA) Officer
[redacted]	Certified Health Physicist
[redacted]	Site Radiation Safety Officer
[redacted]	Site Radiation Safety Officer (Alternate)
[redacted]	Site Safety & Health Officer
[redacted]	Field Investigation Coordinator
[redacted]	Site Supervisor/CQC System Manager
[redacted]	Site Supervisor/CQC System Manager (Alternate)
[redacted]	Project Chemist

The qualifications of key URS personnel and their organizational responsibilities are summarized below.

[redacted] is the **Program Manager** for this contract. All correspondence with the USACE Contracting Officer (CO) will be transmitted through his office. [redacted] will coordinate with the URS Project Manager to meet all base contract and project technical and administrative requirements. He also provides a critical outlet for USACE outside the project team and is in a position to coordinate with other senior URS executives to implement corrective actions.

[redacted] will serve as the **Project Manager** for this project. He will be the primary day-to-day contact with Buffalo USACE personnel and will be ultimately responsible for the technical and relational success of the effort. [redacted] is a URS-certified project manager with over 28 years of experience performing and managing environmental investigations. [redacted] also has more than 10 years of experience performing RI/FS activities at the LOOW for the USACE.

[redacted] will serve as **Project QA/Quality Control (QC) Officer**. In this role he will function independently from the URS Project Manager to verify that URS QA/QC policy is implemented and to serve as the lead Independent Technical Reviewer. [redacted] is an engineer whose 37-year career includes

project manager of three Dayton, Ohio Formerly Utilized Sites Remedial Action Program (FUSRAP) projects for the Buffalo District (Dayton Unit 3 – Bonebreak Seminary; Dayton Unit 4 – Runnymede Playhouse; and Dayton Warehouse).

[redacted] will serve as the **Certified Health Physicist** for the project. [redacted] is a nuclear engineer with extensive experience working with radiological and mixed waste issues, including investigation and remediation of contaminated sites. His knowledge of United States Environmental Protection Agency (USEPA), DOE, NRC, FUSRAP, and state regulations pertaining to the handling of such wastes has been applied in the investigation, remediation, and closure of thorium, radium, and uranium sites in eleven states. [redacted] will provide senior level review of project deliverables and oversee project field health physics support personnel.

[redacted] will serve as the **Field Investigation Coordinator**. In this role he will aid the URS Project Manager in coordinating and monitoring the activities of the project team. [redacted] is a senior geologist/project manager with 20 years of experience in environmental investigation and remediation. [redacted]s served as the Team Coordinator for the Linde 5-Year Review project completed for the USACE Buffalo District in 2010. [redacted] will coordinate all field investigative activities including coordination of URS field resources as well as subcontractors.

[redacted] will serve as the lead **Site Radiation Safety Officer**. [redacted] has over 19 years of experience in radiological assessment and verification surveys; analyzing radiological and site data, and has been designated as a Site Radiation Safety Officer at multiple field sites. Her areas of expertise include radiological assessments, radioactive material regulatory compliance, developing, reviewing and, implementing radiological work plans, radiation safety procedures, and radiological training programs to ensure safe handling of radioactive materials.

[redacted] will serve as the alternate **Site Radiation Safety Officer**. [redacted] has over 12 years of experience, including 2 years serving as a Radiation Safety Officer and 2 years managing a multidisciplinary team of student engineers. She is familiar with radioactive materials regulatory compliance issues and has developed procedures and training methodologies to ensure safe handling of radioactive materials. She has performed radioactive material documentation audits and acted as a liaison with the Utah Division of Radiation Control.

[redacted] will serve as the **Site Safety and Health Officer**. [redacted] is a Health and Safety Specialist/Project Superintendent with 20 years of experience in the industrial manufacturing/environmental remediation fields including serving as an onsite Site Safety and Health Officer (SSHO) for general contractors performing construction, and demolition. Field activities conducted as SSHO for contractor were performed at Bethlehem Steel Corp, General Motors Corp, and Ford Motor Corp as well as serving as Health and Safety Officer (HSO) representing clients for remediation of several former manufacturing gas plants (MGP) across New York State. Daily activities included tailgate safety briefings, site safety inspections, compliance audits, issuing work permits, and safety training. [redacted] is currently a member of the Erie County Hazmat Team. He has Asbestos Supervisor, Asbestos Air Monitoring Technician, Asbestos Monitor, Confined-Space Supervisor and Radiation Technician II certifications. [redacted] will obtain the 30-hour OSHA Construction Safety training by the beginning of field activities.

[redacted] will serve as the lead **Site Supervisor/Contractor Quality Control (CQC) System Manager**. [redacted] has over 10 years of experience in various geologic/hydrogeologic studies. Responsibilities have included drilling supervision during soil boring and monitoring well installation; collection of surface soil, subsurface soil, surface water, groundwater, soil vapor, indoor air, and non-aqueous phase liquid (NAPL) samples for analysis; preparation of boring logs; and assisting in the design of remediation systems. [redacted] served as field geologist for investigation activities at the Shallow Land

Disposal Area located in Parks Township, Pennsylvania under the FUSRAP program, as well as the Dayton Warehouse preliminary assessment/site inspection. [redacted] will also be responsible for overall management of CQC and have the authority to act in all CQC matters for URS.

[redacted] will serve as the alternate **Site Supervisor/CQC System Manager**. [redacted] has over 7 years of experience in the geology/environmental science, construction, and engineering fields. During this time he has been involved in various tasks associated with environmental projects such as groundwater sampling, well development and borehole drilling; geotechnical projects such as rock slope stabilization; environmental monitoring of asbestos abatement projects, including sampling, analysis and inspection; and construction projects such as special inspections and materials testing.

[redacted] will serve as the **Project Chemist**. [redacted] is an Environmental Chemist with over twenty-one years of experience in data auditing/determining data usability, field/lab coordination, and preparing request for proposals (RFPs), subcontract agreements, and QAPPs. [redacted] will participate in preparation of project plans including the QAPP in accordance with the Uniform Federal Policy.

All field personnel will receive Radiological Worker/Authorized User training prior to commencement of field activities.

The following subcontractors will be involved in this project:

Sonic Drilling
[redacted]
Boart Longyear
[redacted]

Excavation
[redacted]
Russo Development, Inc.
[redacted]

Geophysical Survey
[redacted]
Hager-Richter Geoscience
[redacted]

Laboratory Analytical Services
[redacted]
Test America-Saint Louis
[redacted]

IDW – Solids Transportation & Disposal
[redacted]
Energy Solutions
[redacted]

IDW – Liquids Transportation & Disposal
[redacted]
Perma-fix Environmental Services, Inc.
[redacted]

2.4 Project Schedule

A detailed project schedule prepared using Microsoft Project is presented in Appendix A. The project schedule reflects the contract award date of 24 August 2012.

3.0 FIELD ACTIVITIES

The specific field investigative activities are described in this section. The investigation will focus on the primary contaminants of concern. Radiological constituents of concern at NFSS include isotopic uranium, isotopic thorium, and radium-226/228. Other constituents that occur on-site in lesser amounts include daughter products of the uranium series (U-238) and, to some extent, the actinium series (U-235). In addition at EU 4, volatile organic compounds (VOCs) consisting primarily of tetrachloroethene and its degradation products are of primary concern.

The investigative activities described herein will be performed in accordance with USACE-accepted technical work plans, quality assurance/control plans, and health and safety plans. Field activities will be performed in general accordance with URS' Standard Operating Procedures (SOPs) for select activities included in Appendix B unless otherwise stated in the following sections.

URS will perform brush clearing as needed to allow easy access to investigation locations. The cleared brush material will be placed at a location selected by the USACE.

3.1 Task 3 - Drilling and Monitoring Well Installation

URS will coordinate the installation of 17 monitoring wells, MW944 through MW960, at the approximate locations in EUs 1, 2, 4, and 10 shown on Figures 4 through 6 and as described below. The actual well locations may be adjusted in the field, as approved by the USACE, to avoid subsurface utilities.

The monitoring wells will be installed in accordance with standard industry practice and USACE EM 1110-1-4000 *Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites (1* November 1998).

URS will take precautions when installing wells.

Well Locations

The 17 wells will be installed at the following locations (see Figures 4 through 6):

TABLE 2

Well Information

Well Identification	Location	Depth*	Water-Bearing Zone	Figure
MW944 and MW945	EU1, northwest of existing well MW921	5.49 meters (m) (18 feet [ft])	UWBZ	4
MW946	EU2, southeast of existing well 808A	5.18 m (17 ft)	UWBZ	4
MW947	EU4, southeast of existing well 415A	4.57 m (15 ft)	UWBZ	5
MW948	EU4, northwest of existing well MW934	5.49 m (18 ft)	UWBZ	5
MW949	EU4, near MW948	13.7 m (45 ft)	LWBZ	5
MW950 and MW951	EU10, at former temporary well points 831 and 833, respectively	5.49 m (18 ft)	UWBZ	6
MW952, MW953, MW954, and MW955	EU10, north, south, east, and west of existing well OW11B	4.88 m (16 ft)	UWBZ	6
MW956, MW957, MW958, MW959, and MW960	EU10, south of IWCS (Near wells 832, 850, 853, 854, 855, OW07B, and OW13B)	4.88 m (16 ft)	UWBZ	6

*Estimated well depths were determined using stratigraphy and well construction information from nearby borings/wells. The objective of the installation of the proposed monitoring wells is to monitor the same water-bearing zone as the existing wells identified in the "Location" column.

URS will perform geophysical and gamma surveys of the well areas prior to drilling. Details of the means and methods of the surveys are included in the sections 3.2.2 and 3.4 respectively.

Borehole Drilling

Prior to drilling, but after completion of the gamma walkover survey, each well borehole will be manually pre-cleared to a depth of 1.5 meters (5 feet) to identify and avoid subsurface structures and utilities.

Monitoring well borings will be advanced using sonic drilling equipment in accordance with ASTM D6914 – 04E1, Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices, and all other applicable local, state, and Federal regulations and requirements. Water used during the drilling process will be contained and transported to the temporary IDW storage area.

The 16 shallow UWBZ well borings will be advanced using a 0.1-meter (4-inch) diameter sampling core barrel inside a 0.15-meter (6-inch) diameter outer core barrel. Drilling will be performed while continuously collecting soil cores over a 3-meter (10-foot) interval, as appropriate for the final depth of the well (e.g., a 6.1-meter (20-foot) well will initially be hand cleared to a 1.5-meter (5-foot) depth using hand augers/post hole diggers and Sonic drilling will then be performed from 1.5 to 6.1 meters (5 to 20

feet) below grade resulting in one 3-meter (10-foot) soil core interval and one 1.5-meter (5-foot) soil core interval).

For well MW949, the upper 6.1 meters (20 feet) will be advanced using a 0.3-meter (12-inch) diameter outside core barrel. Upon reaching the 6.1-meter (20-foot) depth, a permanent 0.2-meter (8-inch) separation casing will be set into the Gray Clay Unit and cemented in place with a cement/bentonite grout. At least 72 hours later, the remainder of the borehole, from 6.1 to 13.7 meters (20 to 13.7 meters (45 feet)), will be advanced while continuously collecting soil samples over 3-meter (10-foot) intervals using the 0.1-meter (4-inch) inner barrel and 0.15-meter (6-inch) outer barrel set up.

Soil Sampling/Screening

Each boring will be manually cleared to a depth of 1.5 meters (5 feet). As the soils are brought to the surface, they will be screened using a Ludlum Model 44-9 detector (for alpha, beta and gamma radiation), Ludlum Model 43-93 detector (for alpha and beta radiation), and VOC vapors using a photoionization detector (PID). The remainder of the borehole will be advanced using sonic drilling while continuously collecting soil samples.

After drilling each sampling interval, the outer casing will be held in place within the boring while the inner core barrel is removed. A 0.1-meter (4-inch) diameter continuous core will be extruded from the core barrel, sealed in a plastic sleeve, and laid out on a plastic-lined work surface for field screening, visual description, and sample selection.

The plastic sleeve will be sliced open lengthwise to allow the soil core interval to be scanned at 0.15-meter (6-inch) intervals a Ludlum Model 44-9 detector, Model 43-93 detector, and VOC vapors using a PID. The down hole gamma survey will include the top 1.5 meters (5 feet) of each borehole.

Upon reaching the borehole's termination depth, a temporary 0.1-meter (4-inch) diameter PVC pipe (with a cap on the bottom) will be inserted into the hole through the casing and the drill casing will be removed. The down-hole gamma scan will then be performed inside the PVC pipe using a Ludlum Model 44-10 detector and the resulting measurements recorded as detailed in RP-7.0 "Borehole, Core Radiation Measurements" (contained in Appendix A of the Radiation Protection Plan [RPP]). The 50 millimeters (mm) x 50 mm (2-inch x 2-inch) sodium iodide (NaI) Ludlum 44-10 detector will be lowered to the bottom of the hole and slowly retracted with measurements recorded at 0.15-meter (6-inch) intervals. After the entire hole has been logged, a one (1) minute static count will be recorded at the location that exhibited the highest reading. Following the completion of the down-hole gamma logging the temporary PVC pipe will be removed from the hole (using rig winch if necessary and over drilling only if necessary due to borehole collapse). Then the outer casing will be re-advanced and cleaned out to facilitate monitoring well installation.

In each monitoring well boring, a maximum of four (4) soil samples will be collected in accordance with the following:

a. one (1) sample from the top 0.15 meters (6 inches) of soil;

b. one (1) sample from a 0.3-meter (1-foot) interval in the approximate middle of the future well screen;

c. one (1) sample from the interval that exhibits the highest radiological scan measurement on the soil core, and,

d. one (1) sample from the interval that exhibits the highest radiological scan measurements based on the down-hole gamma reading. If the highest down-hole gamma reading and the highest radiological scan measurement are recorded for the same interval, the sample will be collected from the soil core at the depth of the second highest down-hole gamma reading.

Soil sampling locations will be driven by radiological detector readings. EU4 wells may be driven by PID readings, but this decision will be based on PID and radiological detector readings during advancement of monitoring wells MW947, MW948, and MW949 with the final decision made in the field.

For wells MW947, MW948, and MW949, which are intended primarily to monitor DNAPL contamination, the soil samples submitted for laboratory analysis will follow the procedures outlined above but may be adjusted in the field, upon direction from the USACE. Furthermore, the USACE may adjust the sampling intervals and sample numbers at each soil boring as warranted by actual field conditions.

URS will prepare a boring log for each boring using the example boring log form presented in Appendix C. At a minimum, the boring log will record all applicable information shown on Engineering Form 5056 – HTRW Drilling Log. At a minimum, the following information will be provided on each log:

- Boring/well identification
- Start and end dates
- Geologist and driller names
- Drilling company and equipment used
- Hole diameter(s), casing type(s) and diameters
- Sample collection intervals and recoveries
- Boring location (northing and easting) and elevation
- Soil, rock, and/or fill material descriptions in accordance with ASTM D2488-06;
- Material boundaries or transitions
- Depth to the water table
- ♦ Radiological and VOC scan measurements (radionuclide scan measurements for each soil core and down-hole gamma scan measurements)

Well Construction

Well depths and screen intervals will be determined by URS in the field based on the lithology encountered at each monitoring well location and to be consistent with the portion of the formation monitored by nearby existing wells.

Each well will be screened to the extent possible in more permeable units such as sand lenses in the brown clay till unit. The final well depth and screen interval will be selected following approval by the USACE prior to the well installation.

Monitoring wells will be constructed with 0.05-meter (two (2)-inch) diameter, schedule 40 PVC riser. Well screens will be 0.254 mm (0.010-inch) slotted schedule 40 PVC, not to exceed 3 meters (6 feet) in length. The well screen for the shallow wells will be installed to span the water table surface. The deeper well (MW949) will likely have a completely submerged screen interval.

The annular space between the borehole wall and the screen/riser will be filled with an appropriately

sized sand filter pack to 0.6-meters (2 feet) above the screened interval and followed with a 0.9-meter (3-foot) minimum bentonite pellet seal. The sand pack material will be washed gravel or clean sand free of contaminants and silt. The grain size of the sand pack will be compatible with the slot openings of the well screen and the existing surrounding soil. Following adequate hydration time, the remainder of each monitoring well will be backfilled with cement/bentonite grout or bentonite chips as approved by USACE.

The monitoring wells will extend approximately 1 meter (3 feet) above the ground surface and have a protective steel casing extending from a depth of 1.2 meters (4 feet) below ground to approximately 0.05 meters (2 inches) above the well riser. The protective steel casing will be at least 0.05 meters (2 inches) larger in diameter than the well riser and have a locking cap. The lock will be protected by plastic or rubber covers. Two (2) sets of keys will be provided to USACE with the appropriate well location affixed to each.

All well casing and screen will be new, free from contamination, and in good condition before installation. All joints and other accessory parts will be securely fastened in place. Care will be taken to avoid damaging the screen, centralizers, and casing during the installation and throughout all subsequent operations. All joints will be flush threaded as provided by the manufacturer.

The screen and casing will be centered in the well hole and held securely in place during placement of the filter pack. Centralizers will be used as needed. The assembled screen and casing will be placed in the well hole in a manner to avoid jarring impacts d to ensure that the assembly is not damaged.

Each completed well will be straight and plumb. Before placing the filter pack and with top of casing fastened securely in a vertical and horizontal position, a visual plumbness survey will be conducted by the field geologist in the presence of the USACE field representative.

Each monitoring well will have a small weep hole located just above the ground surface seal to prevent the accumulation of water between the well riser and protective casing. After installation of the protective casing and surface seal, the annular space between the inner riser and protective casing will be filled with sand to 0.05 meters (2 inches) below the top of the well riser pipe. A reference mark will be made on the highest point of each well riser for reference during the future elevation survey and subsequent water level monitoring.

Three (3) steel bollards will be placed around wells MW944, MW945, and MW957, within approximately 1 meter (3 feet) of each monitoring well. The bollards will be set below the frost line (which is approximately 1-meter [42 inches]) and extend at least 1 meter (3 feet) above grade. The bollards will be painted yellow or orange with reflectors.

Well construction diagrams will be prepared for each monitoring well and include the following information (at a minimum):

- A diagram that depicts the well installation as it exists in the ground;
- A log of material copied from the corresponding boring log;
- The depth and type of well casing;
- The type of well screen (length, location, diameter, slot size, and material);
- The gradation and description of the filter pack and placement method including how the depth to the top of the filter was determined;
- The type and depths of annulus seals including placement method, hydration time, water content and mix ratios for grout;

- Construction details, including any difficulties setting the casing and screen and sounding procedures for determining well depth; manufacturer and quantities of all materials used in wells, and hole preparation before well installation.

Detailed shop drawings and catalog data for the well screen, casing, protective casing, lockable cap, filter material, and joints proposed use on this project are included for acceptance by the USACE in Appendix D.

It is known, both through documentation provided by USACE and URS employee experience, that the occurrence and flow of groundwater in the Brown Clay Unit/UWBZ is significantly influenced by the presence and extent of more permeable silt, sand, and gravel lenses within the unit. It is also known that these lenses are horizontally and vertically discontinuous. URS assumes that the wells that are required to be installed in this unit will function as useful monitoring wells. During drilling and well installation, URS will attempt to install the wells in the most productive portions of this unit. URS will also provide recommendations to USACE should URS conclude that a well boring is not suitable for well installation. However, URS will not be held responsible should a well become dry due to the lack of recharge from the discontinuous silt, sand, and gravel lenses.

Well Development

At least 72 hours after installation, each monitoring well will be developed by pumping and/or bailing until groundwater parameters pH, specific conductance, temperature, turbidity, and dissolved oxygen have stabilized (i.e. three consecutive readings within 10 percent), or 55 gallons of groundwater has been removed. It is assumed that one (1) 55-gallon drum of development water will be generated from each well. Development water will be contained and transferred to the designated IDW storage area for subsequent disposal. Development water generated from the EU4 wells will be stored separately from other wells due to the likely presence of VOCs in the EU4 wells.

URS will record well development information on well development logs which will include elapsed time between grouting (if applicable) and well development, specific details of development, time duration, description of development water, and field measurements.

Surveying

Each monitoring well will be surveyed for location and elevation. The survey coordinates will be geo-referenced to North American Datum (NAD) 1983 New York State Plane Coordinates and National Geodetic Vertical Datum (NGVD) 88 Datum. Ground surface, top of well pipe (to reference mark) and top of protective casing elevations will be measured to 0.003 m (0.01 ft). Site benchmark data will be used in the survey.

URS will submit a Geographical Information System (GIS) figure (hard copy and electronic file) showing the surveyed monitoring well locations on an NFSS Site Plan for USACE review and acceptance. The survey coordinates and elevations for each monitoring well will be provided electronically in Excel spreadsheet format.

Decontamination

Drilling equipment will be decontaminated with high-pressure steam prior to and between each monitoring well in accordance with the procedure described in Section 6.0. A radiological survey of the drill rig and drilling equipment will be completed prior to drilling activities and a free release survey will be conducted at the end of the work prior to the equipment leaving the site in accordance with the

procedure described in Section 3.4. Decontamination will be performed on a temporary decon pad constructed at a location approved by USACE. Decontamination fluids and solids (i.e., IDW) will be containerized as described in Section 3.3.1.

Groundwater Sampling

URS will collect one (1) groundwater sample from each new monitoring well MW944 through MW960 no sooner than 72 hours after development. The groundwater samples will be collected using low-flow sampling method and analyzed in the field for water quality parameters such as pH, temperature, dissolved oxygen, oxidation-reduction potential (redox), specific conductivity, and turbidity, in accordance with SOP GWLFW-1 in Appendix B.

3.1.1 Soil and Groundwater Analysis

The groundwater and soil samples will be submitted for laboratory analysis in accordance with the following schedule (note that only soil and groundwater from wells MW947, MW948, and MW949 in EU 4 will include analysis for VOCs):

TABLE 3

Monitoring Well Soil and Groundwater Sample Analysis Schedule(4)

PARAMETER	GROUNDWATER	SOIL	METHOD
Mass Uranium (Total-U) (2)	17 filtered[1] 17 unfiltered	68 samples	ASTM D5174-02, Trace Uranium by Pulsed-Laser
Isotopic Uranium-234, 235 and 238(2)	17 filtered[1] 17 unfiltered	68 samples	DOE EML HASL-300m, Alpha-Spectroscopy
Radium- 226	17 filtered[1] 17 unfiltered	68 samples	EPA 903.1, Radon Emanation / EPA 901.1 (soil/sediment)
Radium- 228	17 filtered[1] 17 unfiltered	68 samples	EPA 904.0, Gas Proportional Counting / EPA 901.1
Isotopic Thorium	17 filtered[1] 17 unfiltered	68 samples	DOE EML HASL-300m, Alpha-Spectroscopy
Actinium-227, cesium-137	NA	68 samples	EPA 901.1 (Gamma Spectroscopy – soil/sediment)
Anions (unfiltered only)	17 unfiltered	NA	EPA 300.0 or SW846 9056 Ion Chromatography
Total Dissolved Solids (unfiltered only)	17 unfiltered	NA	Standard Methods 2540C or EPA 160.1
Alkalinity (unfiltered)	17 unfiltered	NA	Standard Methods 2320B or EPA 310.1
Metals + Boron and Lithium	17 filtered[1] 17 unfiltered	68 samples	EPA SW846 6020
Volatile Organic Compounds (VOCs) (3)	3 unfiltered	12 samples	EPA SW846 8260

(1) Groundwater samples will be filtered via disposable 0.45 micron in-line field filters
(2) Expedited turnaround times (i.e., 5 to 7 days) are required for isotopic and total-uranium analyses for groundwater samples from wells MW950 and MW951 (installed near former temporary wells 831 and 833).
(3) Wells MW947, MW948, and MW949 only (monitoring PCE and its degradation compounds in EU 4).
(4) This schedule does not include QA/QC samples, which will be in addition to those listed above
(5) NA – not applicable
(6) USACE split samples will be collected at USACE's discretion.

Samples will be placed in laboratory provided containers. Soil samples for VOC analyses will be placed in 4-oz glass jars with Teflon-lined lids.

The isotopic uranium and mass uranium analyses of the groundwater samples collected from wells MW950 and MW951 will have an expedited turnaround time of 5 to 7 days. The data will determine if additional monitoring wells will be installed in those areas.

In order to comply with USACE sampling protocols, the number of field duplicates and matrix spike/ matrix spike duplicate (MS/MSD) samples will be 10% and 5%, respectively, of the total number of soil samples collected. The same requirements apply to groundwater samples. For example, one (1) field duplicate will be collected for every ten (10) soil samples, and one (1) field duplicate will be collected for every ten (10) groundwater samples.

If limited volume of sample is available, the priority of analysis will be, from highest to lowest priority: RAD, metals, VOCs, SVOCs, pesticides/PCBs, QA/QC duplicates, QA/QC MD, QA/QC MS, QA/QC MSD. The collection of analytical parameters for the QA/QC samples will follow the same priority.

With the exception of the expedited turnaround time required for select groundwater samples collected from wells MW950 and MW951 (see note (2) in the table above), all analytical results for samples collected from the field investigative activities will be received within standard turnaround time (not to exceed twenty one (21) days). URS' subcontract laboratory will provide the appropriate number of sample containers and coolers for all samples. A lab courier will pick up the samples from the site and transport them to the TestAmerica facility in Amherst, New York, who in turn will ship the samples, following proper handling, preservation, and chain-of-custody protocols, to the TestAmerica facility in St. Louis, Missouri. Sample handling, preservation, and chain-of-custody procedures will be overseen by the USACE Health Physicist or other designated USACE personnel.

3.2 Task 4 and Task 5 - Excavations

3.2.1 General

The SOW requires excavations to be performed for two purposes: under Task 4 to access, cut, and plug existing pipelines, and under Task 5 to investigate the absence/presence of contamination. The following text discusses items that are common to both excavations.

During the site visit (Task 1), URS and USACE located the approximate areas to be excavated using field observations and scaling from site maps and plans. Geophysical surveys, described in Section 3.2.2, will be performed to further refine the locations of the excavations.

Per EM 385-1-1 Section 25, an Excavation/Trenching Plan will be submitted and accepted by the USACE prior to beginning excavation operations. The Excavation/Trenching Plan as prepared by the subcontractor who will perform the work is included as Attachment 13 of the Accident Prevention Plan (APP).

Excavation walls will be braced, sloped and/or benched in accordance with applicable local, state, and Federal regulations and requirements to maintain stable sidewalls for personnel to safely enter the trenches (as needed), perform radiological scans, record visual observations, and collect samples. Stable sides and slopes and/or benches will be maintained until excavated soils are returned to the field investigative trench. An OSHA compliant guard rail system will be used to allow personnel to safely scan/inspect the excavation wells when standing at grade. The excavation subcontractor, Russo, will

provide a competent person to inspect and confirm safety aspects of the excavation.

Soils will be stockpiled next to the trench locations on plastic sheeting, laid out in the order of removal, and placed back into the trench once soil classification, radiological scanning, and sampling are completed. Trenches may require dewatering. The dewatering plan is described in Attachment 13-A of the APP. All excavation water generated during dewatering activities will be containerized in drums or in a poly tank and transported to the IDW storage area. Soils will be returned to the trench in the reverse order of removal. Each excavation location will be restored by compacting and re-grading to match adjacent grade followed by seeding and mulching.

Trenches may require dewatering. Should a water seep into a trench, a sump will be created at the end of the trench into which the water will be directed. As needed, a submersible or trash pump will be used to transfer the water from the trench into a temporary storage tank at ground level. The water will be transferred to the IDW storage area for subsequent waste characterization and disposal.

While excavating, URS' field geologist will prepare a detailed excavation log including a description of soil types (using ASTM Method D2488-06 soil classification system) and location of radiological or soil anomalies. Excavation materials will be visually observed and described with respect to depth and location. Photographs of the excavations will be taken and referenced by location and direction for future use. Field activities and observations will also be logged in a bound field logbook and on a field investigative excavation log form. The excavation log will include, but not be limited to, the following:

- A plan view of the excavation;
- Survey coordinates of the excavation;
- Cross-sections of the excavation's walls;
- Project information including project number, location, owner, and client;
- Field information including date and time arrived and personnel responsible for logging the excavation;
- Description of soils, color, moisture content, consistency, gradation, and other pertinent data including each sequential boundary between soil types and individual lithologies;
- Depth of first-encountered free water along with the method of determination and any subsequent distinct water levels encountered thereafter;
- Excavation information including the excavation dimensions, excavation method, sampling method(s), and the start and end time of the excavation for the trench;
- Radiological count measurements from the trenches' sidewall and bottom including the instrument used and calibration information;
- The static count measurement obtained at each sample location;
- The number of samples taken with location and sample number;
- Sample collection and preparation method;
- Backfill type and quantity (if necessary); and,
- Field observations.

A copy of the excavation log sheet will be submitted to the USACE Contracting Officer's Representative (COR) upon completion of the field investigation. The original excavation log will be maintained with the project file.

Each excavation will be surveyed for location, boundaries, dimensions, and elevations by a URS surveyor. The survey coordinates will be geo-referenced to NAD 1983 New York State Plane Coordinates and NGVD 88 Datum. Because the surveying will not be performed at the actual time of

excavation, the depth of the excavation below ground surface will be measured with a tape measure at the time of excavation. The ground surface elevation will subsequently be surveyed by the surveyor.

URS will submit a GIS figure (hard copy and associated electronic files) showing the surveyed excavation locations on a NFSS Site Plan for USACE review and acceptance. Survey coordinates will be provided electronically in Excel spreadsheet format.

3.2.2 Task 4 -Pipeline Excavations

URS will excavate, cut, and plug the 0.25-meter (10-inch) water line in the EU10/EU11 area and the underground pipelines that leave the site to the north and east shown in EU2 and on the northeast corner of EU12. These locations, herein identified as Pipeline Excavation (PE)1, PE2, and PE3, are shown in Figure 2. The sanitary lines exiting the site to the east will not be excavated but will be plugged via Manhole 41 (MH41) shown on Figure 2. It is estimated that nine (9) pipelines will be cut and plugged: four each in the PE2 and PE3 excavations and the 0.25-meter (10-inch) line in the PE1 excavation.

Geophysical Survey

A geophysical survey will be performed under this task to locate subsurface utilities and other features that could potentially interfere with intrusive activities (e.g., drilling and excavation). Survey methods will include electromagnetic (EM), magnetometer, and induced-tone line tracing surveys. The results from geophysical surveys, as well as the site walkover, will be used to map the likely presence of subsurface utilities and appurtenances.

The geophysical survey will include, but not be limited to, the following systems (or equivalent method acceptable by the USACE):

- Geonics Ltd. EM-31™
- Geonics Ltd. EM-61™
- GEM Systems, Inc. GSM-19™
- Ditch Witch 950 R/T induced-tone line tracing system.

QA/QC of each surveying technique will be in accordance with the manufacturer's recommendations. QA/QC procedures will be performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis. URS will provide the QA/QC results to the USACE for information only.

A hard copy geophysical survey report will be prepared and will include graphical presentations of the survey results including a site plan showing the area of investigation and data collection points. Survey coordinates will be provided electronically in Excel spreadsheet format.

Pipeline Excavation, Sampling and Plugging

URS will coordinate excavation in the area of the suspected pipelines to make them accessible for observation, sampling, and plugging. Prior to excavation URS' Health Physicist will survey the ground surface using a NaI radiological detector (Section 3.4). URS will also survey the excavated soil in the bucket (outside the trench) or after it has been removed from the trench and placed on the plastic

laydown. The excavation for the 0.25-meter (10-inch) pipe is estimated to be approximately 2.4 meters (8 feet) below grade. The other underground pipelines in EU2 and EU12 are estimated to exist at depths of approximately 15 to 18 feet below grade. If obstructions are encountered during excavation, an excavation will be performed to access the pipeline beyond the obstruction and operations will continue.

The SOW requires URS to sample the contents of pipelines, as well as the soil beneath the pipelines. Therefore, it will be necessary to enter the excavation. Consequently, URS will implement appropriate shoring and protective systems during excavation. These procedures are identified in the Trenching and Excavation Plan (Attachment 13 of the APP). Because it will be necessary to enter the excavations, URS will also adhere to regulations and requirements for confined space entry.

URS anticipates using a hole saw/core drill of an appropriate diameter (e.g., 0.15 meters [6 inches] for the 0.25-meter [10-inch] pipeline) to penetrate the pipe and gain access to the interior for the collection of samples and plugging. However, the actual penetration method or hole saw diameter will be determined in the field based on actual conditions and the dimensions of the pipelines encountered. Additional discussion of the pipe penetration procedures is presented in the Excavation/Trenching Plan included as Attachment 13 of the APP.

URS assumes that the pipelines are filled with liquid. URS will attempt to minimize liquid entering the excavation upon penetration of the pipeline. Penetrations into the pipes will be made using a wet tap system. The wet tap system will consist of a saddle that will be clamped around the pipe. One side of the saddle will contain a threaded hole into which a valve assembly will be installed. A hole saw will be inserted through the saddle/valve assembly to cut a hole in the pipe. For pipelines under pressure, the valve assembly will be used to regulate water flow from the pipe.

Following the collection of liquid samples from inside the pipe, inflatable sacrificial bladders will be installed through the valve assembly into the upstream and downstream portions of the pipe. Once inflated, the bladders will stop water flow in the pipeline. The section of the pipe between the bladders will then be cut to expose the interior of the pipeline and sediment samples will be collected. Following collection of the sediment samples, a cement/bentonite mixture will then be placed inside each end of the open pipe to seal both ends of the pipe. The bladders will be abandoned in the pipes.

Prior to opening the pipeline, URS will collect one (1) subsurface soil sample from beneath each excavated pipeline to evaluate the potential migration of contaminants from the line into the soil. The soil sample will not include bedding material but will be collected from beneath the bedding, if present.

URS will characterize the pipeline bedding. The characterization will include a description of the bedding composition, depth, visual indications of contamination, and integrity of the bedding. URS will also identify the diameter and composition of each pipeline. In addition to the bedding material, actual depth of the pipeline from ground surface, pipeline material and the trench profile will be logged for each location. Also, photo documentation of pipeline plugging will be included in a final report.

URS will collect one (1) liquid and one (1) sediment/sludge/soil sample from inside each pipeline. At Manhole 41, URS will collect one (1) sediment and one (1) liquid sample from inside the manhole prior to plugging the manhole.

URS anticipates using decontaminated stainless steel spoons or disposable scoops to collect the sediment/sludge/soil samples. For pipelines under pressure, tubing will be connected to the valve system to allow the collection of the liquid samples. For pipelines not under pressure, URS will collect the liquid samples using a peristaltic pump and disposable tubing or direct filling using clean laboratory

bottles.

URS anticipates using a clean container affixed to an extendable pole to grab samples from Manhole 41. Specific equipment to be used for the collection of liquid, soil and sediment samples will be approved by USACE in the field.

Soil and sediment samples collected from in and around the pipelines and from Manhole 41 will be analyzed in accordance with the following schedule:

TABLE 4

Pipeline Soil and Sediment Sample Analysis Schedule

PARAMETER	**Method**
Mass Uranium (Total-U)	ASTM D5174-02, Trace Uranium by Pulsed-Laser Phosphorimetry
Isotopic Uranium-234, 235 and 238	DOE EML HASL-300m, Alpha-Spectroscopy
Radium- 226	EPA 903.1, Radon Emanation / EPA 901.1 (soil/sediment)
Radium- 228	EPA 904.0, Gas Proportional Counting / EPA 901.1 (soil/sediment)
Isotopic Thorium	DOE EML HASL-300m, Alpha-Spectroscopy
Actinium-227, cesium-137	EPA 901.1 (Gamma Spectroscopy – soil/sediment)
Metals + boron and lithium	EPA SW846 6020
Volatile organic compounds	EPA SW846 8260
Semi-volatile organic compounds	EPA SW846 8270
PCBs and pesticides	EPA SW 846 8082/8081

Liquid samples collected from inside the pipelines and Manhole 41 will be analyzed in accordance with the following schedule:

TABLE 5

Pipeline Liquid Sample Analysis Schedule

PARAMETER	METHOD
Mass Uranium (Total-U) (filtered and unfiltered) [1]	ASTM D5174-02, Trace Uranium by Pulsed-Laser Phosphorimetry
Isotopic Uranium-234, 235 and 238 (filtered and unfiltered) [1]	DOE EML HASL-300m, Alpha-Spectroscopy
Radium- 226 (filtered and unfiltered)[1]	EPA 903.1, Radon Emanation
Radium- 228 (filtered and unfiltered)[1]	EPA 904.0, Gas Proportional Counting
Isotopic Thorium (filtered and unfiltered) [1]	DOE EML HASL-300m, Alpha-Spectroscopy
Anions (unfiltered only)	EPA 300.0 or SW846 9056 Ion Chromatography
Total Dissolved Solids (unfiltered only)	Standard Methods 2540C or EPA 160.1
Alkalinity (unfiltered)	Standard Methods 2320B or EPA 310.1
Metals + boron and lithium (filtered and unfiltered) [1]	EPA SW846 6020
Volatile organic compounds	EPA SW846 8260
Semi-volatile organic compounds	EPA SW846 8270
PCBs and pesticides	EPA SW846 8082/8081

(1) Liquid samples will be filtered via disposable 0.45 micron in-line field filters.
(2) USACE split samples will be collected at USACE's discretion.

The sample numbering system will be consistent with that used at the NFSS during previous investigations and include the following nomenclature: "SB" for subsurface soil, "PIPE" for pipeline liquid and sediment samples, and "MH" for manhole liquid and sediment samples.

In order to comply with USACE sampling protocols, the number of field duplicates and MS/MSD samples will be 10%, and 5%, respectively, of the total number of soil samples collected. The same requirements apply to liquid and sediment samples. For example, one (1) field duplicate will be collected for every ten (10) soil samples, and one (1) field duplicate will be collected for every ten (10) liquid samples.

If limited volume of sample is available, the priority of analysis will be, from highest to lowest priority: RAD, metals, VOCs, SVOCs, pesticides/PCBs, QA/QC duplicates, QA/QC MD, QA/QC MS, QA/QC MSD. The collection of analytical parameters for the QA/QC samples will follow the same priority.

Standard turnaround time (not to exceed twenty one (21) days) will be required for all samples collected from the field investigative activities. URS' subcontract laboratory will provide the appropriate number of sample containers and coolers for all samples. URS will prepare the coolers for pickup by the TestAmerica - Buffalo courier under the supervision of the SRSO. The laboratory will then ship the samples to the TestAmerica - St. Louis facility.

Following collection of soil and water samples, URS will plug both ends of each pipeline and Manhole

41 with bentonite and cement, the composition of which is specified in the Excavation/Trenching Plan (Attachment 13 of the APP).

Following pipeline plugging, URS will place a bentonite/concrete mixture in the bottom of the excavation to function as hydraulic barrier to mitigate possible groundwater migration along the pipeline bedding. The excavation will then be backfilled and a confirmation gamma radiation survey will be conducted to document the final radiological condition of the area.

3.2.3 Task 5 - Excavation of Investigative Trenches in the Vicinity of Well OW11B

URS will coordinate the excavation of eight (8) investigative trenches in the general area of well OW11B. Four (4) trenches will be located near each side of the grit chamber; two (2) trenches will be located near the southern end of the decontamination pad; one (1) trench will be located near the underground utility lines; and, one (1) trench will be located near the former railroad bed. It is assumed that each excavation will have the approximate dimensions of 3 meters (10 feet) bgs by 0.6-meters (2 feet) wide by 1.8 meters (6 feet) long. The locations, herein identified as Investigation Excavation (IE) 1 through IE8, are shown in Figure 7.

Prior to excavating the field investigative trench, URS' Health Physicist will survey the ground surface using a sodium iodide (NaI) radiological detector. URS will also survey the excavated dirt in the bucket (outside the trench) or after it has been removed from the trench and placed on the plastic laydown. After excavating the trench to the target depth, URS' Health Physicist will perform a radiological survey of the bottom and sidewalls of the field investigative trench.

The USACE Health Physicist and/or Project Engineer may identify specific soil sample locations during the performance of this work. All radiological scanning and sampling will be performed by URS' Health Physicist. A radiological screening will be performed of the sidewalls and bottom of each investigative trench to identify areas of elevated contamination. Following completion of the screening, static counts will be performed at locations with the highest readings. These activities will be performed from ground surface without entering the excavation. An OSHA-compliant guard rail system will be used to allow the technician to safely perform the measuring from ground surface.

Four (4) soil samples will be collected from each excavation. One (1) sample will be collected from the top 0.15 meter (6 inches) of the highest radiological detector reading during the surface survey prior to excavation. One (1) sample will be collected from the bottom of the excavation and two (2) samples will be collected from the sidewalls of the excavation. These two samples will be collected from the locations with the highest radiological readings.

The soil samples will be collected using a hand auger or Macro core sampler attached to an extended handle.

If groundwater is encountered, one (1) filtered groundwater sample will be collected from each trench and analyzed in accordance with the analytical schedule provided herein.

The excavation area will be restored to its original grade and a confirmation gamma radiation survey will be conducted to document the final radiological condition of the area.

TABLE 6

Investigative Trench Soil and Groundwater Sample Analysis Schedule

PARAMETER	GROUNDWATER	SOIL	METHODS
Mass Uranium (Total-U)	8 filtered	16 to 32 samples	ASTM D5174-02, Trace Uranium by Pulsed-Laser Phosphorimetry
Isotopic Uranium-234, 235 and 238	8 filtered	16 to 32 samples	DOE EML HASL-300m, Alpha-Spectroscopy
Radium- 226	8 filtered	16 to 32 samples	EPA 903.1, Radon Emanation/EPA 901.1 (soil/sediment)
Radium- 228	8 filtered	16 to 32 samples	EPA 904.0, Gas Proportional Counting / EPA 901.1 (soil/sediment)
Isotopic Thorium	8 filtered	16 to 32 samples	DOE EML HASL-300m, Alpha-Spectroscopy
Actinium-227, cesium-137	NA	16 to 32 samples	EPA 901.1 (Gamma Spectroscopy – soil/sediment)
Anions (unfiltered only)	8 filtered	NA	EPA 300.0 or SW846 9056 Ion Chromatography
Total Dissolved Solids (unfiltered only)	8 filtered	NA	Standard Methods 2540C or EPA 160.1
Alkalinity (unfiltered)	8 filtered	NA	Standard Methods 2320B or EPA 310.1
Metals + Boron and Lithium	8 filtered	16 to 32 samples	EPA SW846 6020

(1) Groundwater samples will be filtered via disposable 0.45 micron in-line field filters.
(2) This schedule does not include QA/QC samples, which will be in addition to those listed above
(3) NA – not applicable
(4) USACE split samples will be collected at USACE's discretion.

The sample numbering system will be consistent with that used at the NFSS during previous investigations; however, "TB" will be the identifier for trench soil sample.

In order to comply with USACE sampling protocols, the number of field duplicates and MS/MSD samples will be 10%, and 5%, respectively, of the total number of soil samples collected. The same requirements apply to water samples. For example, one (1) field duplicate will be collected for every ten (10) soil samples, and one (1) field duplicate will be collected for every ten (10) groundwater samples.

If limited volume of sample is available, the priority of analysis will be, from highest to lowest priority: RAD, metals, VOCs, SVOCs, pesticides/PCBs, QA/QC duplicates, QA/QC MD, QA/QC MS, QA/QC MSD. The collection of analytical parameters for the QA/QC samples will follow the same priority.

Standard turnaround time (not to exceed twenty one (21) days) will be required for all samples collected from the field investigative activities. URS' subcontract laboratory will be responsible for providing the appropriate number of sample containers and coolers for all samples. URS will prepare the coolers for pickup by the TestAmerica - Buffalo courier under the supervision of the SRSO. The laboratory will then ship the samples to the TestAmerica - St. Louis facility.

3.3 Task 6 – Investigation Derived Waste

IDW includes, but is not limited to, soil, liquid, and sludge generated during sampling activities, decontamination liquids, and waste personal protective equipment (PPE). URS will take necessary precautions to avoid cross contamination.

URS will use waste minimization methods when dealing with IDW to the extent possible and comply with EPA 540/G-91/009, *Management of Investigation-Derived Wastes During Site Inspections* and applicable New York State and local regulations.

URS has identified the following waste streams that will be managed as part of this investigation:

1. Liquid wastes containing solvents and solvents utilized during decontamination.
2. Liquid wastes not containing solvents (e.g., purge and well development water).
3. Soils generated during drilling
4. Contaminated (based on gamma scans and/or presence of visible contamination) PPE, plastic, and other disposable materials used during sampling and waste management activities.
5. Non-contaminated PPE, plastic, and other disposable materials used during sampling and waste management activities.
6. Existing Shelby tube samples (18)
7. Existing 55-gallon drums of soil (6)
8. An existing cooler containing samples of unknown materials and an empty cooler
9. Approximately 1,500 gallons of existing purge/development water

URS will select a licensed/permitted disposal facility for each waste stream and submit its name and relevant information to USACE for approval.

3.3.1 IDW Management and Storage Requirements

URS will provide water-tight, DOT-approved and EPA-approved temporary storage containers (TSCs) for the storage of IDW generated during investigative activities. IDW will be stored in TSCs at a centralized location approved by the USACE pending sampling, analysis, and disposal. TSCs will be labeled as “Waste Material” with weather resistant paint, and display the matrix, sampling locations, sampling depths, date, point of contact and telephone number.

URS has been informed that USACE will provide storage tanks (i.e., existing onsite poly tanks) to allow for temporary storage of liquid IDW and the efficient separation of liquids requiring different treatment/disposal options.

Materials displaying the presence of radiological contamination will be consolidated with any visibly contaminated material and containerized as ‘radiological waste’. This material will be segregated from non-radiological waste and Radiation Control areas may be established as described in the RPP.

IDW from EU4 wells will be segregated from other wells/IDW due to the presence of VOCs.

Non-contaminated PPE, High Density Polyethylene (HDPE) sheeting, disposable materials, and non-indigenous waste will be placed in trash bags at the point of generation. These bags of non-contaminated PPE, HDPE sheeting, disposable materials, and non-indigenous waste will be collected in lined, sanitary trashcans with lids. The PPE will be cut or torn to render it unusable prior to placement in the trash bags or containers. The containerized PPE, HDPE sheeting, disposable materials, and non-indigenous waste

will be stored in the secure, temporary on-site storage location. In some instances, it may be possible to decontaminate PPE changing its classification from contaminated to non-contaminated.

URS will catalog and track all IDW generated during field investigative activities. Waste manifests and logs will be developed documenting all generated IDW. A logbook will be maintained that documents drum (or waste container) identification numbers, the type of waste, the start generation date, the storage time requirements, and personnel performing the waste containerization. The logbook will include a description of the drums contents (e.g., soil, water, etc.), and the total volume of IDW placed in the temporary on-site storage location.

3.3.2 IDW Sample Analysis and Disposal Requirements

Laboratory data will be used to classify the IDW as hazardous, non-hazardous, or radiological waste. IDW will be segregated and assembled by waste type and/or location of origin. URS will be responsible for supplying the data necessary to support transportation and off-site disposal of the IDW. Procedures for sample handling, preservation, containerization, shipping, holding times, and sample custody are provided in the QAPP.

During the course of the investigation, preferably in the beginning of the field work, URS will sample the existing IDW (e.g., soil cores, coolers, etc.) for waste characterization analysis for the purpose of off-site disposal. IDW generated during the field investigation will be sampled at the completion of field investigation activities.

Waste characterization parameters will be based on the acceptance criteria of the USACE-accepted disposal facility. Off-site disposal options will be determined based on the results of the waste characterization analysis.

URS will comply with EM-1110-35-1, “Management Guidelines for Working with Radioactive and Mixed Waste and EP-200-1-2, “Process and Procedures for RCRA Manifesting”. URS will submit the waste manifests to the USACE for review and signature. URS will not ship any contaminated material for disposal until the off-site sampling results have been provided to and approved by the USACE COR, and the USACE COR signs all shipping papers per DOD Regulation 4500.9-R.

URS will meet and submit all disposal facility requirements, including but not limited to, the disposal facility’s waste acceptance criteria and prepare the waste profile sheets for shipping and disposal of the IDW. Radiological surveys to document compliance with DOT regulations will be conducted on individual waste packages or conveyances as appropriate. URS will be responsible for any package or contaminated materials rejected by the disposal facility for non-compliance with the requirements of the acceptance criteria at no additional costs to the Government. URS will not redirect a shipment without first obtaining USACE approval.

URS will submit the Certification of Disposal and any shipment records to USACE within 10 days of receipt of contaminated material by disposal facility.

3.4 Radiation Survey Procedures

Surface gamma radiation walkover surveys will be conducted at each borehole location and the planned excavation areas before initiating invasive activities. These surveys will be completed and documented in accordance with RP-4.0 “Radiation Surveys” (contained in Appendix A of the RPP). At each borehole location, the survey will cover a circular area with a diameter of approximately 50ft. For the excavation

areas, the survey will extend about 3 m (10 ft) beyond the proposed excavation boundary. The survey will be conducted using a 50 mm (2") NaI detector coupled to a rate meter, with the surveyor walking transects across the area in a serpentine manner, at a speed of about 0.6 m (2 ft) per second. The survey will identify areas of elevated readings (greater than twice background), along with the high, low and average gamma count rate for each area. Background levels will be determined either using project specific background data provided by the USACE, or by scanning a project specific background area identified by the USACE. After installation of the monitoring wells, and restoration of the excavated areas, the surface gamma walkover surveys will be repeated to document the final radiological condition of each area. A GIS figure (hard copy and electronic file) of the surface walkover surveys, pre and post well installation and excavation, will be submitted by URS.

At each borehole location gamma radiation measurements will be collected by logging the borehole with the 50 mm (2") NaI detector, in accordance with RP-7.0 "Borehole, Core radiation monitoring" (contained in Appendix A of the RPP). The core sample materials will be also scanned to identify materials with elevated radiation readings.

During excavation, gamma radiation measurements will be taken with the 50 mm (2") NaI on excavated dirt. These measurements may be collected while the soil is in the bucket outside of the trench or once it is placed in the laydown area. Once excavation is complete, the sides and bottoms of the excavations will be surveyed to identify any area of elevated material. Static one-minute counts will be collected at the location with the highest gamma measurement.

The following radiation detection equipment will be used during the project:

TABLE 7

Radiological Instrument Information

Instrument	Detector	Radiation Detected	Function
Ludlum Model 12	Ludlum Model 44-9 Geiger-Mueller (pancake)	Alpha-beta-gamma	Frisking - personnel, equipment, surfaces, soil core logging
Ludlum Model 2360 scaler/ratemeter	Ludlum Model 43-93 scintillator	Alpha-beta	Direct contamination & frisking - personnel, equipment, surfaces, soil core logging
Ludlum Model 2350-1 digital scalar/ratemeter	Ludlum Model 44-10 NaI scintillator (50 mm x 50 mm [2"x2"])	Gamma	Down hole borehole logging
Ludlum Model 19	Integrated plastic scintillator	Gamma	Radiation exposure rates
Ludlum Model 2221 meter	Ludlum Model 44-10 NaI scintillator (50 mm x 50 mm [2"x2"])	Gamma	General area survey, survey excavated areas
Ludlum Model 2929 dual channel scaler	Ludlum Model 43-10-1 scintillator	Alpha-beta	Smear counting

All instrumentation are specified as examples. These instruments or their equivalents will be used for the project.
All instruments will have an annual calibration and undergo daily operational checks

4.0 FIELD OPERATIONS DOCUMENTATION

4.1 Daily Quality Control Report (DQCR)

A Daily Quality Control Report (DQCR) will be prepared documenting each day of project field operations. The DQCR will be signed by the Site Supervisor/CQC System Manger and submitted electronically to the USACE Buffalo District project manager (PM) on a weekly basis. The DQCR will include, at a minimum, the following information:

- A daily summary of site activities;
- Weather information;
- Field instrument measurements;
- Identification of all field and control samples collected;
- QA sample tables that match up primary, replicate QA/QC, and other field control samples (e.g., blanks);
- Copies of chain-of-custody forms, field-generated analytical results, and any other project forms that are generated;
- Results of quality control activities performed including field instrument calibrations;
- List of Contractor/Subcontractors and area of responsibility for work performed;
- List of site visitors;
- List of on-site equipment;
- Any deviations from the FSP including the justification for the deviation;
- Any problems encountered during daily field activities; and,
- A summary of any instructions received from USACE or government personnel.

A copy of the DQCR is included in Appendix C.

4.2 Field Logbook and Logsheet Requirements

All information pertinent to the field investigative activities, including field instrumentation calibration data, will be recorded in field logbooks. Each logbook will have the site name and project name and number on the inside front cover. Sufficient information will be recorded in the logbooks to permit reconstruction of all conducted field investigative activities. The logbooks will be bound and the pages will be consecutively numbered and water resistant. Entries in the logbooks will be made in black waterproof ink and will include, at a minimum, a description of all accomplished activities, names of individuals involved in field investigative activities, date and time of drilling, excavation, and/or sampling at each location, weather conditions, a description of any problems encountered, and all field measurements. Lot numbers, manufacturer names, and expiration dates of standard solutions used for field instrument calibration will be recorded in the field logbooks. A summary of each day's activities will also be recorded in the logbooks. If any recorded information is noticed to be in error, the original entry will be crossed out so that the original entry is still legible and will be replaced with the new entry. All such changes will be initialed by the Site Supervisor. At the conclusion of each workday, the person responsible for maintaining the logbook will sign and date the day's documentation entries.

Information recorded on other project documents will not be repeated in the logbooks (e.g., boring logs, drum logs, etc.), although a summary of other project related field documentation will be included where deemed necessary. All field logbooks will be kept in the possession of the Site Supervisor or the recording author, or in a secure place when not being utilized for field work. Upon completion of the field activities, all logbooks will become part of the final project evidence file. The title page of each logbook will be labeled as follows:

- Logbook title: NFSS BOP Field Investigation;

- Project name: NFSS BOP Field Investigation;
- USACE contract number and project delivery order number;
- Start date for field investigative activities recorded in the logbook; and,
- End date for field investigative activities recorded in the logbook.

Logbook entries will include, but not be limited, to the following information:

- Name and title of author and Site Supervisor;
- Date and times of arrival and departure from site;
- Description of the sampling and/or monitoring activity;
- Name and address of the field contact(s);
- Names and responsibilities of field crew members;
- Names, affiliations, and purpose of any site visitors;
- Level of personal protective equipment worn at the site and/or specific sampling locations;
- Weather conditions on the day of sampling and any additional environmental conditions or observations relevant to the field activities;
- Field instrumentation or equipment used, and purpose of use (e.g., health and safety screening or sample selection for laboratory analysis);
- Sample collection method and sample handling procedures such as filtration and executed preservation techniques including the distinction between composite and grab samples;
- Number and volume of sample(s) collected with each sample given a unique sampling identification;
- Document the sample locations on a site plan. The exact locations of sampling points will be documented for purposes of generating an accurate representation of the site conditions using the field investigative data and defining data gaps that could impact the project objectives specified in this SOW;
- Location, description and log of sampling point photographs;
- Identification of sample numbers, volumes, and containers (number, size, type) used for each sample collected. Note the day and time of each sample, identify any associated QC samples or any factors that may affect quality. Also, identify the name of the sample collector;
- Record of any field measurements, field screening/analytical results generated, calibration methods used, field results, and QC information;
- Identify decontamination procedures employed for sampling equipment;
- Document appropriate references to maps and photographic logs of the site;
- Record information on scheduling modifications, change orders, sampling or drilling decisions, changes, and/or modifications accepted by the USACE;
- Information regarding access agreements, if applicable;
- Describe the number of shipping coolers packed, note chain of custody numbers or attach a copy of the chain of custody, and record the mode of transportation, and applicable tracking numbers;
- Decontamination procedures;
- IDW documentation including types and numbers of containers (or drums), contents, type, and approximate volume of waste, and waste classification (hazardous or non- hazardous);
- Record name and address of all receiving laboratories and couriers;
- Information on sample preservation methods;
- Maintain appropriate documentation for IDW. Note contents and volumes of waste generated, storage, and disposal methods used. In addition, record all analytical methods and sampling results for the IDW in order to generate waste disposal characterization as necessary;
- Name and address of QA laboratory for the project; and,
- Type, matrix, and characterization method for generated IDW.

Field data collected during invasive soil sampling will be recorded on boring logs formatted specifically for the field investigative activities at the Site.

4.3 Photographic Records

Photographs will be taken to document visual information such as sample locations, field conditions, indications of visual contamination, or additional items as determined by the on-site USACE representative. In some cases, a photograph of the actual sample collected may be required from two or more reference points to facilitate relocating the sampling point at a later date or at locations as specified by the on-site USACE representative. All photographs will be digitized images with descriptive captions and unique identifiers. Coordinates of each photograph will be recorded using global positioning system (GPS) and tabulated in Excel format. A site photo map will also be included with the site photographs and clearly indicate the location and direction of each photograph.

For each photograph taken during the field investigative activities, field logbook entries will include the following items:

- Date and time;
- Photographer (name and signature);
- Site name;
- General direction faced and description;
- Unique identifier in sequential order for each photograph; and,
- Site photo map.

In addition to the information recorded in the field log book, one or more photograph reference maps will be prepared. Photographs taken to document sampling points will include two or more permanent reference points within the photograph to facilitate relocating the point at a later date.

4.4 Sample Documentation

4.4.1 Sample Numbering System

The sample identification system will be consistent with that used at the NFSS during previous investigations and will follow the structure presented in the following table.

TABLE 8

Sample ID Structure

Sampling Location Identification: XXXNNxx-xx-####	
XXXNNxxxxF-####	
XXX = Sample Location Code	Examples 921 - Monitoring Well Location 921 935 - Monitoring Well Location 935
NN = Sample Type	Examples SS = Surface Soil SB = Subsurface Soil GW = Groundwater From Monitoring Well
xx-xx = Sample Depth Or xxxx = Sampling Event	Examples 0.0-0.5 = Surface Soil Sample Depth 1.0-3.0 = Subsurface Soil Sample Depth 0001 = Sample event at specific location (used for groundwater sampling)
F = Filtered Sample (Liquid Sample Only) D = Field Duplicate	Examples F = Filtered Sample
#### = Sequential Sample Number [unique for entire investigation]	Examples 0001 – Unique identifier nonspecific to media 0086 – Unique identifier nonspecific to media 9003 – QA/QC sample for the project
Examples of Sample IDs for this Investigation	
921SS0.0-0.5-0001 – Surface Soil Sample collected from 0.0-0.5’ bgs from location 921 921SB14.0-16.0-0002 – Subsurface Soil Sample collected from 14.0-16.0’ bgs from location 921 921SS0.0-0.5-9002– Duplicate subsurface soil sample collected from 0.0-0.5’ bgs from location 921 921GW0001-0109 – 1st Groundwater sample collected from MW921 unfiltered 921GW0001F-0109 - 1st Groundwater sample collected from MW921 filtered 922GW0001D-9008 – Duplicate groundwater sample collected from MW922	

Note that “SB” for subsurface (pipeline) soil, “PIPE” for pipeline liquid and sediment samples, “TB” will be the identifier for investigative trench soil sample and “MH” for manhole liquid and sediment samples.

4.4.2 Sample Labels

Sample labels will be affixed to all containers during sampling activities at the time of sample collection and securely affixed to the container prior to shipment. Sample label information will include, but not be limited to, the following:

- Sampling contractor identification;
- Sample identification number;
- Site name;
- Sample station number;
- Requested analysis;

- Type of sample (discreet, grab, or composite);
- Type of chemical preservative present in container;
- Date and time of sample collection; and,
- Sampler's name and signature or initials.

4.4.3 Chain of Custody Records

Chain-of-custody forms will be completed and will accompany each sample at all times. Data on the forms will include the sample ID, tracking number, depth interval, date sampled, time sampled, project name, project number, and signatures of those in possession of the sample. Forms will accompany those samples shipped to the designated laboratory so that sample possession information can be maintained. The field team will retain a separate copy of the chain-of-custody reports at the field office. Additionally, the sample ID; date and time collected; collection location; tracking number; and analysis will be documented in the field logbook.

The individual responsible for shipping the samples from the field to the laboratory will be responsible for completing the chain of custody form. This individual will also inspect the form for completeness and accuracy. In addition, this individual will be responsible for determining the shipping classification for samples under United States Department of Transportation (USDOT) Regulatory Requirements. After the form has been inspected and determined to be satisfactorily completed, the responsible individual will sign, date, and note the time of transfer on the form. For commercial carriers, the chain of custody form will be placed in a sealable plastic bag and placed inside the cooler used for sample transport after the field copy of the form has been detached. For laboratory couriers, the chain of custody form will be placed in a sealable plastic bag on the top of the cooler for the courier to accept custody. The field copy of the form will be appropriately filed and kept at the site for the duration of the field investigative activities.

Shipping containers will be secured using nylon strapping tape and chain of custody seals. Chain of custody seals will be placed on each cooler used for sample transport. These seals will consist of a tamper-proof adhesive material placed across the lid and body of the coolers in such a manner that if the cooler is opened, the seals will be broken. Chain of custody seals placed in this manner will ensure that no sample tampering occurs between the time of sample placement in the coolers to the time the coolers are opened for analysis at the laboratory. Cooler custody seals will be signed and dated by the individual responsible for completing the chain of custody form contained within the cooler.

4.4.3.1 Contracted Laboratory Custody Responsibilities

Test America will document the receipt of analytical samples by accepting custody of the samples from the accepted shipping company. In addition, Test America will check the condition of the shipping coolers and received samples upon receipt and will immediately inform URS if any sample containers are broken or if any tampering occurred with the seals on the cooler(s). URS shall, in turn, notify the USACE Buffalo District PM, COR, and/or Project Chemist of such concerns and will recommend corrective actions. This documentation will be accomplished by completing the cooler receipt checklist as provided in the QAPP.

An example cooler receipt checklist will be provided to the laboratory at the start of the project. Copies of the completed checklists will be e-mailed to both the USACE Buffalo District PM and the Project Chemist immediately after they have been completed at the laboratory. The original completed checklists will be transmitted with the final analytical results from the laboratory.

4.5 Field Analytical Records

As discussed in previous sections, documentation of all field activities will be maintained using field logbooks and applicable field forms (i.e., field sample sheets, instrument calibration logs, etc.).

Field instrumentation will be used to scan soil for radiological materials using an accepted radiological detector. As described in the RPP, instruments for radiation surveys will be calibrated annually. Operational checks will be performed and documented per RP-3.0 "Portable Survey Instruments" (contained in Appendix A of the RPP).

Each field instrument used for measurement or analysis will be calibrated in accordance with the manufacturer's recommendations with the calibration procedures. Calibration checks will also be performed as recommended by the manufacturer during the course of field investigative activities. Calibration records will be maintained in a field logbook. Additionally, all field personnel will be properly trained in the operation and calibration of the field instrumentation. Any field instrumentation out of calibration will be immediately re-calibrated. When field instrumentation is out of calibration or damaged, an evaluation will be made to ascertain the validity of previous results since the last acceptable (or valid) calibration check. If it is necessary to ensure the acceptability of suspect data, the originally required tests will be repeated if possible. Data or measurements since the last acceptable (or valid) calibration will be noted as suspect in the field logbook and further evaluated to determine the suitability of the data for its intended use.

Malfunctioning equipment will be replaced and any questionable measurements will be documented in the field logbook. The Site Supervisor will be responsible for ensuring that the field instrumentation are of the proper range, type, and accuracy for the measurements being performed and all field instrumentation are properly calibrated. Field instrumentation will undergo response verification checks as recommended by the manufacturer to detect anomalies in the data being generated. If an unacceptable response is obtained, the data will be labeled suspect, the problem documented in the field logbook, and appropriate corrective actions immediately implemented. Corrective actions will be approved by the USACE prior to implementation.

Field analytical and monitoring data not collected via instrumentation or on logs will be recorded in the field logbooks on a daily basis. At the end of each week, this data will be extracted from the logbooks and incorporated into the project analytical database. All field analytical and monitoring data will be used together with laboratory analytical data to evaluate the nature and extent of soil contamination.

4.6 Documentation Procedures

The documentation procedures for sample collection will include the following steps:

- Collection and placement of samples into laboratory sample containers;
- Completion of sample container label information;
- Completion of sample documentation information in the field logbook;
- Completion of project and sampling information sections of the chain of custody form(s);
- Performing a completeness and accuracy check of the chain of custody form(s);
- Completion of the sample relinquishment section of the chain of custody form(s);
- Placing chain of custody seals on the exterior of the cooler;
- Packaging and shipping the cooler to the nearest laboratory service center ;
- Receive cooler at the laboratory, inspect the contents, and fax a copy of contained chain of custody form(s) and cooler receipt form(s); and,
- Transmittal of original chain of custody form(s) with final analytical results from laboratory.

Original chain of custody record, shipping documents, and sample cooler receipt forms will be attached to each data package.

5.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

URS plans to drop off or use lab courier to deliver samples directly at the TestAmerica laboratory location in Amherst, New York throughout the investigation and have the laboratory handle proper shipping procedures to their St. Louis location. However, in the event that URS must ship samples during the course of the investigation, URS will adhere to the following procedures.

5.1 Sample Packaging

Sample containers will be packaged in thermally insulated rigid-body coolers. Sample packaging and shipping will be conducted in accordance with applicable DOT regulatory requirements. Prior to sample shipment, each container will be prepared as follows:

- Contents of sample containers will be identified with definitive labels placed onto each container.
- The cap tightness will be checked and clear tape placed over the label completely encircling the container.
- Each sample container will be wrapped in bubble wrap or closed cell foam sheets
- Each sample container will be enclosed in a clear zip-lock plastic bag. As much air as possible will be forced from the sample container bags before sealing.

Once the above procedures have been completed for each sample container, the following procedures will be performed for each sample cooler:

- Several layers of bubble wrap (inert packing material) will be placed on the bottom of the cooler and inside the cooler to prevent shifting during transport. The cooler will be lined with an open garbage bag, all samples will be placed upright inside the garbage bag, and the bag will be tied.
- Ice is not required for shipping most radiological solid samples. Ice is required for shipment of VOC and metals soil and groundwater samples. Before initial placement of samples into a rigid-body cooler, the cooler drain plug will be taped shut both inside and outside the container.
- All required laboratory paperwork, including the chain of custody form(s), will be placed inside the cooler if being transported by a shipping courier, or attached to the outside of the cooler if transported by a lab courier, to facilitate exchange of sample custody. If more than one cooler is being used, each cooler will have its own documentation.
- Upon completion of the packing process, the cooler lid will be closed and two signed/dated custody seals will be placed on the cooler, one across the front and one across the side of the cooler, such that opening the cooler will result in breaking the custody seals.
- Rigid-body coolers will be sealed by applying strapping tape directly to the cooler body.
- Arrows indicating “This Way Up” will be placed on each cooler.
- The cooler will then be delivered by commercial courier to the laboratory.

5.2 Requirements for Samples Classified as Radioactive Materials

Samples generated during project activities will be transported in accordance with procedures that ensure compliance with regulatory requirements for shipping radioactive samples. Radiological samples will follow the Sample Packaging procedures presented above for container preparation prior to sample shipment including a radiological survey on the outside of the container for radioactivity. In addition, each cooler will also undergo the following:

- Upon arrival at the site, all coolers for sample shipment will undergo a radiation screening to ensure they are not radioactively contaminated.
- After the samples are properly packaged and before the cooler is sealed, it will undergo a DOT dose rate and contamination survey as detailed in RP-6.0 “Sample Handling and Chain of

Custody" (contained in Appendix A of the RPP) to ensure the package meets the requirements as found in 49 CFR Part 173.

- A notice will be placed on the outside of each cooler that includes the name of the cosigner and the statement: "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910". The outside of the inner packaging or, if there is no inner packaging, the outside of the package itself, will be labeled "Radioactive" if fully applicable.

5.3 Sample Shipping

All environmental samples collected during the project will be shipped no later than 12 to 72 hours after time of collection. The latter time of 72 hours may be necessary if the samples are collected on a Friday and have to be shipped Monday. During the time between collection and shipment, all samples will be stored in a secure area to maintain custody.

6.0 DECONTAMINATION

General specifications for equipment and personnel decontamination are discussed in the following paragraphs. Decontamination of non-disposable equipment (e.g., sampling equipment, heavy equipment, drilling equipment) will be performed to ensure chemical analyses reflect actual concentrations at sampling locations by maintaining the quality of samples and preventing cross-contamination. Field equipment cleaned in accordance with the following sections will meet the minimum requirements for definitive-level data collection.

Heavy equipment and drilling equipment will be decontaminated by cleaning with a steam high-pressure washer over a fully lined and bermed decontamination pad. If warranted by the contaminants of concern (COCs), additional cleaning with detergents and solvents may be required.

6.1 Specifications for Cleaning Materials

Specifications for standard cleaning materials referred to in this section are as follows:

- Soap will be a standard brand of phosphate-free laboratory detergent. Use of other detergent will be documented in the field logbooks and investigative reports. Soap will be obtained from a laboratory supply distributor.
- Potable water will be purchased locally.
- Analyte free water (deionized water) is water that has been treated by passing through a standard deionizing resin column. Analyte free water will be obtained from the contract laboratory as needed.

6.2 Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- Soap will be kept in clean plastic, metal, or glass containers until used. It will be poured directly from the container during use.
- Tap water will be kept in clean tanks, hand-held sprayers, squeeze bottles, or applied directly from a hose.
- Analyte-free water will be stored in clean glass, stainless steel, or plastic containers that can be closed until just prior to use. It may be applied from plastic squeeze bottles.

Hand-held pump sprayers are not acceptable storage or application containers for the above materials (with the exception of tap water). This also applies to stainless steel sprayers. All sprayers have internal gaskets and seals that may contaminate the solutions.

6.3 Safety Procedures for Field Cleaning Operations

Some of the materials used to implement the cleaning procedures outlined in this section can be harmful if used improperly. Caution should be exercised by all field personnel and all applicable safety procedures should be followed. At a minimum, the following precautions will be observed in the field during decontamination operations:

- Safety glasses with splash shields or goggles, and nitrile gloves will be worn during all cleaning operations.
- No eating, smoking, drinking, chewing, or any hand to mouth contact shall be permitted during cleaning operations.

- All decontamination fluids will be properly containerized and managed as IDW.
- Air dry equipment prior to completing radiological surveys.
- Decontamination will not be complete until applicable radiation surveys have been completed, and any smear samples counted.

6.4 Handling of Cleaned Equipment

After field cleaning, equipment will be handled only by personnel wearing clean gloves to prevent re-contamination. The equipment will be moved away from the cleaning area to prevent re-contamination. If the equipment is not to be immediately re-used it will be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is stored prior to re-use must be free of contaminants.

A selected field decontamination location will be approved by the USACE prior to use. Decontamination activities will be conducted so that all solid and liquid wastes generated can be properly contained and collected. Sampling equipment, heavy equipment, and non-disposable protective equipment used in the "exclusion zone" and in the decontamination line will all require decontamination.

Decontamination fluids will be collected daily and stored in 55-gallon drums located at the end of the decontamination line for subsequent disposal in the fractionation tank(s). Cleaning fluids from heavy equipment decontamination will be collected at decontamination pads and transferred to 55-gallon drums or stored in fractionation tank(s). These drums will be staged in a secure storage location, as directed by USACE.

7.0 REFERENCES

- ASTM D6914 – 04E1, Standard Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices
- "Report of the Results for the Remedial Investigation of Underground Utility Lines Formerly Used by the Department of Defense, Lake Ontario Ordnance Works (LOOW)"
- Uniform Federal Policy (UFP) QAPP
- USACE EM 385-1-1, 15 September 2008, Safety and Health Requirements Manual
- USACE ER 385-1-92 (1 May 2007) Safety and Occupational Health Requirements for Hazardous, Toxic and Radioactive Waste (HTRW) Activities
- USACE ER 385-1-80 (30 June 2010) Ionizing Radiation Protection
- USACE EM 385-1-80 (30 May 1997) Radiation Protection Manual
- USACE EM 385-1-1 Section 25 Excavation and Trenching
- USACE EM-1110-35-1 Management Guidelines for Working with Radioactive and Mixed Waste
- USACE EM 1110-1-1804 Geotechnical Investigations
- USACE EM 1110-1-4000 Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites (1 November 1998)
- USACE EM 1110-1-1003 (July 1, 2003) NAVSTAR Global Positioning System Surveying
- USACE EM 1110-1-1005 (January 1, 2007) Control and Topographic Surveying
- USACE EM 1110-1-1802 (August 31, 1995) Geophysical Exploration for Engineering and Environmental Investigations
- USACE document Policies, Guidance and Requirements for Geospatial Data and Systems, ER-1110-1-8156 (September 1995)
- USDOL OSHA 29 CFR 1926 Safety and Health Regulations for Construction
- USDOL OSHA 29 CFR 1910 Occupational Safety and Health Standards
- USDOL OSHA 29 CFR 1910.120 or 1926.65 HAZWOPER Standard
- UFGS-01 35 26 (February 2012) Governmental Safety Requirements
- UFGS-01 35 29.13 (January 2008) Health, Safety, and Emergency Response Procedures for Contaminated Sites
- USNRC 10 CFR Part 20 Standards of Protection Against Radiation
- USACE Engineering Form ENG 5056 - HTRW Drilling Log
- 29 CFR 1926 Subpart P, Safety and Health Regulations for Construction, Excavations
- EPA 540/G-91/009 Management of Investigation-Derived Wastes During Site Inspections
- EP-200-1-2 Process and Procedures for RCRA Manifesting
- Spatial Data Standard for Facilities, Infrastructure and Environment (SDSFIE) 3.0 Gold
- Uniform Federal Policy Quality Assurance Project Plans (UFP-QAPP): Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Final, Version 1, March 2005, (including March 2012 Part 2A Optimized Worksheets, Rev. 1)

FIGURES

APPENDIX A
PROJECT SCHEDULE

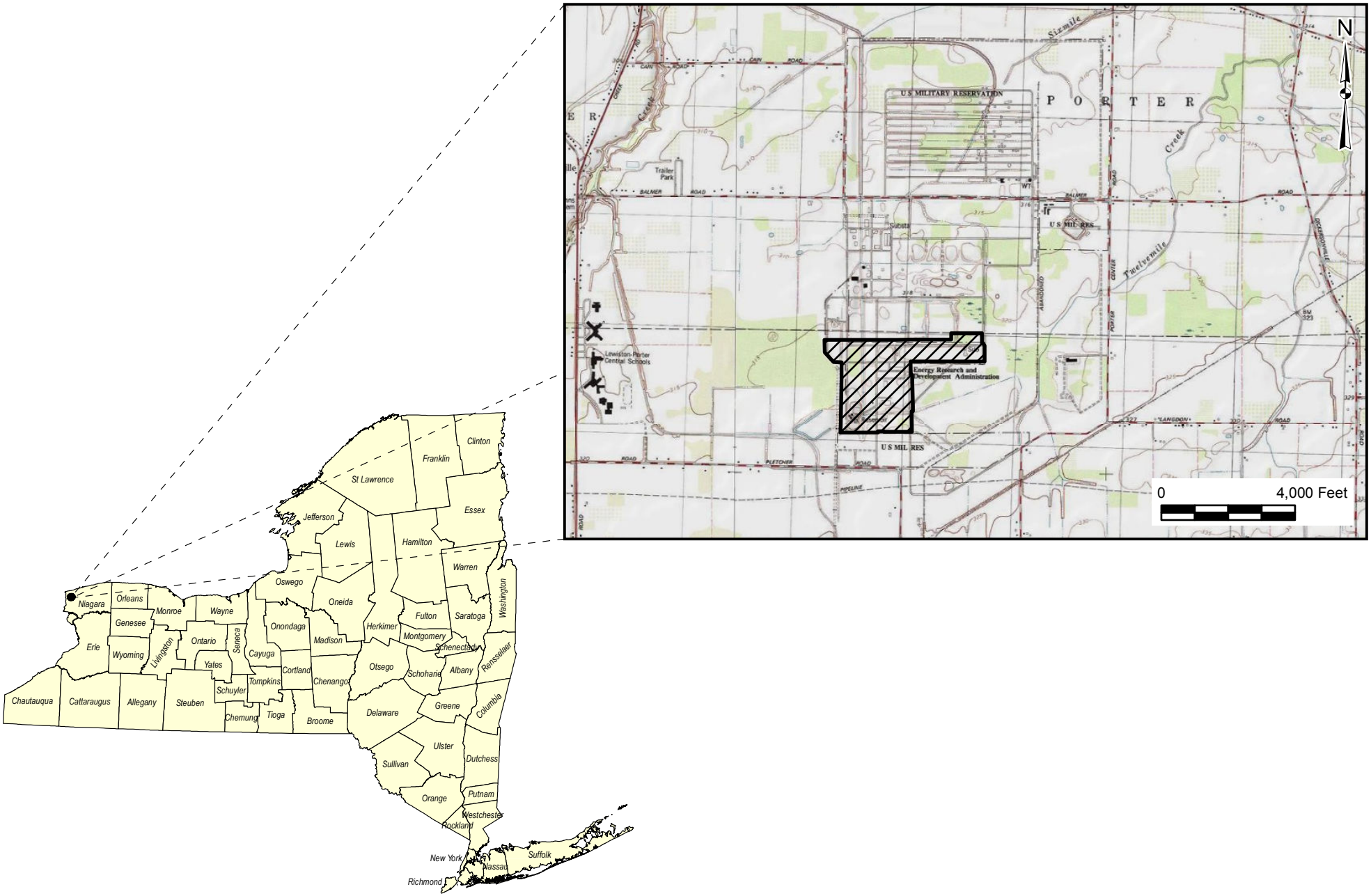
APPENDIX B
STANDARD OPERATING PROCEDURES

APPENDIX C
FIELD FORMS

APPENDIX D
WELL INSTALLATION MATERIALS

FIGURES

I:\11176781\GIS\01 SITE LOCATION.mxd 9/17/2012 MDL



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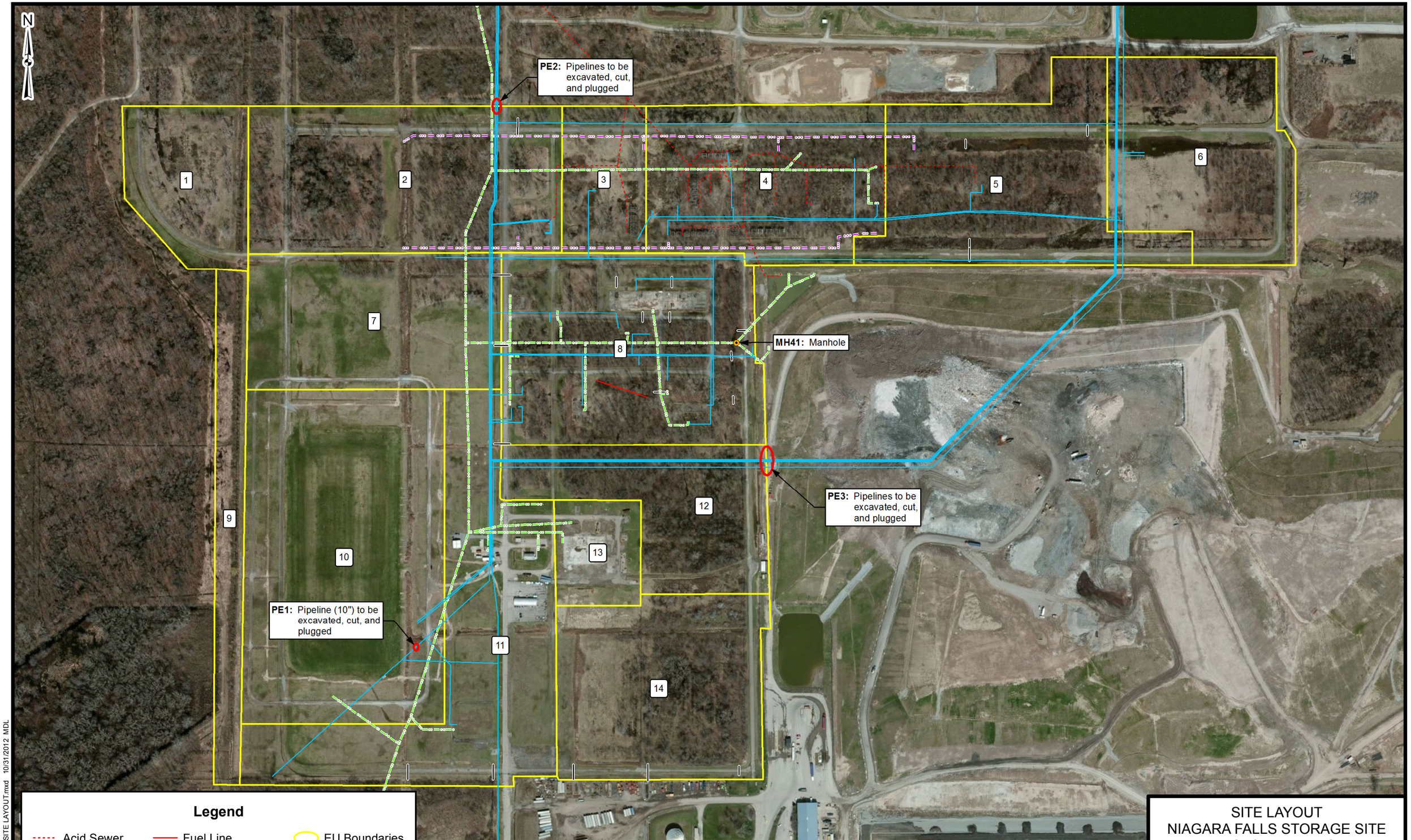
SITE LOCATION
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

FIGURE 1



Source: Bing Maps Aerial © 2010 Microsoft Corporation

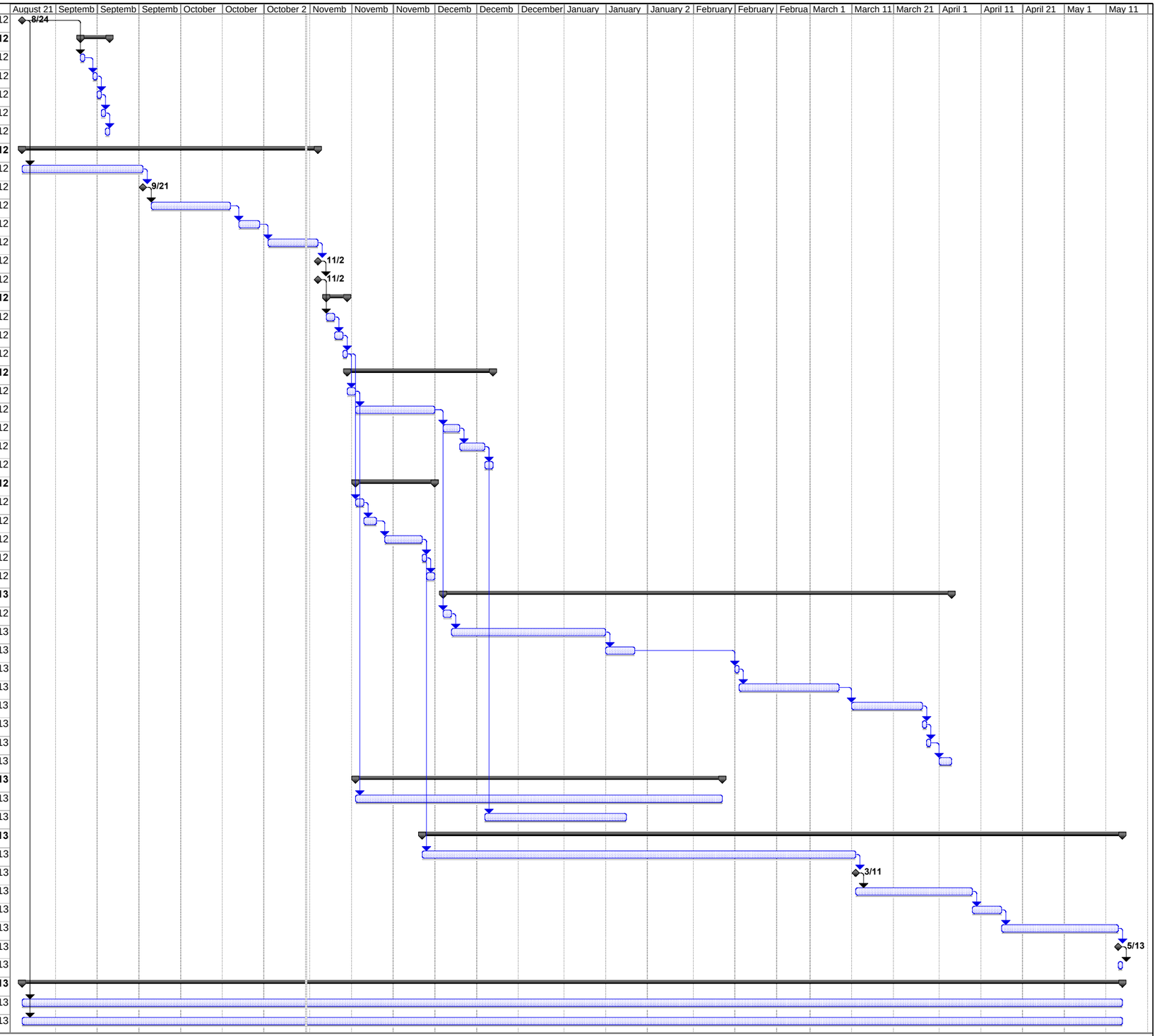
SITE LAYOUT
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

[redacted]

FIGURE 2

I:\11176781\GIS\02 SITE LAYOUT.mxd 10/31/2012 MDL

ID	Task Name	Business Days	Start	Finish
1	Project Award	0 days	Fri 8/24/12	Fri 8/24/12
2	**Site Visit**	**5 days**	**Fri 9/7/12**	**Thu 9/13/12**
3	Site Visit	1 day	Fri 9/7/12	Fri 9/7/12
4	Prepare minutes	1 day	Mon 9/10/12	Mon 9/10/12
5	Submit Minutes to USACE	1 day	Tue 9/11/12	Tue 9/11/12
6	USACE Review	1 day	Wed 9/12/12	Wed 9/12/12
7	Finalize Minutes	1 day	Thu 9/13/12	Thu 9/13/12
8	**Planning Documents**	**50 days**	**Fri 8/24/12**	**Fri 11/2/12**
9	Prepare Draft Planning Documents	20 days	Fri 8/24/12	Fri 9/21/12
10	Submit Draft to USACE	0 days	Fri 9/21/12	Fri 9/21/12
11	USACE Review	15 days	Mon 9/24/12	Fri 10/12/12
12	Response to USACE Comments	5 days	Mon 10/15/12	Fri 10/19/12
13	Revise Documents	10 days	Mon 10/22/12	Fri 11/2/12
14	Submit Final Documents to USACE	0 days	Fri 11/2/12	Fri 11/2/12
15	USACE Approval	0 days	Fri 11/2/12	Fri 11/2/12
16	**Site Investigation**	**5 days**	**Mon 11/5/12**	**Fri 11/9/12**
17	Mobilization	2 days	Mon 11/5/12	Tue 11/6/12
18	Geophysical Survey	2 days	Wed 11/7/12	Thu 11/8/12
19	Receive USACE Approval of Geophysical Survey Results	1 day	Fri 11/9/12	Fri 11/9/12
20	**Drilling and Well Installation**	**27 days**	**Sat 11/10/12**	**Fri 12/14/12**
21	Mobilize Drill Rig	2 days	Sat 11/10/12	Sun 11/11/12
22	Sonic Drilling and Well Installation	15 days	Mon 11/12/12	Fri 11/30/12
23	Well Development	4 days	Mon 12/3/12	Thu 12/6/12
24	Groundwater Sampling	4 days	Fri 12/7/12	Wed 12/12/12
25	Demobilization	2 days	Thu 12/13/12	Fri 12/14/12
26	**Excavation**	**13 days**	**Mon 11/12/12**	**Fri 11/30/12**
27	Mobilize Excavator	2 days	Mon 11/12/12	Tue 11/13/12
28	Pipeline Cut and Plug	3 days	Wed 11/14/12	Fri 11/16/12
29	Investigative Excavations	5 days	Mon 11/19/12	Tue 11/27/12
30	Site Restoration	1 day	Wed 11/28/12	Wed 11/28/12
31	Demobilization	2 days	Thu 11/29/12	Fri 11/30/12
32	**IDW Management**	**84 days**	**Mon 12/3/12**	**Wed 4/3/13**
33	Sample Collection	2 days	Mon 12/3/12	Tue 12/4/12
34	Sample Analyses	23 days	Wed 12/5/12	Thu 1/10/13
35	Prepare Waste Profiles	5 days	Fri 1/11/13	Thu 1/17/13
36	Submit Draft IDW Manifests/Acceptance Letters to USACE	1 day	Mon 2/11/13	Mon 2/11/13
37	USACE Review and Comment	18 days	Tue 2/12/13	Thu 3/7/13
38	Final Waste Manifests for USACE Signature	13 days	Mon 3/11/13	Wed 3/27/13
39	Frac Tank Decontamination	1 day	Thu 3/28/13	Thu 3/28/13
40	Frac Tank Radiological Screening	1 day	Fri 3/29/13	Fri 3/29/13
41	Waste T&D	3 days	Mon 4/1/13	Wed 4/3/13
42	**Environmental Sample Analyses**	**60 days**	**Mon 11/12/12**	**Thu 2/7/13**
43	Soil Analyses	60 days	Mon 11/12/12	Thu 2/7/13
44	Groundwater Analyses	20 days	Thu 12/13/12	Tue 1/15/13
45	**Project Report**	**116 days**	**Wed 11/28/12**	**Tue 5/14/13**
46	Prepare Draft Report	70 days	Wed 11/28/12	Mon 3/11/13
47	Submit Drat Report to USACE	0 days	Mon 3/11/13	Mon 3/11/13
48	USACE Review	20 days	Tue 3/12/13	Mon 4/8/13
49	Address USACE Comments	5 days	Tue 4/9/13	Mon 4/15/13
50	Revise Draft Report	20 days	Tue 4/16/13	Mon 5/13/13
51	Submit Final Report to USACE	0 days	Mon 5/13/13	Mon 5/13/13
52	USACE Approval	1 day	Tue 5/14/13	Tue 5/14/13
53	**Project Management and Meetings**	**185 days**	**Fri 8/24/12**	**Tue 5/14/13**
54	Project Management	185 days	Fri 8/24/12	Tue 5/14/13
55	Bi-weekly Project Meetings	185 days	Fri 8/24/12	Tue 5/14/13



PROJECT SCHEDULE
NFSS BALANCE OF PLANT FIELD INVESTIGATION
FIGURE 3.

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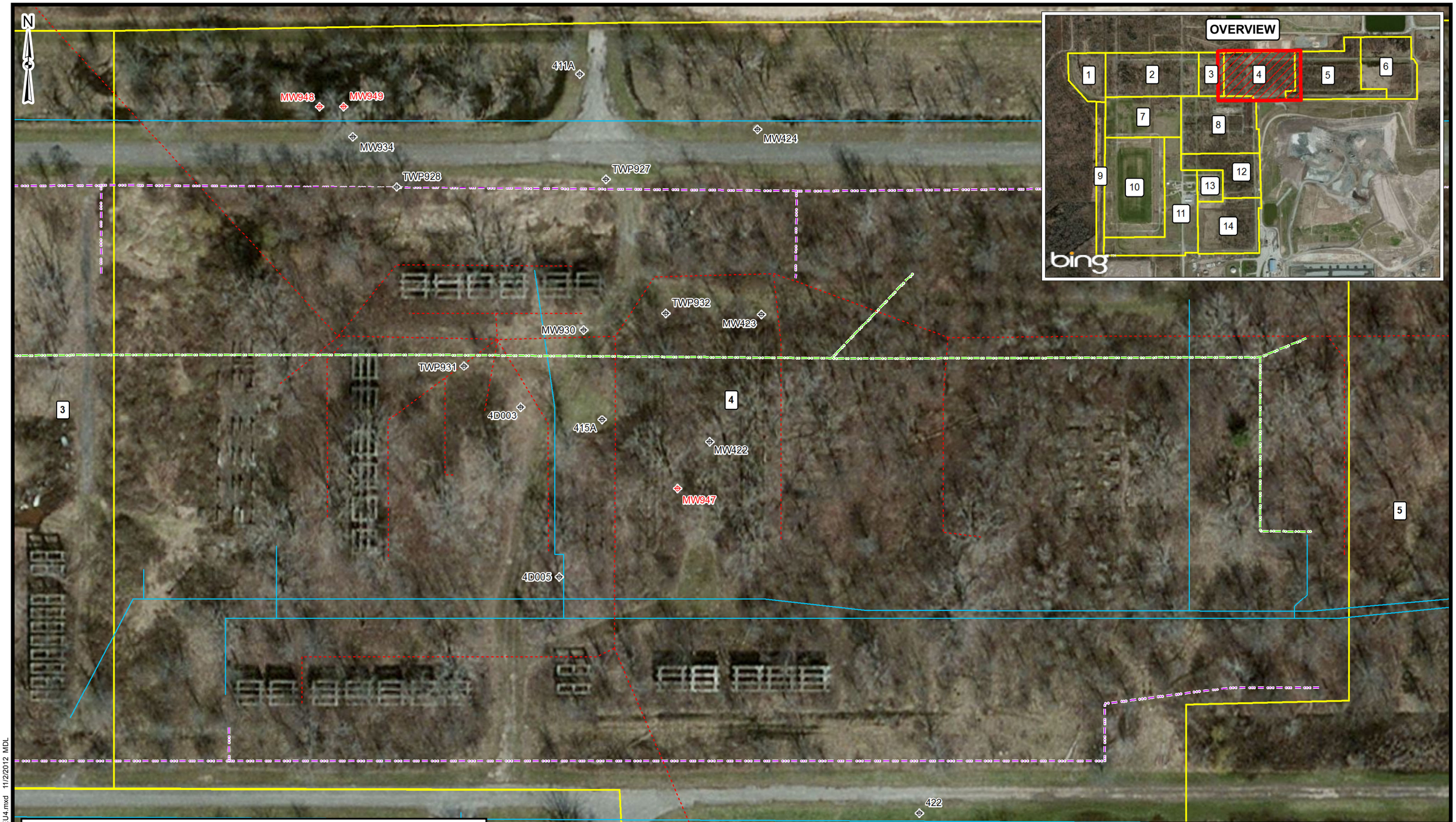

Legend

- Proposed Monitoring Well
- Existing Monitoring Well
- EU Boundaries
- Acid Sewer
- Culvert
- Water Line
- Fuel Line
- Sanitary Sewer
- Storm Sewer

Source: Bing Maps Aerial © 2010 Microsoft Corporation

70 0 70 Feet

LOCATION OF NEW WELLS IN EU4
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

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FIGURE 5

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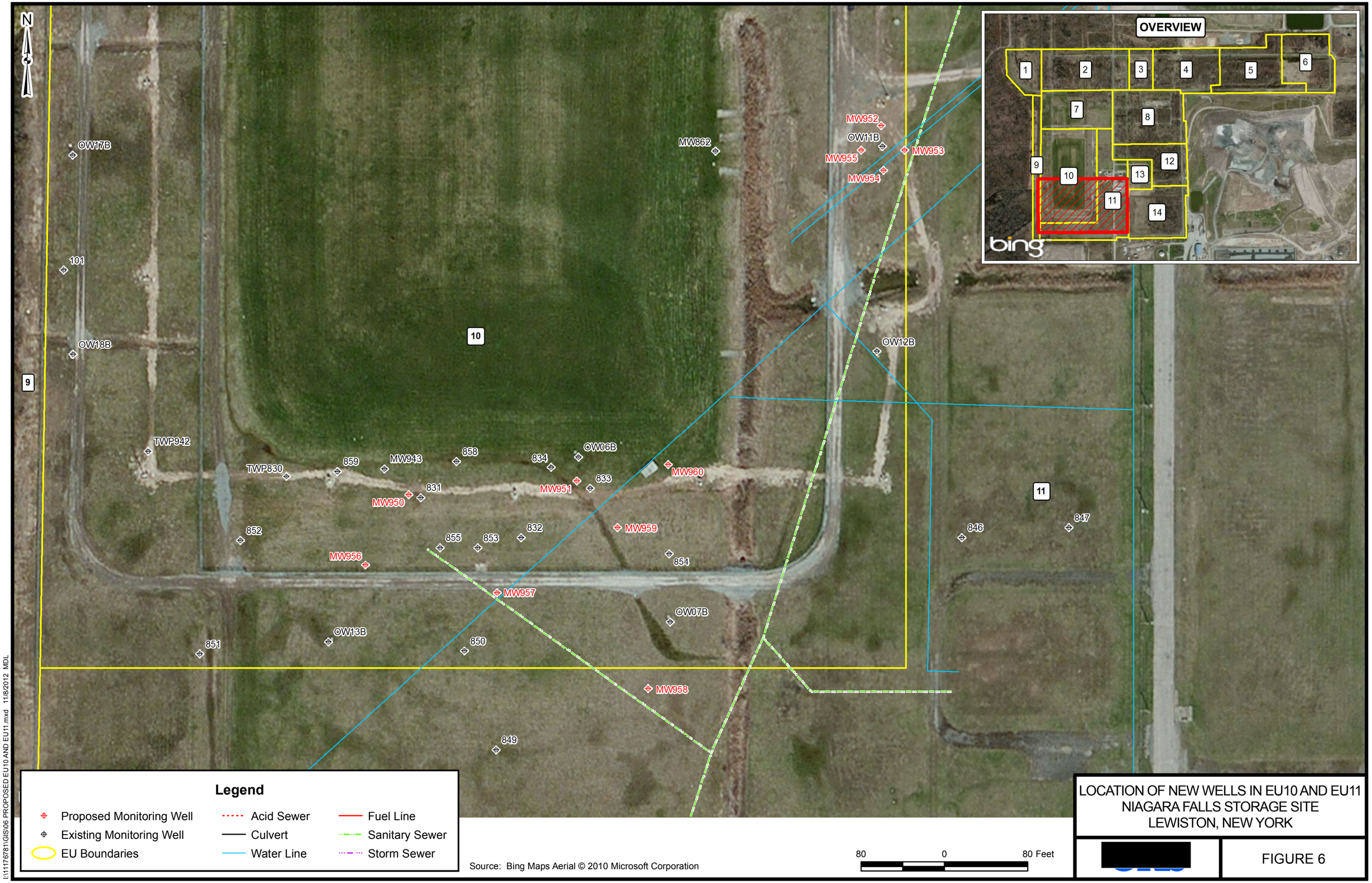

LOCATION OF NEW WELLS IN EU10 AND EU11
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

FIGURE 6

I:\11176781\GIS\06 PROPOSED EU10 AND EU11.mxd 11/8/2012 MDL

Source: Bing Maps Aerial © 2010 Microsoft Corporation

LOCATION OF INVESTIGATIVE TRENCHES IN EU11
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

[redacted]

FIGURE 7

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APPENDIX A
PROJECT SCHEDULE

ID	Task Name	Business Days	Start	Finish
1	Project Award	0 days	Fri 8/24/12	Fri 8/24/12
2	**Site Visit**	**5 days**	**Fri 9/7/12**	**Thu 9/13/12**
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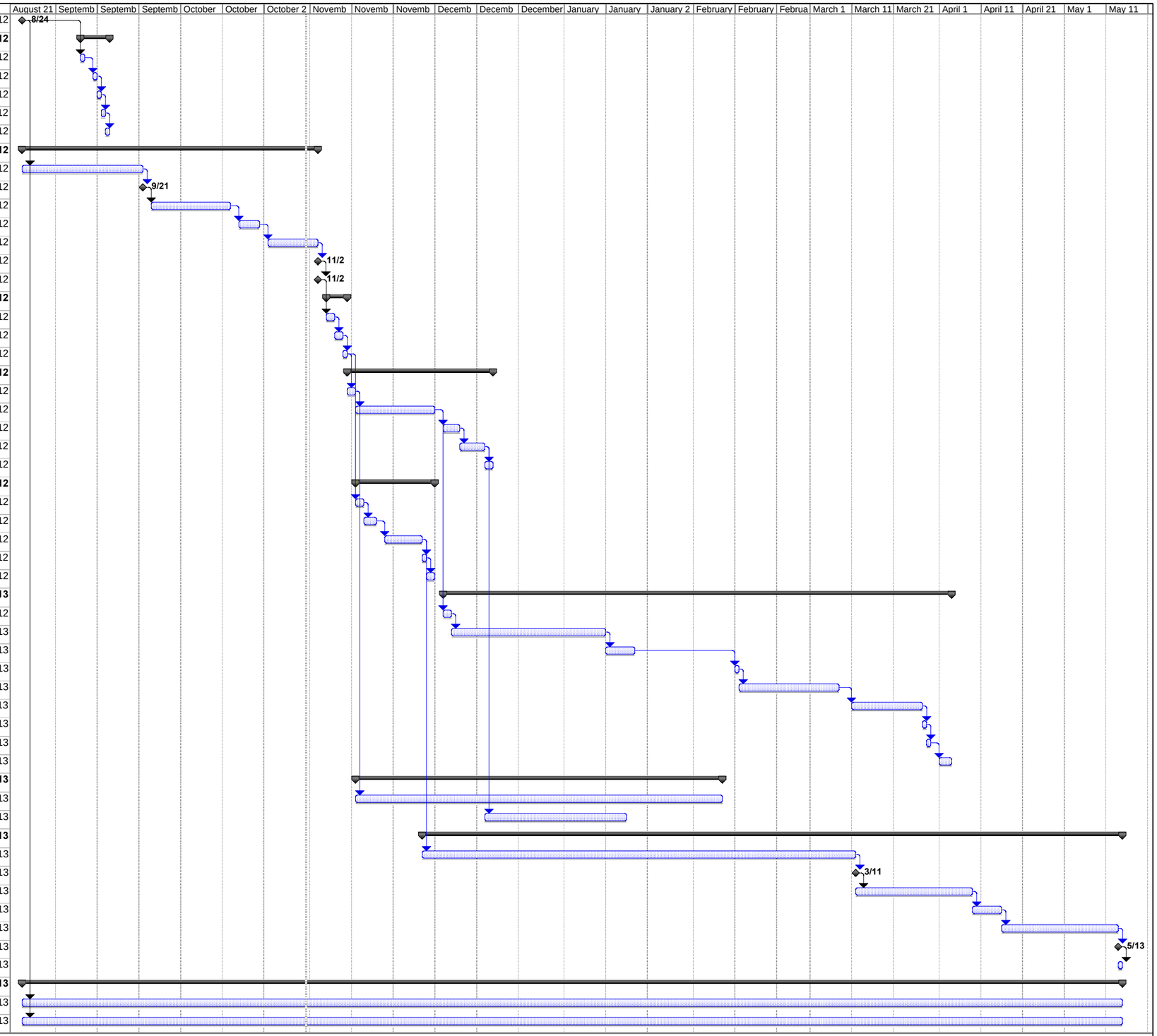

PROJECT SCHEDULE
NFSS BALANCE OF PLANT FIELD INVESTIGATION
FIGURE 3.

APPENDIX B
STANDARD OPERATING PROCEDURES

NFSS BALANCE OF PLANT OPERABLE UNIT FIELD INVESTIGATION

FIELD SAMPLING PLAN

APPENDIX B

TABLE OF CONTENTS

FIELD SAMPLING SOPS

SOP Title	SOP No.	Rev. #	Issue Date
Test Pit Excavation Soil Sample Collection Procedure	SS-03	0	September 2012
Equipment Decontamination	EQPDCN-1	0	September 2012
Investigation Derived Waste Management	IDWMGT-1	1	October 2012
Groundwater Monitoring Well Development	MWDEV-1	1	October 2012
Low-Flow Purging and Groundwater Sample Collection	GWLFW-1	0	September 2012
Soil Classification	SOILLOG-1	1	October 2012
Trenching and Test Pitting	TEST PIT-1	0	September 2012
Sonic Drilling Methods	SONIC-1	1	October 2012
Overburden Well and Piezometer Installation	MWOBIN-1	1	October 2012
Multi-Gas Meter	MGM-1	0	September 2012
Photoionization Detector	PID-1	0	September 2012
Sample Management and Preservation	SAMPMGT-1	0	September 2012
Calibration of Field Instruments	CAL-1	0	September 2012
Field Analytical Parameters	FLDANA-1	0	September 2012

STANDARD OPERATING PROCEDURE

TEST PIT EXCAVATION SOIL SAMPLE COLLECTION PROCEDURE

1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides a general framework for collecting soil samples from test pits or excavations. The primary consideration must be given to obtaining samples that are representative of existing conditions and valid for chemical analysis. The samples must not be contaminated by sampling procedures.

2.0 SUMMARY OF METHOD

Detailed procedures for performing test pit excavations are provided in SOP No. TESTPIT-1. The test pit excavations will be conducted slowly and carefully to reduce the likelihood that any drums, tanks or vessels encountered, if any, are not punctured. Geophysical techniques may be employed to locate potential drums, tanks, or vessels prior to initiating the test pit excavation. The soils and anthropogenic debris encountered during test pit excavations will be described. Photographs will be taken at each pit location and documented in the field notebook. Additionally, air monitoring readings (PID and MGM at a minimum) will be taken throughout the test pit operation and recorded in the field notebook.

3.0 DEFINITIONS

ASTM: American Society for Testing and Materials
MGM: Multi-Gas Meter (including CO, O_2, H_2S and LEL)
PID: Photoionization Detector
VOCs: Volatile organic compounds.

4.0 APPARATUS & MATERIALS

The following equipment will be utilized as part of soil sample collection from a split spoon sampler:

- Clean, laboratory-supplied bottleware;
- PID (SOP No. PID-1);
- MGM (SOP No. MGM-1)
- Personal Protective Equipment (PPE);
- Stainless steel mixing bowls and spoons;

- Decontamination equipment (See SOP No. EQPDCN-1); and
- Field notebook and camera.

5.0 INSTRUMENT CALIBRATION

All air monitoring equipment will be calibrated at the beginning of each day in accordance with the manufacturer's specifications (See SOPs No. PID-1 and No. MGM-1).

6.0 SAMPLE COLLECTION

The following paragraphs describe general documentation and sampling procedures (also see SOP No. TESTPIT-1):

- Samples will be collected and selected for analyses as specified in the Site-Specific plans.
- The material removed from the test pit will be scanned with a portable PID and the results recorded.
- All samples collected for VOC or dissolved gas analysis will be accompanied by a full 4-ounce jar of representative soil for analysis of percent solids (does not need to be collected with zero headspace). Sample aliquots for all other analyses, except VOCs, will be removed from the sampling device and placed in a decontaminated stainless steel mixing bowl to homogenize prior to transferring the sample aliquot to appropriate sample containers. Field duplicate samples will be collected from the same interval as the original sample. Sample aliquots for VOC analysis will be collected before homogenizing the sample. An equipment blank sample should be collected using all non-dedicated decontaminated sampling equipment (ie. – any sampling devices, mixing bowls and spoons.)
- The soils encountered within the test pit will be visually classified to include soil descriptions and classifications, as well as other pertinent data regarding the sampling event and subsurface conditions (i.e., color, apparent staining or discoloration, moisture content, presence of fill material or organic matter, etc.) (SOP No. SOILLOG-1). Photographs will be taken during and at the completion of each test pit. A log of the visual descriptions and photographs will be maintained in the field notebook.
- After the test pit excavation and sampling are completed, the excavated material will normally be used to backfill the test pit.
- Soil samples submitted for chemical analysis will be immediately placed in appropriate laboratory-supplied containers, labeled, maintained in coolers at 4°C, and delivered to an off-site laboratory for analysis using EPA-approved chain-of-custody protocols.

- Quality control sampling will generally occur as follows:

    - Duplicate samples will be collected at the rate of 10% or 1 duplicate sample per 10 normal samples;
    - MS/MSD samples will be collected at the rate of 5% or 1 MS/MSD samples per 20 normal samples;
    - Equipment blanks will be collected at the rate of 1 per week per sampling apparatus; and
    - Trip blanks will be submitted in each cooler that contains samples submitted for VOC analysis.

STANDARD OPERATING PROCEDURES

EQUIPMENT DECONTAMINATION

1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides a general framework for decontaminating equipment used as part of environmental monitoring or sampling activities. For determining the most appropriate decontamination method the primary consideration must be given to the most likely, or suspected, contaminant to be encountered during the investigation in each media.

2.0 SUMMARY OF METHOD

This SOP provides a description of the decontamination procedures used during field investigations. The project specific plans may have site-specific concerns which would require additions or adjustments to these procedures.

This document focuses on methods and equipment that are readily available and typically applied. It is not intended to provide an all-inclusive discussion of decontamination methods.

3.0 DEFINITIONS

Flight: A individual auger section, usually 5 feet in length.

Split-Spoon Sampler: A thick-walled steel tube split lengthwise used to collect soil samples. The sampler is commonly lined with metal sample sleeves and is driven or pushed downhole by the drill rig to collect samples.

4.0 APPARATUS & MATERIALS

The following equipment will be used as part of the decontamination procedures:

- Distilled/Deionized Water;
- Laboratory-grade, non-phosphate detergent (Alconox, or equivalent);
- 10% Nitric Acid solution (if required);
- Methanol or hexanes (if required);
- Steam cleaner;
- Nitrile Gloves (other PPE as required by Health & Safety Plan).

5.0 DECONTAMINATION PROCEDURES

The purpose of decontamination and cleaning procedures during an investigation is to prevent foreign contamination of the samples and cross-contamination between sites. A decontamination area and clean zone will be established for the preparation and breakdown of equipment prior to each sampling task. The decontamination area will be large enough to accommodate equipment to be used for invasive work. Decontamination rinsate will be containerized for temporary storage and subsequent characterization and disposal. Decontamination fluids containing non-aqueous phase liquids will have the non-aqueous phase liquid separated and separately containerized for subsequent characterization and disposal. Solvents and/or acids, if used, will be separately containerized for subsequent characterization and disposal.

Before use, and between each site, all non-sampling equipment will be decontaminated with high-pressure steam, or scrubbed with a non-phosphate detergent and rinsed with water from the approved water source. If appropriate, equipment will be covered in plastic or aluminum foil to protect it from the elements.

All equipment that may directly contact samples will be decontaminated on site. The following sampling-specific decontamination procedures will be observed:

1. Physical removal of gross contamination
2. Wash and scrub with detergent (laboratory grade - non-phosphate detergent)
3. Rinse with tap water
4. Rinse with distilled/deionized water
5. Air dry
6. Protect from fugitive dust and vapors.

Additional solvent (i.e., acetone, methanol, or hexanes) and/or acid rinses may be added to the procedure depending on the site sampling objectives. If these additional rinses are required the procedures for incorporation are provided below:

1. Physical removal of gross contamination
2. Wash and scrub with detergent (laboratory grade - non-phosphate detergent)
3. Rinse with tap water

STANDARD OPERATING PROCEDURES

INVESTIGATION DERIVED WASTE MANAGEMENT

STANDARD OPERATING PROCEDURES

INVESTIGATION DERIVED WASTE MANAGEMENT

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1.0 SCOPE AND APPLICABILITY

The purpose of this Standard Operating Procedure (SOP) is to describe the policy, organization, functional activities, and investigation-derived waste (IDW) management control to be implemented for field investigation activities. The SOP should be used as a guideline for future waste management. The objective of this SOP is to describe the general procedures required to manage IDW. In addition, this SOP establishes the sampling and analytical procedures to be followed to manage the IDW as required by CERCLA, Superfund Amendments and Reauthorization Act (SARA), and Resource Conservation and Recovery Act (RCRA) guidance. Detailed information presented in this SOP addresses the following:

- Typical types of IDW that will be generated and managed during investigation activities.
- Typical specific activities expected to be conducted that may generate IDW.
- Specific waste parameters or characteristics that need to be quantified to ensure safe and effective management of IDW.
- Methods of obtaining necessary data to assess IDW, such as sampling and analysis procedures.
- Options for disposal of IDW.

2.0 SUMMARY OF IDW GENERATION ACTIVITIES

The various activities conducted during field investigations will result in the generation of IDW. Field activities may include soil-gas and geophysical surveys; drilling of soil borings; trenching or test pits; monitoring well installation and development; groundwater testing; collection of soil, surface water, and groundwater samples; and location surveys. IDW generated during field activities may include the following media and waste types:

- Soil
- Drilling mud
- Groundwater
- Decontamination fluids
- Personal protective equipment (PPE)
- Disposable equipment

The above wastes may or may not be considered hazardous for the purposes of handling and disposal. Section 4.3 details how the wastes will be characterized prior to determining the appropriate disposal option. In addition to the IDW listed above, refuse may be generated during field activities. This could include, for example, packaging materials and broken or cut-off well screening and casing. Typically, this refuse can be treated as nonhazardous material and disposed of as appropriate, such as in an on-base industrial dumpster.

However, the IDW generated during these activities could potentially be contaminated with various hazardous substances. Typical types of IDW generated from various field activities are presented in the subsections that follow. As part of the preplanning procedures prior to the initiation of any field effort, the individual contractors should perform site-specific calculations of the total volumes of IDW expected to be generated based on the anticipated activities as part of their project planning.

An effort should be made to reduce the amount of IDW generated during field activities because the quantity of IDW will affect the overall cost of the scope of work and potentially increase liability or exposure. IDW can be minimized through proper planning of all activities that generate IDW. The sampling equipment and method of decontamination should be selected with consideration to the volume of IDW that will be generated. Whenever possible, the number of activities conducted at a site should be reduced.

2.1 Soil-Gas and Geophysical Surveys

Soil-gas and geophysical surveys are conducted to identify and locate anomalies, potential "hot spots," and source areas. These activities potentially generate a small volume of decontamination fluid and PPE.

2.2 Drilling

The drilling technique to be used for soil boring and monitoring well installation is sonic drilling.

Drilling can potentially generate large volumes of PPE and decontamination fluid. These volumes are difficult to estimate because they depend on many site-specific factors.

2.3 Hand Augering, Surface Soil Sampling Activities

Typically, hand augering is conducted using a 3.25-inch inside-diameter (ID) auger. Surface soil sampling is usually completed using hand-held sampling tools. Due to small diameter and limited excavation depth, a small volume of soil cuttings is estimated to be generated during these activities, and a small volume of PPE would also be generated.

2.4 Trenches or Test Pits

Trenches or test pits may be excavated at sites. Following the soil sampling and visual observations of the pit, the excavated soil will generally be placed back into the test pit. In this instance the soil will be placed back into the pit in the same order it was removed. Depending on specific site conditions, the need may arise to remove the excavated soil from the area of contamination (AOC). This could potentially generate large volumes of soil to be treated and/or disposed. Decontamination of the excavation and sampling equipment could potentially generate large volumes of decontamination fluid. PPE will also be generated.

2.5 Location Surveys

Following the completion of sampling activities, the coordinates and elevations of all sampling points, including soil borings, monitoring wells, soil-gas points, and geophysical survey grids, will be surveyed. Small volumes of PPE could potentially be generated.

2.6 Monitoring Well Development and Groundwater Sampling

The volume of groundwater generated through monitoring well development, groundwater sampling, and groundwater bearing zone testing is dependent upon a number of variables, including well diameter, length of the screened interval, saturated thickness of the well, porosity

of the material used as filter packing, duration and rate of pumping. PPE and decontamination fluid would also be generated as a result of these activities, but the volume is dependent on the type and duration of the activity.

Complete well development requires the removal of at least three times the amount of source water used during drilling and construction of the well plus a minimum of three times the volume of standing groundwater within the well. For example, during the development of a 4-inch-ID well with 30 feet of standing water, a minimum of 58 gallons of groundwater plus three times the amount of the source water used during drilling and construction of the well would be generated. An additional 58 gallons of groundwater would be generated while purging the well prior to groundwater sampling.

In general, purge water should be segregated by well and containerized in Department of Transportation (DOT)-approved, 55-gallon drums.

2.7 Surface Water Sampling

Surface water sampling may be conducted to determine the constituents of the surface water at the site. This activity could potentially generate a small volume of decontamination fluid and PPE.

2.8 Decontamination Fluid

The volume of IDW generated as decontamination fluid will be dependent upon a number of site-specific factors, and therefore, will vary in quantity. Site-specific factors include the number and type of field activities per site and the total number of sites being investigated. Decontamination fluid can vary from a few gallons a day for decontamination of instruments to several hundred gallons a day for decontamination of large field equipment such as drill rigs.

2.9 PPE and Disposable Equipment

The volume of IDW generated as PPE and disposable equipment will be dependent upon a number of site-specific factors and therefore, will vary in quantity. Site-specific factors include

the U.S. Environmental Protection Agency (USEPA) health and safety work level (Level D versus Levels C or B), number and type of field activities per site, number of people working on site, total number of sites being investigated, and the amount of disposable equipment that is required. PPE waste volumes generated per day will typically account for one-half of a 55-gallon drum for a crew of four.

3.0 IDW CONTAINMENT

IDW generated during field activities will be contained at the site of generation or at a designated central location. DOT-approved, 55-gallon drums for the handling of hazardous waste (DOT, USEPA-approved DOT-17-H) should be used for the containment of some of the IDW including PPE, and disposable sampling equipment. Roll-off boxes and Baker (aka Frac or fractionation) tanks may be used to contain soil and liquid wastes, respectively. However, DOT-approved, 55-gallon drums may be used to containerize soil and liquid wastes, if preferred. The number of each type of container required at each site should be estimated before field work commences.

Soil cuttings and/or drilling mud will either be contained in DOT-approved, 55-gallon drums or placed in roll-off boxes located in the general area of sites being investigated. If soil cuttings are determined to be potentially hazardous while in the field (i.e., PID readings above designated levels or visible staining), soil cuttings should be segregated by site or boring, containerized in DOT-approved 55-gallon drums lined with polyethylene, and immediately secured with lids. Each drum or roll-off box will be labeled as discussed in Section 4. Drums or roll-off boxes will be stored at the site of generation or transported from the AOC following drilling and stored at a central location. Drums or roll-off boxes will be held until adequate characterization of the site or the contained soil or drilling mud is completed (Section 4).

Liquid wastes will either be stored within the AOC or transported to a central location. Liquid wastes generated during field investigation activities include fluids generated during well installation, development, purging and sampling, groundwater bearing zone testing, surface water sampling, and decontamination of equipment. Liquid wastes may be placed in DOT-approved, 55-gallon drums or consolidated in onsite Baker tanks until the liquid can be characterized for disposal (see Section 4). Each drum will be labeled as discussed in Section 4.

Drums will be stored at the site of generation or transported from the AOC and stored at a central location. Liquid wastes will be stored pending IDW characterization (Section 4).

Depending upon the suspected contaminants present, decontamination fluid generated at each site may be segregated by site and containerized in DOT-approved, 55-gallon drums or stored with other liquid wastes generated at the same site. The decontamination fluid will be stored within the AOC or a designated central location. Decontamination fluid will be held until adequate characterization is complete (Section 4).

PPE and disposable equipment produced through field activities will be segregated by site, double-bagged in plastic bags, secured and labeled using a wire tag. The bags will then be placed in DOT-approved, 55-gallon drums and labeled as discussed in Section 4. Partially filled drums will be secured with lids at the completion of field activities or at the end of the work day. PPE and disposable equipment will be held at the site of generation or a designated central location. PPE and disposable equipment will be held until adequate characterization of the site or of the containerized PPE and disposable equipment is completed (Section 4).

4.0 IDW HANDLING AND MANAGEMENT OPTIONS

This section discusses the proper IDW management procedures to be followed in record-keeping practices, requirements for compliance with storage time limitations, and characterization of IDW. The protocols established for sampling and analysis of contaminated IDW, if required, are also presented in this section.

Following the field activities, including proper labeling and temporary storage of IDW as appropriate, the first task will be to characterize the IDW generated. Proper characterization is required to determine if disposal is necessary and, if so, the appropriate disposal options. Initially, the IDW will be characterized based on a review of analytical data generated from environmental samples collected during field activities. Based on this review, the characteristics of the IDW will be inferred. In some cases, testing containerized IDW may be required to further define disposal options. The management of investigation-derived wastes including containerization and required analyses is presented in Section 4.3 for soil and liquids.

Initially, soil and liquid IDW will be characterized based on the background data. To identify potential contamination, analytical results should be compared to the 95% Upper Tolerance Level for the background samples.

Proper IDW management requires that the following steps be completed:

- Characterize the waste generated
- Determine the quantity of waste that is hazardous
- Evaluate available disposal/treatment methods
- Identify disposal facility waste acceptance criteria and schedule testing of wastes
- Select a disposal option and coordinate manifesting and transport

The investigation team members will conduct the field activities that generate the IDW (Section 2.0), place the IDW in appropriate containers (Section 3.0), and complete record-keeping responsibilities (Section 4.0). Once the waste has been adequately characterized, the investigation team will also arrange for the appropriate treatment or disposal of the IDW. A technical memorandum will document the status of containerized IDW with the following information:

- A complete list of containers stored at each site of generation or at the central area
- Unique identification of each container
- Contents of each container
- Analytical results of the environmental samples
- Volume of potentially contaminated material
- Potential contaminant(s) of concern
- Site maps showing the location of each container at the site
- Recommended treatment and/or disposal options for each container

The investigation team will sample existing containerized IDW, as required, for further characterization or disposal. Handling and managing the off-installation treatment and disposal of IDW after the containers have been characterized for off-site transport would also be required. Additional tasks that would be performed include, but may not be limited to, preparing manifests, tracking containers, tracking 90-day storage limits, arranging the transport of

containers, and arranging the ultimate disposal to a RCRA-permitted off-installation treatment, storage, and disposal facility (TSDF).

4.1 Container Labeling and Record Keeping

Container labeling and record-keeping requirements include: (1) proper labeling of containers as waste pending receipt of analytical test results (proper labeling includes information such as source site number, boring or well number, and permissible storage period); and (2) date(s) of waste generation and type of IDW stored in the container. Drum labels will be placed on the side of the drum, not on the lid, to reduce breakdown of the label by environmental conditions and to prevent the possibility of interchanging labels if lids are reused. Plastic bags used to contain disposable PPE and disposable equipment will be identified with a drum label wrapped around a piece of wire to produce a wire tag that will be used to seal the bag.

IDW containers should be tracked using a form that includes site name, location identification, storage location, contents, source, dates of operation, capacity of container and visual observations of the wastes, odor characteristics, and PID readings. The form should be completed once each container is filled. The quantity (volume) of material in each container should be measured and recorded on the IDW container data sheet prior to sealing the container.

In addition to complying with the above requirements, as appropriate, maintain an inventory of wastes generated, including source, media, storage location, analytical results, and final treatment or disposal. Hazardous waste manifests and material safety data sheets will be completed as appropriate. All manifests will be signed by the generator.

4.2 Storage Time Limits

Several storage and disposal requirements are subject to time limits that begin when the IDW is generated. These include: (1) removal of waste from the site (unless wastes will be stored on site within the AOC); (2) notification of the USACE by the contractor following initial characterization of the IDW; and (3) final treatment or disposal of the IDW.

Within 60 days of waste generation, the investigation team should provide a memorandum to the USACE documenting the initial characterization of the IDW. Sixty days is required to receive analytical results from the laboratory, review the data, interpret the data, and prepare the memorandum. The memorandum will assist in planning and compliance with environmental regulations. Documentation should contain information on quantity of waste, type (soil, water, etc.), site, source (borehole, monitoring well, etc.), contaminants detected, and concentrations. This information will be used to make an initial classification of waste (potentially hazardous, designated, or nonhazardous). The memorandum should include proposed actions to be taken concerning additional sampling and disposal.

As discussed in Section 4, if IDW is characterized to be potentially hazardous, additional sampling of IDW containers will be required to determine if the IDW is hazardous. If the material is defined as RCRA hazardous waste, RCRA regulations (40 CFR 262.34) requires the waste to be transported off site in 90 days. In addition, RCRA regulations (40 CFR 262.34) require that, unless IDW will be stored within the AOC, IDW will be transported to the designated storage area within 3 days. If additional sampling is performed, it is likely that the 90-day limit on RCRA waste will be exceeded. CERCLA-derived wastes may be stored at an area longer than 90 days as long as the storage area complies with RCRA substantive storage requirements (the administrative process for obtaining a permit is not required). The intent of the waste management program will be to dispose of IDW as soon as is practicable. Factors that may influence the length of time of storage include laboratory turnaround time, duration of investigations at the site, storage area volume limitations, time requirements to arrange for off-site disposal, and the degree of risk that the IDW poses to human health and the environment. If IDW is generated that is deemed by the AF, regulatory agencies, or the contractor to present a high degree of risk by storing the IDW, arrangements will be made for immediate transfer or disposal.

4.3 IDW Container Sampling and Analysis Methods

Analytical samples collected during field activities will be analyzed and the results compared to background and regulatory limits before IDW container sampling occurs. Data collection efforts

completed during the field investigation should be sufficient for determining whether IDW is potentially hazardous. The basic objective of IDW sampling is to produce a set of samples representative of the contained IDW media under investigation and suitable for subsequent analysis, if required. PPE and disposable equipment found to be potentially hazardous will be disposed as hazardous materials. The methods, techniques, and analyses used for testing hazardous field-generated wastes that will be disposed of off-installation to a RCRA-permitted facility or Class I disposal facility are presented in the following sections.

The sampling technique chosen for sampling activities will, in part, be dependent upon the physical state of the IDW media to be sampled. The physical state of the IDW will affect most aspects of the sampling effort. The sampling technique will vary according to whether the sample is liquid, solid, or multiphasic. The generation of decontamination fluids through IDW sampling should be minimized and should be a factor considered in the final choice of sampling technique. The decontamination fluids will be minimized through selection of appropriate technique to sample the media in question and ease of cleaning. Care should be exercised to avoid the use of sampling devices plated with chrome or other materials that might contaminate the sample.

If IDW is characterized to be potentially hazardous after review of analytical data generated during field activities, IDW container sampling will be conducted. Testing is required prior to on- or off-installation treatment, storage, or disposal of contaminated material. However, IDW container testing is not required if the IDW is determined to be nonhazardous. Criteria for testing protocol are presented in Section 4. The description of sampling techniques for containerized media is divided into two sections, which address soil and drilling mud, and containerized liquids.

4.3.1 Containerized Soil and Drilling Mud Sampling

Available options for sampling devices suitable for soil and drilling mud sampling include scoops, thin-walled tube samplers, hand augers, core samplers, and sampling tiers. The presence of rocks, debris, or other sampling-specific considerations will dictate the most suitable sampling

method. The sampling technique will also vary according to whether the solid is hard or soft, powdery or clay-like (USEPA, 1986).

If the soil or drilling mud is stored in bins, one composite sample should be collected from each bin. If the IDW is stored in drums, one composite sample should be collected from the cuttings from each boring or from each site.

4.3.2 Containerized Liquid Waste Sampling

Beakers, glass tubes, extended bottle samplers, and Composite Liquid Waste Samplers (COLIWASA) are devices that may potentially be used to sample containerized liquid media. Site-specific conditions may necessitate a variety of sampling options. Site-specific conditions will include the homogeneity or heterogeneity of the liquid to be sampled and stratification and the physical nature of the liquid such as viscosity. Sampling techniques will be chosen based on properties of the liquid medium and ease of decontamination of sampling equipment. Surface water samples from drums can also be readily collected by merely submerging a sample bottle.

If the liquid waste is stored in Baker Tanks, one composite sample should be collected from each Baker Tank. If the liquid waste is stored in drums, one composite sample should be collected from the drums for each sampling event.

5.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), 1984. Waste Analysis Plans. Prepared by the Office of Solid Waste, October 1984.

USEPA, 1986. Test Methods for Evaluating Solid Waste, Third Edition SW-846. Prepared by the Office of Solid Waste and Emergency Response, November 1986.

USEPA, 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final. Prepared by the Office of Emergency and Remedial Response, October 1988.

USEPA, 1988b. CERCLA Compliance with Other Laws Manual, Draft Guidance. Prepared by the Office of Emergency and Remedial Response, August 1988.

USEPA, 1990. CERCLA Compliance with the RCRA Toxicity Characteristics (TC) Rule: Part II. Prepared by the Office of Solid Waste and Emergency Response, October 1990.

STANDARD OPERATING PROCEDURE

GROUNDWATER MONITORING WELL DEVELOPMENT

1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides a general framework for monitoring well development. The goal of monitoring well development is to remove fines and drilling fluid residue from the sand pack and the natural formation in the vicinity of the screened interval; this will assure good communication between the groundwater bearing zone and the well. The result of well development is assurance that a sample collected will be a true representative of the quality of water moving through the formation.

2.0 SUMMARY OF METHOD

The well development process is composed of: (1) the application of sufficient energy in a monitoring well to create groundwater flow reversals (surging) in and out of the well and the sand pack to release and draw fines into the well; and (2) pumping or bailing to draw drilling fluids out of the borehole and adjacent natural formation, along with fines that have been surged into the well.

3.0 DEFINITIONS

Fines: Silt, clay, fine sand.

Parameters: Groundwater variables, i.e., pH, specific conductivity, temperature, turbidity.

Annulus: The gap between the well and borehole where the sand, seal, and grout are installed.

Saturated annulus: The portion of the annulus that is below the groundwater bearing zone.

Drilling fluid: Any fluid the driller may have added during the drilling of the borehole.

Purge water: Any water removed from the well via bailing, pumping, or air lift.

Drawdown: Distance between the static water level and water level while the well is being pumped or bailed at a constant rate.

Bridge: A wedge or build up of sand that occurs when the driller is pouring the sand pack around the screened interval, thus leaving a gap or "open zone" where the natural formation could possibly clog the screen.

Yield: The rate at which a well will produce water.

4.0 APPARATUS & MATERIALS

The following equipment (or equivalent) will be utilized as part of the monitoring well development procedures:

- submersible pump;
- Lamotte 2020 Portable Turbidimeter;
- YSI 6820 Flow Cell;
- Photoionization Detector;
- Water level meter;
- Nitrile Gloves; and
- Field Log Book and Well Development Log.

5.0 INSTRUMENT CALIBRATION

All water quality measurement equipment will be calibrated in accordance with SOP No. CAL-1. All air monitoring equipment will be calibrated in accordance with the appropriate SOP (i.e.: PID will be calibrated using SOP No. PID-1).

6.0 WELL DEVELOPMENT

The following general guidelines are applicable to well development regardless of method.

6.1 Decontamination

It is essential that every effort be made to avoid outside contamination and the cross-contamination of monitoring wells. This can best be done by ensuring that all equipment to be introduced into a well is clean. The level of effort for decontamination is a site- and project-specific issue to be resolved individually for each project.

6.2 Documentation

A critical part of monitoring well development is recording of significant details and events in either a field log book or on a well development log. Listed are some important details to document.

- well designation
- date of well installation
- date of well development
- PID readings, if measured
- static water level before and 24 hours after development
- quantity of water loss during drilling and fluid purging, if water is used
- quantity of standing water in well and sand pack annulus (30 percent porosity assumed for calculation) prior to development
- specific conductivity, temperature, and pH measurements taken and recorded at the start, during, and at the conclusion of development (calibration standards will be run prior to each day's operation in the field)
- depth from top of well casing to bottom of well
- screen length
- depth from top of well casing to top of sediment inside well, before and after development
- physical characteristics of removed water, including changes during development in clarity, color, particulates, and odor
- types and size/capacity of pump and/or bailer used
- description of surge technique, if used
- height of well casing above ground surface
- pumping rate and estimate of recharge rate
- quantity of water removed and time duration for removal

6.3 Calculating Purge Volume

Before the development process begins, the minimum number of gallons to be removed will need to be calculated.

The following information will be obtained to calculate purge volume:

1. Total depth of well (TD)
2. Measured static water level (SWL)
3. Screen length (SL)
4. Well casing inner diameter (ID)
5. Borehole Diameter (BD)
6. Number of gallons of water used during well drilling/construction
7. If the standing water column (SC) is longer then the screen length, note how many feet of sand pack was installed above the screen

To calculate one well volume use the following method:

- To calculate standing water column (SC), TD - WL = SC
- Use a well volume chart to find a multiplier in the "gallons per foot" column that coincides with the well's ID
- SC x ID multiplier = gallons of water in one well volume

To calculate one annulus volume use one of the following methods (2 Options):

Use Option 1, if SC is shorter than the screen length

- Portion of saturated sand pack annulus = SC
- Use a volume chart to find a multiplier in the 'Gallons per foot' column that coincides with the wells BD
- BD multiplier - ID multiplier = annulus multiplier
- Feet of saturated annulus x annulus multiplier x 30%(assumed porosity) = gallons of water in one annulus volume

Use Option 2, if SC is longer than the screen length

- Portion of saturated sand pack annulus is = to the screen length + the number of feet of sand above the top of the screen
- Use a volume chart to find a multiplier in the 'Gallons per foot' column that coincides with the wells BD
- BD multiplier - ID multiplier = annulus multiplier
- Feet of saturated annulus x annulus multiplier x 30%(assumed porosity) = gallons

of water in one annulus volume

To calculate the minimum gallons to be removed use the following formula:

- well volume + sand pack annulus volume + number of gallons lost during well drilling/construction = one purge volume

<u>EXAMPLE:</u>

You are to develop a 4-inch well. From the Well Construction Log you note the borehole diameter was 11 inches, the screen is 15 feet long, and the driller used 75 gallons of water during well construction. With a water level indicator you measure the static water level at 59.45 feet, and with a well tagger you measure the well depth at 71.21 feet.

Record in log book, TD = 71.25'
WL = 59.45'

TD -WL = SC
Log book, SC = 11.8'

From a Volume chart, the "gallons per foot" multiplier for a 4-inch well is 0.653. And, 11.8 x 0.653 = 7.71 (gallons of water in one well volume).

Log book, One well vol. = 7.71 gal.

From a Volume chart, the "gallons per foot" for an 11-inch borehole is 4.937. Therefore, 4.937(BD multiplier) - 0.653(ID multiplier) = 4.284(annulus multiplier). And, 11.8 x 4.284 x 30% = 15.17 (gallons of water in one sand pack annulus volume).

Log book, One sand pack annulus vol. = 15.17 gal.
Drilling fluid lost = 75 gal.

7.71(one well volume) + 15.17(one annulus volume) + 75(fluid lost) = 97.88 gallons(one purge volume). From the work plan you note a minimum of 3 well volumes must be removed during development. Additional water may need to be purged to allow the parameters to stabilize and

the water to clear up.

Log book, One purge vol. = 97.88 gal.

97.88 x 3 = 293.64 (minimum number of gallons to be purged).

Log book, Min. gal. to be purged = 293.64 gal.

6.4 Bailing, Surging, and Pumping

At least 24 hours after grout placement, monitoring wells will be developed by pump-and-surge methods using a centrifugal pump, submersible pump, or bailer. Pumping the well with on-off cycling of the pump will provide sand pack flushing. The pump's vertical location across the well screen or borehole will be varied during development, which involves pumping at least three volumes of standing water from the well casing and/or sand pack annulus (assuming 30 percent porosity). The well or borehole will be considered complete when the water exhibits:

- turbidity measurement of less than 50 Nephelometric Turbidity Units (NTUs); and
- pH, conductivity, and temperature readings appear to be stabilized (3 consecutive readings within 10%); or
- development time reaches 4 hours.
- Well development will be continued as long as turbidity measurements remain above 50 NTUs and are improving over 15-minute intervals.

No water will be added to the well during development. If well yields cannot sustain the flow rate of the pump, a bottom discharge bailer will be used. The pump or bailer will be decontaminated prior to initial use and before development of the next well. All well development fluids will be discharged onto the ground at each well location (or managed as specified in the site-specific plans).

6.4.1 Developing Wells In Tight Formations

Developing low-yield wells is a very lengthy process; the amount of time spent developing a low yield well is project-specific and should be resolved individually for each project. For wells installed in clay or fine-grained silt the method of development should be bailing only. Surging

of such wells has been found to substantially increase the turbidity of the water and does not significantly improve hydraulic well response. These wells should be bailed dry and a record kept on the time it takes for the well to recharge 80 percent.

7.0 ATTACHMENTS

Well Development Log (in Field Forms Appendix)

USEPA, 1991. Management of Investigation-Derived Wastes During Site Inspections. Prepared by the Office of Emergency and Remedial Response, Publication 9345.3-02FS, May 1991.

WELL DEVELOPMENT LOG

URS Corporation

PROJECT TITLE: _____ WELL NO.: _____

PROJECT NO.: _____

STAFF: _____

DATE(S): _____

			WELL ID.	VOL. (GAL/FT)
1. TOTAL CASING AND SCREEN LENGTH (FT.)	=	_____	1"	0.04
2. WATER LEVEL BELOW TOP OF CASING (FT.)	=	_____	2"	0.17
3. NUMBER OF FEET STANDING WATER (#1 - #2)	=	_____	3"	0.38
4. VOLUME OF WATER/FOOT OF CASING (GAL.)	=	_____	4"	0.66
5. VOLUME OF WATER IN CASING (GAL.)(#3 x #4)	=	_____	5"	1.04
6. VOLUME OF WATER TO REMOVE (GAL.)(#5 x ___)	=	_____	6"	1.50
7. VOLUME OF WATER ACTUALLY REMOVED (GAL.)	=	_____	8"	2.60

OR

$V=0.0408 \times (\text{CASING DIAMETER})^2$

PARAMETERS	ACCUMULATED VOLUME PURGED (GALLONS)										
pH											
SPEC. COND. (umhos)											
APPEARANCE											
TEMPERATURE (°C)											

COMMENTS:

STANDARD OPERATING PROCEDURE

LOW-FLOW PURGING AND GROUNDWATER SAMPLE COLLECTION

1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides a general framework for collecting groundwater samples that are indicative of mobile organic and inorganic loads at ambient flow conditions. This procedure does not address the collection of samples from well containing light or dense non-aqueous phase liquids.

2.0 SUMMARY OF METHOD

Low-flow groundwater sampling methods outlined by United States Environmental Protection Agency (USEPA) (USEPA, 1996) will be used for sampling of groundwater monitoring wells. Low-flow groundwater sampling methods and sampling log forms are presented in the attached document.

Purging and sampling a monitoring well process consists of: (1) the application of sufficient energy in a monitoring well to remove stagnant water within the well with as little disturbance as possible; and (2) monitoring water quality parameters to verify stabilization.

3.0 DEFINITIONS

Drawdown: Distance between the static water level and water level while the well is being pumped or bailed at a constant rate.

Low-flow: Pumping rates low enough to minimize drawdown, usually less than 1 liter/minute.

Parameters: Groundwater variables, i.e., pH, specific conductivity, temperature, turbidity.

Purge water: Any water removed from the well via bailing, pumping, or air lift.

USEPA: United States Environmental Protection Agency

Yield: The rate at which a well will produce water.

4.0 APPARATUS & MATERIALS

The following equipment (or equivalent) will be utilized as part of the low flow groundwater sampling procedures:

- Horiba Model U-52 Multi-Parameter Water Quality Monitor (or equivalent);
- Low flow submersible, bladder, or peristaltic pump;
- LaMotte 2020 Portable Turbidimeter (or equivalent);
- Clean, laboratory-supplied bottleware;
- water level meter;
- interface probe;
- Disposable, inline 0.45 micron water filters;
- Nitrile Gloves; and
- Low-flow Groundwater Purging/Sampling Log.

5.0 INSTRUMENT CALIBRATION

All water quality measurement equipment will be calibrated at the beginning of each day in accordance with SOP No. CAL-1.

6.0 SAMPLE COLLECTION

6.1 Low-Flow Purging

Low-flow purging and sample collection will be performed with a submersible, bladder, or peristaltic pumps. The pump intakes will be set at or slightly above the midpoint of the well screen or at the depth specified by the site managers for boreholes without casing.

Throughout the purging and groundwater sample collection process, field water quality parameters will be continually monitored for stabilization. Field parameters, including pH, specific conductance (SC), temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP), will be measured using a Horiba Model U-52 Multi-Parameter

Water Quality Monitor. Turbidity will be measured using a LaMotte 2020 Portable Turbidimeter.

Low-flow sampling methodology, as described in USEPA guidance document, will be used for collecting all samples. The procedure for sampling wells where a dedicated sampling pump has been installed will follow step 1 and steps 5 through 9 presented below. For wells without a dedicated pump, a non-dedicated pump will be used, and the sampling procedure will follow steps 1 through 9 presented below.

1. The depth to water in the well will be measured and recorded to the nearest 0.01 ft. with the electric water level indicator probe or interface probe (minimize immersion of the probe within the standing water column to avoid disturbance of colloidal particles).
2. If the depth to water in the well is less than 15-feet bgs, a peristaltic pump may be used for purging and sampling of the well. If the depth to water is greater than 15-feet bgs, a submersible or bladder pump must be used for purging and sampling of the well.
3. The pump intake will be placed at the midpoint of the zone to be sampled and no closer than within 2 ft of the bottom of the well, if possible. Disposable Teflon®, Teflon®-lined, or HDPE tubing will be utilized.
4. The pump will be slowly lowered to the required depth to minimize the amount of mixing in the well. The pump will be secured to the well casing (or PVC stick-up) to minimize movement.
5. The depth to water with the tubing in the well will be re-measured and compared with the initial reading; if the readings vary by greater than 0.05 ft, field personnel will wait for five minutes, re-measure the water level, and begin pumping.
6. The pump will be started at the lowest flow setting. The pump start time will be recorded and the flow rate will be measured and recorded using a graduated measuring device and stopwatch. During the initial period of pumping (an estimated initial 5 to 10 minutes) the depth to water in the well should be measured frequently, (approximately once per minute) and the pump speed will be adjusted until there is little or no water level drawdown (less than 0.3 feet). However, if drawdown exceeds 0.3 feet but remains stable, continue purging until field indicator parameters stabilize. Every effort will be made in the field to ensure that the well is not dewatered below the top of the well screen in an effort to prevent aeration of the groundwater.
7. The initial groundwater sample discharged from the tubing will be monitored for field parameters.
8. Field parameters and the depth to water in the well will be measured at three to five-minute intervals (initially the water level will be measured more frequently, as

discussed in Step 5 above). The data and the associated time will be recorded on the low-flow sampling data sheet. Attempts will be made to maintain the drawdown in the well during pumping to 0.3 ft or less by adjusting the pump flow rate. Drawdown for each well will vary depending on the recharge capacity of the well. Drawdown may exceed 0.3 ft in some or all wells.

9. Stabilization of the well is considered to have been achieved when:

    A. Three consecutive readings of field parameters are measured within the following limits using a flow-through cell for all parameters except turbidity:
        - Turbidity (10% for values > 1 NTU)
        - DO (10%)
        - SC (3%)
        - Temperature (3%)
        - pH (±0.1 unit)
        - ORP (±10 millivolts)

    B. Drawdown is 0.3 ft or less.

    C. The purge volume is greater than the stabilized drawdown volume of the well plus volume of the extraction tubing.

10. If a well is essentially dewatered due to low recharge rates, samples will be collected once the water level has recovered sufficiently to provide the required sample volume. Samples may be taken even if the field indicator parameters have not stabilized.

11. Samples will be collected after four hours of purging if stabilization criteria are not met, and non-stabilization of parameters will be noted on the low-flow sampling data sheet.

6.2 Purge Water Handling and Disposal

Due to the potential for spreading environmental contamination, planning for purge water disposal is a necessary part of well monitoring. Alternatives range from releasing it on the ground (<u>not</u> back down the well) to full containment, treatment, and disposal. If non-aqueous phase liquid is identified in the well, the purge water will be contained and stored in drums labeled "purge water" or in aboveground portable storage tanks (i.e., "Baker Tanks") until the water samples have been analyzed. Once the contaminants are identified, appropriate treatment or disposal requirements can be determined.

6.3 Low-Flow Groundwater Sample Collection

All groundwater samples should be collected directly from the dedicated tubing for each well into clean, laboratory-supplied bottleware. The sample bottles will be filled in order of the volatility of the analytes so that the containers for volatile organics will be filled first, and samples that are not pH-sensitive or subject to loss through volatilization will be collected last. A preferred collection order is as follows:

- Volatile organics (VOCs)
- Total petroleum hydrocarbons (TPH)
- Total organic halogens (TOX)
- Total organic carbon (TOC)
- Extractable organics (e.g., BNAs, pesticides, herbicides)
- Total metals
- Dissolved metals
- Phenols
- Cyanide
- Sulfate and chloride
- Turbidity
- Nitrate and ammonia
- Radionuclides

VOC samples should be collected first and directly into pre-preserved sample containers. Fill the VOC sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal disturbance to prevent volatilization. During groundwater sampling for VOC and dissolved gas analyses, the flow rate and discharge tubing will be maintained such that no air space will be allowed to develop within the tubing to prevent volatilization. The sample container will be filled until a positive meniscus is formed above the top of the container. The sample container will then be capped and inverted and tapped lightly upon the back of the sampler's hand to determine if any air bubbles are trapped within the container. Containers with trapped air will be topped off until no air bubbles are present. All sample containers containing preservative

will be filled using caution such that none of the preservative is lost due to spillage or overfilling.

The bottleware will be labeled in the field with the date, well designation, project name, collectors' name, time of collection, and parameters to be analyzed. The sample containers should be kept in a cooler until they are needed (i.e., not left in the sun during purging). One cooler should be used to store the unfilled bottles and another to store the samples on ice at 4°C. Temperature, pH, and specific conductance should be measured and recorded in the field before and after sample collection to check on the stability of the water samples over time.

6.4 Field Filtration for Dissolved Metals

Any filtration for estimates of dissolved species loads should be performed in the field with no air contact and immediate preservation and storage. In-line pressure filtration is best with as small a filter pore size as practically possible (e.g., 0.45 micron). Disposable, in-line filters are recommended for convenience and avoiding cross-contamination.

7.0 ATTACHMENTS

Low-flow Groundwater Purging/Sampling Log Form

Typical Groundwater Pump Setup

USEPA Region I, 1996; *Low-Stress (Low-flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells*, Revision 2, July 30, 1996.

LOW FLOW GROUNDWATER PURGING/SAMPLING LOG

Project: _____ Site: _____ Well I.D.: _____

Date: _____ Sampling Personnel: _____ Company: _____

Purging/ Sampling Device: _____ Tubing Type: _____ Pump/Tubing Inlet Location: _____

Measuring Point: Below Top of Riser Initial Depth to Water: _____ Depth to Well Bottom: _____ Well Diameter: _____ Screen Length: _____

Casing Type: PVC Volume in 1 Well Casing (liters): _____ Estimated Purge Volume (liters): _____

Sample ID: _____ Sample Time: _____ QA/QC: _____

Sample Parameters: _____

PURGE PARAMETERS

TIME	pH	TEMP (^{0}C)	COND. (mS/cm)	DISS. O_2 (mg/l)	TURB. (NTU)	Eh (mV)	FLOW RATE (ml/min.)	DEPTH TO WATER (btor)
Tolerance:	**0.1**	**---**	**3%**	**10%**	**10%**	**+ or - 10**	**---**	

Information: WATER VOLUMES--0.75 inch diameter well = 87 ml/ft; 1 inch diameter well = 154 ml/ft; 2 inch diameter well = 617 ml/ft; 4 inch diameter well = 2470 ml/ft ($vol_{cyl} = \pi r^2 h$)

Remarks:

STANDARD OPERATING PROCEDURES

SOIL CLASSIFICATION

3.1.3 Procedure for Identifying Borderline Soils

To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example, a soil containing an estimated 50% silt and 50% fine grained sand may be assigned a borderline symbol "SM/ML". Borderline symbols should not be used indiscriminately. Every effort shall be made to first place the soil into a single group and then to estimate percentages following the USCS soil description.

3.2 Descriptive Information for Soils

After the soil name and symbol are assigned, the soil color, consistency/density, and moisture content shall be described in that order. Other information is presented later in the description, as applicable.

3.2.1 Color

Describe the color. Color is an important property in identifying organic soils, and may also be useful in identifying materials of similar geologic or depositional origin in a given location. The Munsell Soil Color Charts should be used, if possible.

When using the Munsell Soil Color Charts, first attempt to assign the soil a general color, such as brown, gray, red, etc. Then go to the correct area in the charts and assign the applicable color name and Munsell symbol. The ability to detect minor color differences varies among people, and the chance of finding a perfect color match in the charts is rare. Keeping this in mind should help field personnel avoid spending unnecessary time and confusion going through the chart pages. In addition, attempting to describe detail beyond the reasonable accuracy of field observations could lead to making poorer soil descriptions than by expressing the dominant colors simply.

If the color charts are not being used or are unavailable, again attempt to assign general colors to soils. Comparing a particular soil sample to samples from different locations in

TABLE 1

CRITERIA FOR DESCRIBING DRY STRENGTH

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very High	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 2

CRITERIA FOR DESCRIBING DILATANCY

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 3

CRITERIA FOR DESCRIBING TOUGHNESS

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

TABLE 4

CRITERIA FOR DESCRIBING PLASTICITY

Description	Criteria
Nonplastic	A 1/8-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

TABLE 5

CRITERIA FOR DESCRIBING HARDNESS

Density (Sand and Gravel)				**Consistency (Silt and Clay)**			
	Blows/ft*				Blows/ft*		
Term	1.4" ID	2.0" ID	2.5" ID	Term	1.4" ID	2.0" ID	2.5" ID
very loose	0 - 4	0 - 5	0 - 7	very soft	0 - 2	0 - 2	0 - 2
loose	4 - 10	5 - 12	7 - 15	soft	2 - 4	2 - 4	2 - 4
medium dense	10 - 29	12 - 37	15 - 51	medium stiff	4 - 8	4 - 9	4 - 9
dense	29 - 47	37 - 60	51 - 86	stiff	8 - 15	9 - 17	9 - 18
very dense	> 47	> 60	> 86	very stiff	15 - 30	17 - 39	18 - 42
				hard	30 - 60	39 - 78	42 - 85
				very hard	> 60	> 78	> 85

* 140 lb. hammer dropped 30 inches

TABLE 6

CRITERIA FOR DESCRIBING CONSISTENCY

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about 1/4 in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

TABLE 7

CRITERIA FOR DESCRIBING STRUCTURE

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

STANDARD OPERATING PROCEDURE

TRENCHING AND TEST PITTING

1.0 SCOPE & APPLICABILITY

This guideline presents the Standard Operating Procedure (SOP) for test pit excavations. In suitable ground, shallow excavations may provide an efficient and economic method to evaluate the shallow subsurface environment of a site.

2.0 SUMMARY OF METHODS

This SOP establishes guidelines for conducting test pit and trench excavations at hazardous waste sites.

Shallow trial pits do the following:

- permit the in-situ condition of the ground to be examined in detail both laterally and vertically;
- provide access for taking samples and for performing in-situ tests;
- provide a means of determining the orientation of discontinuities in the ground; and
- field sampling personnel are somewhat removed from the sampling site as intrusive activities are conducted, increasing safety.

3.0 DEFINITIONS

DOT: Department of Transportation

EOD: Explosive Ordinance Disposal

MGM: Multi-Gas Meter (including CO, O_2, H_2S, and LEL) (SOP No. MGM-1)

OSO: On-site Safety Officer

OSHA: Occupational Safety and Health Administration

PID: Photoionization Detector (SOP No. PID-1)

SOP: Standard Operating Procedure

Trench or Test Pit: Linear excavation, of varying width, usually used to locate landfill boundaries as well as for clearing landfill location for drilling.

Ground Crew: Composed of excavating support crew and sampling crew.

4.0 APPARATUS & MATERIALS

Trench and test pit excavation is carried out either manually or by using standard equipment such as backhoes, trenching machines, track dozers, track loaders, excavators, and scrapers. Operators of excavating equipment should be skilled and experience in its safe use for digging test pits and trenches. A typical excavator with extending backhoe arm can excavate approximately 15 feet of material. If investigations are required to penetrate beyond 15 feet, soil borings may be a more feasible method.

5.0 HEALTH & SAFETY PROCEDURES

A tailgate safety meeting shall be conducted by a designated on-site safety officer (OSO) before commencing excavation.

Prior to all excavations, the field geologist must confirm that underground utilities (electric, gas, telephone, water, etc.) within the general vicinity to nearby foundations or structures have been cleared or marked off. Certain underground services may not be picked up by detectors and careful excavation of the surface soils, with the ground crew watching for early signs, can help prevent the puncturing of any underground services.

Prior to commencing excavation, standard signals shall be used for rapid and efficient communication between the excavating equipment operator and the ground crew. Before approaching the trench./test pit or excavating equipment, the sampling and support crew must ascertain that the operator has noted their presence.

6.0 CAUTIONS

Material that is brought to the surface should be treated as hazardous and contained in an appropriate manner. If the material is wet, the liquid seeping from the stockpile should be collected and disposed of accordingly.

Entry of personnel into pits or trenches is strictly prohibited unless specifically approved. Also, strict adherence to state and federal Occupational Safety and Health Administration (OSHA) guidelines will be observed.

Personnel should never enter trench deeper than 4 feet (chest height) unless full lateral support of the side walls is provided. Any personnel entering the trench may be exposed to toxic or explosive gases and an oxygen-deficient environment. Air monitoring (PID and MGM at a minimum) is required before and during entry and appropriate respiratory gear and protective clothing is mandatory. Caution should be exercised at all times. At least two people must be present at the immediate site. Ladder access out of the pit must be installed before entry.

Care should be taken to ensure that personnel do not stand too close to the edge of the trench especially during sampling or depth measurements; the combination of deposing soil adjacent to the pit and the risk of caving or toppling of the side walls in unstable soils can lead to unsafe conditions.

7.0 TEST PIT EXCAVATION PROCEDURES

7.1 Excavation

Upon locating the area for excavation, the excavating equipment operator shall determine wind direction and position the machine accordingly. The excavating equipment operator shall outline the area of investigation by extending the bucket arm to its maximum length, and trace a 180-degree outline around the area to be excavated. The support crew shall cordon off the exclusion zone with wooden lathes and brightly colored "caution" tape.

Once any equipment stabilizers are firmly on the ground, excavation can commence. If the area of investigation is beneath vegetative cover or surface debris, the backhoe operator shall scrape the initial 6 inches of topsoil to allow a clear and safe working area. Excavated soil shall be

stockpiled away from the immediate edge to one side of the trench to prevent excavated soil from re-entering the trench or pit and to reduce pressure on the sidewalls, discouraging rotational slips involving large masses of material. The soil shall be deposited downwind of the ground crew and the machine operator. Shifting winds may cause the machine and operator and ground crew to periodically move in order to remain downwind, or to curtail further activities. The support crew should regularly check the machine operator who, if in a partially enclosed cabin, may be susceptible to fumes/gases.

7.2 Stability

Depending on the desired depth of excavation, the trench may require shoring to prevent the sides from collapsing. Lateral support may be provided by a portable aluminum frame system that uses a hydraulic pump to apply pressure to the sidewalls and that can be quickly inserted or extracted, or the sides benched to an appropriate angle. Any timbering or alternative support required in excavations should be installed by skilled personnel.

Groundwater may be pumped out of the pit to stabilize the sidewalls, prevent base heave, and to keep the excavation dry allowing a greater depth to be reached, especially in granular materials that are below the water table.

Near-vertical slopes can stand for seconds, or months, depending on the types of material involved and various other factors affecting their stability. Although personnel should not be entering the excavation, it is prudent to know the possible behavior of the various soil types and conditions that may be encountered. Excavations into fill are generally much more unstable than those in natural soil.

Excavations in a very soft normally consolidated clay should stand vertically, without support, to depths of approximately 12 feet in the short-term only. This critical depth increases as the clays increase in consistency. Long-term stability is dependent on a combination of factors: the type of soils, pore pressures and other forces acting within the soil; and adverse weather effects. Fissured clays can fail along well-defined shear planes and, therefore, their long-term stability is not dependent on their shear strength and is difficult to predict.

Dry sands and gravels can stand at slopes equal to their natural angle of repose no matter what the depth of the excavation (angles can range from approximately 28 to 46 degrees depending on the angularity of grains and relative density).

Damp sands and gravels possess some cohesion and can stand vertically for some time. Water-bearing sands, however, are very difficult in open excavations. If they are cut steeply, as in trench excavation, seepage of water from the face will result in erosion at the toe followed by collapse of the upper part of the face until a stable angle of approximately 15 to 20 degrees is obtained.

Dry silts should stand unsupported vertically, especially if slightly cemented. Welt silt is the most troublesome material to excavate. Seepage leads to slumping and undermining with subsequent collapse, eventually reaching a very shallow angle of repose.

It should not be taken for granted that excavations in rock will stand with vertical slopes unsupported. Their stability depends on the soundness, angle of bedding planes, and the degree of shattering. Unstable conditions can occur if bedding planes slope steeply towards the excavation, especially if groundwater is present to act as lubrication.

7.3 Backfilling

The test pits or trenches should be backfilled immediately upon completion of the hole. Poorly compacted backfill will cause settlement at the ground surface and hence the spoil should be recompacted in several thin layers using the excavator bucket and any surplus material placed over the top of the pit.

In certain areas where soil borings are not required, the pit may be used to install gas monitoring standpipes or piezometers. The granular filter is kept in place using sacking while the backfill material is carefully emplaced around the instrument.

If a sealing layer has been penetrated during excavation, resulting in a groundwater connection between contaminated and previously uncontaminated zones, the backfill material must represent the original conditions or be impermeable. Backfill material could comprise a soil-bentonite mix or a cement-bentonite grout.

7.4 Decontamination

The purpose of decontamination and cleaning procedures during sampling tasks is to prevent foreign contamination of the samples and cross contamination between sites. Before use all sampling and excavation equipment will be decontaminated by steam cleaning. Potentially, all fluids generated by decontamination should be contained in Department of Transportation (DOT)-approved 55-gallon drums.

8.0 DATA ACQUISITION, CALCULATION & DATA REDUCTION

The field record should include a plan giving the location, dimensions, and orientation of the pit, together with dimensioned sections of the sidewalls, description of the strata encountered, and details of any sampling or testing carried out. A photographic record of the test pit, with an appropriate scale, would be ideal.

Any groundwater encountered should be noted with regard to its depth and approximate rate of seepage. If possible the groundwater level within the test pit should be monitored for 20 minutes, with readings taken at 5-minute intervals.

Working from the ground surface the technician can prepare a visual log of the strata/soil profile and decide the interval of sampling. Samples from excavations can be either disturbed or undisturbed.

Disturbed samples are taken from the excavator bucket or from the spoil. To obtain a representative sample of the material at a certain depth, care must be taken not to include scrapings from the sidewalls.

Undisturbed samples may be block samples, cut from in situ material:

- tube samplers may be driven into the floor of the pit using a jarring link and drill rods and extracted using the hoe of the excavator;
- soil samples may be collected from the test pit using a long handled soil coring device;
- test pits will be logged and screened using a PID by a qualified geologist or soil scientist;

- samples of groundwater or leachate may be taken using telescoping poles or a small bailer; and
- if a sample is to be collected for chemical analysis, see SOP No. SS-03 for sample collection methodologies.

The required size of the disturbed samples will vary according to the intended analysis/testing to be carried out. Samples for geotechnical testing will generally need 4 to 6 ounces of material.

9.0 REFERENCES

Scientific and Technical Standards for Hazardous Waste Sites. Book 1, Volume 1, Site Characterization, August 1990.

Tomlinson, M.J., 1986. Foundation Design and Construction, 5th Edition.

STANDARD OPERATING PROCEDURE

SONIC DRILLING METHOD

1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides a general framework for commonly employed sonic drilling methods.

2.0 SUMMARY OF METHOD

The Sonic Method employs the use of high-frequency, resonant energy to advance a core barrel or casing into subsurface formations. During drilling, the resonant energy is transferred down the drill string to the bit face at various sonic frequencies. Simultaneously rotating the drill string evenly distributes the energy and impact at the bit face.

The Sonic driller controls the resonant energy generated by the Sonic oscillator to match the formation being encountered to achieve maximum drilling productivity. When the resonant Sonic energy coincides with the natural frequency of the drill string, resonance occurs. This results in the maximum amount of energy being delivered to the bit face. At the same time, the friction of the soil immediately adjacent to the entire drill string is substantially minimized, resulting in very fast penetration rates.

SONIC BOREHOLE ADVANCEMENT

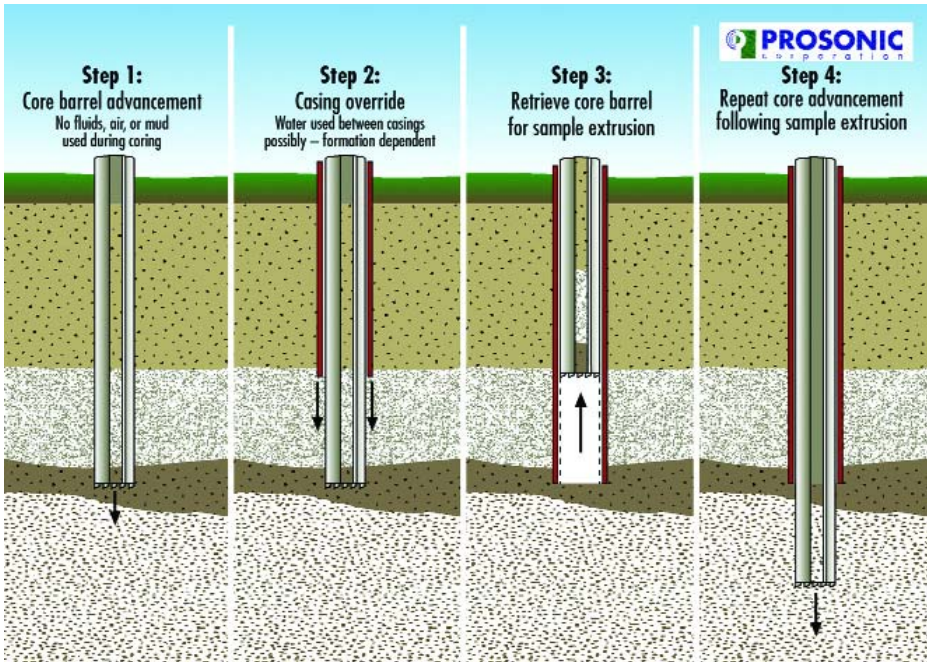
The Sonic Method advances a casing as the borehole is drilled. While there are several ways to drill a borehole (depending upon site-specific conditions and project objectives), the most common means involves advancing a core barrel, which is overridden by a larger diameter drill string that cases the open borehole and prevents collapse.

Typical Sonic Drilling procedure:

1. Sonically advance core barrel into the undisturbed formation. Unless running sands are encountered, no air, mud or water is used in the coring process. If running sands are encountered, air. mud, or water may be used to displace the sands from the core barrel.
2. Sonically override a larger diameter casing over the core barrel.

3. Return the core barrel to the surface for sample extrusion.
4. Complete coring and overriding casing to desired depth.

See Figure below.



STANDARD OPERATING PROCEDURE

OVERBURDEN WELL AND PIEZOMETER INSTALLATION

STANDARD OPERATING PROCEDURE

OVERBURDEN WELL AND PIEZOMETER INSTALLATION

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1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) is applicable to the design and installation of overburden monitoring wells and piezometers. Each monitoring well must be designed to suit the hydrogeologic setting, the type of contaminants to be monitored, the overall purpose of the monitoring program, and other site-specific variables. As such, site-specific objectives for each monitoring well and its respective intended use must be clearly defined before the monitoring system is designed.

2.0 SUMMARY OF METHOD

Guidelines for design and installation of overburden monitoring wells and piezometers are included in this document. Consideration should be given to the following site-specific information before a groundwater monitoring system is designed:

- Purpose of the groundwater monitoring program (water quality, water levels, remediation, flow direction, and velocities);
- Surficial conditions, including topography, climate, drainage, site access;
- Known or anticipated hydrogeologic setting including lithology (consolidated/unconsolidated, depositional environment, presence of fill material), recharge/discharge conditions and ground water/surface water interrelationships;
- Borehole geophysical logs, if any;
- Known or anticipated contaminant chemical characteristics (chemistry, density, viscosity, reactivity, and concentration);
- Anthropogenic or tidal influences; and
- Regulatory requirements.

Siting of monitoring wells should be performed after a preliminary estimation of the hydraulic gradients and groundwater flow direction. In most cases this may be done through review of background data and site terrain. Additionally, production wells in the area may be used to assess the local groundwater flow direction. If the groundwater flow direction cannot be determined by any of these methods, it may be practical to install piezometers in a preliminary phase to determine flow direction.

3.0 DEFINITIONS

Absorption: The penetration or apparent disappearance of molecules or ions of one or more substances into the interior of a solid or liquid.

Adsorption: The process by which atoms, ions, or molecules are held to the surface of a material through ion-exchange processes.

Annular Sealant: Material used to provide a positive seal between the borehole and the casing of the well. Annular sealants should be impermeable and resistant to chemical or physical deterioration.

Annular Space: The space between the borehole wall and the well casing, or the space between a casing pipe and a liner pipe.

Backwashing: A method of filter pack emplacement whereby the filter pack material is allowed to fall freely through the annulus while clean fresh water is simultaneously pumped down the casing.

Bentonite: Hydrous aluminum silicate available in powder, granular, chip or pellet form. It is used to provide a tight seal between the well casing and the borehole.

Bridging: The development of gaps or obstructions in either grout or filter pack materials during emplacement.

Continuous Slot Wire-Wound Intake: A well intake that is made by winding and welding triangular-shaped, cold-rolled wire around a cylindrical array of rods. The spacing of each successive turn of wire determines the slot size of the intake.

Corrosion: The adverse chemical alteration that reverts elemental metals back to more stable mineral compounds and that affects the physical and chemical properties of the metal.

Filter Pack: Sand, gravel, or glass beads that are uniform, clean, and well-rounded that are placed in the annulus of the well between the borehole wall and the well intake to prevent formation material from entering through the well intake and to stabilize the adjacent formation.

Grout: A fluid mixture of neat cement and water with various additives or bentonite of a consistency that can be forced through a pipe and emplaced in the annular space between the borehole and the casing to form an impermeable seal.

Monitoring Well: A well that is capable of providing a groundwater level and sample representative of the zone being monitored.

Naturally Developed Well: A well construction technique whereby the natural formation materials are allowed to collapse around the well intake and fine formation materials are removed using standard development techniques.

Neat Cement: A mixture of Portland cement and water in the proportion of 5 to 6 gallons of clean water per bag (94 pounds) of cement.

Piezometers: A small-diameter, nonpumping well used to measure the elevation of the water table or potentiometric surface.

Sieve Analysis: Determination of the particle-size distribution of soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

Slurry: A thin mixture of liquid, especially water, and any of several finely divided substances such as cement or clay particles.

Tremie Pipe: A device, usually a small-diameter pipe, that carries grouting materials to the bottom of the borehole and that allows pressure grouting from the bottom up without introduction of appreciable air pockets.

Well Cluster: Two or more wells completed (screened) to different depths in a single borehole or in a series of boreholes in close proximity to each other. From these wells, water samples that are representative of different horizons within one or more groundwater bearing zones can be collected.

Well Point: A sturdy, reinforced well screen or intake that can be installed by being driven into the ground.

4.0 APPARATUS & MATERIALS

4.1 Casing Diameter and Screen Length

Monitoring well casing diameter is dependent on the purpose of the well and the amount and size of downhole equipment that must be accommodated. Additional criteria for selecting casing diameters include: drilling or well installation method used, anticipated depth of the well and associated strength requirements, ease of well development, volume of water required to be purged prior to sampling, rate of recovery of the well after purging, and cost.

Monitoring well casing diameters are generally 2 or 4 inches. Pumping tests or some types of borehole geophysical equipment may require wells 6 inches or larger in diameter. Four-inch-diameter wells are usually preferred due to their versatility. In smaller diameter wells, the volume of stagnant water to be purged prior to sampling is minimized, the cost of well construction is reduced, and the well stabilizes relatively quickly. The quantities of potentially contaminated drill cuttings and development and purge water are also reduced.

The borehole diameter should be a minimum of 4 to 6 inches larger than the well casing and screen to allow for proper placement of annular materials.

In situations where groundwater flow lines are close to horizontal, screen lengths are typically 10 to 20 feet, with heterogeneous formations requiring shorter screen lengths. If non-aqueous phase liquids (NAPLs) that are lighter than water are anticipated, the well screen should extend above the water table so these liquids can be sampled. Consideration should be given to seasonal fluctuations in water levels when locating the well screen above the top of the water table. If dense NAPLs are anticipated, the screen interval should extend to the base of the groundwater bearing zone. Well clusters may be necessary when contaminants both denser and lighter than water are anticipated in the same groundwater bearing zone.

4.2 Casing and Screen Materials

Monitoring well casing is specified by diameter, thickness, and type of material. Well screens also require that slot size be specified. Casing thickness is referred to as "schedule." Polyvinyl chloride (PVC) is usually Schedule 40 (thinner wall), although Schedule 80 (thicker wall) is sometimes used. Steel casing is typically Schedule 5 or 10.

Selection of casing and screen material must be based on three primary characteristics: chemical interference potential, chemical resistance, and physical strength. The materials must not assimilate chemicals either by adsorption onto the material surface or absorption into the material matrix or pores; they must be durable enough to withstand potential chemical attacks either from natural chemical constituents or groundwater contaminants; and they must have the structural strength to withstand the forces exerted on them by the surrounding geologic materials and during installation. The three components of casing and screen structural strength are tensile strength, compressive (column) strength, and collapse strength.

Casing and screen materials generally available are Teflon, PVC, stainless steel, galvanized steel, carbon steel, and low-carbon steel. Teflon materials are extremely expensive and of comparatively low strength. Although relatively inert, recent studies have shown that Teflon is prone to sorption of selected organic compounds.

Threaded, flush-joint casing is preferred for monitoring well applications. Welded-joint steel casing may also be acceptable, but is typically more expensive and inconvenient. Glued PVC

should never be used for monitoring wells since the glue may release organic contamination into the well. The casing should have a well cap that is vented to prevent the accumulation of gases and to allow water levels in the well to respond to barometric and hydraulic pressure changes.

The hydraulic efficiency of a well screen depends primarily upon the amount of open area available per unit length of screen. The two screen types commonly used for monitoring wells are machine-slotted, and continuous-slot wire-wound. Hand-slotted, drilled, or perforated casings should not be used as well screens. Slotted casing is manufactured from a variety of materials, including PVC and stainless steel.

Slot openings are designated by numbers that correspond to the widths of the openings in thousandths of an inch (e.g., number 10 slot refers to 0.010 inch slot size). The slots have a consistent width for the entire wall thickness of the casing, which can result in clogging if irregularly shaped formation particles are brought through the screen during well development and sampling.

The bottom of the screen must be sealed by an endcap consisting of the same material as the screen. The use of a sediment sump or trap below the well screen is not appropriate for monitoring wells.

4.3 Filter Pack and Well Screen Design

Filter packs are installed to create a permeable envelope around the well screen. The use of an artificial filter pack in a fine-grained formation material allows the screen slot size to be considerably larger than if the screen were placed in the formation material without the filter pack. The selection of the filter pack grain size should be based on the grain size of the finest layer to be screened.

The filter pack should extend from the bottom of the well screen to approximately 2 to 5 feet above the top of the screen to account for settlement of the pack material during development and to act as a buffer between the well screen and the annular seal. A secondary filter pack is sometimes used to prevent annular seal materials from migrating into the primary filter pack. The secondary filter pack should extend at least 1 foot above the top of the primary filter pack.

The D10 size of the secondary filter pack should be between one-third and one-fifth the D10 size of the primary filter pack.

The materials comprising the filter pack should be as chemically inert as possible. It should be comprised of clean quartz sand or glass beads. Filter pack materials usually come in 100-pound bags; these materials are washed, dried, and factory packaged.

The casing string should be installed in the center of the borehole. This will allow the filter-pack materials to evenly fill the annular space around the screen and ensure that annular seal materials fill the annular space evenly around the casing. If a hollow-stem auger (HSA) rig is used, the auger will adequately centralize the casing string. For other types of drilling, centralizers should be used to ensure the casing string is positioned in the center of the borehole. Centralizers are typically expandable metal or plastic that attach to the outside of the casing and are adjustable along the length of the casing. Centralizers are generally attached immediately above the well screen and at 10- or 20-foot intervals along the casing to the surface.

With the tremie emplacement method, the filter pack is poured or slurried into the annular space adjacent to the well screen through a rigid pipe, usually 1.5 inches in diameter. Initially the pipe is positioned so that its end is at the bottom of the annulus. If the filter pack is being installed in a temporarily cased borehole (hollow-stem auger or steel casing) the temporary casing is pulled to expose the screen as the filter-pack material builds up around the well screen. In unconsolidated formations the temporary casing should only be pulled out 1 to 2 feet at a time to prevent caving. In consolidated or well-cemented formations or in cohesive unconsolidated formations, the temporary casing may be raised well above the bottom of the borehole prior to filter pack emplacement. For deep wells and/or nonuniform filter pack materials, the filter pack may be pressure fed through a tremie pipe with a pump. Emplacement should be continuously monitored with a weighted measuring tape accurate to the nearest 0.1 foot to determine when the filter pack has reached the desired height.

4.4 Annular Seal

Proper annular seal formulation and placement results in the complete filling of the annular space and envelopes the entire length of the well casing to ensure that no vertical migration can occur within the borehole.

Annular seal materials may include bentonite, neat cement grout, or variations of both. Typically, a bentonite seal from 2 to 5 feet thick is emplaced immediately above the filter pack. The use of bentonite as a sealing material depends on its efficient hydration following emplacement. Expansion of bentonite in water can be on the order of 8 to 10 times the volume of dry bentonite. This expansion causes the bentonite to provide a tight seal between the casing and the adjacent formation. Bentonite is available as pellets, granules, chips, chunks, or powder. If the bentonite seal will be above the saturated zone, several gallons of clean water must be poured down the annulus to begin the hydration process. A minimum of 30 minutes should pass to allow for hydration before additional annular seal materials are placed above the bentonite.

Powdered bentonite is generally made into a grout slurry to allow emplacement as a bentonite seal. This grout slurry is prepared by mixing about 15 pounds of a high-solids, low-viscosity bentonite with 7 gallons of water to yield one cubic foot of grout. Once the grout is mixed, it should remain workable for 15 to 30 minutes. During this time the grout is pumped through a tremie pipe with a mud or grout pump. Once in place, the bentonite grout requires a minimum of 24 hours to strengthen. In water with a high total dissolved solids (TDS) content (>5000 ppm) or a high chloride content, the swelling of bentonite is inhibited.

A neat cement is commonly used to seal the remainder of the annulus. Neat cement is made up of one 94-pound bag of Portland cement and 6 gallons of water. The water used to mix the neat cement should be clean with a TDS <500 ppm. Bentonite powder is often added to neat cement to improve workability and reduce slurry weight and density. The proportion of bentonite by volume should be 3 to 8 percent.

The cement-bentonite grout should be mechanically blended in an aboveground rigid container and pumped through a tremie pipe to within a few inches of the bottom of the space to be sealed. This allows the grout to displace groundwater and loose formation materials up the hole. The end of the tremie pipe should always remain in the grout without allowing air spaces. After

emplacement, the tremie pipe should be removed immediately. The grout should be emplaced in one continuous mass before initial setting of the cement or before the mixture loses its fluidity.

4.5 Surface Completions

Two types of surface completions are common for groundwater monitoring wells: aboveground and flush-mounted. Aboveground completions are preferred wherever practical. The primary purpose of either type of completion is to prevent surface runoff from entering and infiltrating down the annulus of the well, and to protect the well from accidental damage or vandalism. The surface seal may be an extension of the annular seal installed above the filter pack, or a separate seal emplaced atop the annular seal.

For aboveground completions, a protective steel casing fitted with a locking cover is set into the uncured cement surface seal. Guard posts should be spaced around each well to afford additional protection.

In a flush-to-ground surface completion, a water-tight monitoring well Christy box or its equivalent is set into the cement surface seal before it has cured. This type of completion is used in high-traffic areas. A low, gently sloping mound of cement will discourage surface runoff. A locking well cap must be used to secure the inner well casing.

5.0 MONITORING WELL INSTALLATION

Overburden monitoring wells and piezometers will generally be constructed of 2-inch inner diameter Schedule 40 well materials and will be installed in 6.25-inch ID HSA borings. They will be generally completed as described below. All monitoring well installation data will be recorded on the attached monitoring well construction summary sheet by the field geologist.

- The well depth will most often be selected based on the depth at which the water table is encountered. The well will generally be screened such that approximately three feet of screen is above the water table.
- The borehole will be advanced to its completion depth.
- The monitoring well will be completed using commercially-fabricated, machine-slotted, flush-joint, 2-inch inner diameter (Schedule 40) PVC well screen with an appropriate length of riser to extend to the ground surface. Screen slot size will be

0.010 inch, and will not exceed 20 feet in length. The screen will be fitted with a PVC bottom plug of appropriate size.

- A filter pack of clean sand of appropriate size will be placed around the screened interval. The filter pack will not extend more than 3 feet below the base of the screen or 5 feet above the top of the screen.
- A bentonite seal 2 to 3 feet thick will be installed above the filter pack. If pellets or chips are used, the seal will be hydrated with potable water at least one hour before continuing.
- The remainder of the annular space will be filled with tremie-grouted or pressure installed cement-bentonite grout mixture to the ground surface. The blend will be proportional to mixing 94 pounds of Portland cement with 5 pounds of bentonite and 8.3 gallons of water. Alternatively, the remainder of the annular space could be filled with bentonite chips to within 2 feet of the ground surface. The bentonite chips would be hydrated with potable water prior to installation of the surface protective casing. No additives or borehole cuttings will be mixed with the seal.
- Wells will either be completed as surface mounted (stick-up) wells with locking caps located on concrete pads or flush mounted road boxes set in concrete with locking inner well caps. In high traffic areas, safety bollards can be installed along the perimeter of the stick-up well concrete pads. A site monitoring well identification number will be affixed to each well.
- Monitoring wells will be surveyed. Vertical controls will be established to the nearest 0.01 foot. Horizontal controls will be established to the nearest 0.10 foot.

STANDARD OPERATING PROCEDURE

MULTI-GAS METER

1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides a description of the established step-by-step methodology for monitoring combustible environments using a multi-gas meter. The multi-gas meter is capable of measuring oxygen (O_2), carbon monoxide (CO_2), hydrogen sulfide (H_2S), and lower explosive limit (LEL). It is not intended to provide an all-inclusive discussion of screening methods.

2.0 SUMMARY OF METHOD

The multi-gas meter (MGM) provides determination of the presence of combustible or toxic constituents or oxygen-rich or deficient atmospheres so that appropriate field decisions can be conducted. Ambient air monitoring at hazardous waste sites is a common safety practice. Activity at a site may cause disturbances that release hazardous vapors into the ambient air. These releases can be detected by commercially available portable air monitoring devices that register real-time data. This data can be used to establish the existence of hazards such as oxygen deficient, toxic, or explosive atmospheres. Personnel protective levels may be based on these readings.

The combustible gas sensor of the MGM is designed to measure combustible gas or vapor content in air. It will not indicate the combustible gas content in an inert gas background, furnace stack, or in other atmospheres with less than 10 percent oxygen. Further, these instruments should not be used where the oxygen concentrations exceed that of fresh air (oxygen enriched atmospheres) because the extra oxygen makes any combustible mix easier to ignite and, thus, more dangerous.

Combustible gases will burn or explode only when the fuel/air mixtures are within certain proportions. The minimum concentration of a particular combustible gas in air which will burn and continue to burn when ignited is defined as the lower explosive limit (LEL). The maximum concentration that can be ignited is defined as the upper explosive limit (UEL).

A small pump pulls the atmospheric sample through a filter and pushes it through the flow indicator and the manifold blocks in which the toxic gas, combustible gas, and oxygen sensors are mounted. The flow is then exhausted to the side of the case. The approximate flow rate is 0.5 liters/minute.

3.0 DEFINITIONS

MGM – Multi-Gas Meter
LEL – Lower Explosive Limit
O_2 - Oxygen
CO_2 - Carbon monoxide
H_2S - hydrogen sulfide
UEL - upper explosive limit

4.0 CAUTIONS

Exposing the multi-gas meter to very humid and rainy weather can result in inaccurate readings and equipment damage. Caution should be taken to avoid use in such conditions.

5.0 APPARATUS & MATERIALS

The field screening will be accomplished utilizing a MGM. Additional supplies will include:

- field log book or field data sheet
- calibration gas and associated equipment.

6.0 INSTRUMENT CALIBRATION

The multi-gas meter will be calibrated and operated in accordance with the manufacturer's specifications printed on the meter at the beginning of each day and recorded in field log book or field data sheet. Below is a summary of the calibration verification procedure.

Initial and End-of-Day Calibration Verification

1.) Measure known concentration of calibration gas.

2.) The readings should be within the limits stated on the gas cylinder, or within 2% of the known concentration of the calibration gas, whichever is larger.

7.0 ATTACHMENTS

None

STANDARD OPERATING PROCEDURE

PHOTOIONIZATION DETECTOR

1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides a description of the established step-by-step methodology for screening soil samples and well headspace using a photoionization detector (PID). It is not intended to provide an all inclusive discussion of screening methods.

Ambient air is drawn into the instrument detector chambers with the aid of a small fan. The PID uses an ultraviolet light source to ionize individual molecules that have an ionization potential less than or equal to that rated for the ultraviolet light source. Gaseous compounds are ionized as they emerge from the ionization chamber, and the ions are then attracted to an oppositely charged electrode, causing a current and finally an electric signal that is proportional to the number of ions.

PID Limitations - Does not detect methane. Does not detect a compound if the lamp used has a lower energy level than the compound's ionization potential. Response may change when gases are mixed. Other voltage sources such as power lines may interfere with the measurements. Readings can only be reported relative to the calibration standard used. Response is affected by high humidity. During cold weather, condensation may form on the UV light source window, resulting in erroneous results. Total concentrations are relative to the calibration gas used. Therefore, contaminant concentrations cannot be identified. Also, while the instrument scale reads 0 to 2,000 ppm, response is linear to the calibration gas. Greater concentrations may be "read" at a higher or lower level than the true value. Wind speeds of greater than 3 miles an hour may affect fan speed and readings, depending on the position of the probe relative to wind direction.

2.0 SUMMARY OF METHOD

Screening soil samples and well headspace with the PID provides rapid determination of the presence of volatile organic compounds (VOC) constituents so that appropriate field decisions can be conducted.

3.0 DEFINITIONS

PID: Photoionization Detector
ppmv: parts per million volume
VOC: Volatile Organic Compound

4.0 CAUTIONS

Exposing the PID to very humid and rainy weather can result in inaccurate readings and equipment damage. Caution should be taken to avoid use in such conditions.

5.0 APPARATUS & MATERIALS

The field screening will be accomplished with a PID utilizing a standard 10.6 electron volt lamp. In the event VOC constituents with an ionization potential greater than 10.6 electron volt (eV), such as methane, are anticipated a suitable lamp (11.8eV) will be exchanged.

Additional supplies will include:

- 100 ppmv isobutylene calibration gas and regulator;
- sealable plastic baggies; and
- field log book or field data sheet

6.0 INSTRUMENT CALIBRATION

The PID will be calibrated and operated in accordance to the manufacturer's specifications at the beginning of each day using the appropriate calibration gas for the suspected contaminant and documented in field log book or field data sheet.

7.0 SAMPLE COLLECTION

7.1 Soil Screening

Generally, soil samples will be collected and placed in dedicated sealable plastic bags. The samples will be maintained in a temperature range of 10°C - 30°C The headspace will then be screened using a PID. The screening method will consist of filling a sealable plastic bag approximately halfway with soil. The bag will be set down to rest for a minimum of 15 minutes. The PID will be inserted in the bag to measure concentrations of VOCs in the headspace above the soil sample. The results of the field screening will be documented in the field log book. Care should be taken when sampling over solids and liquids so that it is not drawn into the instrument.

8.0 REFERENCES

Appropriate PID operations manual will be kept with PID carrying case.

STANDARD OPERATING PROCEDURES

SAMPLE MANAGEMENT AND PRESERVATION

STANDARD OPERATING PROCEDURES

SAMPLE MANAGEMENT AND PRESERVATION

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1.0 INTRODUCTION

This standard operating procedure (SOP) for sample management describes the requirements for sample identification, chain of custody (COC), and sample handling, storage, and shipping. The purpose of this SOP is to define sample management activities as performed from the time of sample collection to the time they are received by the laboratory.

2.0 DEFINITIONS

Sample: Physical evidence collected for environmental measuring and monitoring. For the purposes of this SOP, sample is restricted to solid, aqueous, air, or waste matrices. This SOP does not cover samples collected for lithologic description nor does it include remote sensing imagery or photographs.

Field Team Leader: The individual responsible for the supervision of field work at the site during a given phase of investigation or monitoring.

Sampler: The individual who collects environmental samples during field work.

3.0 SAMPLE MANAGEMENT

3.1 Sample Containers

The sample containers to be used will be dependent on the sample matrix and analyses desired. Unless specified otherwise by the project plan, the containers to be used for various analyses are provided in EPA SW-846. Sample containers are to be filled (approximately 90 percent), with adequate headspace for safe handling upon opening, except containers for volatile organic compound (VOC) analyses, which are to be filled completely with no headspace. This applies to soil samples as well as water samples.

Once opened, the containers are to be used immediately. If the container has been received unsealed or is not used upon opening, it is to be recycled. If the container is used for any reason in the field (i.e., screening) and not sent to the laboratory for analysis, it should be discarded. The contents of the used container and the container itself may require disposal as a hazardous material. When storing before and after sampling, the containers must remain separate from

solvents. Sample containers with preservatives added by the laboratory should not be used if held for an extended period on the job site or exposed to extreme heat conditions.

3.2 Numbering and Labeling

Sample Label: A sample label, as shown in Attachment 1, will be affixed to all sample containers. Labels provided by the laboratory may be used. The sample label will be completed with the following information:

- Client name, project title, or project location
- Sample location
- Sample identification number
- Date and time of sample collection
- Type of sample (grab or composite)
- Initials of sampler
- Preservative used
- Analyte(s) of interest

If a sample is split with another party, identical labels will be attached to each sample container. After labeling, each sample will be refrigerated or placed in a cooler containing wet ice to maintain the sample temperature at 4 degrees Celsius (˚C).

Custody Seals: Custody seals, as shown in Attachment 2, will be used on each sample and/or shipping container to ensure custody. Custody seals used during the course of the project will consist of security tape with the date and initials of the sampler. As a minimum, one custody seal will be placed on the front of the cooler overlapping the strapping tape and one on the side of the cooler. If required by the client, a seal will be placed on each sample container so that it must be broken to gain access to the contents. Since VOC samples may be subject to contamination by the tape, VOC sample containers will first be secured in a "zip-lock" plastic bag. The plastic bag will be sealed with a completed custody seal.

3.3 Chain of Custody

COC procedures require a written record of the possession of individual samples from the time of collection through laboratory analyses. A sample is considered to be in custody if it is:

- In a person's possession.
- In view after being in physical possession.
- In a secured condition after having been in physical custody.
- In a designated secure area, restricted to authorized personnel.

The COC record, an example is shown in Attachment 3, shall be used to document the samples taken and the analyses requested. Information recorded by field personnel on the COC record includes the following:

- Client name
- Project name
- Project location
- Sampling location
- Signature of sampler(s)
- Sample identification number
- Date and time of collection
- Sample designation (grab or composite)
- Sample matrix
- Signature of individuals involved in custody transfer (including date and time of transfer)
- Airbill number (if appropriate)
- Number and type of bottles collected for each analysis
- Type of analysis and laboratory method number
- Any comments regarding individual samples (e.g., HNU readings, special instructions)

COC records will be placed in a plastic bag, secured to the inner lid of the cooler, and transported with the samples. When the sample(s) are transferred, the record is signed by both the receiving and relinquishing individuals. Signed airbills will serve as evidence of custody transfer between the field sampler and carrier as well as carrier and laboratory. Copies of the

COC record and airbill will be retained by the sampler. If the COC records are sequentially numbered, the record number and airbill number will be cross-referenced in both the field logbook and the sample register. If the COC record is not previously numbered, a tracking number of four digits or more should be added to the top of the form and recorded as above.

3.4 Sample Register/Sample Tracking

A sample tracking database, which includes the information below is used to record the samples collected and when.

- Client name
- Project name and location
- Job number
- Date and time of collection
- Sample identification number
- Sample designation (grab or composite)
- Sample matrix
- Number and type of bottles
- Type of analysis
- Sample destination
- Sampler's initials

3.5 Sample Preservation/Storage

The requirements for sample preservation are dependent on the analyses desired and the sample matrix.

(Note: An important step in the sample management process is recording activities performed at each sampling location in the field logbook).

3.6 Shipping

Procedures for packaging and transporting samples to the laboratory will be based on an estimation of contaminant concentrations in the samples to be shipped. Samples will be identified as either environmental, high concentration, geotechnical, or other samples.

Environmental samples are defined as soil or water samples that are not saturated or mixed with product material. Those samples that are saturated in product or are free product samples are defined as high concentration samples.

3.6.1 Environmental Samples. Environmental samples will be shipped in the following manner:

- Each sample will be placed in a separate plastic or "bubble-wrap" bag. As much air as possible is squeezed from the bag before sealing. Bags may be sealed with evidence tape for additional security.
- An ice chest (sturdy construction) is typically used as the shipping container. In preparation for shipping samples, the drain plug is taped shut from the outside and a large plastic bag is used as a liner for the cooler. Approximately 1 inch of packing material, such as vermiculite or bubble wrap, is placed in the bottom of the liner. Sufficient packing material should be used to prevent sample containers from making contact during shipment.
- The bottles are placed in the lined ice chest. Cardboard or foam separators may be placed between the bottles at the discretion of the shipper.
- Water samples for organic analysis and inorganic analysis will be cooled to 4˚C with ice during shipment. The ice will be contained such that the water will not fill the cooler as the ice melts.
- As described previously, the COC record will be placed inside a plastic bag, sealed, and taped to the inside of the cooler lid if a carrier (e.g., Federal Express) is used.
- The cooler is closed and taped shut with strapping tape (filament type) around both ends.
- Two signed custody seals will be placed on the cooler, one on the front and one on the side overlapping strapping tape if possible. Additional seals may be used if the sampler and shipper think more seals are necessary. Wide clear tape will be placed over the seals to ensure against accidental breakage.
- The cooler is handed over to the overnight carrier, typically a cargo-only air service. A standard airbill is necessary for shipping environmental samples.
- No samples shall be held on site for more than 24 hours, except during weekend field activities. Samples collected on the weekend will be stored under refrigeration and shipped the following Monday. Sampling activities for analytes with extremely short holding times, such as 24 hours, will not be scheduled for weekend collection. All DOT regulations will be followed for packaging and shipping.
- Occasionally, multiple coolers will be sent in one shipment to the laboratory. One cooler will have the original COC record and the other coolers will have copies. The plastic bag in which the COC Records are placed will be marked

appropriately "ORIGINAL" or "COPY." In addition, the outside of the coolers will be marked to indicate how many coolers are in the shipment.

3.6.2 High Concentration Samples. High concentration samples will be shipped in compliance with URS Safety Management Standard 048. Individuals involved in the process of shipping hazardous materials/dangerous goods (i.e., high concentration samples) must have received function-specific training. Samples to be shipped by air must be classified, identified, packaged, marked, labeled, and have documentation in accordance with the International Air Transportation Association (IATA) *Dangerous Goods Regulations*, current edition.

3.6.3 Geotechnical Samples. Geotechnical samples will be collected in tubes as undisturbed samples or in plastic bags or glass jars as bulk samples. Proper labeling procedures are described in Section 3.2.2. Holding times do not apply; however, samples should be shipped as soon as possible and kept cool to prevent drying and mold growth. Undisturbed samples should be sealed in resealable plastic bags to maintain sample moisture content.

Geotechnical samples may be shipped in a sturdy box or other container. No ice is necessary. Enough packing material should be added so that samples remain undisturbed. COC procedures are necessary to generate defensible data. Hazardous nature of the samples, including any HNU readings, name of the suspected contaminants present, and the approximate range of concentrations, if known, should be noted on the COC record.

3.6.4 Other Samples. Samples other than environmental or high concentration samples must be shipped according to the requirements of 49 CFR,IATA, and other applicable state and local regulations. Prior to the collection and shipment of these samples, shipment requirements shall be researched; a written description of shipment procedures shall be prepared; and the description reviewed and approved by a URS Shipping Specialist (1-800-381-0664). These shipment procedures will be included in the project plan (if applicable). Examples of such samples include potential asbestos containing material and transformer fluids.

3.7 Holding Times

The holding times for samples will depend on the analysis and the sample matrix.

4.0 REFERENCES

URS. March 2004. Safety Management Standard 048-Hazardous Materials/Dangerous Goods Shipping, Revision 2.

5.0 ATTACHMENTS

1 - Sample Label

2 - Custody Seal

3 - Chain-of-Custody Record

Attachment 1 - Sample Label

[redacted]	LABEL NUMBER			
PROJECT NAME/LOCATION	SAMPLE DATE	SAMPLE TIME		
	PRESERVATIVE			
SAMPLE LOCATION				
FIELD NUMBER	SAMPLER'S INITIALS			
	GRAB		COMPOSITE	
ANALYSIS				

Attachment 2 - Custody Seal

Attachment 3 Chain of Custody

CHAIN OF CUSTODY RECORD

URS

PROJECT NO.

SITE NAME

SAMPLERS (PRINT/SIGNATURE)

TESTS

BOTTLE TYPE AND PRESERVATIVE

LAB _____

COOLER _____ of _____

PAGE _____ of _____

DELIVERY SERVICE: _____ AIRBILL NO.: _____

LOCATION IDENTIFIER	DATE	TIME	COMP/ GRAB	SAMPLE ID	MATRIX	TOTAL NO.# OF CONTAINERS									REMARKS	SAMPLE TYPE	BEGINNING DEPTH (IN FEET)	ENDING DEPTH (IN FEET)	FIELD LOT NO.# (IRPIMS ONLY)

MATRIX CODES						
	AA - AMBIENT AIR SE - SEDIMENT SH - HAZARDOUS SOLID WASTE	SL - SLUDGE WP - DRINKING WATER WW - WASTE WATER	WG - GROUND WATER SO - SOIL DC - DRILL CUTTINGS	WL - LEACHATE GS - SOIL GAS WC - DRILLING WATER	WO - OCEAN WATER WS - SURFACE WATER WQ - WATER FIELD QC	LH - HAZARDOUS LIQUID WASTE LF - FLOATING/FREE PRODUCT ON GW TABLE

SAMPLE TYPE CODES				
	TB# - TRIP BLANK SD# - MATRIX SPIKE DUPLICATE	RB# - RINSE BLANK FR# - FIELD REPLICATE	N# - NORMAL ENVIRONMENTAL SAMPLE MS# - MATRIX SPIKE	(# - SEQUENTIAL NUMBER (FROM 1 TO 9) TO ACCOMMODATE MULTIPLE SAMPLES IN A SINGLE DAY)

RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED BY (SIGNATURE)	DATE	TIME	SPECIAL INSTRUCTIONS
RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED FOR LAB BY (SIGNATURE)	DATE	TIME	

Distribution: Original accompanies shipment, copy to coordinator field files

URSF-075C/1 OF 1/CofCR/GCM

STANDARD OPERATING PROCEDURE

CALIBRATION OF FIELD INSTRUMENTS

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1.0 SCOPE & APPLICATION

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for ground water and surface water. Water quality parameters include temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, oxidation/reduction potential (ORP), and turbidity. This SOP has been based upon the USEPA Region 1 *Draft Calibration of Field Instruments* (1998).

This SOP is written for instruments that utilize multiple probes, (temperature, pH, DO, conductivity/specific conductance, and/or ORP) and the probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature. Communications to the instrument (programming and displaying the measurement values) are performed using a display/logger or computer. Information sent to the instrument is entered through the keypad on the display/logger or computer. It is desirable that the display/logger or computer have data storage capabilities. If the instrument does not have a keypad, follow the manufacturer's instruction for entering information into the instrument.

For ground water monitoring, the instrument must be equipped with a flow-through-cell, and the display/logger or computer display screen needs to be large enough to simultaneously contain the readouts of each probe in the instrument. Turbidity is measured using a separate instrument because turbidity cannot be measured in a flow-through-cell. This procedure is applicable for use with the USEPA Region I Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells.

2.0 SUMMARY OF METHODS

All monitoring instruments must be calibrated before they are used to measure environmental samples. Part of the calibration is performed prior to the field event. For instrument probes that rely on the temperature sensor (pH, DO, conductivity/specific conductance, and ORP),

each temperature sensors needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). Before any instrument is calibrated or used to perform environmental measurements, the instrument must stabilize (warm-up) according to manufacturer's instruction.

Most instruments will require at least two standards to bracket the expected measurement range, that is, one standard less than the expected value and one higher. Calibration must be performed at the beginning of each sampling day prior to sample collection. When an environmental sample measurement falls outside the calibration range, the instrument must be recalibrated to bracket the new range before continuing measurements.

3.0 DEFINITIONS

DO: Dissolved Oxygen

Low-flow: Pumping rates low enough to minimize drawdown, usually less than 1 liter/minute.

mg/l: Milligrams per Liter

mV: Millivolts

ORP: Oxidation/Reduction Potential

NIST: National Institute of Standards and Technology

NTU: Nephelometric Turbidity Unit

Parameters: Groundwater variables, i.e., pH, specific conductivity, temperature, and turbidity.

Purge water: Any water removed from the well via bailing, pumping, or air lift.

SOP: Standard Operating Procedure

USEPA: United States Environmental Protection Agency

Yield: The rate at which a well will produce water.

4.0 APPARATUS & MATERIALS

The following equipment (or equivalent) will be utilized to collect water quality field data:

- YSI Model 6820 Multi-Parameter flow cell (pH, conductivity, ORP, temperature, dissolved oxygen);
- Lamotte 2020 Portable Turbidimeter;
- Solinst Model 101 (water level measurement);
- Solinst Model 122 (interface probe);
- Nitrile Gloves;
- Deionized Water
- Distilled Water; and
- Field log book.

5.0 CALIBRATION PROCEDURES

Calibration will be conducted in accordance with the procedures outlined below. Prior to calibration, all instrument probes must be cleaned according to the manufacturer's instructions. Failure to perform this step (proper maintenance) can lead to erratic measurements.

Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature, pH, dissolved oxygen (% and mg/l), conductivity/specific conductance, and ORP.

The volume of the calibration solutions must be sufficient to cover both the probe and temperature sensor (see manufacturer's instruction for additional information).

While calibrating or measuring, make sure there are no air bubbles lodged between the probe and the probe guard.

5.1 Temperature

Most instrument manuals state there is no calibration of the temperature sensor, but the temperature sensor must be checked to determine its accuracy. This accuracy check is performed at least once per year and the accuracy check date/information is kept with the instrument. If the accuracy check date/information is not included with the instrument or the last check was over a year, the temperature sensor accuracy needs to be checked of the beginning of each sampling event.

Verification Procedure

- Allow a container filled with water to come to room temperature;
- Place a thermometer that is traceable to the NIST and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.
- Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the range of the sensor (usually ± 3%). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

5.2 pH (electrometric)

The pH of a sample is determined electrometrically using a glass electrode. Choose the appropriate buffered standards that will bracket the expected value at the sampling locations. For ground water, the pH will usually be close to seven. The pH probe should be calibrated daily before use, and as necessary if the probe appears to be malfunctioning.

Calibration Procedure

- Place approximately 150 ml of pH 7 buffer in a clean calibration cup (250 ml if using the 6026 "wiped turbidity" probe and extended probe). Carefully immerse the probe end of the sonde into the solution.
- Allow at least 1 minute for temperature equilibration before proceeding.
- From the **Calibration** menu, select **4-ISE1** pH to access the pH calibration choices and then **2-2-Point**. Press ENTER and input the value of the buffer (7 in this case) at the prompt. Press ENTER and the current values of all enabled sensors will appear on the screen and will change with time as they stabilize in the solution. Observe the readings under pH and when they show no significant

change for approximately 30 seconds, press ENTER. The display will indicate that the calibration is accepted.

- After the pH 7 calibration is complete, press ENTER again, as instructed on the screen, to continue.
- Press ENTER again as instructed on the screen, to return to the **Calibration** menu.
- Rinse the sonde in water and dry.
- Repeat the above steps for the second pH buffer solution.
- Rinse the sonde in water and dry the sonde.
- Thoroughly rinse and dry the calibration cups for future use.

5.3 Dissolved Oxygen

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic measurements. The DO probe should be calibrated daily before use, and as necessary if probe appears to be malfunctioning.

Calibration Procedure

- Place approximately 1/8 inch (3mm) of water or a wet sponge in the bottom of the Calibration Cup or Transport Cup. Place the probe end of the sonde into the cup. Make certain that the DO and the temperature probes are not immersed in the water. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperatures of the thermistor and the oxygen probe to equilibrate. (Caution: If the Transport Cup is use, make certain that the cup is vented to the atmosphere by loosening the connection until only 1 or 2 threads are engaged).
- From the Calibration menu, select **2-Dissolved Oxy** to access the DO% calibration procedure.
- Enter the current barometric pressure in mm of Hg (Inches of Hg x 25.4 = mm Hg). (Note The barometric readings which appear in meteorological reports are generally corrected to sea level and are therefore not useful for calibration unless they are uncorrected).
- Press ENTER and the current values of all enabled sensors will appear on the screen and will change with time as they stabilize. Observe the readings under DO% and when they show no significant change for approximately 30 seconds, press ENTER. The screen will indicate that the calibration has been accepted and prompt you to press ENTER again to return to the Calibration menu.
- Rinse the sonde in water and dry the sonde.

- Remove the probe from the container and place it into a 0.0 mg/L DO standard (see note). The standard must be filled to the top of its container and the DO probe must fit tightly into the standard's container (no headspace). Check temperature readings. They must stabilize before continuing.
- Wait until the "mg/l DO" readings have stabilized. The instrument should read 0.0 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L). If the instrument cannot reach these values, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L DO standard. If these measures do not work, contact manufacturer.

5.4 Specific Conductance

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C.

Most instruments are calibrated against a single standard which is near, but below, the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements. The specific conductance probe should be calibrated daily before use, and as necessary if the probe appears to be malfunctioning.

<u>Calibration Procedure</u>

- Place approximately 300 ml of conductivity standard in a clean and dry calibration cup.
- The conductivity standard you choose should be within the same conductivity range as the water you are preparing to sample. However, we do not recommend using standards less than 1 mS/cm. For example:
  - For fresh water choose a 1 mS/cm conductivity standard.
  - For brackish water choose a 10 mS/cm conductivity standard.
  - For sea water choose a 50 mS/cm conductivity standard.
- **Caution**: Before proceeding insure that the sensor is as dry as possible. Ideally rinse the conductivity sensor with a small amount of standard that can be discarded. Be certain that you avoid cross contamination of standard solutions with other solutions. Make certain that there are no salt deposits around the oxygen and pH/ORP probes, particularly if you are employing standards of low conductivity.
- Without removing the probe guard, carefully immerse the probe end of the sonde into the solution. Gently rotate and/or move the sonde up and down to remove

any bubbles from the conductivity cell. The probe must be completely immersed past its vent hole.

- Allow at least one minute for temperature equilibration before proceeding.
- From the Calibration menu, select **1-Conductivity** to access the conductivity calibration procedure and then **1-SpCond** to access the specific conductance calibration procedure. Enter the calibration value of the standard you are using (mS/cm at 25 C) and press ENTER. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- Observe the readings under the Specific Conductance or Conductivity and when they show no significant change for approximately 30 seconds, press ENTER. The screen will indicate that the calibration has been accepted and prompt you to press ENTER again to return to the Calibrate menu.
- Rinse the sonde in tap or purified water and dry the sonde.

5.5 Oxidation/Reduction Potential (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent. The ORP usually does not require calibration: however, older probes that have been deployed extensively may show some deviation from the theoretical ORP value. This deviation is usually due to a change in the concentration in the concentration of the KCl in the reference electrode gel. To determine whether the sensor is functioning correctly, place the ORP probe in 3628 Zobell solution and monitor the millivolt reading. If the probe is functioning within specifications, the ORP reading should be within the range of 221 – 241 at normal ambient temperature. If the reading is outside of this range, the probe can be calibrated to the correct value (231 mV at 25˚ C) as follows:

- Select the **ISE2-ORP** option in the calibration menu.
- Immerse the sonde in a solution with a known oxidation reduction potential value (i.e. Zobell solution) and press ENTER.
- Enter the ORP value of the solution.
- Press ENTER and monitor the stabilization of the ORP and temperature readings.
- After no changes occur for approximately 30 seconds, press ENTER to confirm the calibration.
- Press ENTER again to return to the Calibration menu.

5.6 Turbidity

The LaMotte 2020 turbidimeter has been pre-calibrated in the range of 0 – 1100 NTU with AMCO primary standards manufactured by Advanced Polymer Systems, Inc. This allows the 2020 to be used for treated water, natural water, or waste water. Recalibration of the 2020 by the user is not required. However, a procedure to standardize the calibration should be performed to obtain the most accurate reading over a narrow range.

- Select a LaMotte AMCO 2020 Standard in the range of the samples to be tested.
- Fill a turbidity tube with the standard, cap and wipe the tube clean with a lint-free cloth.
- Open the lid of the meter. Align the indexing arrow mark on the tube with the indexing arrow mark on the meter, and inset the tube into the chamber.
- Close the lid. Push the READ button. If the displayed value is not the same as the value of the reacted standard (within the specification limits), continue with the calibration procedure.
- Push CAL button for 5 seconds until CAL is displayed. Release button. The display will flash. Adjust the display with the up and down arrows buttons until the value of the standard is displayed.
- Push the CAL button again to memorize the calibration. The 202˚ display will stop flashing. Calibration is complete.

5.7 Water Level Meter

An electronic water level meter will be verified daily before use by the procedure detailed below:

<u>Verification Procedure</u>

- The calibration procedure will be to compare the water level meter tape to a known linear measurement standard such as a tape measure at the 10-foot interval. If there is a difference between the and the tape measure of > 0.1 ft, the difference will be recorded on the field calibration log or in the field notebook and all data will be adjusted accordingly.
- The water level meter probe will be lowered into an aqueous solution to confirm that the electronic sounder functions.

5.8 Interface Probe

An electronic interface probe will be verified daily before use by the procedure detailed below:

Verification Procedure

- The calibration procedure will be to compare the interface probe tape to a known linear measurement standard such as a tape measure at the 10 foot interval. If there is a difference between the interface probe tape and the tape measure of > 0.1 ft, the difference will be recorded on the field calibration log or in the field notebook and all data will be adjusted accordingly.
- The interface probe will be lowered into an aqueous solution to confirm that the electronic sounder functions.

6.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

All calibration records must be documented in the project's log book. At a minimum, include the instrument manufacturer, model number, instrument identification number, standards used to calibrate the instruments (including the source), calibration date, and instrument readings.

7.0 REFERENCES

USEPA Region I, 1998. *Draft Calibration of Field Instruments*

8.0 ATTACHMENTS

None

STANDARD OPERATING PROCEDURE

FIELD ANALYTICAL PARAMETERS

1.0 SCOPE & APPLICABILITY

This standard operating procedure (SOP) provides the general framework for collecting groundwater elevation and groundwater quality measurements. To be valid, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of collection to the time of analysis in order to minimize changes in water quality parameters. The primary considerations in obtaining a representative sample of the groundwater are to avoid collecting stagnant (standing) water in the well, to avoid physically or chemically altering the water due to improper sampling techniques, sample handling, or transport, and to document that proper sampling procedures have been followed.

2.0 SUMMARY OF METHOD

This guideline is a general reference for the proper equipment and techniques for measuring water sampling field parameters. The purpose of these procedures is to enable the user to collect representative and defensible groundwater samples and to facilitate planning of the field sampling effort. These techniques should be followed whenever applicable, although site-specific conditions or project-specific plans may require adjustments in methodology.

This guideline describes suggested field measurement, decontamination, and documentation procedures.

3.0 DEFINITIONS

Conductivity (electrical): A measure of the quantity of electricity transferred across a unit area, per unit potential gradient, per unit time. It is the reciprocal of resistivity.

Decontamination: A variety of processes used to clean equipment that contacted formation material or groundwater that is known to be or suspected of being contaminated.

Monitoring Well: A well that is constructed by one of a variety of techniques for the purpose of extracting groundwater for physical, chemical, or biological testing, or for measuring water levels.

pH: A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. (Original designation for potential of hydrogen.)

Piezometer: An instrument used to measure head at a point in the subsurface; a nonpumping well, generally of small diameter, that is used to measure the elevation of the water table or potentiometric surface.

Static Water Level: The elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumpage.

Turbidity: Cloudiness in water due to suspended and colloidal organic and inorganic material.

4.0 APPARATUS & MATERIALS

The following equipment (or equivalent) will be used while collecting water quality field measurements:

- YSI 6820 or YSI 600XLM
- Lamotte 2020 Portable Turbidimeter
- Solinst Model 101 water level meter;
- Solinst 122 Interface Probe;
- Nitrile Gloves; and
- Groundwater Sampling Log and Field Log Book.

5.0 INSTRUMENT CALIBRATION

All water quality measurement equipment will be calibrated at the beginning of each day in accordance with SOP No. CAL-1. Calibration information and calibration verifications shall be recorded in a calibration log book or field log book.

6.0 SAMPLE COLLECTION AND RECORDING OF DATA

A variety of field measurements are commonly made during the sampling of groundwater including: water level, pH, conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity, and temperature. The accuracy, precision, and usefulness of these measurements are dependent on the proper use and care of the field instruments. Valid and useful data can only be collected if consistent practices (in accordance with SOP No. CAL-1 and recommended manufacturers instructions) are followed. The instruments should be handled

carefully at the well site and during transportation to the field and between sampling sites. Instrument manufacturer's instruction manuals will be kept in the URS onsite office and be readily accessible to field crews.

The quality and usefulness of these measurements are limited, based upon the accuracy and precision of the instruments. The primary data quality objectives (DQO) for field measurements collected are to demonstrate general trends in geochemistry. The precision of recording measured field data will be based upon the manufacturer-reported accuracy for the individual field instruments.

6.1 Water Level

Water levels can be measured by several techniques, but the same steps should be followed in each case. The proper sequence is as follows:

1. Check operation of measurement equipment aboveground. Prior to opening the well, don personal protective equipment as required.

2. Record all information specified below on a sampling form or in the field notebook.

3. Record well number, the time and day of the measurement, and top of casing and surface elevations if available.

4. Measure and record static water level and total depth (or top of pump) to the nearest 0.01 foot from the surveyed reference mark on the top edge of the inner well casing. If no reference mark is present, record in the logbook where the measurement was taken from (i.e., from the north side of the inner casing).

5. If the water level is below the top of the dedicated bladder pump, the pump will be removed from the well and placed on clean plastic while the water level measurement is recorded. If a sufficient quantity of water is measured below the top of the pump for sample collection, the pump will be lowered such that the pump intake is located in the center of the standing water column or 6 inches above the bottom of the well, whichever is higher.

6. If the well is artesian, the water level will be measured by temporarily installing a PVC riser extension. The well with extension will be allowed to equilibrate for a minimum of 15 minutes. The water level should be measured from the top of the extension and a negative value should be recorded based on the length of the PVC extension. If the well contains a packer device, the water level will be measured by temporarily installing a length of tubing to the discharge line.

7. If there is evidence of light non-aqueous phase liquid (LNAPL) in the well, the LNAPL surface level and water surface level measurements will be measured using an interface probe.

8. The water level tape should be cleaned by wiping the tape with a paper towel moistened with a water and alconox solution each time the tape is used.

6.1.1 Electric Water Level Indicators. This device consists of a spool of small-diameter graduated polyethylene tape with a weighted stainless-steel probe attached to the end. When the probe comes in contact with the water, an electrical circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contact. This is the recommended method for obtaining accurate water-level measurements.

In conditions where there is oil on the water, groundwater with high specific conductance, water cascading into the well, or a turbulent water surface in the well, measuring with an electric sounder may be difficult. A Solinst Model 101 is the recommended water level meter to be used for this project.

For accurate readings, the probe should be lowered slowly into the well. The tape is marked at the measuring point where contact with the water surface was indicated. The depth to water indicated on the graduated tape is recorded to the nearest 0.01 foot.

6.1.2 Interface Probes. Similar to the electronic water level indicators, this device consists of a spool of small-diameter polyethylene tape with a weighted stainless-steel probe attached to the end. The probe uses an optical sensor to determine if it is in LNAPL, and a conductivity sensor to determine if it is in water. The Solinst Sonic Interface Probe Model 122 is the recommended instrument for obtaining accurate LNAPL and water-level measurements.

For accurate readings, the probe should be lowered slowly into the well. The LNAPL-air interface reading should be taken first going from the air to the LNAPL surface to prevent dripping LNAPL from enhancing the thickness of the reading. The LNAPL-water reading is best taken going up from the water to the LNAPL layer to prevent LNAPLs from coating the conductivity probe which would also enhance the LNAPL thickness reading. This is best done by lowering the probe quickly through the LNAPL layer, minimizing the contact time of the probe in the LNAPL.

6.2 pH

The pH will be measured using the YSI 6820 or YSI 600XLM. Specific calibration instructions are included in SOP No. CAL-1. In general, the meter should be calibrated against two standard pH solutions (7 and >7 or <7). The meter readings will be adjusted, and the probe should then be rinsed thoroughly with distilled water. After calibration, the probe should be used in conjunction with the flow cell to for groundwater measurements. All measurements should be recorded in the field log or on the sampling form. The manufacturer's directions for calibration, maintenance, and use should be read and closely followed. Any problems with the functioning of the meter should be noted in the field log and reported to the office equipment manager.

6.3 Conductivity

The specific conductivity will be measured using the YSI 6820 or YSI 600XLM. The specific conductivity meter should be calibrated in accordance with SOP No. CAL-1. The conductivity of the standard solution should be within the same order of magnitude as anticipated for the water sample. The meter reading will be adjusted to the buffer solution value, and the probe will then by thoroughly rinsed with distilled water. After calibration, the probe should be used in conjunction with the flow cell for groundwater measurements. All measurements should be recorded in the field log or on the sampling form. The manufacturer's directions for calibration, maintenance, and use should be read and closely followed. Calibration solutions should be dated and discarded on their expiration date. Any problems with the functioning of the meter should be noted in the field log and reported to the office equipment manager.

6.4 Temperature

The temperature will be measured using the YSI 6820 or YSI 600XLM. The temperature probe should be calibrated in accordance with SOP No. CAL-1. After calibration, the probe should be used in conjunction with the flow cell for groundwater measurements. The temperature reading should be recorded in the field log or on the sampling form.

6.5 Oxidation-Reduction Potential (ORP)

The ORP will be measured using the YSI 6820 or YSI 600XLM. Specific calibration instructions are included in SOP No. CAL-1. The ORP readings should be recorded in the field log or on the sampling form.

6.6 Dissolved Oxygen (DO)

The DO will be measured using a flow-through YSI 6820 or YSI 600XLM. Specific calibration instructions are included in SOP No. CAL-1. The DO meter should be calibrated using the current barometric pressure at the site. The manufacturer's directions for calibration, maintenance, and use should be read and closely followed. Any problems with the functioning of the meter should be noted in the field log and reported to the field team leader. The DO reading should be recorded in the field log or on the sampling form.

6.7 Turbidity

The turbidity will be measured using a Lamotte 2020 Portable Turbidimeter. The accuracy of the turbidity meter should be verified using a solution provided by the manufacturer in accordance with SOP No. CAL-1. The manufacturer's directions should be read and closely followed. Any problems with the functioning of the meter should be noted in the field log and reported to the field team leader. The turbidity reading should be recorded in the field log or on the sampling form.

7.0 DECONTAMINATION

The general decontamination procedure for non-dedicated groundwater sampling equipment (bailers, pumps, water-level probes) consists of the following steps (Also see SOP No. EQPDCN-1):

1. Scrub and wash with laboratory-grade detergent (such as Alconox) and tap water;
2. Rinse with distilled/deionized water; and

If available, a steam cleaner can also be used for decontaminating some sampling equipment. Steam cleaning is a desired method since it does not introduce any additional chemicals into the

system. As with other procedures documented in this SOP, decontamination procedures may be determined by the client or regulatory agency involved in the project.

APPENDIX C
FIELD FORMS

URS *Corporation*

TEST BORING LOG

BORING NO. :	
PROJECT/PROJECT LOCATION:	SHEET: 1 OF 1
CLIENT:	JOB NO. :
BORING CONTRACTOR:	NORTHING: EASTING:
GROUNDWATER:	GROUND ELEVATION:

DATE	TIME	LEVEL	TYPE	TYPE	CAS.	SAMPLER	CORE	TUBE
				DIA.				
				WT.				
				FALL				

DATE STARTED:
DATE FINISHED:
DRILLER:
GEOLOGIST:
REVIEWED BY:

ELEVATION (FEET)	DEPTH (FEET)	STRATA	SAMPLE NUMBER	SAMPLE DEPTH (ft)	REC (%)	RQD (%)	POCKET PENETRO-METER	MATERIAL DESCRIPTION	WELL CONSTRUCTION	REMARKS
0	0									
-5	5									
-10	10									
-15	15									
-20	20									
-25	25									

COMMENTS:

BORING NO. :

URS

77 Goodell Street
Buffalo, New York 14203
(716) 856-5636

DATE _____

DAY	S	M	T	W	TH	F	S

WEATHER	Bright Sun	Clear	Overcast	Rain	Snow
TEMP	To 32	32-50	50-70	70-85	85 up
WIND	Still	Moder	High	Report No.	
HUMIDITY	Dry	Moder	Humid		

PROJECT MANAGER _____

PROJECT _____

JOB No. _____

CONTRACT No. _____

SUB-CONTRACTORS ON SITE:
EQUIPMENT ON SITE:
WORK PERFORMED (INCLUDING SAMPLING):

SHEET_____ OF_____

DAILY QUALITY CONTROL REPORT

PROJECT _____ REPORT No. _____

JOB No. _____ DATE _____

QUALITY CONTROL ACTIVITIES (INCLUDING FIELD CALIBRATIONS):
HEALTH AND SAFETY LEVELS AND ACTIVITIES:
PROBLEMS ENCOUNTERED/CORRECTION ACTION TAKEN:
SPECIAL NOTES:
TOMORROW'S EXPECTATIONS:

BY _____ TITLE _____

DRILLING SUMMARY

Geologist:

Drilling Company:

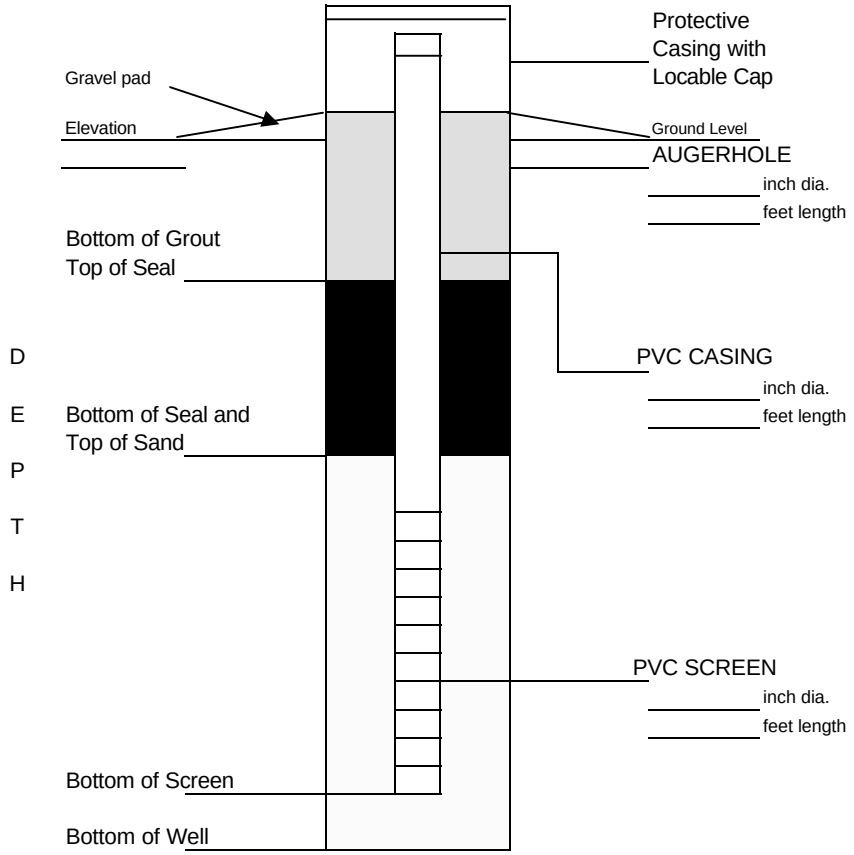
Driller:

Rig Make/Model:

Date:

GEOLOGIC LOG

Depth(ft.)	Description



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*FILTER MATERIAL*
Surface:	Type:	Type: Setting:
		SEAL MATERIAL
Monitor:	Slot Size:	Type: Setting:

COMMENTS:

LEGEND

- Cement/Bentonite Grout
- Bentonite Seal
- Silica Sandpack

Client:	**Location:**	**Project No.:**
URS Corporation	**OVERBURDEN WELL CONSTRUCTION DETAILS**	**Well Number:**

OVERBURDEN WELL
CONSTRUCTION DETAIL FORM

DAILY DRILLING RECORD ***URS Corporation***

PROJECT TITLE: _____ DATE: _____

CLIENT: _____ CONTRACTOR: _____

FROM	TO	PRODUCTIVE HOURS	ACTIVITIES/COMMENTS
TOTAL PRODUCTIVE HOURS			LEVEL B / LEVEL C / LEVEL D (CIRCLE ONE SELCTION)

LABOR:		MATERIALS / SUPPLIES:	
UNITS		UNITS	

WEATHER:

_____ URS ONSITE COORDINATOR	_____ CONTRACTOR REPRESENTATIVE

DAILY DRILLING RECORD

WELL DEVELOPMENT LOG *URS Corporation*

PROJECT TITLE: _____ WELL NO.: _____

PROJECT NO.: _____

STAFF: _____

DATE(S): _____

			WELL ID.	VOL. (GAL/FT)
1. TOTAL CASING AND SCREEN LENGTH (FT.)	=	_____	1"	0.0
2. WATER LEVEL BELOW TOP OF CASING (FT.)	=	_____	2"	0.2
3. NUMBER OF FEET STANDING WATER (#1 - #2)	=	_____	3"	0.4
4. VOLUME OF WATER/FOOT OF CASING (GAL.)	=	_____	4"	0.7
5. VOLUME OF WATER IN CASING (GAL.)(#3 x #4)	=	_____	5"	1.0
6. VOLUME OF WATER TO REMOVE (GAL.)(#5 x ___)	=	_____	6"	1.5
7. VOLUME OF WATER REMOVED (GAL.)	=	_____	8"	2.6

ACCUMULATED VOLUME PURGED (GALLONS)

PARAMETERS											
pH											
SPEC. COND. (umhos)											
TEMPERATURE (°C)											
TURBIDITY (NTU)											

COMMENTS:

WELL PURGE LOG

URS Corporation

PROJECT TITLE: _____ WELL NO.: _____

PROJECT NO.: _____ START: _____

STAFF: _____ STOP: _____

DATE(S): _____ SAMPLE: _____

			WELL ID.	VOL. (GAL/FT)
1. TOTAL CASING AND SCREEN LENGTH (FT.)	=	_____	1"	0.0
2. WATER LEVEL BELOW TOP OF CASING (FT.)	=	_____	2"	0.2
3. NUMBER OF FEET STANDING WATER (#1 - #2)	=	_____	3"	0.4
4. VOLUME OF WATER/FOOT OF CASING (GAL.)	=	_____	4"	0.7
5. VOLUME OF WATER IN CASING (GAL.)(#3 x #4)	=	_____	5"	1.0
6. VOLUME OF WATER TO REMOVE (GAL.)(#5 x ___)	=	_____	6"	1.5
7. VOLUME OF WATER REMOVED (GAL.)	=	_____	8"	2.6

ACCUMULATED VOLUME PURGED (GALLONS)

PARAMETERS											
pH											
SPEC. COND. (umhos)											
TEMPERATURE (°C)											
TURBIDITY (NTU)											

COMMENTS:

CHAIN OF CUSTODY RECORD

URS

PROJECT NO.

SITE NAME

SAMPLERS (PRINT/SIGNATURE)

LAB _____

COOLER _____ of _____

PAGE _____ of _____

DELIVERY SERVICE: _____ AIRBILL NO.: _____

LOCATION IDENTIFIER	DATE	TIME	COMP/ GRAB	SAMPLE ID	MATRIX	TOTAL NO.# OF CONTAINERS	TESTS / BOTTLE TYPE AND PRESERVATIVE								REMARKS	SAMPLE TYPE	BEGINNING DEPTH (IN FEET)	ENDING DEPTH (IN FEET)	FIELD LOT NO.# (IRPIMS ONLY)

MATRIX CODES						
	AA - AMBIENT AIR	SL - SLUDGE	WG - GROUND WATER	WL - LEACHATE	WO - OCEAN WATER	LH - HAZARDOUS LIQUID WASTE
	SE - SEDIMENT	WP - DRINKING WATER	SO - SOIL	GS - SOIL GAS	WS - SURFACE WATER	LF - FLOATING/FREE PRODUCT ON GW TABLE
	SH - HAZARDOUS SOLID WASTE	WW - WASTE WATER	DC - DRILL CUTTINGS	WC - DRILLING WATER	WQ - WATER FIELD QC	

SAMPLE TYPE CODES				
	TB# - TRIP BLANK	RB# - RINSE BLANK	N# - NORMAL ENVIRONMENTAL SAMPLE	(# - SEQUENTIAL NUMBER (FROM 1 TO 9) TO ACCOMMODATE MULTIPLE SAMPLES IN A SINGLE DAY)
	SD# - MATRIX SPIKE DUPLICATE	FR# - FIELD REPLICATE	MS# - MATRIX SPIKE	

RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED BY (SIGNATURE)	DATE	TIME	SPECIAL INSTRUCTIONS
RELINQUISHED BY (SIGNATURE)	DATE	TIME	RECEIVED FOR LAB BY (SIGNATURE)	DATE	TIME	

Distribution: Original accompanies shipment, copy to coordinator field files

URSF-075C/1 OF 1/CofCR/GCM

Figure C4-1

PROJECT _____

PROJECT No. _____

URS JOB No. _____

BY _____

URS
77 Goodell Street
Buffalo, New York 14203
(716) 856-5636

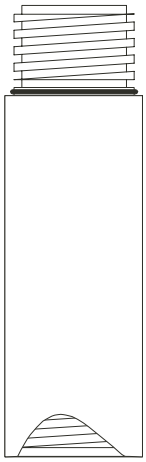
PHOTO LOG

PHOTO & ROLL No.	DATE TAKEN	DIRECTION FACING	DESCRIPTION

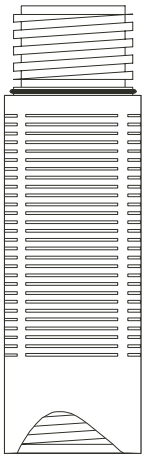
APPENDIX D
WELL INSTALLATION MATERIALS

The following charts present our standard product line for both screen and casing. Lengths are measured shoulder to shoulder, and do not include the male thread length:

Schedules 40 & 80 Threaded PVC Casing & Slotted Screen Products

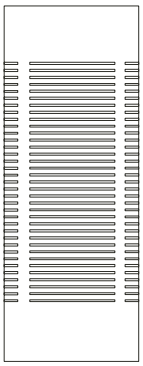


DIA	LENGTHS				SCH 40 & 80 Threads/Inch			SCH 40 SLOT WIDTHS	SCH 80 SLOT WIDTHS	SLOT SPACING			
Inches	2 ft	5 ft	10 ft	20 ft	2 TPI	4 TPI	8 TPI	Inches	Inches	1/8"	3/16"	1/4"	3/8"
0.5	X	X	X				X	.006 - .020	.006 - .020		X		
0.75	X	X	X				X	.006 - .020	.006 - .020		X		
1	X	X	X				X	.006 - .125	.006 - .125		X		
1.25	X	X	X			X		.006 - .125	.006 - .125		X		
1.5	X	X	X			X		.006 - .125	.006 - .125		X		
2	X	X	X		X	XX		.006 - .250	.008 - .250		X		
2" Hi Flow	X	X	X		X			.010 - .060	.010 - .060	X	X		
2.5	X	X	X		X			.006 - .250	.010 - .250		X		
3	X	X	X		X			.006 - .250	.010 - .250		X		
4	X	X	X	X	X	XX		.006 - .250	.010 - .250		X	X	
4" Hi Flow	X	X	X	X	X			.010 - .060	.010 - .060	X	X		
5	X	X	X	X	X			.010 - .250	.020 - .500			X	
6	X	X	X	X	X			.010 - .500	.020 - .500			X	X
8	X	X	X	X	X			.010 - .500	.030 - .500			X	X
10	X	X	X	X	X			.020 - .500	.040 - .500			X	X
12	X	X	X	X	X			.020 - .500	.050 - .500			X	X
14	X	X	X	X	X			.050 - .500	.050 - .500			X	X
16	X	X	X	X	X			.050 - .500	.060 - .500			X	X

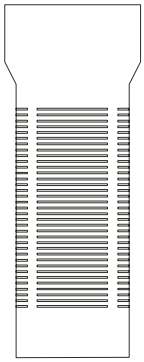


Note: XX indicates no O-ring on SCH 40 4 TPI.

Schedule 40 Plain End & Belled PVC Slotted Screen Products



DIA	LENGTHS		SLOT WIDTHS	SLOT SPACING		
Inches	10 ft	20 ft	Inches	3/16"	1/4"	3/8"
1.25	Std		.006 - .125	X		
1.50	Std		.006 - .125	X		
2.00	Std		.006 - .250	X		
3.00	Std		.006 - .250	X		
4.00	Std	Std	.006 - .250	X	X	
6.00	Std	Std	.010 - .500	X	X	X
8.00	Std	Std	.010 - .500		X	X
10.00	Std	Std	.020 - .500		X	X
12.00	Std	Std	.020 - .500		X	X
14.00	Std	Std	.050 - .500		X	X
16.00	Std	Std	.050 - .500		X	X



Pressure And Strength De-rations

Under static conditions, head pressure exerted on a casing assembly by the water column is equalized inside and outside of the assembly. As the water level inside the casing is lowered, the assembly is subjected to hydrostatic-pressure differential. The casing or screen experiences 1.0 psi of force for every 2.31 feet of head differential between the inside and outside water level, so a water column differential of 231 feet would exert a pressure of 100 psi at the base of a casing assembly.

Consideration should also be taken where drilling fluid additives and cuttings are involved in well construction. Additives and cuttings can increase fluid density as much as 20% in unit weight, as the density of fresh water increases from 8.3 lbs/gal to about 10.0 lbs/gal when drilling mud is used.

Cement slurries typically weigh 13 – 15 lbs/gal which increases fluid density by 55% - 80% over that of fresh water. Potential casing assembly failure can occur if the hydrostatic pressure differential approaches the rated collapse pressure of the casing.

In addition to the hydrostatic pressure differential, the force exerted against a PVC well assembly during the dumping or installation of a filter media into the outside annular space should also be considered.

During well development, care should be taken when using a tight fitting surge block. Vigorous use during development operations of a tight fitting surge block could exceed the burst pressure criteria of a PVC well assembly.

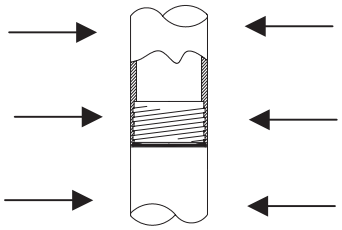
Temperature De-rating Table

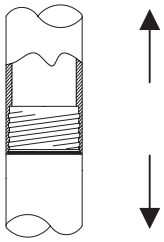
Curing of cement and grout generates sufficient heat to affect PVC strength and performance. When operating at elevated temperatures, the actual values for Collapse Pressure, Burst Pressure (Working Pressure), and Tensile Strength will be de-rated according to the chart at right.

Operating Temp. (ºF / ºC)	Strength De-Rating Factor
73 / 23	1.00
80 / 27	0.88
90 / 32	0.75
100 / 38	0.62
110 / 44	0.51
120 / 49	0.40
130 / 54	0.31
140 / 60	0.22

PVC Pressure And Strength Tables

COLLAPSE PRESSURE	BURST PRESSURE	TENSILE STRENGTH
Pounds per square inch of external hydrostatic pressure that can be safely applied.	Pounds per square inch of internal hydrostatic pressure that can be safely applied.	The suspended weight the threaded joint can sustain in a vertical position without causing stretching or failure.





Testing methods and procedures used are in compliance with ASTM F480 standards for thermoplastic pipe in all applicable areas.

Pipe Size	Collapse Pressure (psi)*		Burst Pressure (psi)*		Tensile Strength (lb)**	
	Sch. 40	Sch. 80	Sch. 40	Sch. 80	Sch. 40	Sch. 80
0.50"	1,100	2,700	300	425	264	344
0.75"	630	1,590	240	345	362	487
1.00"	520	1,270	225	315	581	727
1.25"	300	770	185	260	859	878
1.50"	220	590	165	235	954	1,225
2.00"	140	390	140	200	942	1,542
2.50"	180	450	150	210	2,093	2,890
3.00"	120	320	130	185	2,786	3,839
4.00"	70	210	110	160	4,119	5,823
5.00"	50	150	95	145	5,491	6,864
6.00"	40	140	90	140	7,165	11,384
8.00"	30	100	80	125	10,387	17,332
10.00"	20	85	70	115	15,086	25,124
12.00"	16	80	65	115	19,548	34,430
14.00"	15	80	65	110	20,894	37,651
16.00"	15	70	65	110	26,864	48,033

Notes:
1. Values noted with an asterisk (*) are based on minimum wall & include a 50% safety factor.
2. Values noted with a double asterisk (**) are recommended dry hanging weights for threaded PVC schedules 40 & 80. These values are calculated based on the minimum cross sectional area of either the box or pin thread portion of the joint after machining. The resulting minimal area was multiplied by 7,000 psi tensile strength per ASTM D-1784 to yield the recommended dry hanging weight. Even though these calculated values are lower than actual Johnson Screens test data, Johnson recommends not to exceed the above values for well construction.

PVC Screen Open Area – Schedules 40 & 80

The following tables represent the standard open area and transmitting capacity of the Johnson slotted PVC well screen. All calculations are based on the **inside diameter** of the pipe which represents the most accurate area and transmitting potential of the screen.

The data presented in these tables is for our standard product line. If you have specifications not covered by the data presented in these tables, contact us for our assistance in designing a custom well screen to meet your needs.

PVC SCHEDULE 40 SCREEN OPEN AREA - STD CONSTRUCTION											
Square inches/Foot											
Pipe Size (inches)	Slot Spacing (inches)	Standard Slot Opening (inches)									
		0.010	0.015	0.020	0.025	0.030	0.040	0.050	0.060	0.100	0.125
1/2	3/16	0.76	1.11	1.45							
3/4	3/16	0.84	1.22	1.59							
1	3/16	1.14	1.67	2.17	2.65	3.10	3.96	4.74	5.45	7.83	9.00
1-1/4	3/16	1.71	2.50	3.25	3.97	4.66	5.93	7.11	8.18	11.74	13.50
1-1/2	3/16	2.05	3.00	3.90	4.24	4.97	6.33	7.58	8.73	12.52	14.40
2	3/16	2.51	4.00	5.20	6.35	7.45	9.49	11.37	13.09	18.78	21.60
2 Hi Flow	1/8	3.56	5.14	6.62	8.00	9.29					
2-1/2	3/16	2.89	4.22	5.49	6.00	7.03	8.97	10.74	12.36	17.74	20.40
3	3/16	3.19	4.67	6.07	8.47	9.93	12.66	15.16	17.45	25.04	28.80
4	1/4	3.12	4.58	6.33	7.77	9.16	11.79	14.25	16.55	24.43	28.50
4 Hi Flow	1/8	6.00	8.68	11.17	13.50	15.68					
5	1/4	3.29	4.84	7.00	8.59	10.13	13.03	15.75	18.29	27.00	31.50
6	1/4	3.23	8.15	10.67	13.09	15.43	19.86	24.00	27.87	41.14	48.00
8	1/4	4.33	9.21	12.06	14.80	17.44	22.45	27.13	31.50	46.50	54.25
10	1/4			14.22	17.45	20.57	26.48	32.00	37.16	54.86	64.00
12	1/4			18.33	22.50	26.52	34.14	41.25	47.90	70.71	82.50
14	1/4							50.00	58.06	85.71	100.00
16	1/4							51.25	59.50	87.86	102.50

PVC SCHEDULE 80 SCREEN OPEN AREA - STD CONSTRUCTION											
Square inches/Foot											
Pipe Size (inches)	Slot Spacing (inches)	Standard Slot Opening (inches)									
		0.010	0.015	0.020	0.025	0.030	0.040	0.050	0.060	0.100	0.125
1/2	3/16	0.61	0.89	1.16							
3/4	3/16	0.65	0.94	1.23							
1	3/16	0.91	1.33	1.73	2.12	2.48	3.16	3.79	4.36	6.26	7.20
1-1/4	3/16	1.48	2.17	2.82	3.18	3.72	4.75	5.68	6.55	9.39	10.80
1-1/2	3/16	1.48	2.17	2.82	3.18	3.72	4.75	5.68	6.55	9.39	10.80
2	3/16	2.16	3.17	4.12	5.56	6.52	8.31	9.95	11.45	16.43	18.90
2 Hi Flow	1/8	2.89	4.18	5.38							
2-1/2	3/16	2.43	3.56	4.63	5.29	6.21	7.91	9.47	10.91	15.65	18.00
3	3/16	2.73	4.00	5.20	7.41	8.69	11.08	13.26	15.27	21.91	25.20
4	1/4	2.42	3.57	6.00	7.36	8.68	11.17	13.50	15.68	23.14	27.00
4 Hi Flow	1/8	4.67	6.75	7.45	9.00	10.45					
5	1/4			8.00	9.82	11.57	14.90	18.00	20.90	30.86	36.00
6	1/4			9.00	11.05	13.02	16.76	20.25	23.52	34.71	40.50
8	1/4					12.94	16.66	20.13	23.37	34.50	40.25
10	1/4						20.69	25.00	29.03	42.86	50.00
12	3/8							30.35	35.59	54.32	64.50
14	3/8							28.94	33.93	51.79	61.50
16	3/8								37.24	56.84	67.50

PVC Screem Percent Open Area – Schedules 40 & 80

PVC SCHEDULE 40 SCREEN % OPEN AREA - STD CONSTRUCTION											
Percent Open Area											
Pipe Size (inches)	Slot Spacing (inches)	Standard Slot Opening (inches)									
		0.010	0.015	0.020	0.025	0.030	0.040	0.050	0.060	0.100	0.125
1/2	3/16	3.32	4.84	6.33							
3/4	3/16	2.75	4.00	5.21							
1	3/16	2.93	4.29	5.57	6.80	7.96	10.17	12.17	13.99	20.11	23.11
1-1/4	3/16	3.33	4.86	6.32	7.72	9.06	11.53	13.83	15.91	22.83	26.25
1-1/2	3/16	3.42	5.00	6.50	7.06	8.28	10.55	12.63	14.55	20.86	23.99
2	3/16	3.25	5.18	6.73	8.22	9.64	12.29	14.72	16.95	24.31	27.96
2 Hi Flow	1/8	4.61	6.65	8.57	10.36	12.03					
2-1/2	3/16	3.14	4.58	5.96	6.51	7.63	9.73	11.65	13.41	19.25	22.13
3	3/16	2.78	4.07	5.29	7.39	8.66	11.04	13.22	15.22	21.83	25.11
4	1/4	2.07	3.04	4.20	5.16	6.08	7.82	9.45	10.98	16.21	18.91
4 Hi Flow	1/8	3.98	5.76	7.41	8.96	10.40					
5	1/4	1.74	2.56	3.70	4.54	5.36	6.89	8.33	9.67	14.28	16.65
6	1/4	1.42	3.58	4.69	5.76	6.79	8.73	10.56	12.26	18.09	21.11
8	1/4	1.45	3.08	4.03	4.94	5.82	7.50	9.06	10.52	15.53	18.12
10	1/4			3.78	4.64	5.47	7.04	8.51	9.88	14.59	17.02
12	1/4			4.09	5.02	5.92	7.62	9.20	10.69	15.77	18.41
14	1/4							10.15	11.78	17.39	20.29
16	1/4							9.10	10.50	15.60	18.20

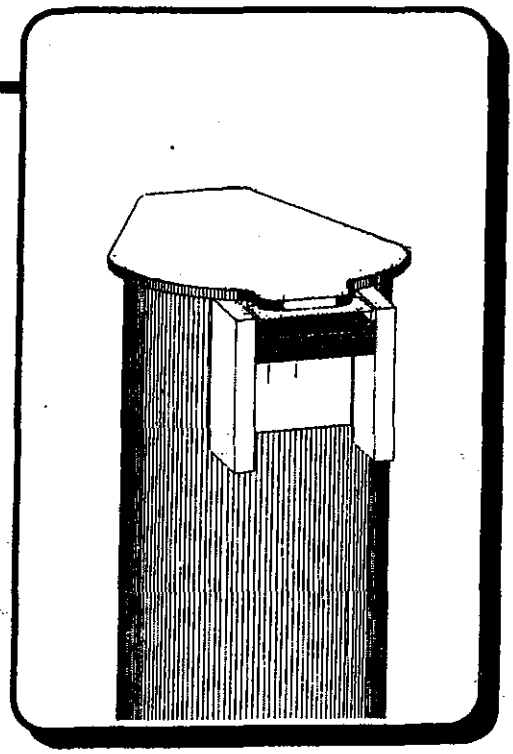
PVC SCHEDULE 80 SCREEN % OPEN AREA - STD CONSTRUCTION											
Percent Open Area											
Pipe Size (inches)	Slot Spacing (inches)	Standard Slot Opening (inches)									
		0.010	0.015	0.020	0.025	0.030	0.040	0.050	0.060	0.100	0.125
1/2	3/16	3.05	4.45	5.81							
3/4	3/16	2.38	3.44	4.51							
1	3/16	2.58	3.77	4.91	6.01	7.04	8.96	10.75		17.76	20.43
1-1/4	3/16	3.13	4.58	5.96	6.72	7.86	10.03	12.00	13.83	19.83	22.81
1-1/2	3/16	2.66	3.90	5.07	5.71	6.69	8.54	10.21	11.77	16.88	19.41
2	3/16	3.00	4.40	5.71	7.71	9.04	11.52	13.80	15.88	22.78	26.21
2 Hi Flow	1/8	4.01	5.80	7.46							
2-1/2	3/16	2.82	4.13	5.37	6.13	7.20	9.17	10.97	12.64	18.14	20.86
3	3/16	2.53	3.70	4.82	6.86	8.05	10.26	12.28	14.14	20.29	23.34
4	1/4	1.70	2.50	4.20	5.16	6.08	7.83	9.46	10.99	16.21	18.92
4 Hi Flow	1/8	3.27	4.73	5.22	6.31	7.32					
5	1/4			4.45	5.46	6.44	8.29	10.02	11.63	17.17	20.03
6	1/4			4.18	5.13	6.05	7.79	9.41	10.93	16.13	18.82
8	1/4					4.54	5.84	7.06	8.19	12.10	14.11
10	1/4						5.78	6.99	8.11	11.98	13.97
12	3/8							7.13	8.36	12.76	15.15
14	3/8							6.19	7.25	11.07	13.15
16	3/8								6.95	10.61	12.60

Steel Round Procover

Global Steel Round Procovers feature all steel construction, including a thick plate lid that extends 1/2" beyond the outside of the steel pipe.
A sturdy hinge and pin assembly with 3/8" thick side plates insures tamper resistance. Heavy steel tabs provide a holed area to insert a padlock.
The padlock is protected from direct effects of the elements.

MODEL NUMBER	PROCOVER SIZE (O.D)	WALL THICKNESS*	MAXIMUM WELL SIZE	LENGTH	WEIGHT
GDS PC 4 x 5	4.500"	.156"	2"	60"	42 lbs.
GDS PC 4 x 7	4.500"	.156"	2"	84"	59 lbs.
GDS PC 6 x 5	6.625"	.188"	4"	60"	72 lbs.
GDS PC 6 x 7	6.625"	.188"	4"	84"	101 lbs.
GDS PC 8 x 5	8.625"	.188"	6"	60"	88 lbs.
GDS PC 8 x 7	8.625"	.188"	6"	84"	124 lbs.
GDS PC 10 x 5	10.750"	.219"	8"	60"	140 lbs.
GDS PC 10 x 7	10.750"	.219"	8"	84"	196 lbs.
GDS PC 12 x 5	12.750"	.250"	10"	60"	167 lbs.
GDS PC 12 x 7	12.750"	.250"	10"	84"	234 lbs.

*Other wall thicknesses and lengths available per ordered request



NON-STANDARD COVERS ARE ALSO AVAILABLE: GALVANIZED, PRIMED, PAINTED, OR ANODIZED
ROUND LID-ONLY ASSEMBLIES ALSO AVAILABLE

Global Drilling Suppliers, Inc.
12101 Centron Place, Cinti, OH 45246
T/ 513/671-8700 F) 513/671-8705

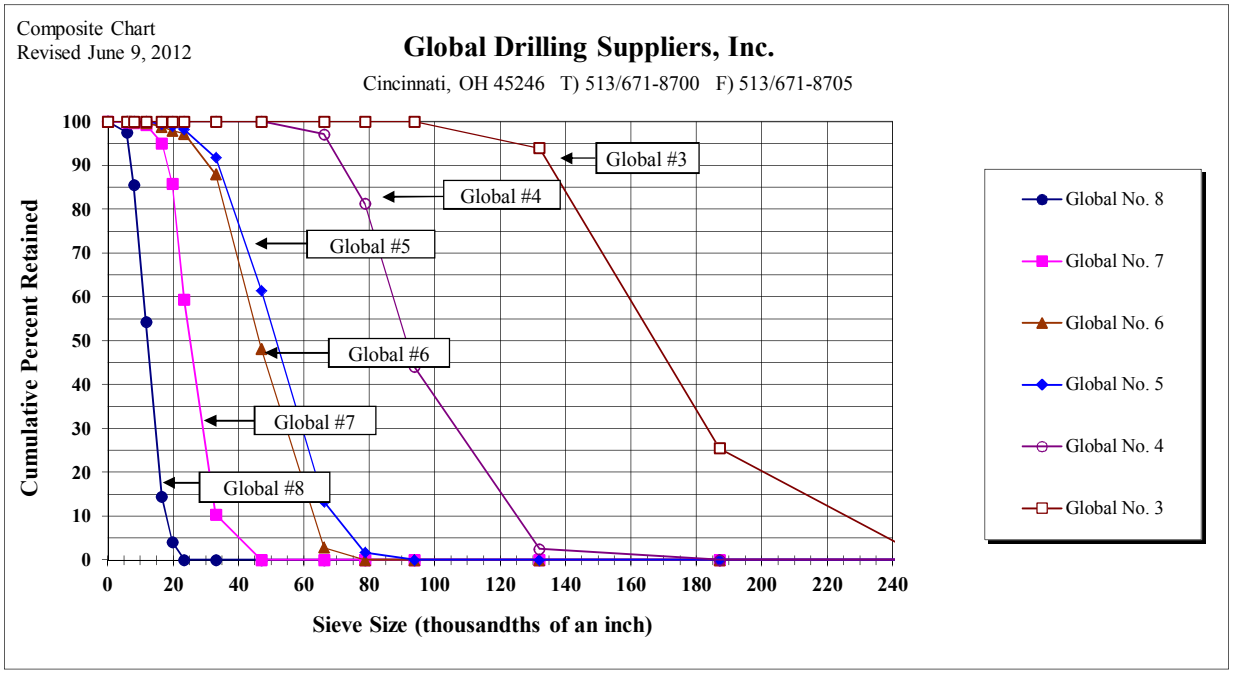
GLOBAL FILTER PACK SIEVE ANALYSES (2012)

Effective: 9-Jun-2012
Supercedes 1-FEB-2011version

Features:
*NSF -approved (Standard 61) *Washed & Dried - will not freeze up
*E-Z carry, UV-treated 50 lb. plastic bags, 56 bags per pallet *99% Quartz Silica
Technical data (average, subject to change):
*Moh hardness - 7 *Sp. Gravity - 2.64 *Porosity - 40% *Roundness & Sphericity - 0.8
*Acid Solubility - <1% *Uniformity Coefficent < 1.7 *Bulk Density - 100#/ft^3

Applicability: No recommendation or inference is made to correlate any filter pack to any particular application or well screen slot size. No. 8 is **NOT** to be used as a primary filter pack.

Sieve Size	Mesh Size	Global No. 8		Global No. 7		Global No. 6		Global No. 5		Global No. 4		Global No. 3	
		Cum. Wt.	Cum. %	Cum. Wt.	Cum. %	Cum. Wt.	Cum. %	Cum. Wt.	Cum. %	Cum. Wt.	Cum. %	Cum. Wt.	Cum. %
0.2500	3								0.5				**0.5**
0.1870	4							0.0	**0.0**	0.0	**0.0**	25.5	**25.5**
0.1320	6							0.0	**0.0**	2.5	**2.5**	94.0	**94.0**
0.0937	8					0.0	**0.0**	0.0	**0.0**	44.1	**44.1**	100.0	**100.0**
0.0787	10					0.0	**0.0**	1.7	**1.7**	81.3	**81.3**	100.0	**100.0**
0.0661	12			0.0	**0.0**	2.9	**2.9**	13.3	**13.3**	97.1	**97.1**	100.0	**100.0**
0.0469	16			0.0	**0.0**	48.2	**48.2**	61.5	**61.5**	100.0	**100.0**	100.0	**100.0**
0.0331	20			10.4	**10.4**	88.0	**88.0**	91.8	**91.8**	100.0	**100.0**	100.0	**100.0**
0.0234	30	0.0	**0.0**	59.4	**59.4**	97.3	**97.3**	98.2	**98.2**	100.0	**100.0**	100.0	**100.0**
0.0197	35	4.1	**4.1**	85.8	**85.8**	98.0	**98.0**	99.0	**99.0**	100.0	**100.0**	100.0	**100.0**
0.0165	40	14.5	**14.5**	95.1	**95.1**	98.9	**98.9**	99.4	**99.4**	100.0	**100.0**	100.0	**100.0**
0.0117	50	54.3	**54.3**	99.3	**99.3**	99.7	**99.7**	100.0	**100.0**	100.0	**100.0**	100.0	**100.0**
0.0083	70	85.5	**85.5**	99.7	**99.7**	99.9	**99.9**	100.0	**100.0**	100.0	**100.0**	100.0	**100.0**
0.0059	100	97.6	**97.6**	99.9	**99.9**	100.0	**100.0**	100.0	**100.0**	100.0	**100.0**	100.0	**100.0**
PAN	PAN	100.0	**100.0**	100.0	**100.0**	100.0	**100.0**	100.0	**100.0**	100.0	**100.0**	100.0	**100.0**



Disclaimer: This information is for reference purposes only. It is based upon manufacturer's recent average data and is subject to change. Due to the inherent segregation characterictics of sand, variations in testing procedures and equipment, no guarantee is made that any individual sample will be representative of the entire lot or of the average sieve analysis from batch to batch. Additionally, slot tolerances in the manufacturing process of well screens and individual well construction methods further precludes that any filter pack will perform 100% per published data. We assume no liability arising from the use or application of this product or information.

ASTM Type I-II (AASHTO TYPE I) Portland Cement

1. Product Description

Basic Use: **Lehigh ASTM Type I-II (AASHTO TYPE I),** low alkali, Portland cement is both a general purpose use and a moderate sulfate use hydraulic cement that can be used for most construction projects. Type I-II cement can be used where precaution against moderate sulfate attack is important. Type I-II cement is formulated to be used in grouts, mortars and concrete.

Color: Lehigh Type I-II, low alkali, Portland cement has no artificial colors added and has a normal color of light gray.

Limitations: Lehigh Type I-II, low alkali, Portland cement is designed to be mixed with water. It should be used in an environment that is free of acids and high sulfates.

2. Technical Data

Applicable Standards: Lehigh Type I-II, low alkali, Portland cement is manufactured to conform to **ASTM C150 – Type I** and **Type II** specifications and **AASHTO M85 – Type I** specification.

Physical Properties: *Lehigh* Type I-II, low alkali, Portland Cement is a fine grey powder. ASTM C150 requires that Type I-II Portland Cement have a minimum Blaine fineness of 280 m2/kg.

Strength: According to ASTM C150 and AASHTO M85, mortar cubes made with Type I-II Portland cement will obtain minimum compressive strengths as listed below:

3 days	-	1740 psi
7 days	-	2760 psi

Set Time: According to ASTM C150 and AASHTO M85, a paste made with Type I-II Portland cement will attain an initial set in a minimum of 45 minutes, and a final set in a maximum of 375 minutes when tested by the Vicat test method.

Specific Gravity: Type I-II Portland Cement typically has a specific gravity of 3.15.

3. Safety and Handling

Cement and wet cement mixtures can dry the skin, cause alkali burns and irritate the eyes and upper respiratory tract. Ingestion can cause irritation of the throat. When working with cement and cement mixtures, workers should wear gloves and clothing impervious to moisture. Further safety measures should include; dust masks, safety goggles and barrier cream for exposed skin.

4. Availability

Lehigh Type I-II, low alkali, Portland cement is available in either 94 lb. paper sacks or in bulk. Custom packaging may be available for selected large quantities.

5. Warranty

Lehigh Northwest Cement Company warrants that Lehigh Type I-II, low alkali Portland cement meets the requirements of ASTM C150 (Type I and Type II cement) and AASHTO M85 (Type I cement).

6. Product Storage

All cement must be stored in a dry weather tight enclosure. Bagged material must be stored on pallets that allow air circulation around them.

7. Technical Services

Technical information and services are available from Lehigh Northwest Cement Company.

■ Lehigh Northwest Cement Company■

P.O. BOX 84728, Seattle, WA 98124■ Phone: (206) 763-2525 ■ FAX: (206) 767-2657

Material Safety Data Sheet
[OSHA 29 CFR 1910.1200]

The QUIKRETE® Companies
One Securities Centre
3490 Piedmont Road, Suite 1300
Atlanta, GA 30329

Emergency Telephone Number
(770) 216-9580

Information Telephone Number
(770) 216-9580

Revision: July 2003

MSDS J

SECTION I: PRODUCT IDENTIFICATION

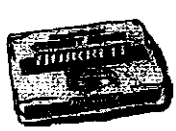
Product Types: QUIKRETE® DRY PACKAGED PORTLAND CEMENT BASED PRODUCTS (SERIES 1)

QUIKRETE® Product Name	Code #	QUIKRETE® Product Name	Code #
→ CONCRETE MIX	1101	FENCE POST MIX	1005
FIBER REINFORCED CONCRETE	1006	CRACK RESISTANT CONCRETE	1006-80
QUIKRETE® 5000	1007	LIGHT WEIGHT CONCRETE	1008
→ FAST SETTING CONCRETE	1004	RIP RAP	1129
SAND MIX	1103	VINYL CONCRETE PATCHER	1133, 1132
BASIC CONCRETE MIX	1015-60	HANDI-CRETE CONCRETE	1141
LIGHT WEIGHT SAND MIX	1103-51	HANDI-CRETE SAND MIX	1143
HIGH YIELD CONCRETE	1100	B-CRETE	1101-81
COMMERCIAL GRADE FASTSET™ CEMENT			1124-92
COMMERCIAL GRADE FASTSET™ NON SHRINK GROUT			1585-09
COMMERCIAL GRADE FASTSET™ REPAIR MORTAR			1241-60
COMMERCIAL GRADE FASTSET™ CONCRETE			1004-51
COARSE & FINE CORE FILL GROUTS (MASONRY GROUTS)			SR-9003, SR-9006

(ALSO APPLIES TO CUSTOM BLENDED AND PRIVATE LABEL CONCRETES AND MORTARS)

SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components	CAS No.	PEL (OSHA) mg/M^3	TLV (ACGIH) mg/M^3
Silica Sand, crystalline	14808-60-7	10 / % SiO_2 +2	0.05 (respirable)
Portland Cement	65997-15-1	5	5
Lime	01305-62-0	5	5
May contain one or more of the following:			
Amorphous Silica (From Fly Ash)	07631-86-9	80 mg/M^3 / % SiO_2	10
Alumina (From Fly Ash)	01344-28-1	5	5
Limestone Dust	01317-65-3	5	5
Calcium Sulfate	10101-41-4 or 13397-24-5	5	5
Calcium Sulfo Aluminate	65997-16-2	15	10



Other Limits: NIOSH has recommended that the permissible exposure limit be changed to 50 micrograms respirable free silica per cubic meter of air (50 ug/M^3) averaged over a work shift of up to 10 hours per day, 40 hours per week. The NIOSH Criteria Document for Crystalline Silica should be consulted for more detailed information.

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Appearance: Gray to gray-brown colored powder. Some products contain coarse aggregate. (QUIKRETE Vinyl Concrete Patcher available in white)

Specific Gravity:	2.6 to 3.15	**Melting Point:**	>2700 °F	**Boiling Point:**	>2700 °F
Vapor Pressure:	None	**Vapor Density:**	None	**Evaporation Rate:**	None
Solubility in Water:	Slight	**Odor:**	None	**Solubility in Water:**	Slight

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Non combustible and not explosive.

SECTION V - REACTIVITY DATA

Stability: Stable.
Incompatibility (Materials to Avoid): Contact of silica with powerful oxidizing agents such as fluorine, chlorine trifluoride, manganese trioxide, oxygen difluoride, may cause fires.
Hazardous Decomposition or Byproducts: Silica will dissolve in Hydrofluoric Acid and produce a corrosive gas - silicon tetrafluoride.
Hazardous Polymerization: Will not occur.
Condition to Avoid: Keep dry until used to preserve product utility.

SECTION VI - HEALTH HAZARD DATA

Route(s) of Entry:	Inhalation?	Yes
	Skin?	Yes
	Ingestion?	Yes

Acute Exposure: Product becomes alkaline when exposed to moisture. Exposure can dry the skin, cause alkali burns and effect the mucous membranes. Dust can irritate the eyes and upper respiratory system. Toxic effects noted in animals include, for acute exposures, alveolar damage with pulmonary edema.
Chronic Exposure: Dust can cause inflammation of the lining tissue of the interior of the nose and inflammation of the cornea. Hypersensitive individuals may develop an allergic dermatitis. Respirable crystalline silica (quartz) can cause silicosis, a fibrosis (scarring) of the lungs and possibly cancer. There is evidence that exposure to respirable silica or the disease silicosis is associated with an increased incidence of Scleroderma, tuberculosis and kidney disorders.

Carcinogenicity Listings:	NTP:	Known carcinogen
	OSHA:	Not listed as a carcinogen
	IARC Monographs:	Group 1 Carcinogen
	California Proposition 65:	Known carcinogen

NTP: The National Toxicology Program, in its "Ninth Report on Carcinogens" (released May 15, 2000) concluded that "Respirable crystalline silica (RCS), primarily quartz dusts occurring in industrial and occupational settings, is *known to be a human carcinogen*, based on sufficient evidence of carcinogenicity from studies in humans indicating a causal relationship between exposure to RCS and increased lung cancer rates in workers exposed to crystalline silica dust (reviewed in IAC, 1997; Brown *et al.*, 1997; Hind *et al.*, 1997)

IARC: The International Agency for Research on Cancer ("IARC") concluded that there was "*sufficient evidence* in humans for the carcinogenicity of crystalline silica in the forms of quartz or cristobalite from occupational sources", and that there is "*sufficient evidence* in experimental animals for the carcinogenicity of quartz or cristobalite." The overall IARC evaluation was that "crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is *carcinogenic to humans (*Group 1)." The IARC evaluation noted that "carcinogenicity was not detected in all industrial circumstances or studies. Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." For further information on the IARC evaluation, see IARC Monographs on the Evaluation of carcinogenic Risks to Humans, Volume 68, "Silica, Some Silicates..." (1997)

Signs and Symptoms of Exposure: Symptoms of excessive exposure to the dust include shortness of breath and reduced pulmonary function. Excessive exposure to skin and eyes especially when mixed with water can cause caustic burns as severe as third degree.

Medical Conditions Generally Aggravated by Exposure: Individuals with sensitive skin and with pulmonary and/or respiratory disease, including, but not limited to, asthma and bronchitis, or subject to eye irritation, should be precluded from exposure.

Emergency First Aid Procedures:

Eyes: Immediately flush eye thoroughly with water. Continue flushing eye for at least 15 minutes, including under lids, to remove all particles. Call physician immediately.

Skin: Wash skin with cool water and pH-neutral soap or a mild detergent. Seek medical treatment if irritation or inflammation develops or persists. Seek immediate medical treatment in the event of burns.

Inhalation: Remove person to fresh air. If breathing is difficult, administer oxygen. If not breathing, give artificial respiration. Seek medical help if coughing and other symptoms do not subside. Inhalation of large amounts of portland cement require immediate medical attention.

Ingestion: Do not induce vomiting. If conscious, have the victim drink plenty of water and call a physician immediately.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

Spills: If spilled, use dustless methods (vacuum) and place into covered container for disposal or use if not contaminated or wet. Use adequate ventilation.

Waste Disposal Method: The packaging and material may be land filled; however, material should be covered to minimize generation of airborne dust. This product is not classified as a hazardous waste under RCRA or CERCLA.

SECTION VIII - CONTROL MEASURES

Inhalation: DO NOT BREATHE DUST. In dusty environments, the use of an OSHA, MSHA or NIOSH approved respirator is recommended. Local exhaust can be used, if necessary, to control airborne dust levels.

Eyes: Wear tight fitting goggles.

Skin: The use of barrier creams or impervious gloves, boots and clothing to protect the skin from contact is recommended. Following work, workers should shower with soap and water. Precautions must be observed because burns occur with little warning -- little heat is sensed.

WARN EMPLOYEES AND/OR CUSTOMERS OF THE HAZARDS AND REQUIRED OSHA PRECAUTIONS ASSOCIATED WITH THE USE OF THIS PRODUCT.

NOTE: The information and recommendations contained herein are based upon data believed to be correct. However, no guarantee or warranty of any kind, express or implied, is made with respect to the information contained herein. We accept no responsibility and disclaim all liability for any harmful effects, which may be caused by exposure to silica contained in our products.

MATERIAL SAFETY DATA SHEET

1. Product and Company Identification

Material name	PUREGOLD® GEL
Version #	13
Revision date	21-February-2009
Chemical description	Smectite Clay
Manufacturer	CETCO Drilling Products Group 2870 Forbs Avenue Hoffman Estates, IL 60192 US safetydata@amcol.com http://www.cetco.com/ General Information (800) 527-9948 CHEMTREC® (800) 424-9300

2. Hazards Identification

Emergency overview	Material can be slippery when wet
Potential health effects	
Routes of exposure	Inhalation.
Eyes	Dust or powder may irritate eye tissue.
Skin	Non-irritating to the skin.
Inhalation	Repeated or prolonged inhalation may cause toxic effects. For additional information on inhalation hazards, see Section 11 of this safety data sheet.
Ingestion	No significant adverse effects are expected upon ingestion of the product.
Target organs	Lungs.
Chronic effects	This product has the potential for generation of respirable dust during handling and use. Dust may contain respirable crystalline silica. Overexposure to dust may result in pneumocononiosis, a respiratory disease caused by inhalation of mineral dust, which can lead to fibrotic changes to the lung tissue, or silicosis, a respiratory disease caused by inhalation of silica dust, which can lead to inflammation and fibrosis of the lung tissue. Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

3. Composition / Information on Ingredients

The manufacturer lists no ingredients as hazardous according to OSHA 29 CFR 1910.1200.

Composition comments	Bentonite contains naturally occurring crystalline silica (not listed in Annex I of Directive 67/548/EEC) in quantities less than 6%. Occupational Exposure Limits for impurities are listed in Section 8.

4. First Aid Measures

First aid procedures	
Eye contact	Flush eyes immediately with large amounts of water. If irritation persists get medical attention.
Skin contact	No special measures required. Get medical attention if irritation develops or persists.
Inhalation	Remove to fresh air. If not breathing, give artificial respiration or give oxygen by trained personnel. Get medical attention, if needed.
Ingestion	No special measures required. If ingestion of a large amount does occur, seek medical attention.
Notes to physician	Provide general supportive measures and treat symptomatically.

5. Fire Fighting Measures

Flammable properties	This material will not burn.
Extinguishing media	
Suitable extinguishing media	Use any media suitable for the surrounding fires. Dry chemical, CO_2, water spray or regular foam.

Protection of firefighters

Protective equipment and precautions for firefighters Material can be slippery when wet

Hazardous combustion products None known.

6. Accidental Release Measures

Personal precautions Material can be slippery when wet. Wear a dust mask if dust is generated above exposure limits.

Environmental precautions No special environmental precautions required.

Methods for cleaning up Avoid the generation of dusts during clean-up. Collect dust or particulates using a vacuum cleaner with a HEPA filter. Reduce airborne dust and prevent scattering by moistening with water.

7. Handling and Storage

Handling Keep formation of airborne dusts to a minimum. Provide appropriate exhaust ventilation at places where dust is formed. In case of insufficient ventilation, wear suitable respiratory equipment.

Storage Guard against dust accumulation of this material. No special storage conditions required. No special restrictions on storage with other products.

8. Exposure Controls / Personal Protection

Occupational exposure limits

ACGIH

Impurities	Type	Value	Form
INERT OR NUISANCE DUST (SEQ250)	TWA	10 mg/m3	Inhalable particles.
		3 mg/m3	Respirable particles.
QUARTZ (14808-60-7)	TWA	0.025 mg/m3	Respirable fraction.

U.S. - OSHA

Impurities	Type	Value	Form
INERT OR NUISANCE DUST (SEQ250)	PEL	15 mg/m3	Total dust.
		5 mg/m3	Respirable fraction.
	TWA	5 mg/m3	Respirable fraction.
		50 mppcf	Total dust.
		15 mppcf	Respirable fraction.
		15 mg/m3	Total dust.
QUARTZ (14808-60-7)	TWA	2.4 mppcf	Respirable.
		0.3 mg/m3	Total dust.
		0.1 mg/m3	Respirable.
		0.1 mg/m3	Respirable dust.

Exposure guidelines Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

Engineering controls If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. If engineering measures are not sufficient to maintain concentrations of dust particulates below the OEL, suitable respiratory protection must be worn.

Personal protective equipment

Eye / face protection Wear dust goggles. Eye wash fountain is recommended.

Skin protection No special protective equipment required.

Respiratory protection Use a particulate filter respirator for particulate concentrations exceeding the Occupational Exposure Limit.

General hygeine considerations Use good industrial hygiene practices in handling this material.

9. Physical & Chemical Properties

Appearance Not available.

Color Not available.

Odor	None.
Odor threshold	Not available.
Physical state	Solid.
Form	Granular. Powder. Pellets. or Chips.
pH	7 - 11
Melting point	Not available.
Freezing point	Not available.
Boiling point	Not available.
Flash point	Non-flammable
Evaporation rate	Not available.
Flammability	Not available.
Flammability limits in air, upper, % by volume	Not available.
Flammability limits in air, lower, % by volume	Non-explosive
Vapor pressure	Not available.
Vapor density	Not available.
Specific gravity	2.5497 estimated
Relative density	Not available.
Solubility (water)	Negligible
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
VOC	0 % estimated

10. Chemical Stability & Reactivity Information

Chemical stability	Stable at normal conditions.
Conditions to avoid	None known.
Incompatible materials	None known.
Hazardous decomposition products	None known.
Possibility of hazardous reactions	Will not occur.

11. Toxicological Information

Chronic effects

In 1997, IARC (the International Agency for Research on Cancer) concluded that crystalline silica inhaled from occupational sources can cause lung cancer in humans. However in making the overall evaluation, IARC noted that "carcinogenicity was not detected in all industrial circumstances studied. Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." (IARC Monographs on the evaluation of the carcinogenic risks of chemicals to humans, Silica, silicates dust and organic fibres, 1997, Vol. 68, IARC, Lyon, France.)

In June 2003, SCOEL (the EU Scientific Committee on Occupational Exposure Limits) concluded that the main effect in humans of the inhalation of respirable crystalline silica dust is silicosis. "There is sufficient information to conclude that the relative risk of lung cancer is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore, preventing the onset of silicosis will also reduce the cancer risk..." (SCOEL SUM Doc 94-final, June 2003)

According to the current state of the art, worker protection against silicosis can be consistently assured by respecting the existing regulatory occupational exposure limits. Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

Carcinogenicity

IARC Monographs on Occupational Exposures to Chemical Agents: Overall evaluation

QUARTZ (14808-60-7) 1 Human carcinogen.

US ACGIH Threshold Limit Values: A2 carcinogen

QUARTZ (14808-60-7) Group A2 Suspected human carcinogen.

US NTP Report on Carcinogens: Known carcinogen

QUARTZ (14808-60-7) Known carcinogen.

12. Ecological Information

Ecotoxicological data

Product	Test Results
PUREGOLD® GEL	LC50 Fish: 19005 mg/l 96.00 Hours estimated

* Estimates for product may be based on additional component data not shown.

Ecotoxicity This material is not expected to be harmful to aquatic life.

Environmental effects Based on the physical properties of this product, significant environmental persistence and bioaccumulation would not be expected.

Persistence and degradability Not available.

13. Disposal Considerations

Disposal instructions Dispose in accordance with all applicable regulations. Material should be recycled if possible.

14. Transport Information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

15. Regulatory Information

US federal regulations OSHA Process Safety Standard: This material is not known to be hazardous by the OSHA Highly Hazardous Process Safety Standard, 29 CFR 1910.119.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - No
Delayed Hazard - Yes
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

Section 302 extremely hazardous substance No

Section 311 hazardous chemical Yes

Inventory status

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of New and Existing Chemicals (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes

Country(s) or region	Inventory name	On inventory (yes/no)*
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

State regulations WARNING: This product contains a chemical known to the State of California to cause cancer.

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

QUARTZ (14808-60-7) Listed.

US - California Proposition 65 - CRT: Listed date/Carcinogenic substance

QUARTZ (14808-60-7) Listed: October 1, 1988 Carcinogenic.

US - Pennsylvania RTK - Hazardous Substances: Listed substance

QUARTZ (14808-60-7) Listed.

16. Other Information

Further information This safety datasheet only contains information relating to safety and does not replace any product information or product specification.

Recommended restrictions Workers (and your customers or users in the case of resale) should be informed of the potential presence of respirable dust and respirable crystalline silica as well as their potential hazards. Appropriate training in the proper use and handling of this material should be provided as required under applicable regulations.

HMIS ratings

NFPA ratings Health: 1
Flammability: 0
Instability: 0

Disclaimer The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability, for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use.

Third party materials: Insofar as materials not manufactured or supplied by this manufacturer are used in conjunction with, or instead of this product, it is the responsibility of the customer to obtain, from the manufacturer or supplier, all technical data and other properties relating to these and other materials and to obtain all necessary information relating to them. No liability can be accepted in respect of the use of this product in conjunction with materials from another supplier. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Issue date 21-February-2009

Other information CETCO is an AMCOL International company.

MATERIAL SAFETY DATA SHEET

1. Product and Company Identification

Material name	PUREGOLD® MEDIUM CHIPS
Version #	05
Revision date	26-January-2009
Chemical name	Bentonite
Chemical description	Smectite Clay
Manufacturer	CETCO Drilling Products Group 2870 Forbs Avenue Hoffman Estates, IL 60192 US safetydata@amcol.com http://www.cetco.com/ General Information (800) 527-9948 CHEMTREC® (800) 424-9300

2. Hazards Identification

Emergency overview	Material can be slippery when wet
Potential health effects	
Routes of exposure	Inhalation. Eye contact.
Eyes	Dust or powder may irritate eye tissue.
Skin	Non-irritating to the skin.
Inhalation	Repeated or prolonged inhalation may cause toxic effects. For additional information on inhalation hazards, see Section 11 of this safety data sheet.
Ingestion	No significant adverse effects are expected upon ingestion of the product.
Target organs	Lungs.
Chronic effects	This product has the potential for generation of respirable dust during handling and use. Dust may contain respirable crystalline silica. Overexposure to dust may result in pneumocononiosis, a respiratory disease caused by inhalation of mineral dust, which can lead to fibrotic changes to the lung tissue, or silicosis, a respiratory disease caused by inhalation of silica dust, which can lead to inflammation and fibrosis of the lung tissue. Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

3. Composition / Information on Ingredients

The manufacturer lists no ingredients as hazardous according to OSHA 29 CFR 1910.1200.

Composition comments	Bentonite contains naturally occurring crystalline silica (not listed in Annex I of Directive 67/548/EEC) in quantities less than 6%. Occupational Exposure Limits for impurities are listed in Section 8.

4. First Aid Measures

First aid procedures	
Eye contact	Flush eyes immediately with large amounts of water. Get medical attention if irritation develops or persists.
Skin contact	No special measures required. Get medical attention if irritation develops or persists.
Inhalation	If symptoms are experienced, remove source of contamination or move victim to fresh air. If the affected person is not breathing, apply artificial respiration. If breathing is difficult, give oxygen. Call a physician if symptoms develop or persist.
Ingestion	No special measures required. If ingestion of a large amount does occur, seek medical attention.
Notes to physician	Provide general supportive measures and treat symptomatically.

5. Fire Fighting Measures

Flammable properties	None known.

Extinguishing media

Suitable extinguishing media Use any media suitable for the surrounding fires. Dry chemical, CO2, water spray or regular foam.

Protection of firefighters

Protective equipment and precautions for firefighters Material can be slippery when wet

Hazardous combustion products None known.

6. Accidental Release Measures

Personal precautions Material can be slippery when wet. Wear a dust mask if dust is generated above exposure limits.

Environmental precautions No special environmental precautions required.

Methods for containment None necessary.

Methods for cleaning up Avoid the generation of dusts during clean-up. Collect dust or particulates using a vacuum cleaner with a HEPA filter. Reduce airborne dust and prevent scattering by moistening with water.

7. Handling and Storage

Handling Keep formation of airborne dusts to a minimum. Provide appropriate exhaust ventilation at places where dust is formed. In case of insufficient ventilation, wear suitable respiratory equipment.

Storage Guard against dust accumulation of this material. No special storage conditions required. No special restrictions on storage with other products.

8. Exposure Controls / Personal Protection

Occupational exposure limits

ACGIH

Constituents	Type	Value	Form
INERT OR NUISANCE DUST (SEQ250)	TWA	10 mg/m3	Inhalable particles.
		3 mg/m3	Respirable particles.
QUARTZ (14808-60-7)	TWA	0.025 mg/m3	Respirable fraction.

U.S. - OSHA

Constituents	Type	Value	Form
INERT OR NUISANCE DUST (SEQ250)	PEL	15 mg/m3	Total dust.
		5 mg/m3	Respirable fraction.
	TWA	5 mg/m3	Respirable fraction.
		50 mppcf	Total dust.
		15 mppcf	Respirable fraction.
		15 mg/m3	Total dust.
QUARTZ (14808-60-7)	TWA	2.4 mppcf	Respirable.
		0.3 mg/m3	Total dust.
		0.1 mg/m3	Respirable.
		0.1 mg/m3	Respirable dust.

Exposure guidelines Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

Engineering controls If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. If engineering measures are not sufficient to maintain concentrations of dust particulates below the OEL, suitable respiratory protection must be worn.

Personal protective equipment

Eye / face protection Wear dust goggles.

Skin protection No special protective equipment required.

Respiratory protection Use a particulate filter respirator for particulate concentrations exceeding the Occupational Exposure Limit.

General hygeine considerations Eye wash fountain is recommended. Use good industrial hygiene practices in handling this material.

9. Physical & Chemical Properties

Appearance	Not available.
Color	Various.
Odor	None.
Odor threshold	Not available.
Physical state	Solid.
Form	Pellets. Chips. Tablet.
pH	7 - 9
Melting point	Not available.
Freezing point	Not available.
Boiling point	Not available.
Flash point	Non-flammable
Evaporation rate	Not available.
Flammability	Not available.
Flammability limits in air, upper, % by volume	Non-explosive
Flammability limits in air, lower, % by volume	Non-explosive
Vapor pressure	Not available.
Vapor density	Not available.
Specific gravity	2.5503 estimated
Relative density	Not available.
Solubility (water)	Negligible
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
VOC	0 % estimated
Percent volatile	0 % estimated

10. Chemical Stability & Reactivity Information

Chemical stability	Stable at normal conditions.
Conditions to avoid	None known.
Incompatible materials	None known.
Hazardous decomposition products	None known.
Possibility of hazardous reactions	Will not occur.

11. Toxicological Information

Chronic effects

In 1997, IARC (the International Agency for Research on Cancer) concluded that crystalline silica inhaled from occupational sources can cause lung cancer in humans. However in making the overall evaluation, IARC noted that "carcinogenicity was not detected in all industrial circumstances studied. Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." (IARC Monographs on the evaluation of the carcinogenic risks of chemicals to humans, Silica, silicates dust and organic fibres, 1997, Vol. 68, IARC, Lyon, France.)

In June 2003, SCOEL (the EU Scientific Committee on Occupational Exposure Limits) concluded that the main effect in humans of the inhalation of respirable crystalline silica dust is silicosis. "There is sufficient information to conclude that the relative risk of lung cancer is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore, preventing the onset of silicosis will also reduce the cancer risk..." (SCOEL SUM Doc 94-final, June 2003)

According to the current state of the art, worker protection against silicosis can be consistently assured by respecting the existing regulatory occupational exposure limits. Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

Carcinogenicity

IARC Monographs on Occupational Exposures to Chemical Agents: Overall evaluation

QUARTZ (14808-60-7)	1 Human carcinogen.

US ACGIH Threshold Limit Values: A2 carcinogen

QUARTZ (14808-60-7)	Group A2 Suspected human carcinogen.

US NTP Report on Carcinogens: Known carcinogen

QUARTZ (14808-60-7)	Known carcinogen.

12. Ecological Information

Ecotoxicological data

Product	Test Results
PUREGOLD® MEDIUM CHIPS	LC50 Fish: 19000 mg/l 96.00 Hours estimated

* Estimates for product may be based on additional component data not shown.

Ecotoxicity This material is not expected to be harmful to aquatic life.

Environmental effects Based on the physical properties of this product, significant environmental persistence and bioaccumulation would not be expected.

Persistence and degradability Not available.

13. Disposal Considerations

Disposal instructions Dispose in accordance with all applicable regulations. Material should be recycled if possible.

14. Transport Information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

15. Regulatory Information

US federal regulations OSHA Process Safety Standard: This material is not known to be hazardous by the OSHA Highly Hazardous Process Safety Standard, 29 CFR 1910.119.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - No Delayed Hazard - Yes Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No
Section 302 extremely hazardous substance	No
Section 311 hazardous chemical	Yes

Inventory status

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of New and Existing Chemicals (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

State regulations WARNING: This product contains a chemical known to the State of California to cause cancer.

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

QUARTZ (14808-60-7) Listed.

US - California Proposition 65 - CRT: Listed date/Carcinogenic substance

QUARTZ (14808-60-7) Listed: October 1, 1988 Carcinogenic.

US - Pennsylvania RTK - Hazardous Substances: Listed substance

QUARTZ (14808-60-7) Listed.

16. Other Information

Further information This safety datasheet only contains information relating to safety and does not replace any product information or product specification.

Recommended restrictions Workers (and your customers or users in the case of resale) should be informed of the potential presence of respirable dust and respirable crystalline silica as well as their potential hazards. Appropriate training in the proper use and handling of this material should be provided as required under applicable regulations.

HMIS ratings

NFPA ratings Health: 1
Flammability: 0
Instability: 0

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability, for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use.

Third party materials: Insofar as materials not manufactured or supplied by this manufacturer are used in conjunction with, or instead of this product, it is the responsibility of the customer to obtain, from the manufacturer or supplier, all technical data and other properties relating to these and other materials and to obtain all necessary information relating to them. No liability can be accepted in respect of the use of this product in conjunction with materials from another supplier. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Issue date

26-January-2009

Other information

CETCO is an AMCOL International company.

QUIK-GROUT®

One-Sack Borehole Grouting and Plugging Material

Description

QUIK-GROUT® one-sack grouting and plugging material is a sodium bentonite-based grout designed for grouting water wells, monitoring wells, and for plugging boreholes. QUIK-GROUT grouting and plugging material does not contain any polymers.

Applications/Functions

- Can seal or grout plastic and steel casings
- Can seal downhole instrumentation in test and observation holes
- Can plug abandoned boreholes and earthen cavities
- Not recommended for use as a cement additive

Advantages

- Easy-to-use one sack grout
- Dust-free mixing
- Can be mixed and pumped using conventional rig equipment
- Rehydratable
- No heat of hydration
- Can develop a 20% active solids slurry weighing 9.4 lb/gal (1.13 g/cm^3) with hydrostatic gradient of 0.489 psi/ft (11.1 kPa/meter)
- Can create a low permeability seal to prevent entry of contaminants from the surface
- Can develop a permanent, flexible seal to prevent commingling between aquifers
- NSF/ANSI Standard 60 certified

Typical Properties

Appearance	Beige to tan granules
Specific gravity	2.6
pH (8% slurry)	8.2
Electrical Resistivity	0.98 ohm-meter
Yield Volume	26.3 gallons per 50-lb sack
	99.5 liters per 23-kg sack
Permeability (in fresh water)	2.5 x 10^{-8} cm/sec

Recommended Treatment

For maximum results, pre-treat make-up water with Soda Ash to less than or equal to 100 mg/l total hardness and to a pH range of 8.5 – 9.5.

The recommended mixing rate is one 50-lb (23-kg) sack of QUIK-GROUT grouting and plugging material per 24 gallons (91 liters) of fresh water to create a 20% active solids by weight grout with a density of 9.4 lb/gal or 1.13 g/cm^3.

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Because the conditions of use of this product are beyond the seller's control, the product is sold without warranty either express or implied and upon condition that purchaser make its own test to determine the suitability for purchaser's application. Purchaser assumes all risk of use and handling of this product. This product will be replaced if defective in manufacture or packaging or if damaged. Except for such replacement, seller is not liable for any damages caused by this product or its use. The statements and recommendations made herein are believed to be accurate. No guarantee of their accuracy is made, however.

Recommended Mixing Procedure

Do not over mix and do not use a centrifugal pump.

1. Using a mixing device, blend one sack of QUIK-GROUT® grouting and plugging material into 24 gallons (91 liters) of fresh water. Rate of addition should be about 20 to 30 seconds per 50-lb (23-kg) bag.

   Note: The resulting slurry should have an oatmeal consistency containing unyielded or partially yielded bentonite.

2. Pump slurry through tremie pipe into hole without delay. Grout slurry should be pumped through tremie pipe from bottom of interval to surface to ensure effective displacement. Maintain submergence of tremie pipe a minimum of 10-feet within grout column for uniform displacement.

Additional Information

- The grouting material and method selected will depend upon the specific subsurface environment including all prevailing geological and hydrological factors and any existing regulatory requirements. The grouting process may not be complete until the grout is static at the desired level.
- The use of bentonite may not be appropriate in environments where the formation water chemistry has a total hardness greater than 500 parts per million and/or a chloride content of greater than 1500 parts per million.
- If questions arise regarding subsurface environments it is always best to consult your local Baroid IDP representative to determine if the Baroid product of choice is appropriate for the given conditions.

Packaging

QUIK-GROUT grouting and plugging material is packaged in 50-lb (23-kg) multiwall paper bags, containing 0.7 ft^3 (0.02 m^3).

Availability

QUIK-GROUT grouting and plugging material can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

Baroid Industrial Drilling Products

Product Service Line, Halliburton

3000 N. Sam Houston Pkwy E.

Houston, TX 77032

Customer Service	(800) 735-6075 Toll Free	(281) 871-4612
Technical Service	(877) 379-7412 Toll Free	(281) 871-4613