Consulting
Engineers and
Scientists

Remedial Investigation Work Plan

99 Granite Redevelopment
99 Granite Street Brooklyn, New York
Site No. C224269

Submitted to:
New York State Department of Environmental Conservation
Division of Environmental Remediation
50 Circle Road
Stony Brook, NY 11790

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Project 1704281

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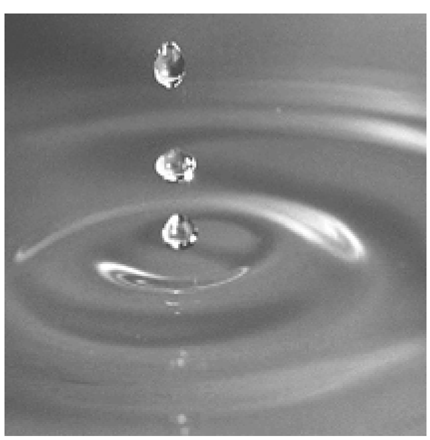

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Abbreviations and Acronyms

BCA	Brownfield Cleanup Application
BCP	Brownfield Cleanup Program
Bilow	Bilow Engineering, LLC
CAMP	Community Air Monitoring Program
DO	Dissolved Oxygen
DUSR	Data Usability Summary Report
EDD	Electronic Data Deliverable
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
ESA	Environmental Site Assessment
ESI	Environmental Site Inspection
FER	Final Engineering Report
FSP	Field Sampling Plan
GEI	GEI Consultants, Inc., P.C.
HAZWOPER	Hazardous Waste Operations and Emergency Response
HASP	Health and Safety Plan
IRM	Interim Remedial Measure
LDPE	Low-Density Polyethylene
LEG	Lawrence Environmental Group, LLC
Liberty	Liberty Environmental Inc.
NYCDEP	New York City Department of Environmental Protection
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PDD	Preliminary Decision Document
PFASs	Polyfluoroalkyl Substances
PID	Photoionization Detector
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QEA	Qualitative Exposure Assessment
RI	Remedial Investigation

RIR	Remedial Investigation Report
RIWP	Remedial Investigation Work Plan
SCG	Standards, Criteria, and Guidance
SCH	Schedule
SCOs	Soil Cleanup Objectives
SVOCs	Semi-Volatile Organic Compounds
TCL	Target Compound List
USDOT/UN	United States Department of Transportation/United Nations
VOCS	Volatile Organic Compounds
MEASUREMENTS	
bgs	below grade surface
L/min	liters per minute
mg/L	milligrams per liter
PM-10	particulate matter
µg/kg	micrograms per kilograms

Certification

I, Edward Bradshaw, certify that I am currently a Qualified Environmental Professional as defined in 6 NYCRR Part 375 and that this Report Remedial Investigation Work Plan (RIWP) was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

August 20, 2018

Signature

Date

1. Background and Site Description

1.1 Introduction

GEI Consultants, Inc. P. C. (GEI) has prepared this Remedial Investigation Work Plan (RIWP) for the Site located at 99 Granite Street (Block 3457, Lot 49) in Brooklyn, New York (the "Site" or the "99 Granite Street Site"). The Site (Site No. C224269) was accepted into the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP) on March 27, 2018 with 99 Granite Redevelopment, i.e. the Applicant, participating in the BCP as a Volunteer pursuant to Brownfield Cleanup Agreement ("BCA") Index No. C152248-09-17.

Information regarding the Site conditions was obtained from the *Phase I Environmental Site Assessment* (ESA), dated December 10, 2013 prepared by Lawrence Environmental Group, LLC (LEG), the *Geotechnical Study* prepared by Bilow Engineering, LLC (Bilow), *Soil Disposal Characterization Report* dated July 5, 2017 prepared by Liberty Environmental Inc. (Liberty) and the *Phase II Environmental Subsurface Investigation* (ESI) report dated October 26, 2017, prepared by GEI.

The site location map is provided as **Figure 1**.

1.2 Objective of the RIWP

The objective of this RIWP is to obtain valid data to evaluate and define the nature, extent, and degree of semi-volatile organic compounds, and metals impacts previously identified onsite. The data generated during the field investigation will be used to determine what risks, if any, that the onsite impacts present to public health and to the environment. Additionally, the RIWP has been designed to provide data needed to perform a remedial alternatives analysis for the Site and recommend remedial actions for the site.

1.3 Background

GEI's analysis of historical information regarding the project site indicates that the Site, as well as the surrounding properties to the north and west were vacant land until at least 1907 based on the Sanborn Maps. The LEG Phase I ESA identified sub-grade railroad tracks as an adjacent property which, based on a review of the Sanborn Maps within LEG's Phase I ESA, indicate the railroad tracks were constructed sometime in the 1800s. It appears that there was also a sewer line that was re-routed at the same time the railroad tunnel was constructed. This sewer line now transverses the subject property at a depth of approximately 5-feet below ground.

The project site, located at 99 Granite Street Brooklyn, New York, includes one (1) triangular-shaped parcel totaling approximately 0.18 acres in an urban setting. The site does not have any buildings or structures on it and is currently vacant.

Potable water is supplied to the Site by the New York City Department of Environmental Protection (NYCDEP)

1.4 Description of Local Hydrogeological Conditions

The information below was derived from the GEI's Geotechnical and Phase II ESI reports.

1.4.1 Site Soil/Stratigraphy

Bilow's Geotechnical Engineering Study indicates the subsurface conditions at the subject property consists of a layer of fill which ranges in thickness from 5 to 9 feet below the existing ground surface. Bilow's report describes the fill as "generally loose with various dense pockets of possibly gravel and construction debris."

Both Liberty's and GEI's soil borings indicate the presence of fill material, fragmented brick, concrete and ash, at the same depths as the Bilow Geotechnical Engineering Study. It is GEI's opinion that during the construction of the railroad and associated tunnel, fill was placed on the subject property since the subject property and adjacent and surrounding properties were indicated, on Sanborn Maps, to be vacant land**.**

The fill and soils encountered during the geotechnical study and environmental investigations were composed of fill materials, consisting of silty sand with trace to some amounts of clay, gravel, bricks and, ash. This layer extended to a depth of approximately 9 feet below grade. A silt and clay layer was encountered beneath the fill layer. This layer extended from approximately 10 feet below grade to approximately 15 feet below grade. Below this layer, a sandy soil with silt, gravel and cobbles, considered glacial till, was encountered. This layer extended from approximately 30 feet below grade to 40 feet below grade.

1.4.2 Aquifer Characteristics

The water table at the Site was present at a depth of approximately 28 feet below grade surface (bgs).

1.4.3 Groundwater Flow Direction

Regional groundwater flow maps that include the Site indicate that the shallow groundwater flow at the Site is to the north-northwest towards English Kills.

1.5 Previous Report Findings

Prior to the preparation of the RIWP, a Phase I ESA, and Phase II ESI, were conducted for the Site. The tasks conducted for the Phase II ESI consisted of a geophysical survey, and the collection of subsurface soil samples.

The LEG Phase I ESA did not find any recognized environmental conditions (RECs) for the Site.

1.5.1 Summary of Findings and Conclusions of the Liberty Soil Disposal Characterization

Based on the findings of this soil disposal characterization, the following conclusions are provided:

Liberty oversaw the advancement of 8 soil borings at the property using a Geoprobe® direct-push apparatus. All borings were advanced to 20 feet below grade (the proposed basement depth). At each boring, the Liberty field scientist performed soil screening and logged soil classification observations. Based on field screening, 80 discrete soil samples were collected from the borings, and grouped into 8 subsets of 10 samples each. Each subset was a horizontal composite of a 2-foot depth interval from 0 to 2 feet, 2 to 4 feet, and so on to 18 to 20 feet.

Each individual biased grab sample from its associated depth interval subset was submitted for Target Compound List (TCL) volatile organic compounds (VOCs). Ethylene Chloride and Acetone were the only analytes detected from the 10 individual grab samples. Methylene Chloride, a common laboratory contaminant, was detected in every individual grab sample (GP-5 (0-2 feet), GP-3 (2-4 feet), GP-5 (4-6 feet), GP-4 (6-8 feet), GP-6 (8-10 feet), GP-6 (10-12 feet), GP-7 (12-14 feet), GP-6 (14-16 feet), GP-6 (16-18 feet), and GP-20 (18-20 feet), ranging from 8.2 to 17.6 micrograms per kilograms (µg/kg), all of which are below the NYSDEC's Soil Cleanup Objectives (SCOs) Unrestricted Use standard of 50.0 µg/kg. Acetone, also a common laboratory contaminant, was detected in samples GP-6 (8-10 feet) and GP-6 (16-18 feet) at 16.3 and 20.5 µg/kg respectively, both below the NYSDEC SCOs Unrestricted Use standard of 50.0 µg/kg.

Polychlorinated Biphenyls (PCBs) were not detected in any of the samples, and none of the corrosivity, ignitability, or reactivity analyses exceeded their respective hazardous waste thresholds. One metal, lead, exceeded its hazardous waste characteristic threshold of 5.0 milligrams per liter (mg/L) in two of the ten composite samples – in the 8 to 10-foot interval and in the 10 to 12-foot interval. The excavated material from this soil horizon should be segregated and handled separately from the other non-hazardous excavated materials.

Multiple metals and Polycyclic Aromatic Hydrocarbons (PAHs) were detected in the composite samples at various concentrations, and these will be reviewed by the disposal facility to determine whether they meet their acceptance criteria.

1.5.2 Summary of Findings and Conclusions of the GEI Phase II ESI

A total of three (3) soil test borings were conducted on the subject property and a total of six (6) soil samples will be collected. One (1) soil sample was collected from each boring location, at a depth of 0 to 4 feet, 4 to 8 feet and 8 to 12 feet. The 0 to 4 and 4 to 8 feet samples were evaluated in the field and one composite sample from the two zones were sent for lab analysis. In addition, one (1) composite soil sample from each boring location at a depth 8 to 12-feet was sent to the lab for analysis.

- The soil at SB-1 contains concentrations of Semi-Volatile Organic Compounds (SVOCs) that exceeds the NYSDEC in accordance with 6 New York Codes, Rules and Regulations (NYCRR) Part 375 SCOs for Restricted and Unrestricted Residential Use.
- The soil at SB-1 contains concentrations of Metals that exceeds the NYSDEC in accordance with 6 NYCRR Part 375 SCOs for the Protection of Groundwater and Unrestricted Residential Use.
- The soil at SB-2 contains concentrations of Metals that exceeds the NYSDEC in accordance with 6 NYCRR Part 375 SCOs for Protection of Groundwater and Unrestricted Residential Use.
- The soil at SB-3 contains concentrations of Metals that exceeds the NYSDEC in accordance with 6 NYCRR Part 375 SCOs for Protection of Groundwater and Unrestricted Residential Use.

1.5.3 Proposed Future Use of Site

The proposed redevelopment project includes the construction of a 17-story approximately 63,000 gross square foot residential building at 99-101 Granite Street, Brooklyn, New York. The Site is further known and designated as Block 3457 and Lot 49 (f/k/a Lots 49 and 35). The new building will cover approximately 17,632 square feet and will include below-grade parking with additional parking on the first floor. The first floor will also consist of lobby space for the entrance to a community facility and residential rental units. The community facility will occupy the second and third floors, while all remaining floors will be utilized for residential purposes. The proposed use is consistent with the R6 general residence district zoning.

1.6 Project Organizational Structure and Responsibility

GEI will coordinate with NYSDEC to conduct the RIWP. Approval of this RIWP by the NYSDEC will be obtained prior to Site investigation.

The drilling subcontractor will be responsible for all drilling activities to include, but not be limited to, compliance with all applicable Occupational Safety and Health Administration (OSHA) regulations, personnel health and safety, installation of soil borings, soil vapor probes, and groundwater monitoring wells associated with the RIWP, and any other specified tasks outlined in this RIWP.

GEI will be responsible for project management, subcontractor oversight, RIWP compliance, determination of corrective measures when needed, monitoring for health and safety, perimeter-air monitoring activities, collection of analytical samples, and maintenance of Site sampling and meteorological logs. GEI will also serve as the Site Health and Safety Officer.

The following are the key personnel or agencies involved with RIWP activities at the Site:

NYSDEC:	James Drumm Project Manager NYSDEC Division of Environmental Remediation 625 Broadway, 12th Floor Albany, NY 12233 (518)402-9768
Drilling Subcontractor:	To be Selected
GEI:	Gary Rozmus, P.E. Program Manager 110 Walt Whitman Road, Suite 204 Huntington Station, NY 11746 (631) 479-3510
	Edward Bradshaw Project Manager 110 Walt Whitman Road, Suite 204 Huntington Station, NY 11746 (631) 759-2977
	Ms. Jaimie Wargo Quality Assurance Officer 455 Winding Brook Drive Glastonbury, CT 06033 (860) 368-5300
Remedial Party Contact:	Medford Ber LLC c/o PAR Group Development LLC 60 North Prospect Avenue Lynbrook, NY 11563

Resumes of key GEI personnel for this project are included in **Appendix A**.

2. Scope of Work

All field work will be performed in accordance with the Field Sampling Plan (FSP) methods included in **Appendix B**. Analytical sampling will be performed in accordance with the Quality Assurance Project Plan (QAPP) included in **Appendix C**. A Community Air Monitoring Plan (CAMP) will be implemented during field activities and is included in **Appendix D**. The locations of all proposed sampling points for the RIWP samples are depicted in **Figure 2**.

The RIWP scope of work includes the following general tasks:

- Mobilization and Site Access
- Site Preparation
- Odor and Fugitive Dust Control
- Soil Boring Installations
- Soil Vapor Probe Installations
- Groundwater Monitoring Well Installations
- Material Handling
- Site Restoration
- Survey
- Soil, Soil Gas and Monitoring Well Sampling
- Reporting

2.1 Execution of the RIWP

Site work will commence at 0700 Monday through Friday with no heavy truck traffic until 0800. All work must be completed and the work area closed for the evening at 1700 unless otherwise authorized by the property owner. During working hours, the drilling subcontractor will make every effort to minimize potential community impacts. These include, but are not limited to, noise and traffic concerns associated with the execution of the RIWP. Site work will not be conducted on weekends or holidays without prior approval by the property owner.

2.2 Mobilization and Site Access

The selected drilling subcontractor will submit a Site-specific Health and Safety Plan (HASP) meeting the minimum requirements of GEI’s HASP, which is included in **Appendix E**. All work will be performed in accordance with OSHA, state, and industry safety standards. All onsite personnel performing intrusive activities that have the potential to come in contact with impacted materials will have the requisite 1910.120 OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) Training as well as Site-specific training prior to intrusive activities. All personnel performing work associated with this RIWP will be required to have both general and Site-specific training. The general training includes all applicable OSHA and state required training, such as 40-hour HAZWOPER and the 8-hour Refresher Training. Supervisory personnel will also have supervisory training. All personnel will be in a medical surveillance program. Also, Site-specific training will be given to all personnel performing fieldwork at the Site daily. This Site-specific training will include a review of potential Site hazards, required personal protective equipment (PPE), and Site warning and evacuation procedures.

The drilling subcontractor will apply for and obtain all necessary Federal, State, and local permits associated with the RIWP. These permits may include, but are not limited to, traffic routing, road opening, construction/zoning, etc. Conditions of these permits will be complied with during the construction.

The property owner will provide access to the Site. This access will be for all RIWP activities.

The drilling subcontractor will be responsible for contacting the Long Island One Call Center to request that all utilities on the Site be located and marked. The Contractor is responsible for resolving all potential conflicts. Underground utility protection will be the responsibility of the selected Contractor. When all utilities have been verified/ confirmed/protected, then intrusive activities may be initiated.

The selected drilling subcontractor will mobilize all necessary labor, equipment, supplies, and materials to complete the RIWP. Lay down areas for equipment, supplies and materials, the appropriate exclusion zone(s) and support area(s) will be identified to conduct the planned activities safely and effectively. All equipment will be inspected prior to utilization for the RIWP and checked periodically for performance and corrective repair. All equipment will be cleaned prior to arrival on the project site.

2.3 Site Preparation

The Site will be prepared for the RIWP. Site preparation activities necessary to provide support for the work include the establishment of work zones, support facilities, decontamination facilities, and installation of temporary security measures around work areas. The work area may change daily based on the locations of the sampling points. Modifying the work area daily should help to reduce the need for erosion control, security and overnight safety measures, and minimize disruption to normal community operations.

All work will be conducted to minimize impacts to existing utilities.

2.4 Odor and Fugitive Dust Control

In accordance with NYSDEC and New York State Department of Health (NYSDOH) requirements, a CAMP will be implemented at the Site during ground intrusive activities. The objective of the CAMP is to provide a measure of protection for the downwind community (i.e., offsite receptors, including residences and businesses and onsite workers not involved with Site RIWP activities) from potential airborne contaminant releases as a direct result of intrusive RIWP activities. Air monitoring stations will be placed up-wind and downwind of each intrusive work area (i.e., soil boring, soil vapor probe and monitoring well locations). VOCs and respirable particulates (PM-10) will be monitored at the up-wind and downwind stations on a continuous basis. In addition, to the fixed stations, VOCs and particulates will be monitored in the work zone using hand held equipment. VOCs and particulates will also be monitored around the perimeter of the work zone on a regular basis (hourly) by the GEI air monitoring personnel.

2.5 Site Characterization Soil Sampling

Five shallow soil samples (SSB-1 through SSB-5) will be collected to provide general coverage of the soil conditions across the site. During the installation of these borings, soil samples will be collected from every 5-foot interval from each boring to the water table, approximately 28-feet bgs, and will be inspected for impacts (e.g., staining and odor) and screened for volatile soil vapors using a photoionization detector (PID). Each 5-foot interval shall have a composite sample (except for the VOC sample), collected for laboratory analysis. VOCs samples shall be obtained via grab sample utilizing a Terra Core™ sampler in accordance with USEPA SW-846 Method 5035.

Soil samples will be properly transported to a NYSDOH Environmental Laboratory Accreditation Program (ELAP)-certified laboratory under chain-of-custody procedures and analyzed for target compound list (TCL) VOCs by United States Environmental Protection Agency (USEPA) Method 8260B, SVOCs by EPA Method 8270C Total Analyte List (TAL) metals by EPA Method 6010B and 7471B, and polychlorinated biphenyls (PCBs) and pesticides by EPA Method 8082, Quality Assurance/Quality Control (QA/QC) samples will be collected according to the QAPP. The data will be provided in a Category B data deliverable.

All analyses will be performed by a (NYSDOH Environmental Laboratory Accreditation Program (ELAP)-certified laboratory

2.6 Soil Vapor Monitoring Point Installations

Three (3) soil vapor samples (SV-1, through SV-3) will be collected. The rationale for the investigation sample locations is provided below:

- SV-1: Northern portion of the site
- SV-2: Central portion of the site
- SV-3: Southern portion of the site

All samples will be collected in accordance with the Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (NYSDOH October 2006). Conditions in the field may require adjustment to the sampling locations. The soil vapor probes will be installed to a depth of 6 feet below grade.

The soil vapor points will be installed using 1-inch diameter steel drill rods advanced using direct push drilling methods. The soil vapor probe will consist of a prefabricated 2-3-inch perforated steel vapor probe tip attached to 3/8-inch diameter low-density polyethylene (LDPE) plastic riser tubing. Once driven to depth, the rods are removed leaving only the tip and the tubing. The vapor probe borehole will be backfilled with #2 Morie well grade gravel. A surface seal will be placed using an impermeable clay seal installed within the last 6 inches of the probe-hole annulus from surface grade level. The vapor well will be purged using a hand pump or equivalent device after installation.

Samples will be collected in 6-liter Summa canisters which have been certified clean by the laboratory and analyzed by using USEPA Method TO-15. Flow rate of both purging and sampling will not exceed 0.2 liters per minute (L/min). Sampling will occur for the duration of 8 hours. A sample log sheet will be maintained summarizing sample identification, date and time of sample collection, sampling depth, identity of samplers, sampling methods and devices, soil vapor purge volumes, volume of the soil vapor extracted, vacuum of canisters before and after the samples are collected, apparent moisture content of the sampling zone, and chain of custody protocols.

As part of the vapor intrusion evaluation, a tracer gas will be used in accordance with NYSDOH protocols to serve as a QA/QC device to verify the integrity of the soil vapor probe seal. Helium will be used as the tracer gas and a box will serve to keep it in contact with the probe during testing. A portable monitoring device will be used to analyze a sample of soil vapor for the tracer prior to sampling. If the tracer sample results show a significant presence of the tracer, the probe seals will be adjusted to prevent infiltration. As the conclusion of the sampling round, tracer monitoring will be performed a second time to confirm the integrity of the probe seals.

The soil vapor data and indoor air sampling data will be evaluated in accordance with NYSDOH guidance document requirements to determine if remedial actions are warranted.

2.7 Groundwater Monitoring Well Installations

Three (3) groundwater monitoring wells (MW-1 through MW-3) will be installed. The wells will be installed to bridge the water table. Groundwater is anticipated to be approximately 28-feet bgs. The monitoring wells will be installed to a depth of approximately 35-feet bgs with at least 10-feet of screen within the groundwater.

Each monitoring well will be constructed with 2-inch diameter schedule (SCH) 40 polyvinyl chloride (PVC) 0.010-inch slotted well screen threaded to 2-inch diameter SCH 40 PVC riser to surface. The wells will be completed with a Morie #2 sand pack to 2 feet above top-of-screen, 2 feet of wetted bentonite pellets, and tremie-grout to surface. Monitoring wells will be finished with an expanding well cap and accessed through an 8-inch bolted manhole. Drill cuttings and development water will be properly stored onsite until proper transportation and disposal.

2.8 Monitoring Well Development

Monitoring wells may be developed using a high flow pump and will be monitored for drawdown and recovery. Well development fluids will be pumped into 55-gallon drums, a large volume tank, or mobile tanker truck. All groundwater generated during development activities will be disposed offsite at an appropriate facility.

2.9 Monitoring Well Sampling

Groundwater samples will be collected from each monitoring well following installation and proper well development utilizing low-flow sampling techniques. Field parameter readings will be monitored during sampling including pH, oxidation reduction potential (ORP), specific conductance and dissolved oxygen (DO). Each monitoring well will be sampled for TCL VOCs by United States Environmental Protection (EPA) Method 8260B, TCL SVOCs by EPA Method 8270D, 1,4 dioxane and per- and polyfluoroalkyl substances (PFASs) by either EPA Method 537 or ISO 25101, pesticides, PCBs, and dissolved TAL Metals by EPA Method 6010B; QA/QC samples will be collected according to the QAPP. Additional lab analyses may be included based on field observations. Groundwater samples will be properly transported to a NYSDOH ELAP-certified laboratory under chain of custody procedures.

2.10 Material Handling

RIWP-derived wastes produced during soil boring and monitoring well installations, including soil cuttings, groundwater, decontamination waters, and removed groundwater will be collected and stored within 55-gallon United States Department of Transportation/United Nations (USDOT/UN) drums. The transporter and transport vehicle must be approved in accordance with 6 NYCRR, Chapter IV, Part 364. The location of the waste storage area will be determined during the preliminary Site visit to be completed prior to the start of RIWP activities.

2.11 Site Restoration

The drilling subcontractor will restore all areas disturbed by the RIWP activities to pre-existing conditions based on the applicable access agreements. Restoration actions shall include, but may not be limited to:

- Removal of all temporary facilities, including decontamination areas, and unused materials
- Replacement or repair of all asphalt and concrete surfaces removed or damaged during the RIWP, as appropriate.

2.12 Survey

All monitoring well, soil vapor and soil boring locations will be surveyed by a professional surveying firm.

Following completion of the RIWP activities, a New York State Licensed Land Surveyor will survey all monitoring wells. The elevation of each new monitoring well will be determined to ±0.01 foot. All locations and elevations will be tied to the New York State Plane Coordinate System.

2.13 Reporting

Reporting is discussed in Section 5.

3. Quality Assurance/Quality Control (QA/QC) Protocols

QA/QC protocols are included in **Appendix C**.

4. Health and Safety Protocols

Health and safety protocols are detailed in the HASP, which is included in **Appendix E**.

5. Data Evaluation and Remedial Investigation Report

The soil, sediment, soil vapor/indoor air quality and groundwater sample results will be compared to 6 NYCRR Part 375 Unrestricted Use SCOs, NYSDOH guidance values, and the New York State Ambient Water Quality Standards and Guidance Values for Class GA Groundwater, respectively. These are the current target SCOs.

5.1 Data Evaluation

The purpose of the data evaluation is to determine the extent of onsite soil, soil vapor, and groundwater impacts and to assure that data obtained during the implementation of the RIWP are adequate in quantity and quality, and applicable to project objectives. To make this determination, the data will be reviewed for the quality of data coverage, compatibility of data collection methods, and completeness, with respect to meeting project objectives.

To facilitate the interpretation of data generated during the remedial investigation activities, the data will be tabulated in data summary tables. Figures showing sampling locations with the corresponding analytical results will be prepared to enhance the overall understanding of Site conditions regarding the magnitude, location, and flow and transport of contamination.

5.2 Geologic/Hydrogeologic and Water Quality Characteristics

Geologic and hydrogeologic characterization will incorporate the results of subsurface evaluation and sampling activities, groundwater sampling and monitoring activities, as well as general hydrogeologic and hydraulic features of the Site. The characterization will set forth conclusions regarding the direction, gradients, and potential fluctuations or anomalies of shallow groundwater in the immediate vicinity of the Site.

5.3 Qualitative Exposure Assessment

The purpose of the Qualitative Exposure Assessment (QEA) is to document how people may be exposed to site contaminants and to identify and characterize the potentially exposed current population and under the reasonably anticipated future use of the site. The exposure assessment must evaluate the five elements associated with exposure pathways, and describe how each of these elements pertains to the site being evaluated. The exposure pathway elements that must be addressed, include: (1) a description of the contaminant source(s) including the location of the contaminant release to the environment (any waste disposal area or point of discharge) or if the original source is unknown, the contaminated environmental medium (soil, indoor or outdoor air, biota, water) at the point of exposure; (2) an explanation of the contaminant release and transport mechanisms to the exposed population; (3) identification of all potential exposure point(s) where actual or potential human contact with a contaminated medium may occur; (4) description(s) of the route(s) of exposure (i.e., ingestion, inhalation, dermal absorption); and (5) a characterization of the receptor populations who may be exposed to contaminants at a point of exposure. In addition to human exposure, the QEA will also address the potential for fish and wildlife impacts from site contaminants.

5.4 Additional Field Investigations

Additional field investigations may be required as the data is developed during the implementation of the site investigation. Conditions that would warrant additional investigation include data gaps, further delineation of groundwater or soil contamination, or additional data necessary to evaluate or determine the effectiveness of a potential remedial alternative technology.

If additional investigation is required, a supplemental work plan will be prepared and submitted to the NYSDEC for review and approval for implementation during this site investigation.

5.5 Remedial Investigation Report

The results, along with supporting documentation, will be provided to the NYSDEC in the form of a Remedial Investigation Report (RIR). Laboratory data will be provided as a Category B deliverable and a third-party data usability summary report (DUSR) will be prepared. All data generated as part of the remedial investigation (RI) will be submitted to NYSDEC in the appropriate Electronic Data Deliverable (EDD) format. The RIR will contain a description of the source, as well as characterizations of the geologic, hydrogeologic, soil, soil vapor and water quality. Additionally, if needed, the RIR will contain a remedial action alternative analysis as well as the proposed remedial alternative. The Remedial Action Report (RAR) is further described in Section 6 below.

Based on the findings of the RI, a list of remedial action objectives will be developed with the requirement for the selected remedial measures to be protective of human health and the environment under the proposed future use scenario. Proposed SCOs for the property will also be presented based on the proposed future use of the Site. SCOs will be based on published standards, criteria, and guidance (SCG) and other NYSDEC and NYSDOH accepted values.

The RIR will present the findings of the RI, and implemented remedy of the redevelopment, and is organized as follows:

- Certification
- Introduction
- Site Description and History
- Methods of Investigation
- Nature and Extent of Contamination

- Remedial Program
- Qualitative Human Health Exposure Assessment
- Summary and Conclusions

5.6 Interim Remedial Measures (IRM)

In addition to cleanup of affected media described in this work plan, IRMs may be proposed to address unacceptable or imminent risks. Preliminary results from the RI will be used to evaluate the necessity for an immediate response associated with a particular medium, route of exposure, or potential sensitive receptor. The IRM will be selected with the understanding that the measure should be compatible with the overall project objectives and long-term remedial action goals.

If an IRM is deemed necessary, an IRM work plan will be submitted to the NYSDEC with the RIR, which describes the proposed measure, justification for its selection, and a schedule for the activities associated with its implementation. The IRM Work Plan will present the project scope, objectives, planned activities, sampling procedures and reporting requirements. Depending on specific circumstances and conditions at the Site following complete implementation of IRMs, the activities associated with the IRMs may be determined to constitute complete remediation.

6. Remedial Investigation Report

Remedial alternatives, beyond the planned impacted soil excavation as an IRM are not anticipated to be warranted for the Site, but may be evaluated based on the information generated during the implementation of this RIWP, which will be summarized and presented in the RIR.

If additional remediation beyond the removal and cleanup associated with the impacted soil excavation is required because other impacts are identified which require remediation, then the following steps may be needed.

Should an IRM be the only remedial work required, an evaluation of the remedial action objectives, alternatives scoping and analysis of remedial action alternatives will be performed to support that conclusion that the IRM is appropriate and that no other actions are needed.

6.1 Remedial Alternatives Scoping

<u>Objectives of the Remedial Alternatives Evaluation</u>

The overall objective of the remedial alternatives evaluation process is to select a remedial action. The selected remedial action will be based upon the criteria listed in Section 4.2 of NYSDEC Division of Environmental Remediation DER-10 Technical Guidance for Site Investigation and Remediation. Analysis of Remedial Action Alternatives

<u>Remedial Investigation Report/Remedial Action Report</u>

Upon completion of the RI results and findings, as well impacted soil excavation, the need for further remediation will be evaluated. A RIR will then be submitted to NYSDEC for comment and approval.

7. Citizen Participation Activities

GEI will provide personnel and materials to assist the NYSDEC in providing the community with information relating to the ongoing investigations at the Site. GEI will:

- Establish a Community Information Repository at the local library, or other community center;
- Participate in public meetings that the NYSDEC deems necessary to apprize the community of the current or proposed activities;
- Identify public and elected officials who may have a need to be informed;
- Identify the affected or interested public; and
- Disseminate the approved fact sheets to the Site Contact List.

A description of the plan is presented below.

7.1 Description of Citizen Participation Activities

This section describes the specific citizen participation activities that are to be carried out during the implementation of the RIWP.

7.1.1 Citizen Participation Plan

The Citizen Participation Plan (CPP) will be deposited in the designated document repository. In addition to the CPP, previously prepared documents, such as the Phase I report, Phase II report, Brownfield Cleanup Agreement, and HASP will be filed in the repository.

7.1.2 RIWP

The Final RIWP will be placed on file in the document repository as well.

7.1.3 Remedial Investigation Report

The RIR will be placed in the information repositories and the public will be so notified of this with the fact sheet.

7.1.4 Interim Remedial Measures

If an IRM is to be implemented, the public will be involved as part of the Citizen Participation Process.

7.1.5 Remedial Action Work Plan

Remedial alternatives, beyond impacted soil excavation as an IRM are not anticipated to be warranted for the Site, but will be evaluated based on the information generated during the implementation of this RIWP, which will be summarized and presented in the RIR.

If additional remediation beyond the impacted soil excavation is required because other impacts are identified which require remediation, then the following steps may be needed.

Should an IRM be the only remedial work required, an evaluation of the remedial action objectives, alternatives scoping and analysis of remedial action alternatives will be performed to support that conclusion that the IRM is appropriate and that no other actions are needed.

If further remediation is determined to be needed, beyond the removal of impacted soil removal, a Draft RAWP will be prepared which details the proposed remedial actions. NYSDEC will issue a Preliminary Decision Document (PDD) and the PDD will be placed in the document repository. An NYSDEC fact sheet will be distributed to the media on the Contact List to announce the availability of the PDD for public review and comment. A fact sheet and notice of public meeting, if necessary, will be distributed by a mailing. Public comments will be solicited to aid in the preparation of the Final RAWP. The public meeting will be conducted, if required. Following the public comment period, NYSDEC will issue a Decision Document, at which time the RAWP will be finalized.

7.1.6 Post Remedial Action

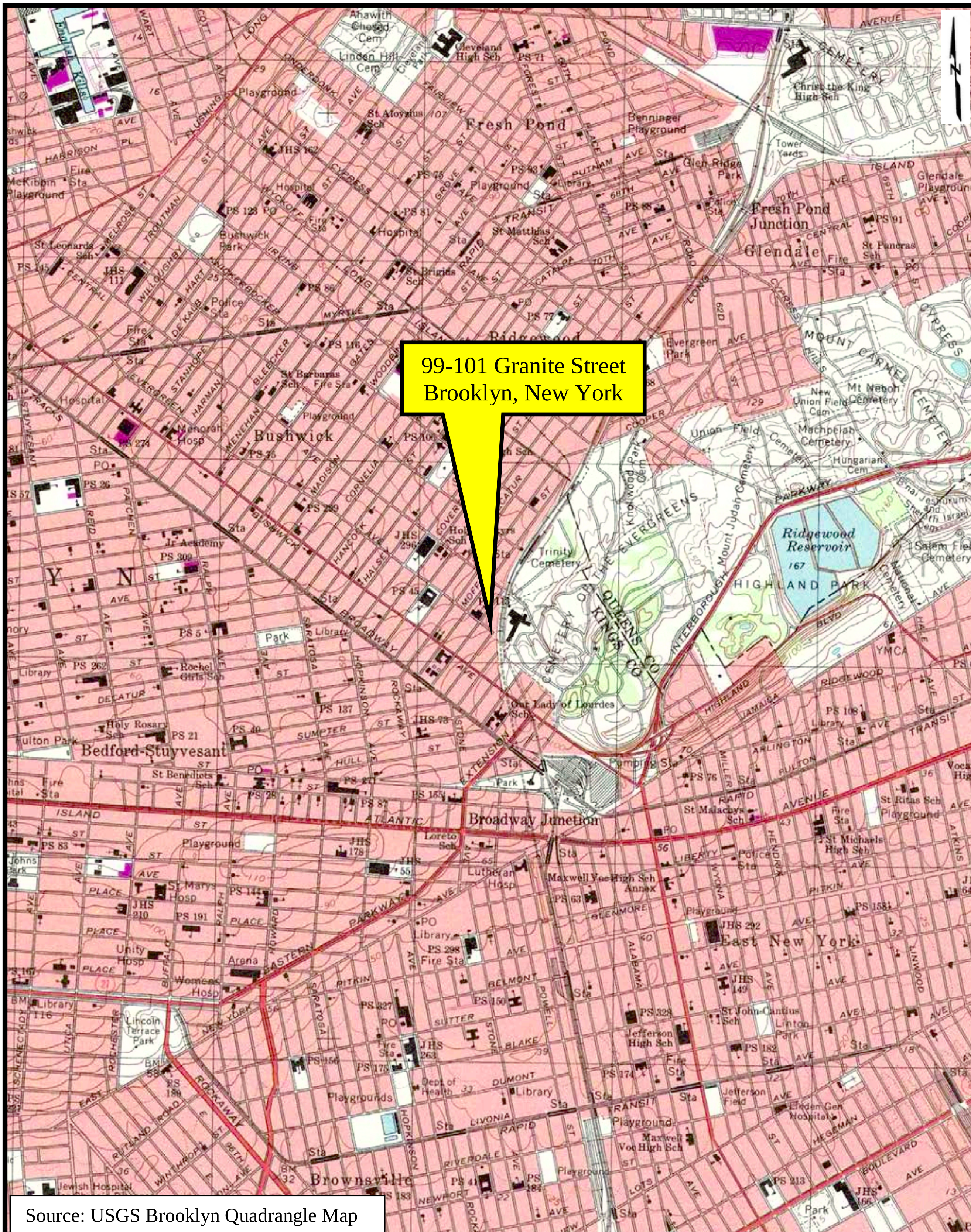
Following completion of the remedial action, or actions, two Fact Sheets will be prepared. The first will summarize the Final Engineering Report (FER) and the second will announce the issuance of the Certificate of Completion. The two sheets will be combined if the FER and Certificate of Completion issuance occur close in time.

8. Schedule

The project schedule for implementation of the RIWP activities is presented below. The schedule may be affected by regulatory review time periods, contractor response timeframes, timeframes necessary to negotiate access agreements with property owners, community issues, permit review and approval timeframes, or other unknown factors. In addition, if the scope of the proposed RIWP changes as a result of negotiating access or regulatory review, then revisions to the work plan, and plans and specifications or change orders with the drilling subcontractor and/or GEI may be required and the schedule presented herein, may be impacted. Every effort, however, will be made to keep the project on the anticipated schedule.

MILESTONE	**Time Frame (weeks)**	
	Individual	**Cumulative**
GEI Submits Final RIWP to NYSDEC	0	0
NYSDEC Approves Final RIWP	2	2
Public Comment Period	4	6
Drilling Subcontractor Mobilizes for Soil Borings, Soil Vapor Probes, and Groundwater Well Installations	1	7
RIWP Activities Completed	2	9
GEI Submits RIR and IRM Work Plan	4	13
NYSDEC Approves Final RIR and IRM Work Plan	4	17
Public Comment Period	4	21
Implementation of IRM	2	23
GEI Submits RAWP (if necessary)	2	25
NYSDEC Approves Final RAWP (if necessary)	4	29
Public Comment Period (if necessary)	4	33
GEI Submits FER	2	35
NYSDEC Approves Final FER	4	39
COC Issued by NYSDEC	4	43

Figures



Source: USGS Brooklyn Quadrangle Map

99 GRANITE STREET, BROOKLYN, NEW YORK	GEI Consultants	SITE LOCATION MAP
MEDFORD BER	Project 1704281	June 2018 Fig 1

NOTES:
LIBERTY ENVIRONMENTAL INC.
COMPACTED SOILS FROM GP-1 TO GP-8 TO DEPTHS FROM 0-2, 2-4, 4-6, 6-8, 8-10, 10-12 12-14, 14-16, 16-18 AND 18-20.

THE COMPOSITE SAMPLE RESULTS ARE AS FOLLOWS:

0-2 EXCEEDED THE NYC DEC PART 375 RVSCORR FOR SVOCS

2-4 EXCEEDED THE NYC DEC PART 375 RVSCORR FOR SVOCS

4-6 EXCEEDED ARSENIC

6-8 EXCEEDED SVOCS

8-10 EXCEEDED HAZARDOUS LEVEL FOR LEAD

10-12 EXCEEDED HAZARDOUS LEVEL FOR LEAD

			CLIENT ID:	SB-3 (0-3)	
			LAB ID:	AD00725-005	
			COLLECTION DATE:	10/20/2017	
			SAMPLE MATRIX:	Soil	
			SAMPLE UNITS:	mg/Kg	
TestCoc	CAS#	Analyte	Part375 Restricted Residential mg/Kg	Result	RL
		Metals			
HG-SOIL	7439-97-6	Mercury	0.81	1.4	0.092

			CLIENT ID:	SB-1 (0-4)	
			LAB ID:	AD00725-001	
			COLLECTION DATE:	10/20/2017	
			SAMPLE MATRIX:	Soil	
			SAMPLE UNITS:	mg/Kg	
TestCode	CAS#	Analyte	Part375 Restricted Residential mg/Kg	Result	RL
		SemiVolatiles			
BNA-8270	83-32-9	Acenaphthene	100	0.68	0.11
BNA-8270	208-96-8	Acenaphthylene	100	ND	0.11
BNA-8270	98-86-2	Acetophenone	NA	ND	0.11
BNA-8270	120-12-7	Anthracene	100	0.99	0.11
BNA-8270	1912-24-9	Atrazine	NA	ND	0.11
BNA-8270	100-52-7	Benzaldehyde	NA	ND	0.11
BNA-8270	56-55-3	Benzo[a]anthracene	1	**1.9**	0.11
BNA-8270	50-32-8	Benzo[a]pyrene	1	**1.5**	0.11
BNA-8270	205-99-2	Benzo[b]fluoranthene	1	**2**	0.11
BNA-8270	191-24-2	Benzo[g,h,i]perylene	100	0.96	0.11
BNA-8270	207-08-9	Benzo[k]fluoranthene	3.9	0.63	0.11
BNA-8270	111-91-1	bis(2-Chloroethoxy)methane	NA	ND	0.11
BNA-8270	111-44-4	bis(2-Chloroethyl)ether	NA	ND	0.028
BNA-8270	108-60-1	bis(2-Chloroisopropyl)ether	NA	ND	0.11
BNA-8270	117-81-7	bis(2-Ethylhexyl)phthalate	NA	ND	0.11
BNA-8270	85-68-7	Butylbenzylphthalate	NA	ND	0.11
BNA-8270	105-60-2	Caprolactam	NA	ND	0.11
BNA-8270	86-74-8	Carbazole	NA	0.5	0.11
BNA-8270	218-01-9	Chrysene	3.9	1.6	0.11
BNA-8270	53-70-3	Dibenzo[a,h]anthracene	0.33	0.25	0.11
BNA-8270	132-64-9	Dibenzofuran	59	0.35	0.028
BNA-8270	84-66-2	Diethylphthalate	NA	ND	0.11
BNA-8270	131-11-3	Dimethylphthalate	NA	ND	0.11
BNA-8270	84-74-2	Di-n-butylphthalate	NA	ND	0.11
BNA-8270	117-84-0	Di-n-octylphthalate	NA	ND	0.11
BNA-8270	206-44-0	Fluoranthene	100	4.3	0.11
BNA-8270	86-73-7	Fluorene	100	0.49	0.11
BNA-8270	118-74-1	Hexachlorobenzene	1.2	ND	0.11
BNA-8270	87-68-3	Hexachlorobutadiene	NA	ND	0.11
BNA-8270	77-47-4	Hexachlorocyclopentadiene	NA	ND	0.11
BNA-8270	67-72-1	Hexachloroethane	NA	ND	0.11
BNA-8270	193-39-5	Indeno[1,2,3-cd]pyrene	0.5	**0.84**	0.11
BNA-8270	78-59-1	Isophorone	NA	ND	0.11
BNA-8270	91-20-3	Naphthalene	100	0.72	0.028
BNA-8270	98-95-3	Nitrobenzene	15	ND	0.11
BNA-8270	621-64-7	N-Nitroso-di-n-propylamine	NA	ND	0.028
BNA-8270	86-30-6	N-Nitrosodiphenylamine	NA	ND	0.11
BNA-8270	87-86-5	Pentachlorophenol	6.7	ND	0.56
BNA-8270	85-01-8	Phenanthrene	100	4	0.11
BNA-8270	108-95-2	Phenol	100	ND	0.11
BNA-8270	129-00-0	Pyrene	100	3.6	0.11

N

LEGEND:

GP-1 BORING PERFORMED BY LIBERTY ENVIRONMENTAL ON 6/20/2017

SB-1 BORING PERFORMED BY GEI CONSULTANTS ON 10/20/2017

0 50 100
SCALE: 1" = 50'

SOURCE:
1. MAP EXTRACTED FROM GOOGLE MAPS

99 GRANITE ST. BROOKLYN, NY	GEI Consultants	PREVIOUS SAMPLE LOCATIONS
MEDFORD BER LLC	Project 1704281	JUNE 2018 Fig. 2

\\gdc1v-fs01\ I:\Tech\Environmental Projects\PAR Group\99 Granite St Brooklyn\CAD\Figures\FIG - 1.dwg - 11/13/2017

LEGEND:

SB-1 PROPOSED SOIL BORING LOCATION

MW-1 PROPOSED MONITORING WELL LOCATION

SV-1 PROPOSED SOIL VAPOR LOCATION

SOURCE:

1. MAP EXTRACTED FROM GOOGLE MAPS

0 50 100

SCALE: 1" = 50'

99 GRANITE ST. BROOKLYN, NY	GEI Consultants	PROPOSED SAMPLING LOCATIONS
MEDFORD BER	Project: 1704281	AUGUST 2018 Fig. 3

\\hts1v-fs01\ I:\Tech\Environmental Projects\PAR Group\99 Granite St Brooklyn\CAD\Figures\FIG - 1.dwg - 11/13/2017

Appendix A

Key GEI Personnel Resumes

Edward Bradshaw
Senior Practice Leader

resume

Edward Bradshaw is a Senior Practice Leader in GEI's Huntington, NY office. He has over 29 years' experience in environmental engineering. His responsibilities include providing leadership, strategic guidance and management to the greater New York Metro area market segment. In addition to providing technical oversight and managing project personnel, he is responsible for budget analysis, quality, safety and schedule performance of major environmental projects. He is responsible for the management of projects and initiatives within various industries including electric and gas utility, manufacturing, printing, real estate development, waste management, railroad, food services, petroleum distribution, pharmaceutical and general manufacturing, and also provide environmental services to municipal agencies. As a Senior Practice Leader, he leads and stewards the performance of project teams ensuring project tasks are completed on time and within budget and are of high quality. Additionally, he is responsible for the day to day management of the technical and field staff, as well as managing several contracts with multiple companies.

PROJECT EXPERIENCE

Second Avenue Subway, NYC Transit Authority, Environmental Manager. Prepared and implemented a Hazardous Materials Intrusive Investigation Work Plan to assess the presence of hazardous materials at sites identified by the SDEIS (and supplemental data review) that may affect construction/operation of the Project. Developed Concept/ Preliminary designs for soil/groundwater areas identified as needing special management during construction. The management of contaminated materials was required both as separate projects in advance of general construction, and as part of the overall construction project. A standard design specification was prepared for treatment of contaminated dewatering effluent when it is encountered, so that the treatment systems can be readily available on short notice. Developed Preliminary Contaminated Soil Monitoring and Confirmation Protocols for use during remedial action and associated construction. Developed a Spoils Management Plan. The plan will show the quantity, quality, and rate at which spoil will be produced from different portions of the project; provide means for minimizing intrusion into the community; promote beneficial reuse; and, identify the permit requirements.

NJ Trans-Hudson Express, Environmental Manager. Managed the LSRP/Remedial design work for several properties NJ Transit purchased as part of this project. The total billings on this work was in excess of $1.1MM. Prepared and implemented a Soil and Groundwater Investigation Work Plan to assess the presence of contamination at sites identified by the SDEIS (and supplemental data review) that may affect construction/operation of the project;

EDUCATION
B.S. Civil Engineering, Manhattan College
M.E. Environmental Engineering, Manhattan College

EXPERIENCE IN THE INDUSTRY
29 years

EXPERIENCE WITH GEI
Since 2017

CERTIFICATIONS
Certified Environmental Specialist
Professional Environmental Health & Safety Auditor
OSHA 40 Hour HAZWOPER
OSHA 30 Hour Construction
OSHA Incident Commander Training
OSHA Hazardous Materials Management
OSHA Hazardous Operations and Emergency Response
OSHA Hazardous Materials Specialist
US DOT HazMat General and Security Awareness
NYSDEC Class A and B PBS Operator
PADI Advanced SCUBA Diver

PROFESSIONAL ASSOCIATIONS
National Association of Safety Professionals (NASP)
National Association of Environmental Professionals (NAEP)

GEI Consultants

Prepare and implement Property Acquisition Environmental Cost Estimate (PAECE) reports for properties designated for full and/or partial acquisition, as well as temporary and/or permanent easements; Developed concept/ preliminary designs for soil/groundwater areas identified as needing special management during construction. It was anticipated that the management of contaminated materials was required both as separate projects in advance of general construction, and as part of the overall construction project. Reviewed construction design to determine environmental impacts; Developed Remedial Action Work Plans (RAWP) for sites along NJT's alignment which require remediation. RAWPs were for sites contaminated with coal tar, chromium, petroleum and PCBs. Developed a Spoils Management Plan. Provided means for minimizing intrusion into the community; promoted beneficial reuse; and, identified the permit requirements; Prepared plan which provided requirements for the collection, sampling, and discharge of dewatering effluent generated during project construction.

NJ Turnpike Interchange 6 to 9 Widening Program Project Manager. Responsible for managing the Freshwater Wetlands Individual Permit and Flood Hazard Area Permit applications and associated fieldwork and reporting. Manage the site investigation of land donation and wetland preservation site which included an ecological survey/investigation. Responsible for coordinating field personnel for ID 27 sampling, excavation and disposal. Ensure environmental permits are updated for each segment.

Managed "on-call" environmental contracts for both the MTA and Port Authority on New York and New Jersey. The contract required us to prepare bid documents, analyze bids, select contractor(s), and supervise the contractor during work. Developed and maintained systems to allow projects to be implemented effectively.

Confidential Client Chromium Site in Jersey City, NJ, Environmental Oversight/Construction Manager. After successfully negotiating the existing contract renewal, for $1.4MM, prepared a written and cost proposal for oversight services at another site where the client was to begin remediation. Facilitated a two year construction management contract worth $1.8 million. Advised client of any constructability or bidding problems with the proposed construction specifications and methods for staging the work; Participated in updates of the contractor's schedule and subsequently review the contractor's schedule and provide recommendations of adjustment or approval to the client as required. Maintained a master construction schedule; Maintained a direct line of communication with the project's design consultant as it pertains to the project's technical evaluation issues and resolutions; Participated in the client's bid analysis for all contracts associated the chromium sites; Enforced the environmental commitments project-wide; Worked with client to identify site-specific mitigation needs and construction sequencing to limit impacts and help ensure environmental compliance; Informed client of contract non-compliance, so that the client can assess the need for payment to be withheld or for a stop-work order to be issued; Facilitated timely communication of environmental compliance issues to the client. Responsible for ensuring effective written communication with the contractor(s), transmittal of information on environmental requirements and compliance; Enforced contract language that clearly states that the contractor(s) is responsible for complying with all Federal, State, and local environmental regulations and plans and procedures.

Project Manager, Con Edison, generation facilities. Monitored all phases of planning, design and construction for Con Edison at several generation facilities throughout the five boroughs of New York City. Additionally, ensured that the work met all applicable regulatory requirements, developed and maintained project schedule and budget, tracked all change orders and maintained document control; Managed completion of hazardous waste cleanups valued in excess of $1.0 million with major utility companies in the tri-state area, including Con Edison.

Project Manager, geotechnical investigations, generating plants. As Project Manager, managed the geotechnical investigations and laboratory testing for ten simple cycle, natural gas-powered generating plants. Three sites are adjacent to current Con Edison facilities and located in residential and industrial neighborhoods. Prior to and during the geotechnical investigations, managed the health and safety plans for each site. Completed complex field investigations that included drilling numerous borings; performing field reconnaissance and geophysical studies; and acquiring published subsurface and geologic data. Engineering recommendations were provided for rock supported piles, friction piles, undreamed (belled) piles, as well as soil improvements. Assisted the design engineer in selecting the most effective methods to found the generation equipment in the limited space that is available.

Project Manager, NYC Dept of Design and Construction. As Project Manager, managed several contracts with the New York City Department of Design and Construction for the upgrade, removal, replacement of petroleum storage tanks, approximately 100 tanks, at New York City owned and operated facilities throughout New York State. Responsible for handling contaminated soil/groundwater encountered during the removal/replacements.

Gary Rozmus, P.E.
Senior Consultant

resume

Gary Rozmus is a recognized leader in the environmental services and Brownfield redevelopment marketplace. His expertise is in Site assessment (Phase I, II and II ESAs, soil vapor intrusion and RI/FS); remediation; Brownfield redevelopment and risk-based closure (including area-wide and site specific planning and redevelopment); environmental compliance; regulatory interaction and negotiations; permitting; impact assessments; hazardous materials management (including asbestos containing materials-ACM, lead-based paint and other building and facility hazardous materials); GIS mapping and inventory; hazardous and non-hazardous waste management; litigation support; design, construction and facility decommissioning and demolition environmental services; stormwater and wastewater management; natural resource assessments; landfill closure; emergency incident/derailment consulting response; sustainable environmental design; and real estate transaction and support.

EDUCATION
M.S., Civil Engineering, Polytechnic Institute of New York
B.S., Civil Engineering, Manhattan College

EXPERIENCE IN THE INDUSTRY
43 years

EXPERIENCE WITH GEI
4 years

REGISTRATIONS AND LICENSES
Professional Engineer, NY No. 056744

CERTIFICATIONS
e-RAILSAFE Badge: e-VERIFILE.COM, Inc

MTA Metro-North Railroad Roadway Worker Procedures Training

PREVIOUS EXPERIENCE

Vice President in charge of national and regional business development and client and project management to private and public clients. Directed the corporate Brownfield Redevelopment and Transit and Rail environmental services business development groups. Developed and implemented strategic business development plans, served as client manager/point of contact and senior project manager or project manager on numerous projects.

Major clients and projects include:

Freight Railroads

CSXT: provided services to CSXT since the 1980s. This includes its corporate environmental, real estate (RPI) and law departments. These projects include the transfer of the NYC Highline to New York City for development as a promenade park and the sale of the Staten Island north shore line and St. George's railyard to NYC. The railyard has been redeveloped from a Brownfield site to a NY Yankees minor league ballpark. Hundreds of projects were performed and grew account to generate $3-4 million in annual consulting fees.

Norfolk Southern: provided services under a master services contract to the environmental, real estate and design and construction groups. These projects include the investigation and closure of sites in central NY, real estate leasing support services and facilities engineering assistance. Projects ranged up to several hundred thousand dollars.

Amtrak: provided services under a master services contract and on design and construction projects. These projects included conducting environmental compliance audits of major shop facilities, preparing environmental compliance plans and programs, facility design and bridge design. Projects ranged up to several hundred thousand dollars.

GEI Consultants

Transit Railroads

Directed and provided senior project management support for national transit client programs including Long Island Railroad (LIRR), Metro North Railroad (MNR), NYC Transit Authority, New Jersey Transit (NJT), SEPTA and WMATA. Led the efforts to win general environmental services contracts with LIRR, MNR and NJT and led efforts to win environmental services work as part of design and construction projects with total fees in the millions of dollars range.

Public and Private Sector Clients

Directed and provided senior project management services to public clients including NYC Mayor's Office of Environmental Remediation, NYC Economic Development Corporation; Triborough Bridge and Tunnel Authority, NYS and NYC DOT, other NYC agencies, other NY municipalities; and private clients including attorneys; manufacturers/distributors-e.g. Duracell and Frito Lay, developers, communication companies and construction contractors. As Senior Vice President and principal, led the environmental services area for primarily private clients.

- Awarded an ACEC Diamond Award and ACEC National Recognition Award for developing the NYC SPEED portal (Searchable Property Environmental E-database)
- Secured and directed a multi-year Brownfield consulting services contract through the NYCEDC for the NYCMOER. Led a team of environmental planners and GIS specialists in developing the NYC SPEED portal which mapped the entire City of NY and identified vacant Brownfield sites and environmental/Phase I data for each site as well as many other informational features
- Secured and managed area-wide Brownfield contracts under eight NYSDOS Brownfield Opportunity Area (BOA) grant awards.

PROJECT EXPERIENCE

City of Mt. Vernon Canal Village Brownfield Opportunity Area (BOA) and Local Waterfront Revitalization Plan (LWRP) Study, Mt. Vernon, NY. Environmental Project Manager for the Canal Village combined BOA and LWRP project to develop a redevelopment plan for the 251-acre waterfront area which includes the industrial area in the southeast corner of the City. This area lays along the eastern edge of the city limits that coincide with the Hutchinson River and its southern boundary with the Bronx, New York City. Because this planning effort has been made possible by two separate grants being combined—New York State's BOA and LWRP programs—there are two separate project boundaries which overlap. The work will serve as a BOA Nomination Report and as a neighborhood master plan for the Canal Village and the Hutchinson River Waterfront. This project included a study of the transportation and pedestrian network; industrial sector and regional relationships; strategic redevelopment sites investigation; public outreach; climate change impacts, habitat restoration, waterfront redevelopment plans, and green infrastructure opportunities; economic and market conditions study; urban design and open space considerations; and priority/catalytic redevelopment site selections.

City of Newburgh Brownfield Opportunity Area (BOA) Project, Newburgh, NY, City of Newburgh. Environmental Task Leader for the study to create a strategy for revitalizing and redeveloping the Census Tract area of the city of Newburgh, New York. This work included analysis of local, regional, and national markets to determine best land use revitalization, inventory and analysis of brownfield sites, existing land use patterns and zoning, transportation systems and infrastructure, and natural resources and environmental features. Tasks included community outreach and participation in the BOA process and the development of a redevelopment master plan.

Remedial Investigation/Remedial Analysis, Elmira, NY, Norfolk Southern Railway Company. Project Principal responsible for project oversight of the development of a remedial investigation work plan, remedial investigation report, and remedial alternatives analysis for a former rail yard in accordance with the site's voluntary cleanup agreement with the New York State Department of Environmental Conservation. Investigative efforts included surface and subsurface soil sampling, groundwater sampling, and soil gas investigation.

Newtown Creek Brownfield Opportunity Area, Brooklyn, NY, Greenpoint Manufacturing and Design Center. Project Manager responsible for providing services related to the Newtown Creek Brownfield Opportunity Area in Brooklyn, New York. Tasks included planning, developing a public engagement strategy, attending meetings, analyzing existing conditions of the study area, developing conceptual design guidelines, completing an economic analysis, developing a geographic information system (GIS) database, and preparing project recommendations and a draft nomination plan document.

Site Remediation, Redevelopment, and Legal Support Services, Huntington, NY, Town of Huntington. Project Manager responsible for site remediation, redevelopment, expert witness, and legal support services for the Town of Huntington in the Huntington Station Brownfield Opportunity Area. The Town had obtained a property under eminent domain that had been contaminated under prior usage involving a solid waste transfer station. Acted as Senior Project Manager in charge of evaluating remedial and redevelopment alternatives and costs that would meet New York Department of State brownfield future use standards and requirements. In addition, our firm was retained to assist the Town and legal counsel in litigation between the Town and the prior owner for cost recovery purposes.

Planning Work for Brownfields Opportunity Area Nomination Study, Huntington, NY, Town of Huntington. Project Manager responsible for planning work for the preparation of a Brownfields Opportunity Area nomination study to receive New York Department of State approval for the development of the Huntington Station area.

Brownfield Cleanup Program and Vacant Properties Database, New York, NY, New York City Mayor's Office of Environmental Remediation. Assistant Project Manager assisting with the development of a database for a Brownfield Cleanup Program (BCP) to promote the redevelopment of potentially contaminated and under-used sites. The City's BCP is the first municipal program of its kind in the country, and it is intended to facilitate the fast and efficient cleanup and reuse of contaminated sites. One of the 10 brownfield initiatives is the creation of a database of historical site uses across the city that can be used to identify potential brownfield sites. This vacant property database assists in the rapid redevelopment of these sites and allows the City to measure long-term progress toward the plan's goals.

On-Call Environmental Services, Various Locations, National Railroad Passenger Corporation (Amtrak). Contract Manager/Program Director providing on-call environmental service, which included conducting assignment audits of various facilities, designing a chemical storage and equipment washing facility at the Bear Delaware shop, and preparing spill prevention control and countermeasure (SPCC) plans for various facilities. Services also included permitting and plans; derailment and emergency response; SPCC and hazardous waste contingency; geographic information systems (GIS) services; hazardous waste and RCRA; air emissions permitting, compliance, and reporting; wastewater and stormwater; due diligence investigations; remedial investigations and feasibility studies; remedial design, oversight, and operation; wetlands assessments and mitigation; environmental management system, compliance audits, and environmental training; asbestos, lead-based paint, and mold services; environmental impact statement and National Environmental Policy Act services; industrial hygiene; and brownfield redevelopment.

Long Beach Brownfield Opportunity Area Study, Long Beach, NY, City of Long Beach. Project Manager responsible for providing professional planning services for the preparation of an approvable Brownfield Opportunity Area pre-nomination study for the revitalization of the bayfront area consistent with New York State Department of State and New York State Department of Environmental Conservation requirements. The project area was along Reynolds Channel on the southern shore of Long Island that is programmed for mixed-use redevelopment, including mid-rise residential development and a waterfront promenade.

Babylon Train Wash Facility, Babylon, NY, MTA Long Island Railroad. Senior Environmental Project Manager responsible for providing services for the conceptual, preliminary, and final designs and construction services for the unmanned, automatically operated, single-direction Babylon Train Wash Facility. The facility is designed to accommodate electric and diesel-hauled trains and consists of a single-story unit masonry building adjacent to the steel-framed wash bay with metal clad siding.

Coes Neck Phase II Site Assessment, Bethpage, NY, Nassau County. Project Manager responsible for reviewing and evaluating the Coes Neck Phase II site assessment report on behalf of surrounding community groups.

Construction-Phase Services, Long Island City, Queens County, NY, MTA Long Island Railroad. Senior Environmental Project Manager responsible for providing construction-phase services for the demolition and reconstruction of Long Island City Diesel Yard in Long Island, New York. Construction-phase responsibilities included reviewing submittals, investigating field conditions, and resolving technical issues.

Environmental Services, NY, Confidential Client. Assistant Project Manager responsible for providing remediation assistance and other environmental services, including a document review and site visit; ongoing interim remedial measures (IRMs); operation and maintenance and reporting; an IRM engineering assessment; meetings and communications; troubleshooting and repair of the soil vapor extraction systems and groundwater extraction treatment system; record of decision-related services; and oil spill assistance.

Phase I Environmental Site Assessment, Hempstead, NY, Planned Parenthood of Nassau County. Project Manager responsible for performing a Phase I environmental site assessment.

Remedial Investigation/Remedial Alternative Analysis, Brooklyn, NY, Frito-Lay, Inc. Senior Project Manager responsible for providing project oversight and technical and policy assistance for a remedial investigation and alternatives analysis. The remedial investigation was conducted in accordance with New York State Department of Environmental Conservation (NYSDEC) DER-10 Guidelines. The work included a remedial investigation work plan, remedial investigation report, and supplemental remedial investigation work plan and the implementation of the supplemental remedial investigation and remedial alternatives analysis. Our firm prepared the brownfield applications and successfully worked with the NYSDEC case manager to gain acceptance into the Brownfield Cleanup Program.

General Engineering Services, Suffolk County, NY, Metron Development Services. Assistant Project Manager responsible for performing general engineering services for project development.

Hudson Line Overpass Improvements, Westchester County, NY, MTA Metro-North Railroad. Senior Environmental Project Manager responsible for providing construction supervision and inspection services for the rehabilitation of the Hudson Line stations from Hasting-on-Hudson to Ossining in Westchester County, New York. The goal of the project was to rehabilitate Hudson Line historic station overpasses and platforms, including canopies, stairs, and amenities.

Croton-Harmon Maintenance Facility Replacement Priority Repairs, Croton-on-Hudson, NY, MTA Metro-North Railroad. Senior Environmental Project Manager responsible for designing multiple fixed-facility improvements, including the preparation of design-build construction documents for a new wheel truing facility; the study and design of facility modifications and improvements to support the new M-7 fleet; and preparation of construction documents for roof and facade repairs and plumbing renovations inside and outside of the main shop facility. The new facility is a 12-bay, pre-engineered, 8,250-square-foot passenger-train maintenance facility incorporating vehicle pits for wheel-truing equipment, 3-ton bridge crane, and storage areas.

Acquisition Due Diligence Assessment and Environmental Health and Safety Compliance Audit, Fulton, NY, Crompton Corporation. Senior Project Manager responsible for a pre-acquisition due diligence assessment and regulatory compliance audit of a plastic extrusion equipment plant constructed in the early 1900s. A site survey was conducted and historical records reviewed to identify potential areas of environmental concern. Company environmental and health and safety files and practices were reviewed to assess the current status of regulatory compliance.

On-Call Services, Northport, NY, Village of Northport. Project Manager responsible for providing on-call services, including environmental, civil, geotechnical, structural, electrical and mechanical engineering, architectural, and construction management services.

Harmon Maintenance Facility Replacement, Phases I, II, and IV, Croton-on-Hudson, NY, MTA Metro-North Railroad (MNR). Environmental Task Leader for the various phases of the replacement of a rail maintenance facility. Responsibilities include providing leadership for the environmental tasks involved with the facility design and master planning efforts for the yard. Phase I included structural and facilities design, preparation of a master plan for the yard, and leadership for environmental design tasks at the yard. Our firm teamed with a construction company on a design-build contract to construct the Phase II improvements to the yard. Phase II consisted of the design and construction of several new facilities in the northern portion of the site and clearing a portion of the site for the major facilities to be constructed in Phase III and thereafter. In addition, our firm has designed a new wheel-truing facility, priority repairs to the main shop, and work to be performed at Metro-North's Ossining Substation, approximately 2 miles south of the Harmon site. Our firm was also selected to prepare the design-build documents for Croton-Harmon Yard and Shop Phase IV, Stage I, which is the latest stage of the $1.0 billion multiyear reconstruction of the century-old Harmon Shop. The Phase I, II, and IV work included assistance needed to address the environmental issues of concern, which are described below:

- Assistance to Metro-North's legal counsel in determining that the project was categorically exempt from the State Environmental Quality Review Act and National Environmental Policy Act, resulting in overall design cost savings
- Development and implementation of guidelines, which address the management of soils generated during investigation or excavation that will allow the reuse of soils on site
- Development and implementation of a geographic information system (GIS)/key database to store the chemical and geological data generated at the site
- Treatment and management of dewatering fluids discharged to the local publicly owned treatment works in accordance with permission requirements
- Asbestos, lead-based paint, and polychlorinated biphenyl (PCB) abatement
- Tank closure and construction
- Air permitting compliance
- Modifications to the facility stormwater discharge permit to include changes to the postconstruction wastewater stormwater management system
- Coverage for construction stormwater discharges under the New York State Department of Environmental Conservation State Pollutant Discharge Elimination System permit program GP-02-01
- Design of new environmental systems for the site, such as a spill control system for a new 400,000-gallon fuel oil storage tank and a fuel pad oil-water separator. Coordinated requirements with regulatory agencies.

In accomplishing these tasks, our firm took a proactive approach, and together with MNR, contacted regulatory agencies at the beginning of the project to introduce them to the project concepts and involve them in decision-making processes. We also involved the other design discipline team leaders in the process.

Croton-Harmon Maintenance Facility Replacement, Phase II, Croton-on-Hudson, NY, MTA Metro-North Railroad. Environmental Task Leader for Phase II of the replacement of the Croton-Harmon Maintenance Facility. Responsibilities included providing leadership for the environmental tasks involved with the facilities design and master planning efforts for the yard. Our firm provided design and construction assistance under a design-build contract for the Phase II work. Tasks included assisting Metro-North's legal counsel in determining that the project is categorically exempt from the requirements of New York's State Environmental Quality Review Act and the National Environmental Policy Act, which resulted in overall design cost savings; developing guidelines that address the management of soils generated during investigation or excavation activities, which allowed the reuse of petroleum-contaminated soils on site; developing and implementing a geographic information system (GIS)/key database in which to store chemical and geological data generated at the site; obtaining approval for dewatering fluids to be accepted by the local publicly owned treatment works, resulting in cost and time savings for the management of contaminated groundwater; designing new environmental systems for the site, such as a spill control system for a new 400,000-gallon fuel oil storage tank and a fuel pad oil-water separator, and coordinating the associated requirements with the regulatory agencies; obtaining coverage under New York's State Pollutant Discharge Elimination System (SPDES) Permit GP-02-01 for stormwater discharges during construction; modifying the facility's industrial stormwater SPDES permit; and modifying the facility's groundwater monitoring well network.

North White Plains Station Access and Parking Improvements, White Plains, NY, MTA Metro-North Railroad. Environmental Task Leader/Site Planning Coordinator for the preparation of an environmental impact statement pursuant to the National Environmental Policy Act of 1969 and its amendments to analyze alternatives for improved station access and parking at Metro-North's North White Plains Station, with the Federal Transit Administration acting as federal lead agency, and begin preliminary design efforts. The commuter parking capacity was 1,200 spaces, which were located in three lots on the west side of the railroad tracks and a fourth lot on the east side of the tracks. Vehicle access to the three lots located to the west of the tracks was limited to the Bronx River Parkway from the west. Significant areas of the parking facilities were located within the County's Bronx River Parkway Reservation, a sensitive environmental area. Project elements evaluated included the construction of a multilevel parking structure, improvements to existing surface parking areas, the development of remote park-and-ride lots, improved station facilities, an intermodal area, pedestrian and bicycle connections, vehicular access to parking, and the reclamation of the Bronx River Parkway Reservation areas currently used for parking.

Niantic River Bridge, Niantic, CT, National Railroad Passenger Corporation (Amtrak). Environmental Task Leader responsible for addressing asbestos and lead-based paint management and associated wetlands issues involved with the replacement of a drawbridge. The drawbridge, located on Amtrak's Northeast Corridor is an electrified, two-rack railroad with high-density rail traffic. Intercity service is operated by Amtrak, and commuter service is provided by Metro-North Railroad. Oversaw the engineering services for the final design of track, signals, communications, catenary, traction power, structural, environmental, and geotechnical analyses. Our firm was retained to perform construction-related services to maintain continuity between the designer and installation contractor.

Grand Avenue Bus Depot, Environmental Services, Queens, NY, MTA New York City Transit. Senior Project Manager responsible for providing environmental services for a $226 million design-build project for a bus and central maintenance facility. Environmental services included developing and implementing an environmental permit strategy; modifying the facility air permit as required to reflect design-build conditions; conducting a Phase I assessment; developing and implementing soils, asbestos, waste management, and dewatering plans; developing and overseeing the implementation of a construction stormwater management plan; and obtaining permits for water and wastewater discharges and storage tanks and unloading systems. Soil and waste management plans were prepared, and ongoing management of contaminated soils encountered during excavation was provided. Our field personnel documented subsurface conditions during soil excavation and handling activities. On-site responsibilities included assistance with field screening of soils, collection of laboratory samples, and documentation and tracking of excavated USTs, asbestos, drums, and other discovered items of environmental concern.

Brownfield Redevelopment, Babylon, NY, Town of Babylon. Senior Project Manager and Principal-in-Charge responsible for conducting Phase I and Phase II assessments and end-use planning and for providing other engineering services related to the brownfield redevelopment of the Straight Path Area in the Hamlet of Wyandanch. This work was funded under a U.S. Environmental Protection Agency Brownfield Grant.

Harlem Line Station Improvements, Bronx and Westchester, NY, MTA Metro-North Railroad. Environmental Task Manager responsible for asbestos and lead-paint management, including abatement, handling, and disposal during the construction of improvements to rail stations, including the design and construction of new canopies, shelter installation with heat and lighting, platform lighting upgrades and uninterruptible power supply emergency lighting systems, installation of canopy drainage and supports, tactile warning strips, platform replacements that are enclosed, new and/or extension of public address system and electric service upgrades as required, pigeon-proofing, replacement of platform edge strips, and fall protection.

Nassau Expressway Rehabilitation, Queens, NY, New York State Department of Transportation. Environmental Task Manager responsible for asbestos and lead-paint surveys and abatement design, stormwater management, and permitting involved with the final highway design (Phases V and VI) for the rehabilitation and resurfacing of Nassau Expressway/Interim Nassau Expressway - Rockaway Boulevard (from the Van Wyck Expressway to the Nassau County line), including associated ramps and certain bridges, and preliminary design, right-of-way, and final design services for the proposed multiuse (bike/pedestrian) path.

Wall Revetment, Asharoken, NY, William Gallo. Senior Project Manager responsible for providing design, permitting, and construction management for a rock revetment wall along a property on Long Island Sound. The wall was constructed on the seaward side of a sheet pile retaining wall, which was in need of rehabilitation due to severe beachfront erosion and age.

Property Purchase, Site Development, and Litigation Support and Testimony, NJ, Confidential Client. Senior Project Manager responsible for providing litigation support and testimony in a cost allocation and recovery matter regarding two adjacent properties on which environmental concerns were noted and reported. The larger, 26-acre property was a former chemical plant that had gone through an administrative consent order cleanup under the direction of the New Jersey Department of Environmental Protection, which allowed waste residuals to be capped in place and groundwater contamination to remain unremediated. The smaller, 6-acre property was a trucking terminal with a fueling island and USTs. In addition, an extensive Phase II investigation was performed to establish a pre-existing environmental baseline for both properties. The client subsequently purchased the properties and developed a rail-to-truck intermodal facility. The sites border a river, and the federal and state governments took actions against the adjacent property owners to pay for the assessment and cleanup of the river. The former property owner sued our client to have them included in the cost recovery action. We provided litigation support to our client and their attorneys and testified during the trial.

Elevated Rail, NY, Confidential Client. Senior Project Manager responsible for reviewing demolition and material management plans provided by a prospective purchaser and for providing field oversight, including split sampling. The elevated railroad structure was built around 1900 and consists of trackage and ballast in a concrete containment supported by steel columns and extends approximately 1.7 miles. Assisted in addressing liabilities associated with handling ballast, which may be affected by chemical residuals, lead-based paint on the steel work, asbestos-containing materials, and areas of potential concern throughout the abandoned line. Split samples were collected during the purchaser's waste characterization efforts to verify the analytical results and to evaluate the proposed disposal and reuse methods.

Property Purchase and Site Redevelopment, NJ, Confidential Client. Senior Project Manager responsible for a Phase I environmental site assessment of two adjacent properties. The larger property, totaling 26 acres, was a former chemical plant that had gone through an Administrative Consent Order cleanup under the direction of the New Jersey Department of Environmental Protection (NJDEP), which allowed waste residuals to be capped in place and groundwater contamination to remain unremediated. The smaller property, totaling 6 acres, was a trucking terminal with a fueling island and USTs on the property. To establish a pre-existing environmental baseline for both properties, an extensive Phase II investigation was performed. The client subsequently purchased the properties and developed a rail-to-truck intermodal facility. An asbestos survey was conducted in support of the demolition of an on-site administration building. To support redevelopment work on the 6-acre property, an 8,000-gallon gasoline and diesel fuel UST on the property was removed. When removed, the gasoline tank was found to have several holes, and a sheen of phase-separated hydrocarbons was noted on groundwater that infiltrated the excavation. The observed release was reported to NJDEP. Organics detected in the gasoline tank excavation are not organics present in gasoline and were believed to be attributable to an off-site source detected in the baseline groundwater samples. This information was submitted to NJDEP. To support the site improvement of both properties, Occupational Safety and Health Administration (OSHA) surveillance of utility line trenching on the properties was provided, due to the groundwater contamination beneath the site. This required the preparation of a comprehensive health and safety plan, and personnel were provided to monitor trenching activities.

Croton-Harmon Maintenance Facility Replacement, Phase I, Croton-on-Hudson, NY, MTA Metro-North Railroad. Environmental Task Leader responsible for providing leadership for the environmental design tasks involved with the facility design and the master planning for the yard. Our firm was the overall environmental technical lead responsible for overseeing the efforts of four environmental design subconsultants. Tasks performed included assisting Metro-North's legal counsel in determining that the project was categorically exempt from New York's State Environmental Quality Review Act and the National Environmental Policy Act, which resulted in overall design cost savings; developing guidelines to address the management of soils generated during investigation or excavation operations, which allowed the reuse of petroleum-contaminated soils on site; developing and implementing a geographic information system (GIS)/key database to store the chemical and geological data generated at the site; obtaining approval for dewatering fluids to be accepted by the local publicly owned treatment works, which resulted in cost and time savings for the management of contaminated groundwater; and designing new environmental systems for the site, such as a spill control system for a new 400,000-gallon fuel oil storage tank and a fuel pad oil-water separator, and coordinating requirements with the regulatory agencies.

Brownfields Conversion of Rail Yard, NY, Confidential Client. Senior Project Manager responsible for a site that has been redeveloped as a sports park, which includes restaurants and retail activities. This former rail yard consists of 53 acres of property, including 25 upland areas and 28 acres under water. The site was used as a locomotive and railcar servicing and maintenance facility and switchyard from 1883 to 1994. A presale environmental assessment performed by our firm showed evidence of residuals common to rail yards. Several environmental issues were addressed by removing a UST and aboveground storage tank, removing asbestos from a fire-damaged pier, closing a weigh-scale pit, and removing debris and a railcar in poor condition. The site had been leased to a car parking concession that had filled the leased area and other parts of the property with shredded asphalt shingles. Some of this material was removed from wetland-related areas in accordance with a consent order with the State.

Town Improvements, Northport, NY, Village of Northport. Senior Project Manager and Principal-in-Charge responsible for providing various architectural and engineering services. Served as a Village Engineer in providing design and construction management during the upgrade of the municipal wastewater treatment plant, design and construction management of an interim roadway retaining structure along a major village thoroughfare, engineering assistance during a hillside collapse and response from the U.S. Army Corps of Engineers, design and construction management of a domed roadway salt and sand storage facility, engineering services for the Village Planning Board and Zoning Board of Appeals for various site development projects, architectural design of a new concession and restroom facility in Steers Park, design and construction management of various roadway improvement projects throughout the Village, engineering services involved with New York State Department of Environmental Conservation stormwater discharge regulation requirements, and design and construction management for the installation of new street lamps along Main Street.

Natural Gas Pipe Line Metering Stations, Various Locations, Southeastern U.S., Confidential Client. Project Director for remedial investigations and feasibility studies at more than 200 metering stations along a major natural gas pipeline located in the southeastern United States. In the past, mercury manometers were used in the metering process. Breakage, spillage, and operations and maintenance disposal practices resulted in mercury contamination inside the buildings and in the surrounding soils and groundwater. Due to the large number of sites, our firm used a rapid assessment process that relied primarily on field-testing techniques. Our firm pioneered the use of mercury vapor industrial hygiene equipment to quickly determine the presence/absence and the relative amount of mercury contamination in soil samples. This technique allowed the measurement of mercury vapor levels at various depths in boreholes, as well as in individual soil samples. An immunoassay field test was used on a representative number of samples to more specifically describe the mercury concentrations in samples of concern. Finally, a limited number of samples were sent to the laboratory for mercury measurements in accordance with accepted laboratory protocols. A combination of this data was used to describe the extent of contamination at each of the metering stations and determine the need for and the extent of remedial actions required.

Expert Witness Services, Manhattan, NY. Expert Witness representing the owner of a property in midtown Manhattan whose tenant, an automobile service and fueling station, was decommissioning and closing the site. Fuel oil contamination was found on site, and the tenant claimed that it was not due to its operations. Provided technical and litigation support to the property owner and its attorney. Served as the plaintiff's Expert Witness in the case against Getty Oil to recover damages arising from environmental contamination allegedly caused by Getty Oil to the plaintiff's property. The court ruled in favor of the plaintiff and found Getty liable to the plaintiffs for more than $1 million.

Health and Safety Management, Oyster Bay, NY, Town of Oyster Bay. Senior Project Manager in charge of an on-call brownfield services contract, which included environmental Phase I and II investigations, end-use planning, and remedial design. Also provided health and safety consulting services and groundwater monitoring services to the Town.

LaGuardia, John F. Kennedy (JFK), and Newark Airports, New York City Metropolitan Area, NY, Various Clients. Principal-in-Charge responsible for fueling facility upgrades, site assessments, and remediation projects at three airports. Investigated the nature and extent of petroleum residuals at the LaGuardia Airport fuel farm and designed an upgrade to the tank farm and fuel truck loading area, which provided improved control of releases from the fueling operations. Rehabilitated several deep petroleum product recovery wells at the JFK Airport satellite fuel farm and investigated and remediated releases at the ramp fueling station at Newark Airport.

Illegal Landfill at a Religious Cemetery, Long Island, NY, Kaye Scholer, LLP. Senior Project Manager responsible for developing a restoration and closure plan for a cemetery. The cemetery contracted to fill 8.5 acres with about 180,000 cubic yards (CY) of soil and demolition debris to increase the area for burials. The state, however, cited the operation as a nonpermitted solid waste management facility after the contractor delivered 460,000 CY of material. The cemetery owners signed a consent order that required characterizing the fill materials and preparing a restoration plan. Local civic organizations and politicians demanded that the fill material be removed from the site. The estimated cost of removal and off-site disposal was about $20 million. It was argued that characterizing the fill was not warranted, and a site investigation/closure was proposed to verify that no environmental impacts occurred and closure of the site was in accordance with the cemetery's expansion plan. As part of the landfill closure, quarterly landfill gas monitoring is performed. The monitoring database is summarized in quarterly reports to the New York State Department of Environmental Conservation. The site is characterized by very steep slopes. Slope stability analyses were performed under various closure scenarios to evaluate alternative closure scenarios.

Environmental Site Assessment and On-Call Environmental Engineering Services, Long Island, NY, Northrop-Grumman Corporation. Senior Project Manager responsible for coordinating environmental site assessment and environmental engineering services on an on-call basis. The work included UST investigations and closure work, site investigations for soil excavation projects, asbestos investigations and abatement design and management, and environmental construction management for the closure of manufacturing facilities.

Manufacturing Research and Development Facility, NY, Confidential Client. Project Manager for the presale assessment of a former manufacturing research and development facility, consisting of a 25,000-square-foot main building and two smaller buildings on a 10-acre site. Identified cadmium and mercury residues from prior laboratory activities on building interior surfaces, equipment, and other areas. Determined acceptable metals concentrations on building surfaces and in soil through a risk assessment.

Abandoned Industrial Property, NY, Confidential Client. Environmental Task Leader in charge of a Phase I/Phase II environmental assessment of an inactive railroad property adjacent to mainline track to establish baseline conditions prior to the railroad leasing the site for industrial use. To prepare the site for future use, the owner decided to remove approximately 30,000 cubic yards of concrete and demolition debris that had been stockpiled on the site by others. Our firm was retained to characterize and manage the removal and disposal of the debris pile. The project was coordinated with the New York State Department of Environmental Conservation's Division of Solid and Hazardous Materials to obtain the Department's concurrence on the scope of the proposed project and the Division of Environmental Permits to obtain a Tidal Wetlands Permit, due to the site location adjacent to a surface water body.

Illegal Landfill on Railroad Property, NY, Confidential Client. Principal-in-Charge for a project involving an illegal landfill site on inactive railroad property. A preliminary environmental assessment of the site was conducted in 1987. In 1988, illegal dumping occurred at the site, which resulted in approximately 500,000 cubic yards of waste being landfilled at the site. A site investigation was conducted in 1994, and ongoing monitoring has been performed at the site since that time. Groundwater and surface water sampling has been conducted, and volatile organic compounds, semivolatile organic compounds, metals, pesticides, ammonia, and various other landfill leachate constituents have been found in groundwater and surface water. A phytoremediation system has been designed and installed that consists of approximately 1,000 trees planted to withdraw groundwater from two water-bearing zones beneath the site. A landfill closure plan was designed and constructed, which included dewatering and closing on-site ponds, performing site grading and development, installing a multilayer cap on the 500,000-cubic-yard waste piles with gas controls, installing stormwater control systems, and installing a groundwater recovery and recirculation system. Also served as a fact witness for the property owner in his cost recovery action against waste generators whose waste was disposed at the site.

The landfilling has been conducted on 26 acres of the overall 39 acres of the inactive railroad. During the course of the site investigation, the railroad negotiated the sale of the rail yard outside of the landfill area. The sale included the track and right-of-way. Environmental issues of concern were addressed with minimal remediation. The sale was to support a revitalization project. The adjacent property is being developed into a sports complex, including restaurants and shops.

Railroad Pre-purchase Property Assessments, Westchester County, NY, MTA Metro-North Railroad. Senior Project Manager responsible for performing prepurchase property assessments to assist this railroad client in acquiring property to expand two rail facilities.

Site Investigation for Inactive Railroad Yard, NY, Confidential Client. Senior Project Manager for a presale site investigation to identify environmental issues that could be of concern to future users of the site. The development of the site was intended to be for sports, recreational, and commercial uses. Actions were taken to address the environmental issues of concern to both the state's and the buyer's satisfaction.

Railroad UST Closures, Various Locations, U.S., Confidential Client. Senior Project Manager responsible for a UST closure program. The program was originally limited to USTs in two states but was so successful that 12 more states were included. The closure program addressed specific state compliance requirements and included the following: initial UST registration, cost recovery for eligible tanks, paperwork and schedule tracking, tank removal, sampling and analysis operations, the establishment of the extent of soil and/or groundwater contamination, the design of remedial alternatives, remedial implementation, and site closure. Provided oversight and supervision services during the various phases of the work. More than 200 USTs were closed. The tanks ranged in capacity from 100 to 20,000 gallons and included buried railcars. Soil remediation efforts included on-site bioremediation cells, off-site bioremediation, and landfilling. Implemented groundwater remediation programs at some of the sites.

Railroad Consent Order Compliance, Various Locations, U.S., Confidential Client. Senior Project Manager for several sites that were placed under a U.S. Environmental Protection Agency consent order. Assisted the client in responding to the items required by the consent order, including demolition, site cleaning, the closure of oil-water separators, the removal of drums, asbestos abatement, the removal of underground tanks, upgrades for aboveground tanks, the closure of septic systems, and the backfilling of open pits.

Remediation Services for Abandoned Railroad Yard, PA, Confidential Client. Senior Project Manager responsible for overseeing the excavation of 11 USTs and the stockpiling of 1,500 cubic yards of diesel-contaminated soils at an abandoned railroad yard. Solicited competitive bids from remedial contractors for on-site soil roasting or cold-batch asphalt recycling. Soil roasting was more cost-effective because it eliminated the need to landfill the waste. Provided oversight during the remedial work and coordinated state air and water permits. Following soil sampling to verify the treatment, the roasted soil was spread on site, graded, and seeded to close out the project.

Chemical Railcar Derailment, MI, Confidential Client. Senior Project Manager for a project involving a railcar derailment site in a residential area where more than 50,000 gallons of volatile organics and acids were released, some of which ignited. Conducted a remedial investigation that determined the nature and extent of chemical residues and their impacts on air, soil, surface water, and groundwater. Built a surface water diversion system as an interim measure to control overland flow from the area. The state initially demanded soil remediation to background levels, but a risk assessment indicated only a low exposure risk, which resulted in a significant reduction in the extent of required soil remediation. The state also initially listed the excavated soil as hazardous, but the soil was delisted on our petition. This was the first instance in the state where hazardous soil was delisted to a nonhazardous waste based on a private-party petition.

Locomotive Petroleum Spill, FL, Confidential Client. Senior Project Manager responsible for developing a cost-effective remedial action plan (RAP) to clean up soil and groundwater contaminated by approximately 4,000 gallons of diesel fuel. The RAP was based on data from soil borings and monitoring wells and called for limited soil excavation. Employed an organic vapor analyzer to delineate specific areas for excavation. Used an interceptor trench to contain and recover free product and dissolved petroleum constituents. The work was done in close coordination with the railroad to avoid disrupting normal operations. Negotiated soil cleanup levels with the state and demonstrated that it was not necessary to excavate the contaminated soil beneath the tracks. The soil and groundwater cleanup objectives were satisfied, and the state closed its file after receiving the site rehabilitation report.

Railcar Manufacturing Facility RCRA Management Plan, WV, Confidential Client. Senior Project Manager responsible for auditing waste management practices and developing a sitewide RCRA management plan at a facility that manufactures, renovates, and rebuilds approximately 40 railcars a day. The management plan integrated many diverse waste streams, including RCRA wastes, other chemical wastes, and waste oil from more than a dozen trade shops. The audit included reviewing operations in each shop and interviewing supervisors and foremen to identify chemical use, waste streams, and waste handling/disposal practices. Recommended product substitution and waste stream segregation to minimize the volume of RCRA wastes. Developed a sitewide RCRA contingency plan.

Site Investigation and Remedial Services for Inactive Railroad Yard, MD, Confidential Client. Senior Project Manager responsible for developing and managing a site investigation and subsequent remedial actions at a closed railroad yard. Facility operations had included painting, metal working, fueling, car building, and engine repair. Closure activities included site characterization, negotiations with state agencies, remedial design, bid specifications, and remedial implementation. Issues of concern included the characterization and disposal of unlabeled drummed waste; the removal of storage tanks; the remediation of soils contaminated with polychlorinated biphenyls (PCBs), chromium, and lead; the closing of two large lagoons containing petroleum-contaminated sludge and free liquids; and the removal of petroleum product floating on the water table. Closing the lagoons involved pumping off and treating approximately 200,000 gallons of water and stabilizing the lagoon sludge using lime kiln material. The remedial action was complicated by karst geology.

Railroad Service Yard Closure, IN, Confidential Client. Senior Project Manager for a preclosure investigation at a 250-acre locomotive and car service yard that found polychlorinated biphenyls (PCBs) and asbestos in buildings, hazardous residuals in underground tanks, and contaminated soil. A biological treatability study demonstrated that in situ biological treatment could remediate petroleum-impacted soil in two fueling areas. This yard contained more than 200,000 cubic yards of cinder, and elevated concentrations of polynuclear aromatic hydrocarbons were found in many of the cinder samples. A site-specific risk assessment demonstrated that no additional remedial actions were necessary.

Regulatory Compliance Assistance, NY, Confidential Client. Senior Project Manager responsible for determining the regulatory compliance of aboveground storage tanks, USTs, and drum storage areas at an aircraft manufacturing facility. Supervised the preparation of a health and safety plan to protect workers during tank closures, site assessments, and new tank system construction. Assisted in the preparation of plans and specifications for new USTs to replace underground tanks that did not meet UST requirements or would soon be out of compliance. The new specifications for gasoline, diesel fuel, and JP-4 jet fuel tanks included secondary containment and leak detection in accordance with municipal, state, and federal regulations. Developed closure plans for waste storage areas and underground and aboveground tanks. New tanks were constructed and old tanks were removed in a sequence that avoided disrupting the plant's activities. Managed the decommissioning of 30 manufacturing buildings with 1.2 million square feet of floor space. The demolition addressed lead paint, polychlorinated biphenyls (PCBs), reinforced-concrete slabs, and utility and testing tunnels. Provided asbestos abatement design and bid-phase management services to remove asbestos-containing roofs, thermal insulation, floor tiles, and other materials from the buildings.

Bridge Rehabilitations, New York, NY, New York City Department of Transportation. Principal-in-Charge of a project team that oversaw environmental issues of concern associated with the rehabilitation of the Williamsburg, Throgs Neck, Whitestone, and Verrazano-Narrows Bridges. The principal issue of concern was the lead paint being removed during the work. The primary project activities involved worker protection to meet Occupational Safety and Health Administration (OSHA) requirements, the containment and management of lead-based paint dislodged/removed during the work, and the assessment of surrounding areas (soil, pavements, tops of buildings) where the lead may have fallen prior to and during the work. Several buildings required asbestos abatement and demolition and UST inspections and removals.

Remediation Services for U.S. Environmental Protection Agency Superfund Site, WI, Confidential Client. Senior Project Manager responsible for a remedial investigation, a feasibility study, and a remediation project. The site was a former munitions manufacturing facility that contained several landfills, waste lagoons, and areas affected by chemicals associated with the manufacturing processes. Conducted an investigation of the on- and off-site groundwater, soil, and waste. The chemicals of concern at the site included chlorinated hydrocarbons, a forge compound consisting of graphite and long-chain hydrocarbons mixed with kerosene and chlorinated solvents, polynuclear aromatic hydrocarbons, arsenic, and metals. Performed a risk assessment to define the need for remedial action at the site. Conducted a pilot study to evaluate the use of forge compound and forge compound mixed with soil as a secondary fuel in cement kilns. An 11-acre lagoon filled with up to 12 feet of forge compound was excavated, and the material was used as fuel at the kilns. Several on-site landfills were consolidated and closed in place with a soil vapor extraction system serving as the "bottom liner" for the landfill wastes.

Investigative and Remedial Services for Abandoned Industrial Property, WV, Confidential Client. Senior Project Manager responsible for investigating and remediating an abandoned property under the West Virginia Department of Environmental Protection's Voluntary Remediation Program. Historic uses of the 8.5-acre site included a railroad switching yard, a scrap metal yard, a steel mill, a tool and die operation, a wall plaster manufacturer, and a lumber warehousing operation. The involved city has been identified as a U.S. Environmental Protection Agency brownfields pilot community, and the city is interested in facilitating the development of several properties in the vicinity of the subject property. Obtained historical site information from the city and conducted a fast-track Phase I environmental assessment of the site to identify areas of potential concern. Based on the findings of the Phase I assessment, developed and implemented a site investigation work plan to assess the potential presence of residual contamination associated with former site uses. Reviewed the site investigation results in consideration of the proposed redevelopment of the site for commercial use and evaluated potential risks posed by chemical residuals in surficial and shallow soils. Determined that the chemical residuals in the soils did not pose a risk since they will be capped under the proposed site development. Concluded that no remedial action was warranted, and the agency concurred.

Class I Railroad Freight Yard, IL, Confidential Client. Senior Project Manager responsible for obtaining a no further remediation (NFR) letter for a former railroad yard under the Illinois Environmental Protection Agency's (IEPA's) Site Remediation Program (SRP). The 24.73-acre site was used as a railroad freight yard and contained several freight houses, platforms, and many switching tracks. The freight yard was closed and dismantled in the early 1970s and has been vacant since its decommissioning. Based on the site's location, the redevelopment potential of this brownfield for multiuse, multifamily housing made it extremely attractive to potential developers. As such, the site's remediation objectives were designed to allow for unrestricted residential use. Performed an assessment that found elevated concentrations of arsenic in surficial and near-surface soils and concluded that these elevated concentrations were from historical and routine applications of arsenic-containing herbicides to the main tracks. After a sales agreement was completed with a local developer, the site was enrolled in the IEPA's SRP. Based on past site operations and the results of the initial assessment, arsenic was identified as the only chemical of concern. Performed a feasibility assessment concerning the achievement of both risk-based criteria and generic metropolitan statistical area median background values and concluded that soil excavation was the preferred remedial action to achieve a residential land use endpoint. However, reaching the risk-based criteria and/or generic background values required the excavation and disposal of a large quantity of soil. Conducted further research to assess actual arsenic soil concentrations within the city. The study addressed arsenic levels within various types of fill material that had been imported to the site and the subsequent construction of the freight yard. Based on this study, a site-specific arsenic level was calculated for the area surrounding the impacted zone. Used this information to show the IEPA that achieving default risk-based criteria and/or generic background levels was impractical. Presented an alternative remediation objective (RO) based on the statistical evaluation of data collected outside the Federal Insecticide, Fungicide, and Rodenticide Act application area and the practicality of achieving the alternative RO. The alternative RO was reviewed and accepted by the IEPA. Submitted a remedial action completion report to the IEPA that resulted in the issuance of a NFR letter for unrestricted residential use of the site. The site was sold to a local developer for redevelopment as a multifamily housing complex.

Railroad Yard and Track Redevelopment and Site Remediation, NY, Confidential Client. Senior Project Manager for a site where a land developer had illegally operated a nonpermitted landfill on property owned by a major railroad company. It was alleged that hazardous wastes, medical wastes, asbestos, construction and demolition debris, and municipal wastes had been disposed of in the landfill. Landfill leachate constituents, including hazardous substances, were found in the groundwater downgradient of the site, which is elevated relative to undeveloped wetlands to the south. Prepared a site investigation plan and a closure alternatives study to further define the site hydrogeology; increase the database on possible contaminant migration from the landfill; and identify the extent of contamination and potential impacts to human health and the environment, particularly the adjacent wetlands. Work included installing groundwater monitoring wells and sampling surface water and sediments in the wetlands. The objective of the closure alternatives study was to develop alternative closure and postclosure plans to mitigate unacceptable environmental impacts, evaluate these alternatives, and recommend a cost-effective remediation program. Successfully negotiated the acceptance of the plan and study with the state. The landfilling had been conducted on 26 acres of the 39-acre inactive railroad yard. During the course of the site investigation, the railroad negotiated the sale of the railroad yard outside of the landfill area. The sale included the track and right-of-way, a railroad bridge, and tracks connecting to existing freight lines. Environmental issues of concern were addressed with minimal remediation. This purchase was made to support revitalization. The adjacent property is being developed into a sports complex, including restaurants and shops.

Former Scrap Metal Yard, WV, Confidential Client. Senior Project Manager for a project involving a property that has been used as a railroad yard since the early 1900s. A small parcel on the property, approximately 6 acres, was leased to another party in the early 1970s and used for scrap metal salvaging and sorting. The scrap metal operations were terminated sometime in the 1980s. A subsequent inspection of the parcel by the U.S. Environmental Protection Agency identified polychlorinated biphenyls (PCBs) in the soil at two locations. In response to this finding, the property owner implemented two site investigations that focused on defining the horizontal and vertical extent of the PCBs in the soil, which indicated that approximately 4,400 cubic yards of soil were affected by the PCB residuals. A real estate developer subsequently expressed interest in purchasing and developing the parcel. Based on the environmental conditions identified at the property and the site development interest, the site was accepted into the West Virginia Department of Environmental Protection's (WVDEP's) Voluntary Remediation and Redevelopment Program. A site assessment work plan was developed and approved by WVDEP to guide the characterization of soil and groundwater at the property with respect to PCBs and other chemicals typically found at railroad yards and scrap yards. The resulting environmental monitoring database was used to assess public health and environmental risks posed by the chemical residuals under the proposed site development scenario. It was concluded that the site development plan, including building slabs, parking lots, roadways, and gardens, would provide an engineering barrier above the chemical residuals and mitigate risks to human health and the environment. As a result no active remediation was needed, saving the property owner the multimillion-dollar cleanup that would have been needed to remediate the site. The owner will thus profit by selling the property, the developer will be able to obtain property that will fit into its development plans, and both will benefit from the development and the rehabilitation of the downtown area.

Railroad Mechanical Facility, MD, Confidential Client. Senior Project Manager responsible for providing environmental and engineering management services during the investigation, decommissioning, and remediation of a railroad mechanical facility. The site consists of 45 acres occupied by 38 structures. The project included a site investigation, remedial actions, lagoon closure, storage tank decommissioning, asbestos abatement, building demolition, and floating product recovery. Performed a preliminary assessment to characterize the site and identify areas of potential environmental concern. Based on the findings of the preliminary assessment, prepared and submitted a lagoon closure plan to the Maryland Department of the Environment (MDE) for approval. Prepared contract and bidding documents, provided project and field management of the closure activities, characterized the underlying soils, and prepared a summary report for submittal to MDE. Provided construction management services during the pumping, cleaning, and dismantling of abandoned aboveground storage tanks and USTs. Prepared an assessment of the potential environmental impacts associated with each tank. Prepared specifications and contract documents for the demolition of the 38 structures at the former locomotive manufacturing, maintenance, and repair facility. The larger structures included a 25-stall roundhouse, two erecting shops, a powerhouse equipped with several boilers, an 80-foot stack, and a wastewater treatment plant. The facility had been inactive for 10 years, and most structures were in poor condition. Performed a structural survey to identify those structures that posed safety concerns due to their potential for collapse and conducted a confirmatory asbestos inspection to verify the asbestos materials and quantities identified by a previous survey. Evaluated the feasibility of a partial demolition approach to remove safety hazards, as well as the full demolition. The full demolition option was selected, and the demolition and abatement specifications were finalized. Performed oversight inspections and air monitoring throughout the duration of the asbestos abatement to make certain of compliance with project specifications and applicable regulations. Provided construction management and inspection services during construction and demolition activities. The facility demolition included the characterization of residual liquids and sludges in the on-site wastewater treatment plant and various subgrade pits, as well as disposal coordination. With the completion of demolition activities, the facility is being entered into Maryland's Voluntary Cleanup Program. Product recovery will continue, and risks posed by residual constituents will be evaluated in consideration of a commercial/retail end use. There is an interest in extending a boulevard through the site, which would create a significant amount of useful and valuable real estate and return this former railroad yard to a beneficial use.

Environmental Assessment, Remediation, and Regulatory Compliance for the Railroad Industry, Various Locations, U.S., Various Clients. Principal-in-Charge responsible for managing a firmwide team providing environmental consulting services to the railroad industry since 1987. Railroad clients have included Norfolk Southern; Conrail; Amtrak; CP Rail; the Metro-North Railroad; and the New York, Susquehanna, and Western Railway. Hundreds of tasks have been performed for these clients throughout the United States.

Services provided have involved investigating and remediating railroad sites affected by a variety of chemicals, including solvents, diesel fuel, lubricating oils, gasoline, arsenic, polynuclear aromatic hydrocarbons, and metals; conducting human health and environmental risk assessments; inspecting and removing numerous UST systems and assessing and remediating spills; providing assistance during train derailments involving spilled hazardous chemicals and diesel fuel; assessing the nature and extent of chemical residues in inactive facilities and designing and overseeing the cleanup and demolition of these structures; obtaining approvals of RBCA at rail sites and for barge lines; performing Phase I and Phase II assessments of properties being sold and/or purchased; assessing hazardous material management practices across the system and assisting with the steps needed to comply with the Clean Air Act 112-R Risk Management Plan requirements; and providing wastewater, air, and hazardous/solid waste engineering services.

UST Program for a Municipality, Hempstead, NY, Town of Hempstead. Project Manager responsible for managing a detailed survey of 90 USTs owned by a town in Nassau County, New York. Developed and coordinated a tank compliance program designed to register, test, remove, and close old tanks and design and oversee the construction of new tank facilities. Negotiated tank closure criteria with the state based on risk. Coordinated a compliance program that included registration, leak testing, bidding, and oversight services during UST removal operations. Designed new tank facilities and provided construction oversight.

Site Investigations for a Class I Railroad, Various Sites, U.S., Confidential Client. Project Manager responsible for site investigations at railroad yards characterized by failed USTs and aboveground storage tanks. Primary contaminants of concern were industrial solvents and diesel fuel. Negotiated site closures with state regulators and designed remediation systems, including soil roasting, bioremediation, barriers, and product recovery and pump-and-treat systems.

Environmental Assessment LaGuardia Airport, New York, NY, Ogden Aviation Services. Principal-in-Charge of the reconstruction of a bulkhead seawall surrounding a bulk fuel storage terminal. Prepared health and safety and confined space entry plans to cover the excavation and removal of fuel-contaminated soils. Collected and analyzed soil samples to determine the concentrations of gasoline and aviation fuel to assess potential entry hazards. The entry plan allowed the confined spaces to be classified as nonpermit-required spaces, which allowed workers to enter the excavation in Level C protection. This classification was justified by pre-entry continuous air monitoring, the design of a confined space entry program, and the cleaning of the confined workspace so that the workers could avoid contact with contaminated soils.

Remedial Action Plan, FL, Confidential Client. Project Manager responsible for the cleanup of 4,000 gallons of diesel fuel released during a tank car derailment. The technology assessment identified air sparging, interceptor trenches, and a groundwater pump-and-treat system as the most feasible and cost-effective remedies. Developed and implemented a remedial action plan. Provided construction oversight during the abatement, investigation, and remedial construction to make certain that the work plan and designs were followed in a cost-effective manner.

Environmental Compliance for the Rehabilitation of the Williamsburg Bridge, New York, NY, New York City Department of Transportation. Project Manager responsible for the environmental oversight and hazardous waste and materials compliance program and a site-specific health and safety plan related to the containment, collection, and disposal of lead paint waste. Other significant issues included asbestos abatement, RCRA compliance, demolition, UST decommissioning, and soil remediation.

Pipe Line Rupture, IN, Buckeye Pipeline Company. Project Manager responsible for overseeing the installation of a groundwater pump-and-treat system after a major pipeline ruptured and released several hundred gallons of petroleum product. Evaluated the impact of the release and designed a cost-effective treatment system that met the operating parameters and the state's discharge criteria.

Site Assessment at Willow Run Airport, Detroit, MI. Project Manager responsible for directing a site assessment to document and evaluate environmental concerns at this property to prepare for long-range redevelopment. Estimated the extent of environmental problems and the risks associated with site development and identified potential funding sources to address environmental risks and liabilities. Provided a preliminary evaluation of the environmental constraints implied by redeveloping the airport and nearby properties.

Environmental Compliance for the Rehabilitation of the Whitestone and Verrazano-Narrows Bridges, New York, NY, New York City Department of Transportation. Project Manager responsible for managing air monitoring and environmental compliance assistance during the rehabilitation of two major bridges. The principal issues of concern were to protect workers, the public, and the environment from lead hazards and to manage lead paint waste in accordance with hazardous waste requirements.

Assessment of an Electronics Manufacturing Facility, NY, Confidential Client. Project Manager responsible for managing an investigation of an electronics manufacturing facility to evaluate ways to decommission and demolish the building and dispose of the debris. Supervised the oversight of the building cleaning program, which included removing asbestos-containing material and polychlorinated biphenyl (PCB) equipment prior to demolition and remediating mercury residues found on building surfaces and in on- and off-site soils. Developed building demolition and soil excavation protocols to minimize fugitive dust. Supervised the air monitoring program used to document compliance with ambient air quality standards during the work. USTs and waste disposal pits were decommissioned using negative ventilation enclosures with exhaust air treatment. Residential soil on properties adjacent to the site and residential interiors near the site were contaminated with mercury dust. Developed a sampling plan and cleanup protocol and provided oversight during the cleanup.

Wire and Cable Manufacturing Facility Decommissioning, NY, Confidential Client. Project Manager responsible for managing the decommissioning of a closed, 300,000-square-foot industrial facility located on 40 acres, which was a listed Superfund site. A site investigation and risk assessment showed that demolition workers and the public could be exposed to unacceptable levels of organics and heavy metals. The risk assessment also found that the state-approved remedy to solidify on-site soils contaminated with heavy metals was not justified because the metal concentrations were below levels of concern. The state accepted the risk assessment and rescinded its request to remediate the soil. Developed a plan to minimize the exposure risk posed by the building residues by increasing the level of worker protection and developing dust control programs during demolition in lieu of more costly building decommissioning. Asbestos insulation in the closed facility was in very poor condition, and asbestos fibers were spread throughout the building. Developed and carried out an interior cleanup plan to remove the asbestos, as well as other residuals from prior manufacturing operations. Several aboveground wastewater tanks containing cyanide residuals were cleaned and closed in place. An on-site electrical substation was vandalized, and transformers and circuit breakers containing polychlorinated biphenyls (PCBs) were damaged. Decommissioned the substation, removed the PCB fluid, and cleaned up PCB-contaminated soil.

Tool Manufacturing Facility Closure, NY, Confidential Client. Senior Project Manager responsible for directing the decommissioning of a turn-of-the-century tool manufacturing facility that consisted of forging, cutting, machining, parts washing, steel hardening, and painting operations. Fuel oil for the forges and an on-site power plant was stored in USTs. Developed a facility decommissioning plan that involved the cleanup of machinery pits and contaminated building surfaces and the demolition and disposal of the facility buildings. Asbestos was found in certain areas of the facility. Designed and carried out an asbestos abatement program. The roof of the main building was covered with corrugated asbestos roofing material. Obtained waivers from the state's full-enclosure requirements that would have increased the cost of work. Provided oversight and air monitoring services during building demolition and UST removal operations.

Aircraft Manufacturing Facility Closure and Site Redevelopment, NY, Confidential Client. Project Manager responsible for the decommissioning of 30 manufacturing buildings with 1.2 million square feet of floor space. The demolition addressed lead paint, polychlorinated biphenyls (PCBs), reinforced-concrete slabs, and utility and testing tunnels. Provided asbestos abatement design and bid-phase management services to remove asbestos-containing roofs, thermal insulation, floor tiles, and other materials from the buildings. The main plant site was redeveloped into a large-scale recreational, retail, and commercial development. Construction and demolition debris was used to fill in an existing recharge basin. This fill served as a cap for the contaminants in the basin sediments.

Superfund Assessment of a Metal Finishing Facility, WI, Confidential Client. Senior Project Manager responsible for conducting a Superfund remedial investigation/feasibility study and a risk assessment and developing arguments to support the continued discharge of groundwater contaminated by metal finishing waste into a nearby river prior to the RCRA alternate concentration limit regulations.

Site Investigation and Corrective Action Plan for a Recycling Facility, OH, Confidential Client. Project Manager responsible for developing and supervising a site investigation and multiphase RCRA corrective action program at a solvent recovery facility. Negotiated a phased soil cleanup based on continuing discharges to surface waters with limits established through a risk assessment.

Response Strategy Development for a Waste Recovery and Treatment Facility, WI, Confidential Client. Project Manager responsible for supervising and developing a CERCLA response strategy for a potentially responsible party committee at a site where groundwater contaminated by metal-working waste and solvent discharged to a river.

Remedial Program Following a Transportation Accident, MI, Confidential Client. Project Manager responsible for supervising a remedial program after a transportation accident released extremely toxic materials. Established cleanup requirements for uncommon chemicals based on a risk assessment where no cleanup protocols existed.

Site Investigation of a Textile Finishing Facility, NJ, Confidential Client. Project Manager responsible for supervising an Industrial Site Recovery Act site investigation, including soil and groundwater sampling and UST removal. Designed a petroleum recovery and in situ soil remediation system.

PROFESSIONAL ASSOCIATIONS

American Society of Civil Engineers, Member

American Railway Development Association, Board of Directors and former Environmental Committee Co-chair

New York City Brownfield Partnership, Board of Directors and Former First President

Railroad Environmental Conference at University of Illinois at Urbana - Champaign (annual), Conference Moderator and Planning Committee

National Brownfield Association, Former Member of NYS Executive team and National Advisory Board

Northeast Sustainable Communities Workshop, Conference Moderator and Planner

Brownfield Renewal Magazine, Brownfield Award Judge

EPA National Brownfield Conference, Speaker and Conference Planning Committee

Sustainable Long Island Conference, Speaker and Conference Planning Committee

Appendix B

Field Sampling Plan

Consulting
Engineers and
Scientists

FIELD SAMPLING PLAN

GEI Consultants, Inc., P.C.
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Huntington Station NY 11746
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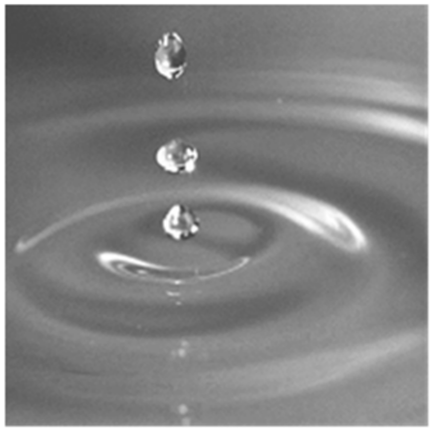


Table of Contents

Acronyms and Abbreviations

AOC	Area of Concern
ASTM	American Society for Testing and Materials
BOD	Biological Oxygen Demand
BTEX	Benzene, Toluene, Ethyl Benzene, Xylenes
CAMP	Community Air Monitoring Plan
CD	Corrected Depth
COC	Chain of Custody
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DOT	Department of Transpsortation
EM	Electro-Magnetic
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FSP	Field Sampling Plan
GC/MS	Gas Chromatograph/Mass Spectrometer
GIS	Geographic Information Systems
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HASP	Health and Safety Plan
HSAs	Hollow-Stem Augers
ID	Inner Diameter
IDW	Investigation Derived Waste

IHC	In-House Consultants
JHS	Jar Head Space
LNAPL	Light Non-Aqueous Phase Liquid
MC	Macrocore®
MTBE	Methyl Tert-Butyl Ether
NAPL	Non-aqueous Phase Liquids
NAVD	North American Vertical Datum
NYSDEC	New York State Department of Environmental Conservation
OD	Outer Diameter
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation Recovery Act
SC	Specific Conductance
SMP	Site Management Plan
SOP	Standard Operating Procedure

SPLP	Synthetic Precipitate Leaching Procedure
SPT	Standard Penetration Test
SVOC	Semi-Volatile Organic Compounds
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds

Measurements

bgs	Below Ground Surface
ft	Feet or Foot
g	Grams
lpm	Liters per minute
mg/L	Milligram per liter
ml	Milliliter
mL/min	Milliliters per minute
MSL	Mean Sea Level
mV	Millivolt
ng	Nanogram
NTUs	Nephelometric Turbity Units
ppm	Parts per million
µg/Kg	Microgram per kilogram

Section 1

INTRODUCTION

1. Introduction

This document serves as a Field Sampling Plan (FSP) for various types of environmental sampling activities that may be utilized during implementation of Site Characterizations, Remedial Investigations, Interim Remedial Measures, Feasibility Studies, Remedial Designs, and/or Remedial Actions. The primary intent of this document is to promote accuracy and consistency for field and office support operations.

This FSP encompasses a broad range of activities to improve the planning, implementation, and documentation of field and pertinent office operations. All methodologies presented in this document may not be applicable to site-specific situations. In the event of differences between the FSP and any site-specific work plan, including a work plan or a quality assurance project plan, the provisions of the site-specific plan will prevail.

This document is organized according to the chronological sequence of typical work flow proceeding from project setup to field activities and then to data collection.

The document contains two types of guidance:

General Guidance Procedures – Documents intended to be informative and not prescriptive. The documents are designed to provide necessary background information to adequately understand associated field processes.

Standard Operating Procedures (SOPs) – Documents intended to provide the necessary procedures and notes to successfully implement the operation.

This FSP incorporates requirements including but not limited to New York State Department of Environmental Conservation (NYSDEC) Division of Environmental Remediation (DER)-10, Technical Guidance for Site Investigation and Remediation dated May 3, 2010, any applicable local, state, or federal requirements, and client requirements. Each SOP is current as of the effective date indicated in the header and will be updated as necessary.

This document has been provided to all staff performing field tasks for the client.

2. FSP Layout Design

2.1 Header Information

i. Each SOP contains, within its designation, a two letter abbreviation of the general category in which it belongs (i.e. PP-001 means it is in Project Planning). The table of contents provides the definition for each abbreviation. The SOP name and number is provided in the header and footer of the document. As discussed in the previous section, GEI guidance documents are not given an SOP reference number.

ii. The revision number is provided in the header of each SOP.

iii. The effective date is provided in the header of each SOP. The effective date provides the date when the revisions to the SOP are in effect and provides information as to the last time the SOP was updated. Each SOP should contain the most up-to-date version and effective date.

2.2 Footer Information

i. Each footer contains the page number and total page numbers as well as a second reference to the SOP name.

2.3 Body of Text

i. Details of the SOP are provided sequentially.

ii. Notes are provided to understand precautions or common issues associated with the performance of the procedure.

iii. References provide sources for the creation of the SOP.

iv. Attachments provide reference to external documentation that could be reviewed in conjunction with the document.

v. Reference and inclusion of complete SOPs are included within this document. Each SOP should contain the most up-to-date version and revision date.

Section 2

PROJECT PLANNING ACTIVITIES (PP)

SUMMARY GUIDANCE

PP-001 General Guidance on Project Planning Activities

1. Objective

The purpose of this summary guidance section is to present a summary of the project planning activities that must be completed prior to the start of field activities. The following text outlines the steps which should be followed.

To begin, the task-specific work plan should be reviewed to identify the specifics of the task to be completed. This includes the type of work, sampling requirements, and schedule, among others. A site visit (if possible) should be made to verify that sample locations are accessible. Once the review of the work plan is completed, it can then be determined which steps need to be taken to start the project. A project planning checklist (see attached) should be completed and includes the items detailed below

2. Execution

- **Subcontractor Selection** – If the subcontractor is to be contracted through GEI, the subcontractor should be selected based on a combination of their qualifications and their proposed costs, if not identified in the Master Services Agreement. A minimum of two subcontractor cost proposals should be obtained for each task.
- **Subcontractor Agreement** – Once a subcontractor is selected, a subcontractor agreement between GEI and the subcontractor must be established. This agreement is task specific and should reference an approved proposal from the subcontractor.
- **Markouts** – If the project includes intrusive work, a utility markout request must be called in to Dig Net (811). Markouts must be called in at least 72 hours prior to the start of intrusive activities; however, five business days is recommended. If the work conducted is on private property, markouts by a private markout company should be obtained as public utility locating services will generally only identify line point-of-entry to a private property from a right-of-way. Markout verifications from Dig Net must be received at least one day prior to the start of field activities. Following the receipt of the markout verifications, a GEI utility clearance form must be completed, and the markouts must be visually verified. The markout verifications, verification spreadsheet and the GEI utility clearance forms must be compiled and remain onsite during the duration of intrusive activity. In addition, markouts must be checked every 10 days throughout the duration of intrusive work. For more information on markouts, please see SOPs PP-002 and PP-003.

- **Health and Safety** – A site-specific Health and Safety Plan (HASP) must be developed prior to any field work. The site-specific HASP must be reviewed by the staff involved in the project and signed prior to the start of work (by field staff). Subcontractors are required to provide their own HASPs (which are at a minimum, as strict as the GEI HASP), or must sign and comply with the GEI site-specific HASP. The subcontractor must also provide the proper certifications for the field crew, which should include, but is not limited to, OSHA certifications (8-hour and 40-hour HAZWOPER) and medical clearance documentation. In addition, tailgate safety meetings must be held daily, which discuss hazards related to the task being performed. For more information, please refer to the site-specific HASP. For the SOPs presented in this FSP, health and safety items must be adhered to during the conduct of all field activities.
- **Notifications** – prior to the scheduling of field activities, all team members should be identified. The appropriate project manager should be notified as soon as possible of the upcoming work and the proposed schedule. As a general rule, at least one week notice should be provided. The client will coordinate access to any private property where sampling is planned to be conducted.
- **Data Group Notification** – GEI's Data Group should be notified if laboratory analysis is to be performed. The Data Group should be made aware of the types of analysis being performed, the approximate number of samples to be collected, the validation requirements and turnaround times.
- **Lab Notification** – If laboratory analysis is needed, the selected laboratory should be notified as soon as possible to order the necessary sample bottles and supplies. They also should be informed of the anticipated amount of samples, type of analysis and required turnaround times.
- **Equipment** – Any specialized equipment or supplies, including Community Air Monitoring Program (CAMP) equipment, needed for the job should be ordered, to allow for sufficient lead time. CAMP equipment is required for any intrusive work. For more information on CAMP requirements, please see the site-specific HASP or Work Plan and SOPs AR-001 through AR-005.
- **Investigation Derived Waste (IDW) Management** – Consideration should be given to the management of IDW. Based on the work to be performed at the specific site, a determination needs to be made on how the IDW is to be handled. Possibilities include drums for soil and groundwater, frac tanks for groundwater or roll-offs for soil. Reducing the amount of IDW generated through selection of the appropriate sampling and investigation methods, as well as cost and efficiency of disposal, should always be considered.

- **Background Information** – Prior to field activities, pertinent background information should be discussed with the field staff and GEI task and project managers. Such information may include: historical perspective, property owner/community member interests, potential litigation matters, access and logistical issues, safety concerns, requirements and concerns, among others.
- **Kick-off Meeting** – A kick-off meeting should be conducted prior to the start of field activities. At a minimum, the meeting should be attended by the project manager and field staff. This meeting should review the tasks to be completed, equipment needed, laboratory analysis, and a review of any necessary background information (including potential sensitivities associated with the site or work area of the site). Other items that should be discussed include the process of and the need to keep the client informed of the work progress (including any relevant observations) and the steps to be taken if a member of the field crew is approached/questioned by a regulator or a member of the public or media.

SUMMARY GUIDANCE

PP-002 General Guidance on Private Utility Markout

1. Overview

Prior to installing any wells, performing excavations or penetrating the subsurface for any investigation; all service lines, including water, electrical power, natural gas, sewers, cable and product distribution piping, and others, must be mapped out on the ground surface. This requirement is independent of the need for borehole clearing to 5 feet. Both exercises together minimize the safety risk as well as the time and cost penalty associated with severing an underground line.

This guidance describes and recommends technologies that should be (and normally are) employed from the companies performing the mapping, which are private utility locators. Public utility locating services will identify line point-of-entry from a right-of-way, but in many cases are unwilling to mark locations within the footprint of a site. Even if the public companies provide onsite service, it is good insurance to have a private company verify buried utility locations because of the potential consequences of hitting an unknown buried utility.

Because subsurface lines may be metal, plastic, clay, or concrete, multiple technologies are generally needed for their identification. For most applications the following technologies are fit-for-purpose.

Electro-Magnetic (EM) Device: This technology uses an electro-magnetic field in the subsurface to accurately locate metallic lines or non-metallic lines incorporating a metallic trace wire along their surface. The field is created either by direct contact to the pipe or trace wire, or by an induced current via radio waves.

Sewer Sonde: For non-metallic lines where internal access is possible (such as cleanout ports in a sewer), a beacon or 'sonde' that emits a signal to a surface receiver as it is snaked through the pipe provides the same accuracy as the EM detector. If the internal condition of the pipe is desired, a camera can be deployed instead of only a sonde.

Ground Penetrating Radar (GPR): This technology involves radar waves reflecting to a surface receiver which provides a visual real-time map of the subsurface by which anomalies (such as pipes or tanks) may be detected. It has limitations in clay or wet soils and requires a skilled operator for interpretation. For high risk utilities (e.g. PVC natural gas lines without trace wire) where line-of-sight projection from site entry point to a kiosk or other building is uncertain, GPR should be considered.

For most sites, utility markouts using the above technologies can be conducted in about two hours, assuming work covers a limited area where subsurface activities will be conducted. Consideration should be given to mapping an entire site if as-built drawings are suspect and work is planned over an extended period of time.

SUMMARY GUIDANCE

PP-003 General Guidance on Maintaining Markouts

1. Overview

Maintain the marks set down by utility operators/ locators at your site. Several steps should be taken to ensure site markouts are maintained/refreshed throughout the project.

Walk-through the site to become familiar with the markings and the locations of buried utilities. Pay special attention to any changes in direction that the underground facilities take. Consider photographing the markouts.

If the excavation will cause the removal or disturbance of markings, establish offset marks in order to maintain a reference point for those underground facilities.

Make sure that everyone involved in your excavation is aware of any offsets that have been established, any marks that have been compromised, or any other information regarding facility locations.

Don’t put spoil piles over markings.

If the markouts are located over grassy areas or if snow is expected, flags or stakes should be employed to avoid having the markouts washed away by rain or covered by snow.

Avoid driving machinery over stakes and flags. Paved areas should be swept periodically so that painted marks remain visible.

If marks have faded or have been compromised to the point where proper and safe excavation is no longer possible, call the public or private utility markout service and make a request for a new markout ticket. If the markings at your site are refreshed, make sure that you use the uniform color code.

Attachment A

Project Planning Checklist

SITE: ____

PROJECT MANAGER: ____

Activity	Completed (Yes, No or NA)	Date Completed	Comments
Subcontractor Identified (if needed)			
Subcontractor agreement			
Markouts			
HASP			
Subcontractor certs obtained			
National Grid Notifications			
Data Group Notified			
Laboratory notified			
Equipment Ordered			
IDW Management			
Background info reviewed			
Kick-off meeting or call			

Section 3

FIELD DOCUMENTATION (FD)

STANDARD OPERATING PROCEDURE
FD-001 Field Notebook

1. Objective

Proper documentation of all site activities is a crucial part of the field investigation process. Documentation, relative to sampling procedures, includes sample labels, sample seals, field logbooks, chain of custody (COC) records, sample analysis request forms, and laboratory sample logs. The field notebook serves as a record of significant field activities performed or observed during the project. The field notebook provides a factual basis for preparing field observation reports, if required, and reports to clients and regulatory agencies. Example field notes are provided in Appendix A.

2. Execution

- Use a separate all-weather bound notebook for each site/location/ project number, as appropriate.
- Write neatly using black or blue waterproof indelible pen (or note if field conditions [i.e., cold or wet weather] require use of pencil).
- Write the project name, project number, book number (i.e., 1 of 3), and date on the front cover. On the inside cover, identify the project name, project number, and “Return Book To:” the office address of the project manager.
- Number all of the pages of the field book starting with the first entry if notebook is not numbered already.
- Record activities as they occur.
- Neatly cross out mistakes using a single line and initial them. Erasures are not permitted. If an error is made on an accountable document assigned to one individual, that individual will make all corrections. The person who made the entry will correct any subsequent error discovered on an accountable document. All subsequent corrections will be initialed and dated.
- Sign or initial and date the bottom of the last daily page of an entry. Place a diagonal line through unused portions of a page.
- Record the following information upon each arrival at the site:
    1. Date/time/weather/project number.
    2. GEI personnel.
    3. Purpose of visit/daily objectives.
    4. Record conversations with:
        a. Contractors.
        b. Client.
        c. Visitors (include complete names, titles, and affiliations whenever possible).
        d. GEI office staff.

e. Landowners (site or abutters).

5. If possible, record telephone numbers of individual contacts for the site in the field notebook.
6. Note time of arrival and departure of individuals visiting the site.

- Potential additional observations to record (as needed):
  1. Type and quantity of monitoring well construction materials used.
  2. Use of field data sheets or electronic logging equipment (e.g. boring logs, monitoring well sampling logs, etc.).
  3. Ambient air monitoring data.
  4. Locations and descriptions of sampling points.
  5. Sample media (soil, sediment, groundwater, etc.).
  6. Sample collection method.
  7. Sample identification number(s) and date and time of sample collection.
  8. Approximate volume of groundwater removed before sampling.
  9. Field observations.
  10. Any field observations made such as pH, temperature, turbidity, conductivity, water level, etc.
  11. References for all maps and photographs of the sampling site(s).
  12. Information pertaining to sample documentation: bottle lot numbers/dates, method of sample shipments, COC record numbers, and overnight shipping numbers.
  13. Surveying data (including sketches with north arrows).
  14. Changes in weather.
  15. Rationale for critical field decisions.
  16. Recommendations made to the client representative and GEI Project Manager.
  17. Include a site sketch or representative site photograph of conditions at the end of the day, if required.
  18. Time.
  19. Summarize work completed/work remaining.

3. Notes

- Only record facts.
- Record all observations regardless of relevancy.
- Identify conditions or events that could affect/impede your ability to observe conditions.
- Do not use spiral notebooks because pages can be easily removed.

4. References

New Jersey DEP Field Sampling Procedures Manual, August 2005.

Yerington Mine Site SOP-03 Standard Operating Procedure Field Notes and Documentation, Revision 0 Revision Date: June 6, 2006.

ASFE Model Daily Field Report (1991), ASFE, Inc.

5. Attachments

Attachment A – Example Field Notes

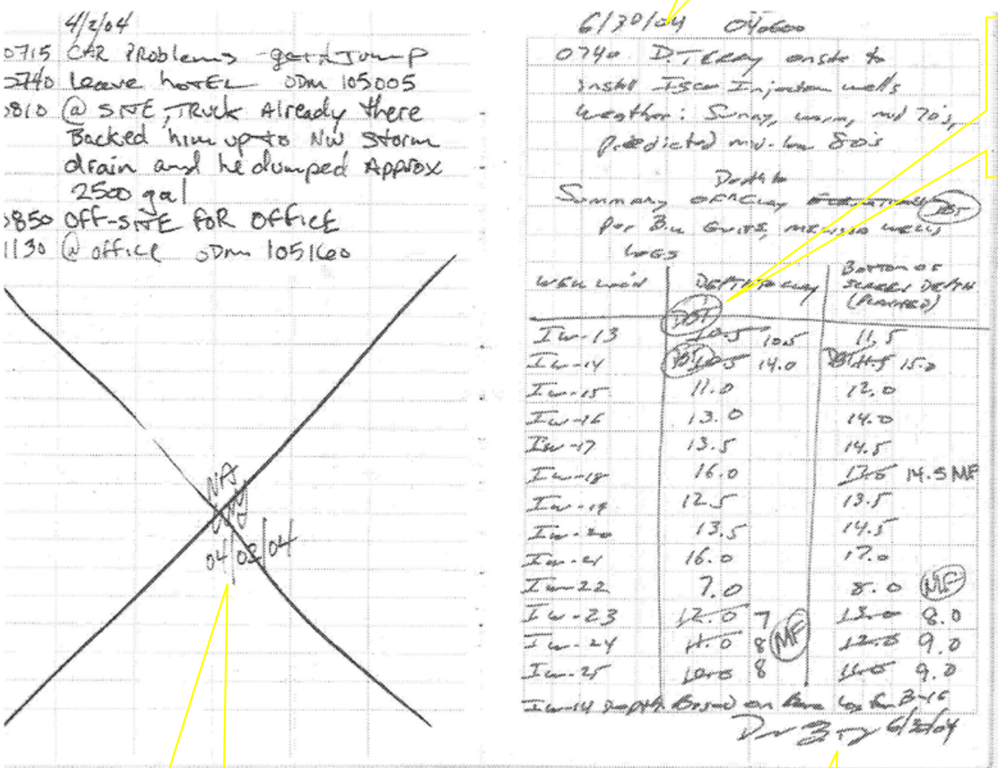
Attachment A

SOP FD-001

Attachment A – Example Field Notes

Start of each day includes:
- **Date**
- **Project Number**
- **People on site**
- **Purpose of Work**
- **Weather Conditions**

Errors are single line crossed out and initialed



Blank Space crossed out and initialed

Bottom of each page signed and dated

GEI Consultants

STANDARD OPERATING PROCEDURE

FD-002 Field Observation Report

1. Objective

A Daily Report may be required to accurately summarize the activities, observations, and decisions made during the day's field work. The daily field observation report may serve as a permanent record of the day's activity for the Project Manager (PM) and In-House Consultant (IHC).

2. Execution

- If required, at the close of the day's field work, a Daily Report must be prepared by the individual responsible for the field notebook. This report must be completed before leaving work for the day. Contents of the report should include, at a minimum, the following information.
    1. A record of person(s) present at the site, time of arrival, departure times (e.g., GEI, contractor(s), client, etc.).
    2. A record of the daily objective(s) and the activities performed (e.g., drilled five borings in the overburden).
    3. A summary of deviation(s) from the field plan or objectives.
    4. A summary of field decision(s) made, who made it/them, and the basis for such decision(s).
    5. A diagram, sketch, and/or map showing the location and extent of the work or other significant observation(s) made during the day.
    6. Any recommendations that may result from field observations and any actions that resulted from those recommendations.
    7. A summary listing and field sketch showing location(s) of field activity.
- Submit a draft report to the PM/IHC for review and editing related to the clarity and conciseness of the report. Complete any editorial changes, sign, date, and submit the report to PM/IHC for approval/signature. Field Observation Reports should be written neatly. They are not required to be typed unless specifically requested by the PM.

3. Notes

- Not all projects require daily field observation reports.
- The Field Observation Report should be based solely upon factual information, not opinions. Any speculation should be clearly noted in the report as such.

- The Field Observation Report should never be released to anyone other than the PM/IHC prior to review and signoff unless explicitly authorized by the PM/IHC.

4. References

New Jersey DEP Field Sampling Procedures Manual, August 2005.

Yerington Mine Site SOP-03 Standard Operating Procedure Field Notes and Documentation, Revision 0 Revision Date: June 6, 2006.

ASFE Model Daily Field Report (1991), ASFE, Inc.

5. Attachments

Attachment A – Example Daily Report Form

Attachment A

Attachment A: FIELD OBSERVATION REPORT

	Date:
Project :	**Report No.**
Client :	**Page:**
Contractor:	**GEI Proj. No.**

Time of Arrival: **Departure:** **Weather:**

<u>Persons Contacted, Company</u> **<u>GEI Representatives</u>**

Purpose of Site Visit:

Observations

1.

By:	**Reviewed By:**

STANDARD OPERATING PROCEDURE
FD-003 Sample Handling and Chain of Custody

1. Objective

To properly collect, label, document, preserve, package, and transport environmental samples; provide a record of the custody of any environmental field sample from time of collection to delivery to the laboratory. The chain of custody (COC) can be used as a legal document to demonstrate that samples were not mishandled and that they were delivered to the laboratory within the timeframe necessary to start analysis. A sample is under custody if it is in:

a) GEI's possession;
b) GEI's sight after being in GEI's possession;
c) it was in GEI's possession and then it was locked up to prevent tampering; or
d) a designated secure area. GEI facilities are designated secure areas.

2. Execution

- Review the work plan and Quality Assurance Project Plan (QAPP) prior to sampling to determine the following:
  - i. The analysis required by the work plan and sample volumes required by the laboratory to perform those analysis. (Be explicit when requesting analysis on the COC (e.g. rather than "VOCs" [Volatile Organic Compounds], write "VOCs 8260".)
  - ii. The turnaround time required by the project.
  - iii. If the data will be sent directly from the laboratory to the data validator or Data Group.
  - iv. Holding time restrictions for sampling media and analytical methods.
- Label the jar or bottle
- Following sample collection, the sample container is labeled using a waterproof marker with the sample ID, the date and time (military time) of sample collection, project number, sample preservatives, and the sampler's initials. Sample custody begins at this time.
- Record the above information in the field notebook.
- Individually wrap sample jars with packing material. Place samples in a chilled (4°C) cooler immediately after collection.
- Complete a COC for the samples as described below, and sign off on the COC each time a new person takes possession of the samples. A COC form must accompany each shipment/delivery of samples to the laboratory. GEI or laboratory COC forms may be used as long as the laboratory form contains the same required information as described below.

- An example COC is provided in Attachment A.
- Place a custody seal on the cooler if shipping.
- Transport samples to the laboratory as soon as possible. It is preferable the samples are sent from the field rather than brought back to the office for submission at a later date.

2.1. Chain of Custody (COC) Completion

- Record the project name and number, the sampler's name(s) and the site, town, and state where the samples were collected.
- For each sample, enter the sample identification number, date and time (military time) collected, whether the sample is a grab or composite sample and the number of sample containers. Record the type of analysis (including laboratory method; e.g. EPA-SW846 Method XX) requested and the preservative (if appropriate) in the vertical boxes.
- When samples are ready to be relinquished, complete the bottom of the form with date and time (military time) and signatures of relinquisher and receiver of samples as indicated. The sample collector is always the first signature while the analytical laboratory is the final signature. Theoretically, all individuals handling the samples between collection and laboratory should sign the form; however, if a common carrier (i.e., FedEx, UPS) is used for shipping, GEI must identify the carrier in the 'Received by' box on the COC. If the sampler hand delivers the samples to the laboratory, the received box must be signed by the laboratory.
- Include turnaround time and project contact on the COC.
- The forms are in triplicate (white, yellow, and pink copies). The pink copy should be retained by the sampling personnel and provided to the Data Group for proper filing. The white and yellow copies should accompany the samples to the laboratory.
- Prior to sample shipment, the COC must be placed inside the cooler (in a ziplock bag or other watertight package taped inside the lid of the cooler), and the cooler must be sealed with a signed COC seal.
- If a common carrier such as FedEx is used to transport the samples to the laboratory, include the carrier tracking number and identify the carrier in the "Received by" box on the COC.
- Any unused sampling containers/media that is sent back to the lab should be included on the COC. Return samples to the laboratory in a timely manner.
- Field duplicates should be anonymous to the laboratory, but must be recorded for use by the Data Group. To keep track of this information, link the field duplicate with the proper sample in the field copy of the COC and also the field book.

- Prior to samples being sent to the laboratory, the project or task manager will check the COCs for accuracy against the sample tracking summary, if appropriate, or the work plan.
- After the samples are sent to the laboratory, the field copy must be sent to the Data Group. You can send the field copy with duplicate information in the mail to the Data Group.

3. Notes

- The field notebook must document all GEI personnel who had custody of any samples prior to shipping the samples to the laboratory, the samples must be relinquished to the shipper and the COC signed and dated by the sampler and the shipper, even if both people are GEI personnel.
- Keep the number of people involved in collecting and handling samples and data to a minimum.
- Only allow people associated with the project to handle samples and data.
- Always document the transfer of samples and data from one person to another on chain of custody forms.
- Always accompany samples and data with their chain of custody forms.
- Give sample identification at all times that is legible and written with permanent ink.
- When sending samples via a common carrier, use one COC per package.
- Do not send samples from more than one site with separate COCs in a single package.

4. References

New Jersey Department of Environmental Protection, Field Sampling Procedures Manual, August 2005.

Connecticut Department of Environmental Protection, Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory

Determination of Volatile Organic Compounds, Version 2.0 February 28, 2006.

5. Attachments

Attachment A – Example Chain of Custody

Attachment A

CHAIN OF CUSTODY

AMERICAN ANALYTICAL LABORATORIES
56 Toledo Street, Farmingdale NY 11735
(T) 631-454-6100 (F) 631-454-8027
www.american-analytical.com

CERTIFICATIONS
NY ELAP - 11418 PA DEP - 68-00573
NJ DEP - NY050 CT DOH - PH-0205

Client Information	Project Information
Company Name	Project Name
Address	Street
City State Zip	City State Zip
Project Contact	Project # / Purchase Order #
Phone #	Sampler's Name / Company
E-mail	Sampler's Signature

Analytical Test / Information

LAB SAMPLE # (LAB USE ONLY)	Sample Information			Sample Collection			Sample Containers	Number of Each Preserved Bottle							
	Client Sample ID	Sample Type	Matrix Code	Date	Time	Glass / Plastic	Total # of bottles	NONE	HCl	NaOH	HNO_3	H_2SO_4	DI Water (5035A)	MeOH	OTHER

Turnaround Time (Business Days)

Standard
- [ ] 7-10 Business Days
- [ ] 5 Day *RUSH*
- [ ] 4 Day *RUSH*
- [ ] 3 Day *RUSH*
- [ ] 2 Day *RUSH*
- [ ] 1 Day *RUSH*

Please contact laboratory for rush service availability

SAMPLE TYPE

G = Grab
C = Composite
B = Blank

MATRIX CODE

L = Liquid **PC** = Paint Chip
S = Soil **SL** = Sludge
O = Oil **SD** = Solid
W = Wipe **M** = Misc

ELECTRONIC DELIVERABLES

NYCRR Part 375 - please circle
Unres/ Comm/ Industrial/ Residential/ Res Residential/ PGW
NJ Soil Clean Up Criteria **SCDOH Action Levels**
CP 51 - Gas / Fuel **TCLP Hazardous Waste**
TOGS **NYSDEC EQUIS**

Comments / Remarks

Cooler Temp: ____________

Sample custody must be documented below, each time samples change possession, with a signature, date, and time.

RELINQUISHED BY (SIGNATURE)	DATE / TIME	PRINTED NAME	RECEIVED BY LAB (SIGNATURE)	DATE / TIME	PRINTED NAME
RELINQUISHED BY (SIGNATURE)	DATE / TIME	PRINTED NAME	RECEIVED BY LAB (SIGNATURE)	DATE / TIME	PRINTED NAME

STANDARD OPERATING PROCEDURE

FD-004 Photo Documentation

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1. Objective

To properly document and retain photographic records. Keeping a record of photographs taken is crucial to their validity as a representation of an existing situation.

2. Execution

- Photographs of a site, individual samples, or other observations should be taken using a digital camera.
- All photographic records should be recorded in the Field Notebook (SOP FD 001) and the following information should be recorded in the field notebook:
    i. Number of photograph in sequence.
    ii. Compass direction describing the direction the photograph was taken (e.g. looking southeast).
    iii. Brief description of what the photograph is intended to show.
- The field notebook should also note who took the photographs, and the date and time each photograph was taken.
- The photographs should be electronically backed up on a computer or other data storage device.
- Photographs should be placed on a photograph record template and the relevant information describing the photograph should be inserted into the caption section for each photograph.

3. References

New Jersey Department of Environmental Protection, Field Sampling Procedures Manual, August 2005.

4. Attachments

Attachment A – Example of Photo Documentation Template

Attachment A

Attachment A – Example of Photographic Record
GEI Consultants, Inc.

Project: Project Name

Location: Project Location

Photographer: K. Barber
Date: 10/25/07
Photo No.: 1
Direction: N

Comments:
Entrance of site with tree mulching operations.

Photographer: K.Barber
Date: 10/25/07
Photo No.: 2
Direction: W

Comments:
On-site building built in 1936.

STANDARD OPERATING PROCEDURE

FD-005 Surveying and Mapping Specifications

1. Objective

The objective of this Standard Operating Procedure (SOP) is to present the minimum requirements for establishing horizontal and vertical surveying control for field programs. Accurately surveyed locations are a key element in the evaluation of all field data, and are necessary for the preparation of geologic profiles and the interpretation of horizontal and vertical groundwater flow directions, and the locations of facilities. The accuracy of measurements and established elevations is particularly important when groundwater gradients are low, as errors may easily lead to misinterpretation of the direction of groundwater flow. The survey is usually performed after the field activities have been completed. Activities and land features requiring accurate horizontal and vertical control include:

- borings;
- test pits and trenches;
- monitoring wells and piezometers;
- geophysical surveys;
- surface water and drainage features;
- buildings and structures; and
- underground utilities and storage tanks as marked on the surface.

2. Execution

Mapping shall be based on field measurements and calculated to sufficient accuracy to be in conformance with A-2 standards, regardless of the intended end product of such work.

Standard site plans, as a minimum, shall provide the following elements:

- Location of all surface features, including, but not limited to: buildings, structures, fences, aboveground utilities, drainage equipment, underground features as marked on the surface, limits of pavement, landscaped or graded areas, and a general description of surface material and vegetation. All monitoring wells, soil borings, test pits, and other samples points shall be located.
- Location of all enclosed or abutting water bodies. Flow direction of rivers, streams, or surface drainage shall be noted with arrows.
- Location of boundaries by reference to other plans, when available, and to lines of occupation, where apparent. If this information does not exist, the surveyor shall make reference to Assessor's map and lot numbers.

- Disclaimers of certification to boundary and title should be prominently displayed.
- Location of surface features on abutting properties to a distance of 100 feet beyond property boundaries of study area are desired where practical, but in any case, to a minimum of 20 feet. Names of abutting property owners, as listed by the Town Assessor, shall be included.
- Include a location map of sufficient scale and detail to locate the site from a statewide reference.
- Provide a verbal and graphical scale of distance. All maps shall include a north arrow with reference to direction (magnetic, true, or grid). Unless a site-specific grid system is required, NAD83 (2007) should be identified as the horizontal datum.
- All maps shall be accompanied by copies of all field notes and sketches used in their preparation. The surveyor shall provide a coordinate and elevation list for all control and location points.
- Topography, when requested, shall conform to Class T-2 standards (90 percent of contours true to within 1/2 contour interval). The vertical datum should be identified on the plan. Monitoring well elevations shall be established at the ground surface and at the top of casing or riser.
- Requirements for location by state plane coordinates will include reference to geodetic monuments or global positioning system (GPS) base stations used.
- Plan should comply with GEI’s Section 3 “File Specifications for Subcontractors” provided below.

Requests for boundary survey entail the following additional requirements.

- Examination of record descriptions of the property and adjoining parcels, of record surveys and plans, and of record easements appurtenant to the property. Record search will extend long enough to determine the original intended boundary locations. Certification as to ownership should be provided by the client’s legal counsel.
- Location and description of all boundary monumentation found.
- Location of record easements and visible evidence of entry.
- Location and description of apparent encroachments by structures, occupation, and improvements on the property.
- Location and description of any conflict between deed description and actual occupation.
- Distance and bearing of property lines are to be shown to the nearest hundredth foot (0.01') and arc second (0°00'01"). Area should be shown in decimal acres and/or square feet.

- Plans should include certification as to conformation to state standards for boundary and topographic survey. No other certifications should be provided, except as specifically negotiated with the client.

2.1. Survey Requirements for Exploration Programs

The project manager shall go over the survey program with the survey chief to be sure that all requirements are understood and that the survey crew is alerted to potential site hazards.

The following criteria should be met for all survey programs.

- The survey is to be performed by or under the direction of a registered professional land surveyor.
- The survey shall be accurately performed to a precision of 0.01 foot for vertical control and 0.1 foot for horizontal control.
- Horizontal control is to be related to either a state plane coordinate system or the Universal Transverse Mercator (UTM) coordinate system. North American Vertical Datum (NAVD) 1988 should be used as the vertical datum unless a site-specific datum is required.
- Elevation precision to be obtained at monitoring wells and piezometers shall be:
    i. Top lip of protective casing without cover (0.01 foot); this point should only be used for vertical control and not for water-level measurements.
    ii. Top of monitoring well riser pipe (0.01 foot); a permanent reference point should be marked on the top of the riser to be used as the measuring point for all water-level measurements.
- Establish a permanent site benchmark on the most stable nearby feature and note its location on survey maps.
- The surveyor should submit a report of the survey, including a copy of all original field notes. Survey information needs to be reviewed carefully with respect to horizontal and vertical determinations. Survey errors may often be caught by using relative distances between wells or noting apparent anomalies in water levels or flow directions.

2.1.1. Previous Use of a Datum Other Than Mean Sea Level

Many times a parcel of land contains a previously established vertical benchmark on site to which elevations have been referenced. Such an arbitrary local datum may not provide any specific information about its relationship to Mean Seal Level (MSL), or a standard vertical datum. An arbitrary datum, when used, should be identified as a local or arbitrary datum. In other cases, when a standard city-wide local datum is used, the vertical relationship to the standard datum should be provided.

Otherwise, surveys at all sites subject to agency review shall be referenced to NAVD88.

2.12. Weather Conditions

Inclement conditions increase the chance for errors in identification, measurement, and recordings. Surveyors need to take extra time to assure proper identification of all monitoring wells surveyed, to guarantee ice- and snow-free surface elevation shots, and to carefully record survey data despite adverse conditions. Obtaining stable tripod set-ups may be more difficult under these conditions. Sightings should use shorter distances than under more favorable conditions. Warm, sunny days generate heat waves that may present problems for optical instruments.

2.13. Work at Hazardous Waste Sites

Surveyors need to be made aware of hazardous site conditions and potential exposures. Surveyors should have been enrolled in a health monitoring program for any sites which require personal protection above Level D. Note that anticipated risks to surveyors would be expected to be less than for those engaged in collecting samples or in subsurface explorations. However, potential exposure to hazardous materials should be pointed out and appropriate protective equipment worn and used. Surveyors shall also be made aware of other site activities and procedures for evacuation in case of emergency.

3. File Specifications For Subcontractors

3.1. General File Standards

- The method of naming files shall incorporate the name of the site and/or the GEI project number and the content. For example, SITE NAME-001110-Site Layout.
- All files provided to GEI will be electronically transmitted or recorded on CD, DVD, or other permanent recording medium. All referenced files and other supporting files such as special line types, color tables, images, etc., shall be included.
- All files are to be provided in .DWG or .DXF format and shall be compatible with AutoCAD Release 2007.
- It will be standard procedure to have purged all unused entities from a CAD file prior to delivery.
- Each file will be clearly labeled as follows:
    i. Project No.:
    ii. Project Name:
    iii. Drawing Title:
    iv. File Size:
    v. Date:

vi. Revised Date:

- Files which contain non-standard ACAD fonts, line types or custom menus are not acceptable.

3.2. General Drafting Standards

- All entity line types, colors, etc. are to be defined "BYLAYER."
- It shall be standard to use "object snap" for the creation or insertion of all entities (as compared to "eyeballing").
- All symbols will be originally drawn on layer "0." This will allow the symbol to acquire the color and line type properties it is inserted on. All symbols used to define sample locations are to contain attributes describing the sample identifier and any elevation data required by contract.
- All line entities are to be continuous polylines (PLINES).
- All text shall be rotated such that it is readable from the bottom of the sheet and from the right of the sheet. It will be standard to use the AutoCAD style "STANDARD" and Arial font whenever possible. All text shall be of a size such that it is legible when plotted at the file's intended scale.
- North up or to the right.

3.3. General Layering Standards

- The following are some of the acceptable layer names. Others may be added as needed. Descriptions of new layers are to be provided to GEI.
    i. PROPERTY (property lines)
    ii. TRAVERSE
    iii. BASELINE
    iv. BUILDING (buildings, other on-site/off-site structures)
    v. STREET
    vi. ELEC (all electrical lines, manholes, power poles, transformers)
    vii. WATER (all water lines, manholes, hand holes, gates, valves)
    viii. SAN (all sanitary sewer lines, manholes, catch basins, if combined sanitary/storm sewer)
    ix. STM (all storm sewer lines, manholes, roof drains, catch basins)
    x. CONTOUR (all contour lines & labels)
    xi. TEL (telephone)
    xii. GAS (all gas lines, valves, etc.)
    xiii. TEXT
    xiv. TANKRIVER
    xv. STREAM
    xvi. SEDIMENT (sediment sample location)
    xvii. SURFACE SOIL (surface soil sample location)
    xviii. MW (monitoring well location)

xix. BORING (soil boring location)
xx. SURFACE WATER (surface water sample location)
xxi. PAD, SLAB, STRUCTURE, FND (foundations or miscellaneous structures)
xxii. EASEMENT
xxiii. SAMPLING LAYERS (begin with “E” existing or “P” proposed)

3.4. Additional Data Required

- All files shall be accompanied by a “check plot” of each file. The “check plot” shall be checked for accuracy and corrected as necessary.
- Whenever surveyed files are supplied to GEI, they shall be considered incomplete until GEI is provided with copies of all field notes and sketches, data printouts, and a point reference file (if applicableI).

Section 4

DRILLING METHODS (DM)

SUMMARY GUIDANCE

DM-001 General Guidance on Determination of Appropriate Drilling Methods

1. Objective

There are multiple drilling methods which can be employed based on the type of stratum (e.g. overburden or bedrock) and the end use of borehole. End uses include geotechnical investigation, subsurface soil sampling, and monitoring well installation or a combination thereof.

The following text describes different methods of drilling with considerations for their use to collect groundwater and/or subsurface soil samples. Profiles of subsurface conditions encountered and well installation details must be recorded on logs. Procedures for field documentation are provided in Section 3 – Field Documentation.

2. Hollow-Stem Augers (HSAs)

Borings can be installed in unconsolidated formations using hollow-stem augers (HSAs). The augers are advanced by rotation and the drill cuttings are brought to the surface by travelling up the outside of the auger flights in a screw-like manner. HSAs have the advantage of allowing the well to be installed inside the hollow stem of the auger, which prevents the borehole from collapsing. Upon reaching the planned well depth, the casing and screen are placed inside the HSAs and the flights are individually removed while the annular space around the well is filled with the filter pack and grout, as appropriate. Conversely, solid-stem augers must be completely removed from the borehole before well installation, which can lead to collapse of the borehole. For this reason, solid stem augers are seldom used for installation of monitor wells.

HSAs come in a variety of sizes and allow collection of soil samples utilizing split spoons or Shelby tubes. Samples are collected ahead of the augers for determining soil/sediment type, stratigraphy, depth to the water table, and for collecting soil samples for chemical analysis. During this process, the standard penetration test (SPT, American Society for Testing and Materials [ASTM] Method D 1586) can also be performed. The HSA method also has an advantage over mud-rotary drilling techniques in that drilling mud is not used that can contaminate the soil samples and potentially reduce the yield of the wells.

A disadvantage of the method is that HSAs cannot be used to drill into competent bedrock or through large boulders. Also, heaving or running sands can be forced up inside the augers as a result of strong vertical groundwater gradients, which can hamper efforts to collect soil samples or complete well installation. Furthermore, the maximum depth achievable using HSAs, which is generally shallower than other methods, is dependent not only on the ability of the rig (e.g., horsepower, rig-torque, weight of augers, etc.), but also the lithology of the material drilled.

3. Rotary Drilling

Rotary drilling methods include both direct rotary and reverse-circulation rotary. Direct rotary is more commonly used in environmental investigations, whereas reverse-circulation rotary is used in drilling large-diameter water supply wells. In direct rotary drilling the borehole is advanced by rotating the drill pipe (rods) and bit to produce a cutting action. The cuttings are removed from the borehole by continuous circulation of a drilling fluid. The fluid or mud is pumped down the inside of the drill pipe and is circulated back to the surface on the outside of the pipe. The fluid removes the drill cuttings from the borehole and cools and lubricates the bit. Mud used during direct rotary consists of additives (e.g., bentonite), water, or air.

Reverse-circulation rotary drilling is similar to direct rotary except the drill rigs are larger and the flow of the drilling fluid is reversed. The drilling fluid moves upward inside the drill pipes and circulates back to the borehole via settling pits. The drilling fluid returns to the borehole via gravity and moves downward in the annular space between the drill pipe and borehole wall. Drilling fluids for reverse-circulation rotary are generally water and any suspended particles picked up from the surrounding formations.

Mud-rotary methods can be used to drill in both unconsolidated and consolidated (bedrock) formations. In addition, drilling mud stabilizes the borehole and limits the potential for borehole collapse. Disadvantages of using the mud-rotary method include the difficulty in determining the depth to the water table, the potential for drilling mud to impact soil samples and dragging of contamination into deeper zones since the drill cuttings are re-circulated in the borehole. Wells installed using this method typically take longer to develop than wells installed using the HSA or air-rotary methods due to the invasion of mud filtrate into the formation.

In air-rotary drilling, compressed air is directed down the inside of the drill pipe to a percussion “hammer” that breaks up soil and shatters rock. As in mud-rotary drilling, air removes the cuttings and lubricates the bit. However, since air has no viscosity, it cannot be used to stabilize a borehole therefore, casing must be advanced in unconsolidated formations to keep the borehole open. This is why air rotary methods are best suited for drilling in bedrock formations. The percussion-type air-rotary hammer bit provides the best penetration rate when drilling bedrock consisting of crystalline rock. However, when drilling above the water table, an air-rotary bit can grind the soil and bedrock to a fine powder which is blown out of the hole with air and which has the potential to be inhaled. Therefore, drilling above the water table using air-rotary methods requires the addition of potable water to the borehole for dust control. In addition, the air compressor should be of the oil-less variety, or have a filter to prevent any oil from entering the borehole.

A disadvantage of using rotary methods while drilling in unconsolidated formations is the requirement of pulling the drill pipe out of the hole each time a split-spoon soil sample is collected (and the SPT is performed). This adds up to considerable amounts of time when deep wells are being installed or when continuous split-spoon sampling is being performed. As stated above, split-spoons used to collect soil samples can become contaminated when they are advanced down a mud-filled borehole.

A special type of rotary drilling is bedrock coring, wherein a special core bit and barrel are used to retrieve relatively undisturbed core samples of the bedrock. Coring allows better characterization of bedrock lithology and other features including orientation of fractures and bedding planes, which can control contaminant migration. Core barrels can either be unoriented or oriented. An oriented core is scribed with respect to magnetic north. Although more expensive than collecting an unoriented core, this method gives the true orientation of the features encountered in the core.

Drilling fluids are generally air (air-rotary) or bentonite and/or water (mud-rotary). Water added to a borehole must be of potable quality. The source of the potable water used during the installation (and development) of monitor wells should be documented (e.g., in the Remedial Investigation Report).

Bentonite is high swelling clay with sodium montmorillonite as its primary clay mineral. Bentonite is added to water to increase the viscosity of the drilling fluid so that drill cuttings can be removed from the borehole more effectively. At the same time, the viscosity must be low enough to allow cuttings and coarse-grained particles to settle out once they are circulated out of the hole. Bentonite also adds weight to the drilling fluid, which helps to maintain borehole stability.

4. Sonic Drilling

The method involves driving a core barrel using vibration, rotation, and a downward force to collect soil samples. A sonic drill rig looks and operates very much like a conventional top-drive rotary or auger rig. The main difference is that a sonic drill rig has a specially designed, hydraulically powered drill head or oscillator, which generates adjustable high-frequency vibrational forces. The oscillator uses two eccentric, counter-rotating balance weights or rollers that are timed to direct 100 percent of the vibrational energy at 0 and 180 degrees. There is an air spring system in the drill head that insulates or separates the vibration from the drill rig itself. The sonic head is attached directly to the drill pipe or outer casing, sending the high-frequency vibrations down through the drill pipe to the bit.

A core barrel is advanced using vibration, rotation, and downward force to collect continuous soil cores up to 20 feet in length. The bit at the end of the core barrel contains carbide teeth allowing the core barrel to be advanced through most overburden, soft bedrock, and minor obstructions such as bricks and boulders. Once the core barrel has been advanced, a secondary or over-ride casing is advanced down to the same depth as the inner core barrel. The over-ride casing keeps the borehole from collapsing while the inner core barrel is removed. Once the core barrel is removed, the soil core is pushed out of the core barrel through the use of vibration and either air or water pressure. Soil core diameters are dependent on the size of core barrel used and range from 3 to 12 inches. The use of multiple over-ride casings of increasing diameter allows the borehole to be telescoped down through multiple confining units. The setup used in sonic drilling makes this drilling method amendable to collecting soil cores and installing wells in angled boreholes. With only the bottom of the inner and outer core barrel exposed to the aquifer at any given time, determining the location of the water table can be difficult.

While this drilling method has the capability of drilling through and providing samples of coarse gravels, boulders, and tight clays, these situations will result in slow drilling or advancement of the core barrel. The result is a hotter core barrel and a longer contact time between the core barrel and the encased soil core. The aforementioned conditions will increase the probability that the sonic method will raise the temperature of the soil core and facilitate volatile organic compound (VOC) and semi-volatile organic compound (SVOC) loss.

The ability to quickly install deep borings and wells, while generating a large-diameter continuous soil core, makes this drilling technique invaluable when continuous soil sampling is needed to assess deep or complex geological situations. However, sonic drilling's high cost, relative to other drilling methods, may be prohibitive for small projects or shallow boreholes. The higher cost of the drilling method should be weighed against the cost savings incurred due to its faster drilling rate and high quality of the soil core produced.

5. GeoProbe®-Direct Push

The method involves hydraulically pushing a sampling device attached to a string of hollow rods into the subsurface for the purpose of collecting soil and/or groundwater samples (e.g., Geoprobe®). The method can be used to collect discrete soil samples or groundwater samples, as well as install small-diameter groundwater monitoring wells.

Advantages of the direct-push method include the relatively quick collection of groundwater samples and, when used along with a mobile laboratory, collection of data in “real” time. The method allows for collection of multiple samples in a day with the potential for achieving contaminant delineation in one mobilization of the field equipment. The data can also be used to select locations of permanent monitor wells.

Disadvantages of using a mobile lab include the fact that the data quality achieved are often suitable only for screening purposes. Direct-push methods typically result in very turbid groundwater samples since an oversize borehole is not produced and a filter pack is not used. Turbid samples can produce higher metal concentrations in groundwater samples since metals are typically adsorbed onto soil particles. Use of direct-push methods can also cause cross-contamination since contamination from shallow zones may be driven down to deeper zones.

Another disadvantage of using direct-push technology for collecting groundwater samples is the potential to breech confining units. To prevent this, soil sampling using direct-push technology or conventional split-spoon sampling techniques should first be performed to identify the presence, depth and lateral extent of confining units. Pushing through confining units should be avoided if the presence of dense non-aqueous phase liquid (DNAPL) or very soluble compounds, such as methyl tert-butyl ether (MTBE), are suspected or the contaminant plume appears to be diving in the aquifer.

STANDARD OPERATING PROCEDURE

DM-002 Hollow-Stem Auger

1. Objective

To standardize the drilling of overburden soil borings for environmental investigations. This standard operating procedure (SOP) addresses the use of hollow-stem augers to drill the soil boring.

2. Execution

- If work is to be conducted on private property, verify that the client has been notified (see SOP PP-001) and that access has been granted.
- Ensure that markout procedures outlined in PP-001, PP-002, and PP-003 have been completed.
- Ensure that a safety check has been conducted.
- Inspect the drilling rig to make sure it has been appropriately decontaminated and that the down-hole equipment has been steam-cleaned. Check that the steam-cleaner is working properly (i.e., that steam is being produced). Record all observations and measurements in the field notebook.
- Plastic sheet, plywood sheet, or other suitable cover will be placed around the auger area during drilling, if needed, to contain soil cuttings.
- Soil cuttings will be placed in a 55-gallon steel drum or a roll-off container for subsequent sampling and disposal. Decontamination water and drilling water will be placed in tanks and/or 55-gallon steel drums for proper disposal.
- Prior to the start of drilling, the borehole location should be hand-cleared to a minimum of 5 feet below ground surface.
- For all split-spoon soil samples, use a 140-pound hammer to drive the sampler, unless conditions necessitate using a 300-pound hammer (see SOPs SM-001, *Split-Spoon Sampling* and SM-0003, *Soil Classification,* for details). Count and record the number of blow counts per 6-inch increments, confirming, blow counts with driller if necessary.
- Remove the sample with a clean laboratory spoon and transfer it directly to a suitable sample container.
- Label, preserve, and store the sample in accordance with SOP SC-002 *Sample Handling*.
- Decontaminate the split-spoon sampler after each use (see *Equipment Decontamination,* SOP QA-001) or use another decontaminated split-spoon sampler.
- Direct the drillers to drill the borehole to the top of the next sampling interval. Remove the auger cutting bit/plug and insert the split-spoon

sampler into the interior of the augers (the drillers are responsible for this activity). Measure the stick-up of the rods attached to the sampler to ensure that the nose of the spoon is in virgin soil below the augers.

- Watch for signs of a soil strata change at depth during drilling (i.e., change in blow counts, change in soil color, soil wetness, soil contamination, bouncing of the drill rig, etc.). If important to the investigation, stop drilling and collect a soil sample.
- Repeat until the borehole has been drilled to the desired depth.
- If a monitoring well is not installed in the soil boring, the boring should be abandoned with cement/bentonite grout. Do not backfill the boring with drill cuttings unless explicitly allowed under state-specific regulations and approved by the client.
- Complete boring log and, if necessary, well installation logs (SOP SM-003, *Soil Classification*).
- Record boring locations on a site map and in a field notebook sketch. Measure each location from onsite reference points in the field notebook so that enough information can be obtained to recreate the location.
- All boring locations or monitoring well locations should be surveyed and a boring/well location figure generated.

3. Notes

- In areas of significant soil contamination, hollow-stem augers may cross-contaminate upper soil layers as contaminated cuttings move up the auger flights. The potential also exists for contaminated augers to carry contamination to deeper soil strata.
- If *in situ* borehole permeability tests are to be performed prior to installation of the monitoring well, the hollow-stem auger method is not appropriate due to water loss at the auger junctions.
- If significant unanticipated contamination is encountered during drilling, stop drilling to confer with the project manager and evaluate health and safety conditions. If the borehole is to be advanced below the contaminated strata, use telescoping techniques, if appropriate, (see SOP DM-008 *Monitoring Well Telescoping*) to avoid cross-contaminating underlying geologic strata.
- When drilling below the groundwater table in fine to medium sands, the potential exists for the phenomenon of “running sands” or “blow in” to occur. Frequent measurements inside the hollow-stem augers after the drill bit/plug is removed will indicate if running sands are present.
- If necessary, arrange for the storage of contaminated soil cuttings and water in drums or other appropriate containers in a secure place at the site. Containers should be labeled.
- Plan the drilling program to drill borings from the least- to most-contaminated areas. Be prepared in advance and know where

alternative drilling locations are in the event that problems are encountered at each planned soil boring location. Alternative locations will need to have utility clearance.

4. References

Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers (October 1990), American Society for Testing and Materials [ASTM] D5092-90.

Nielsen, D.M. (1993), "Correct Well Design Improves Monitoring," Environmental Protection, July, pp. 38-49.

Standard References for Monitoring Wells (April 1991), Commonwealth of Massachusetts Department of Environmental Protection, WSC-310-91.

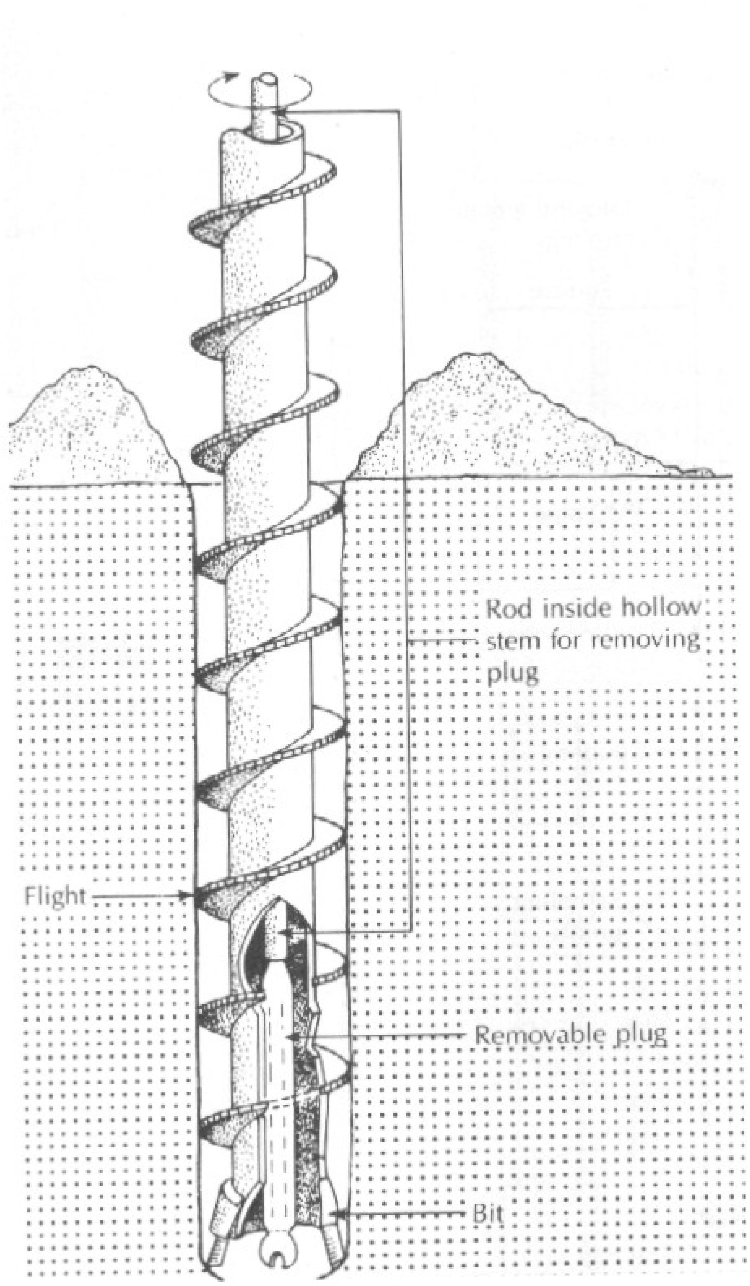
5. Attachments

Attachment A – Hollow-Stem Auger

Attachment A

SOP DM-002

Attachment A – Hollow Stem Auger



GEI Consultants

STANDARD OPERATING PROCEDURE

DM-003 Sonic Drilling

1. Objective

The objective of this standard operating procedure (SOP) is to standardize the drilling of overburden soil borings for environmental investigations. This SOP addresses the use of sonic drilling to drill the soil boring.

2. Execution

- If work is to be conducted on private property, verify that the client has been notified (see SOP PP-001) and that access has been granted.
- Ensure that markout procedures outlined in PP-001, PP-002, and PP-003 have been completed.
- Inspect the drilling rig to make sure it is clean and that the down-hole equipment has been steam-cleaned. Check that the steam-cleaner is working properly (i.e., that steam is being produced). Record all observations and measurements in the field notebook.
- Prior to the start of drilling, the borehole location should be hand-cleared to a minimum of 5 feet below ground surface (bgs).
- Collect soil cores in shorter runs. While some sonic rigs have the capability of collecting 20 feet of soil core at a time, the process of collecting the longer core results in the core being in contact with the core barrel for a longer period of time and consequently absorbing more heat from the core barrel itself.
- The core barrel should be cleaned with tap water following each use.
- The field geologist will classify and sample the soil located within the liner.
- Upon completion, the excess soil will be placed into a 55-gallon drum for disposal and the inner liner properly disposed.
- The core barrel will then be advanced, within the isolation casing on the same borehole, to collect the next soil core interval.
- Add water between the inner core barrel and the outer override casing. This water would reduce friction and adsorb heat between the inner core barrel and the outer over-ride casing.
- Maximize drilling advance rate. The faster the core barrel is advanced, the less likely the core barrel will heat up, and the less contact time the soil core has with the core barrel. Drilling with a 3-inch diameter core barrel and a 5-inch diameter override casing, instead of the standard 4-inch core barrel and 6-inch over-ride casing, may increase advance rates and reduce the potential for soil core heating.
- If a significant decrease in drilling advance rate is observed, stop drilling and remove what soil core has accumulated in the core barrel.

Resume drilling through the resistant material (gravel, boulder, hard clay, etc.). When the resistant material has been penetrated and the drilling advance rate increases, stop drilling and remove what material has accumulated in the core barrel.

- Wash down the core barrel with cool water to cool the core barrel and associated casing, and resume drilling.
- If a well is to be installed in the borehole, the sandpack and grout are placed as the core-barrel and over-ride casing(s) are selectively vibrated out of the ground. The vibratory action reportedly facilitates the settlement of the sandpack and grout. Upon completion, no casing is left in the ground other than the well casing and screen.

3. Notes

- Disturbance of the soil core is most likely to occur during removal of the soil core from the core barrel. The soil cores are usually vibrated out of the core barrel into plastic bags approximately 5 feet in length. As the plastic bags are a little larger than the soil core itself, fragmentation of the soil core may occur as the core is extruded into the bag or while the bagged core is being moved in an unsupported manner. Soil conditions that are prone to disturbance include wet or dry zones that contain little or no fines, and well graded sands that contain significant volumes of water.
- If integrity of the soil core is of concern, the following procedures should be implemented:
  - i. Measures should be taken to ensure that the core, from the time it is extruded from the core barrel, is rigidly supported through the use of some type of cradle or carrying device.
  - ii. The core should not be removed from its cradle until all sampling of the core has been completed. Acrylic liners are available for some core sizes and can be used to hold the core together upon removal from the core barrel.
  - iii. If the soil is to be sampled for volatile organic compounds (VOCs), acrylic liners must be used.
  - iv. Sampling of the soil core for VOCs or semi-volatile organic compounds (SVOCs) must be approved on a case by case basis. Proposals for VOC or SVOC soil core sampling must include provisions to minimize core fragmentation and heat generation, such as:
    1. Acetate liners in the core barrel so that the soil core does not have to be extruded out of the core barrel.
    2. Limit the length of soil core generated during a given downhole run.
    3. Implement practices to reduce the residency time of the soil core in the core barrel.

- For the analysis of SVOCs, the use of the acetate liners is not required.
- The large diameter of the core barrel enables ground water sampling equipment to be placed inside the core barrel so that discrete depth groundwater samples can be collected during borehole advancement.

4. References

Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers (October 1990), American Society for Testing and Materials [ASTM] D5092-90.

STANDARD OPERATING PROCEDURE
DM-004 Drive and Wash

1. Objective

The objective of this standard operating procedure (SOP) is to standardize the drilling of overburden soil borings for environmental investigations. This SOP addresses the use of casing with either the drive-and-wash or spin method to drill the soil boring.

2. Execution

- If work is to be conducted on private property, verify that the client has been notified (see SOP PP-001) and that access has been granted.
- Ensure that markout procedures outlined in PP-001, PP-002, and PP-003 have been completed.
- Steam cleaning may be performed by drillers either on site or prior to site mobilization. If performed prior to site mobilization, observe the drilling rig to make sure it is clean and that the down-hole equipment has been steam-cleaned. Check that the steam-cleaner is working properly (i.e., that steam is being produced). Record all observations and measurements in the field notebook (See SOP FD-001).
- If a surface-soil sample is desired, this sample should be collected prior to hand-clearing the borehole and in accordance with SOP SM-001 and American Society of Testing and Materials (ASTM) Specification D-1586-84.
- Prior to the start of drilling, the borehole location should be hand-cleared to a minimum of 5 feet below ground surface.
- For all split-spoon soil samples, use a 140-pound hammer to drive the sampler, unless conditions necessitate using a 300-pound hammer (see SOPs SM-001, *Soil Sampling Techniques Including Split-Spoon* and SM-0003, *Soil Classification,* for details). Count and record the number of blow counts per 6-inch increments, confirming, blow counts with driller if necessary.
- Decontaminate the split-spoon sampler after each use (see SOP QA-001 *Equipment Decontamination).*
- Instruct drillers to drill the borehole, either by pounding or spinning the casing, to the top of the next sampling interval.
- The wash water should be carefully observed for indications of a soil strata change with depth (i.e., change in soil color and particle size). Record the changes and depth of changes on the boring log. Make sure that the soils in the borehole have been fully removed by the rotary bit before sampling by measuring the depth of the borehole, or by measuring the length of stick-up of drill rods to verify that the driller has sufficiently cleaned out the boring.

- Monitor the return wash water and record water losses from around the borehole onto the ground surface.
- Follow steps until the borehole has been drilled to the desired depth. If refusal is encountered, a 5-foot core of the rock (at a minimum) may be required to confirm the bedrock surface (see site-specific field sampling plan).
- If a monitoring well is not installed in the soil boring, the boring should be abandoned with cement/bentonite grout. Do not backfill the boring with drill cuttings unless explicitly allowed under state-specific regulations and approved by the client.
- Complete boring log and, if necessary, well installation logs (see SOP SM-006 *Rock Coring Log*).
- Record boring locations on a site map. Measure each location from on-site reference points and record the information in the field book.

3. Notes

- At all times, follow safety procedures as defined in the site-specific Health and & Safety Plan.
- When the first 5-foot section of casing is pounded into the ground, make sure that the casing (i.e., the borehole) is vertical.
- If significant unanticipated contamination is encountered during drilling, stop drilling to confer with the project manager and evaluate health and safety conditions.
- If the borehole is to be advanced below the contaminated strata, use telescoping techniques (see DM-008 *Monitoring Well Telescoping)* to avoid cross-contaminating underlying geologic strata.
- While drilling through contaminated strata, do not recirculate the drilling water. Be prepared to containerize the drilling water in these situations.
- When drilling below the groundwater table in fine to medium sands, the potential exists for the phenomenon of “running sands” to occur. To minimize the problem, remove the drill rods with the rotary bit very slowly while adding potable water to the casing. A head should be kept on the borehole at all times.
- Arrange for the storage of contaminated soil cuttings and water in drums or other appropriate containers in a secure place at the site (see SOP SC-003, *Investigation Derived Waste*).
- Plan the drilling program to drill borings from the least to most contaminated areas. Be prepared in advance and know where alternative drilling locations are in the event that problems are encountered at each planned soil boring location. These locations must also have been cleared by the state utility service prior to drilling.

4. References

Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers (October 1990), American Society for Testing and Materials [ASTM] D5092-90.

Nielsen, D.M. (1993), "Correct Well Design Improves Monitoring," Environmental Protection, July, pp. 38-49.

Standard References for Monitoring Wells (April 1991), Commonwealth of Massachusetts Department of Environmental Protection, WSC-310-91.

ASTM Standard D1586, Standard Method for Penetration Test and Split Barrel Sampling of Soils.

STANDARD OPERATING PROCEDURE

DM-005 GeoProbe® Direct Push Boring

1. Objective

The purpose of this standard operating procedure (SOP) is to standardize soil sample collection using GeoProbe® and MacroCore® technologies. A Geoprobe® relies on a relatively small amount of static (vehicle) weight combined with percussion as the energy for advancement of a tool string. Using a Geoprobe®, you can drive a MacroCore® to obtain continuous soil cores or discrete soil samples.

2. Execution

- Complete utility markout procedures in accordance with PP-001, PP-002, and PP-003.
- Inspect the drilling rig to make sure it is clean and that the down-hole equipment has been steam-cleaned. Check that the steam-cleaner is working properly (i.e., that steam is being produced). Record all observations and measurements in the field notebook.
- Prior to the start of drilling, the borehole location should be hand-cleared to a minimum of 5 feet below ground surface.
- Insert a Macrocore® (MC) liner, (i.e., polyvinyl chloride [PVC]) into the sample tube, and connect a MC drive head to the top of the sample tube. A diagram of the MC assembly is provided as Attachment A.
- The drive head is then tightened into the sample tube, and a drive cap is attached to the drive head.
- Place the sampler in the driving position, and drive the sampler until the drive head reaches the ground surface.
- Remove the drive cap, attach a pull cap to the sampler drive head, and pull the sampler out of the ground.
- Remove the cutting shoe and filled liner.
- When the sampler is brought to the ground surface, it should be opened immediately, and the length of recovery should be measured and recorded.
- Decontaminate the sampler if necessary (SOP QA-001 *Equipment Decontamination*) and reassemble the parts with a new liner, and insert the sampler down the same hole to take the next soil core.
- In non-cohesive soils, slough material may enter the sampler as the next core is collected (see notes below).
- Careful logging of soil stratigraphy is necessary to document whether soil sloughing has occurred within the borehole (see limitations).
- Remove the sample with a clean laboratory spoon and transfer it directly to a suitable sample container.

- Label, preserve, and store the sample in accordance with SOP SC-002 *Sample Handling*.
- If a monitoring well is not installed in the soil boring, the boring should be abandoned with either cement/bentonite grout. Do not backfill the boring with drill cuttings unless explicitly allowed under state-specific regulations and approved by the client.
- Upon completion, all soil boring locations will be surveyed. This will include the location and ground surface elevation.

3. Notes

- The GEI oversight person shall ensure that the borehole created by the MC sampling tube does not collapse between collection of each sample. If the borehole collapses and representative samples cannot be obtained using the standard macro-core sampler, then one of two options may be used.
    i. The MC sampler can be fitted with a piston rod assembly, or a 1.5-inch outer diameter (OD), large bore sampler equipped with a piston rod assembly may be used to collect the samples. The sample tube (MC) is advanced through the caved-in borehole material to the top of the desired sampling interval. The sample tube remains closed by a piston tip as it is advanced. Upon reaching the target sample depth, the piston tip will be released and the discrete sampler device is then advanced to collect the representative sample.
    ii. The piston rod assembly is driven up to the top of the sample tube as the sample enters the tube.
- Because the MC sampling tube uses a dedicated, disposable liner made of clear plastic, the only part of the sampler that contacts the soil sample is the cutting shoe. Each sample liner will be disposed of after use and a new liner will be placed in the macro-core tube prior to collection of subsequent samples. Cutting shoes and sample collection spoons used to transfer samples to the laboratory jars will be decontaminated between use.

4. References

ASTM D6001-05 Guide for Direct Push Water Sampling for Geoenvironmental Investigations, April 2005.

GeoProbe Systems, "GeoProbe MacroCore MC-5 1.25-inch Light Weight Center Rod Soil Sample System SOP", Technical Bulletin No. MK 3139, November 2006.

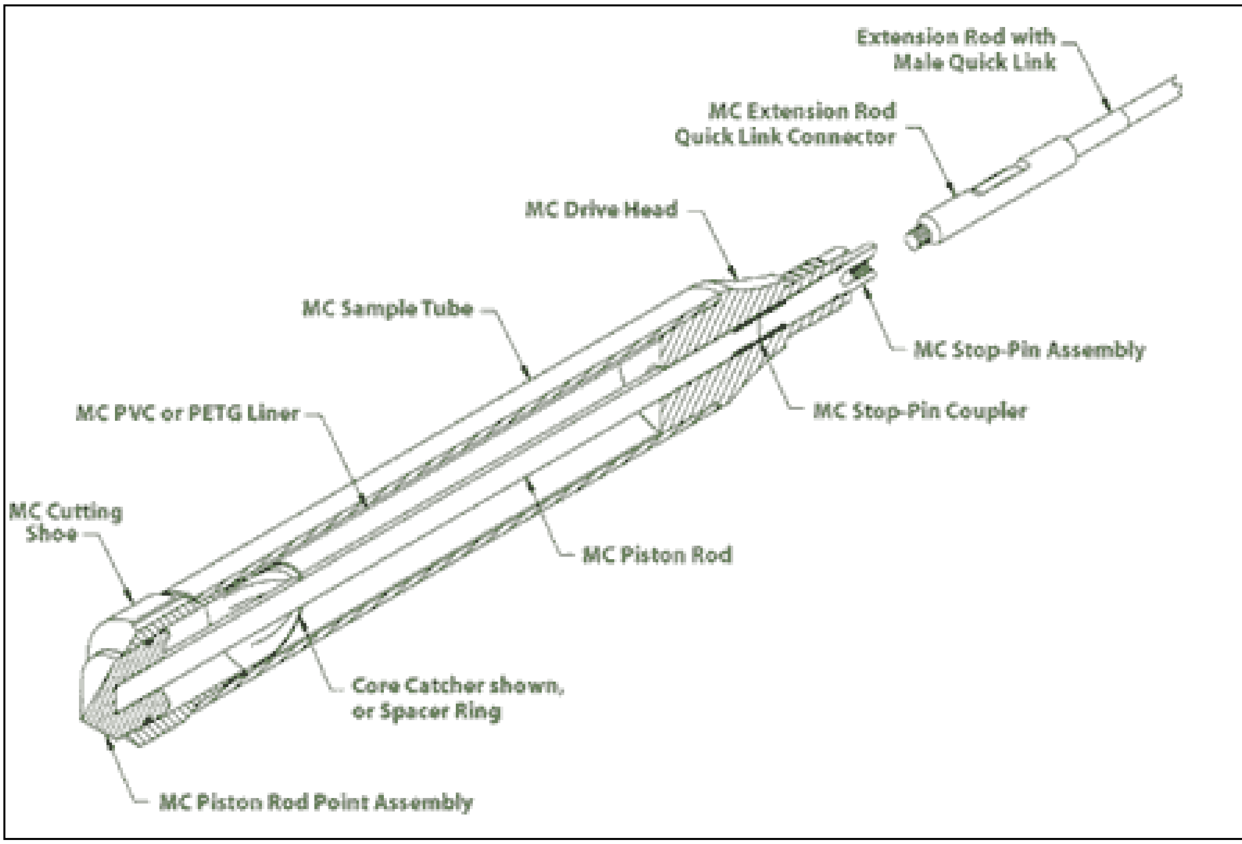
5. Attachments

Attachment A – GeoProbe® with Macrocore® Sampler Assembly

Attachment A

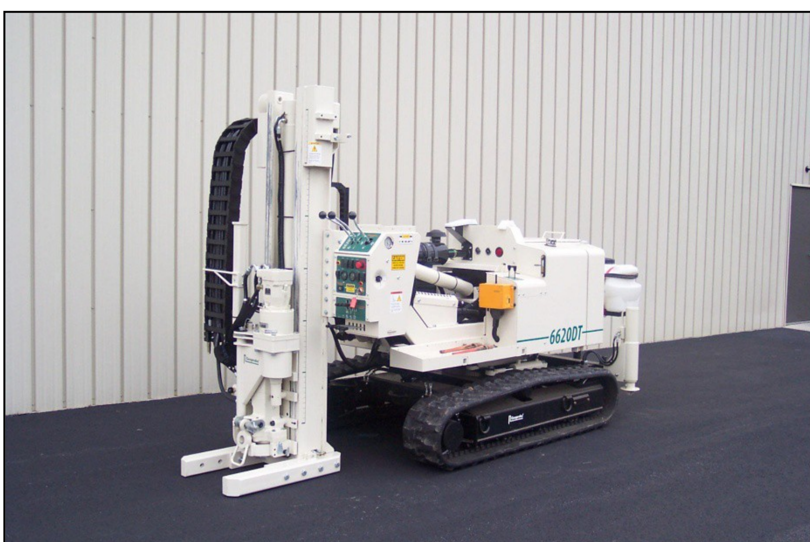
SOP DM-005

Attachment A – GeoProbe® with Macrocore® Sampler Assembly



Above: Diagram of a Macrocore® sampler

Right: A track-mounted GeoProbe ® Rig



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STANDARD OPERATING PROCEDURE

DM-006 Monitoring Well Construction and Installation

1. Objective

The objective of this standard operating procedure (SOP) is to standardize the installation of overburden monitoring wells for environmental investigations. This SOP assumes the monitoring wells will be constructed of flush-joint polyvinyl chloride (PVC) pipe; the screened section will have factory-slotted openings. Well dimensions (well diameter, screen length, and screen slot-diameters) will be specified in the Work Plan and recorded in field notes, along with rationale for any changes from the work plan.

2. Execution

- Attachment A provides a diagram of typical shallow, intermediate, and deep groundwater monitoring well construction detail.
- During the monitoring well installation, record all pertinent information on Attachment B, Well Construction Form.
- Using a weighted tape, measure and record the depth of the completed soil boring (within the augers), if applicable, before beginning the well installation.
- Measure the depth to groundwater in the borehole over a 10 to 15 minute period to ensure that the groundwater elevation has approximately stabilized. Compare the saturated soil depth estimated from the soil samples, if collected prior to well installation, to the measured water level in the borehole. If drilling water has been used during boring advancement, pump the water out of the borehole to the static water depth, based on examination of the soil samples, and monitor the recovery of groundwater until the level has stabilized.
- Choose the monitoring well screen and riser lengths so that the slotted section of the screen intersects the groundwater table, for shallow wells. If the borehole is deeper than the desired well depth, then fill the base of the borehole with sand.
- A minimum of a one-foot sump should extend to the bottom of the well if dense non-aqueous phase liquid (DNAPL) is suspected.
- Monitoring well screens should be constructed of either 2 or 4 inch inner diameter (ID) 0.01-inch or 0.02-inch slotted Schedule 40 PVC well screen.
- If DNAPL is suspected, the monitoring well should be constructed of either 2 or 4 inch ID 0.02-inch slotted Schedule 40 PVC well screen.
- Monitoring wells should be constructed of either 2 or 4 inch ID Schedule 40 threaded flush-jointed PVC. One-inch wells may be installed with prior approval of the client and the New York State Department of Environmental Conservation.

- Install and secure a bottom well cap. The bottom cap should be secured with either a threaded coupling and/or stainless steel screws. Do not use any kind glue to secure well sections together.
- Place at least 12 inches of clean uniformly graded medium quartz filter sand pack into the base of the borehole. Measure and record the depth of the boring. Temporarily cover the top of the riser pipe and lower the complete well plus riser into the borehole, with the base resting on the sand pack.
- Add adequate sand to surround the area around the slotted section. The filter sand should extend at least 2 feet above the top of the slotted section.
- Remove the drilling casing/augers from the borehole slowly, at a maximum of 2-foot intervals. As the drillers pour or use tamping rods to place the filter sand in the borehole, take frequent measurements of the depth-to-sand. Do not let the sand bridge in the annular space. Continue to observe the water level in the borehole.
- Place at least 1 foot of bentonite seal above the filter pack. If the seal is above the water table, use at least 5 gallons of potable water to hydrate the bentonite.
- If necessary, pump bentonite-cement grout using a tremie pipe into the bottom of the annular space to the ground surface. Grout should be mixed in approximately the following proportions: 7.5 gallons water to one 94-pound bag of cement to 2-4 pounds of pulverized bentonite. The grout must be mixed using the pump on the rig to ensure proper mixing. The protective casing should be set in the grout before it sets.
- The protective surface casing will be either a flush-mounted roadbox or a steel “stick up” pipe. The base of either type of casing should extend at least 1 foot into the grout below the ground surface (below the frost line) whenever possible.
- Cut the monitoring well riser flat and place a mark or V -notch or an arrow on the casing with an indelible marker at one point for surveying and groundwater measurements. Cut the well riser so that the top of the well is 3 to 6 inches below the top of the protective casing.
- Set bentonite-cement grout in the annular space between the protective casing and the borehole up to the ground surface. Slope the concrete radially away from the protective casing at the ground surface to promote surface water runoff. In areas of high traffic or areas of parking lots and/or roadways where plowing occurs, set the roadbox FLUSH with the ground surface to avoid damage to the well.
- If the well is installed in a high-traffic area with a guardpipe, additional protection such as steel pole bumpers around the guardpipe may be necessary.
- Place a locking, vented cap on the well pipe.

- All well locations should be photodocumented in accordance with SOP FD-004, *Photo Documentation*.
- Label the protective well casing with a paint pen and tape out the location to nearby landmarks so that the well may be located in the future. Make sure to enter this information in the field notebook. If possible, place a brightly colored stake or other identifier adjacent to the well.
- Develop the well (see SOP DM-009, *Monitoring Well Development*).
- Upon completion, all newly installed monitoring wells will be surveyed. This will include the well location, ground surface elevation and measuring point elevation.

3. Notes

- At all times, follow safety procedures as defined in the site-specific Health and Safety Plan.
- Site-specific conditions must be evaluated to determine appropriate materials.
- The water table will fluctuate seasonally and from year-to-year. Try and estimate the maximum high and low elevations of the water table from the current water table elevation and the season. Place the 10-foot screen so that at least 2 feet of the screen will extend above the top of the screen when water is at its highest. If very substantial fluctuations in the groundwater table are expected, a 15-foot screen is acceptable.
- Do not screen across different hydrostratigraphic units if possible (for example, outwash sands and till) unless specified in the Work Plan or approved by the Project Manager.
- If the formation is composed of a material that is uniformly coarser than the filter sand, the grain size of the filter sand must be increased. Consideration should also be given to changing the slot size on the well screen. Differences in average grain size should generally not be greater than a factor of two to four times.
- Do not use borehole/auger cuttings for backfill during monitoring well installation. If the cuttings are suspected to contain contamination which was identified during drilling, cuttings are to be containerized for later characterization and not used for filter pack materials.
- Do not screen across a confining layer (e.g., silt or clay). Backfill all confining layers with hydrated bentonite or grout.

4. References

Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers (October 1990), American Society for Testing and Materials [ASTM] D5092-90.

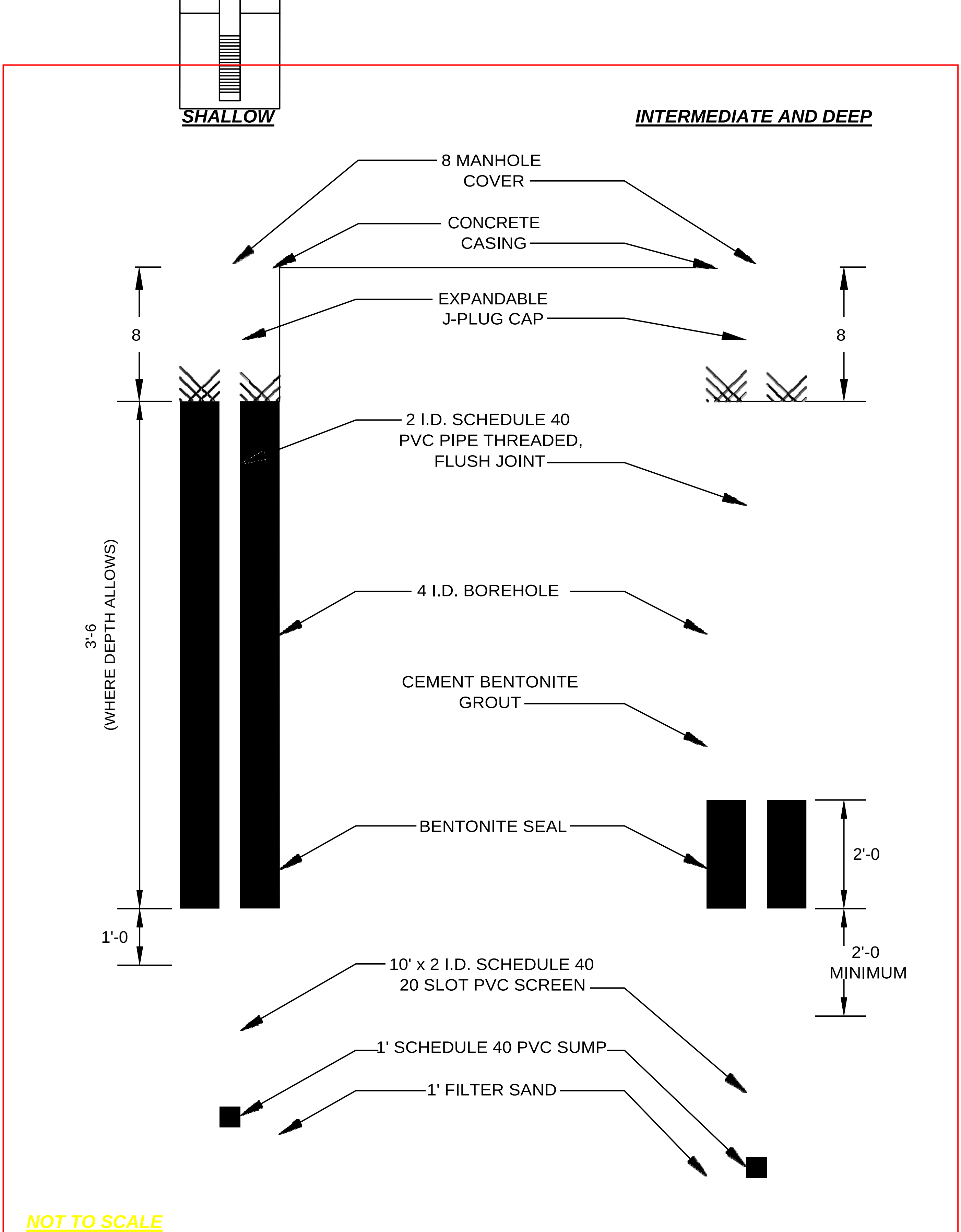
Nielsen, D.M. (1993), "Correct Well Design Improves Monitoring," Environmental Protection, July, pp. 38-49.

5. Attachments

Attachment A – Typical Shallow, Intermediate, and Deep Groundwater Monitoring Well Construction Detail

Attachment B – Well Construction Form

Attachment A



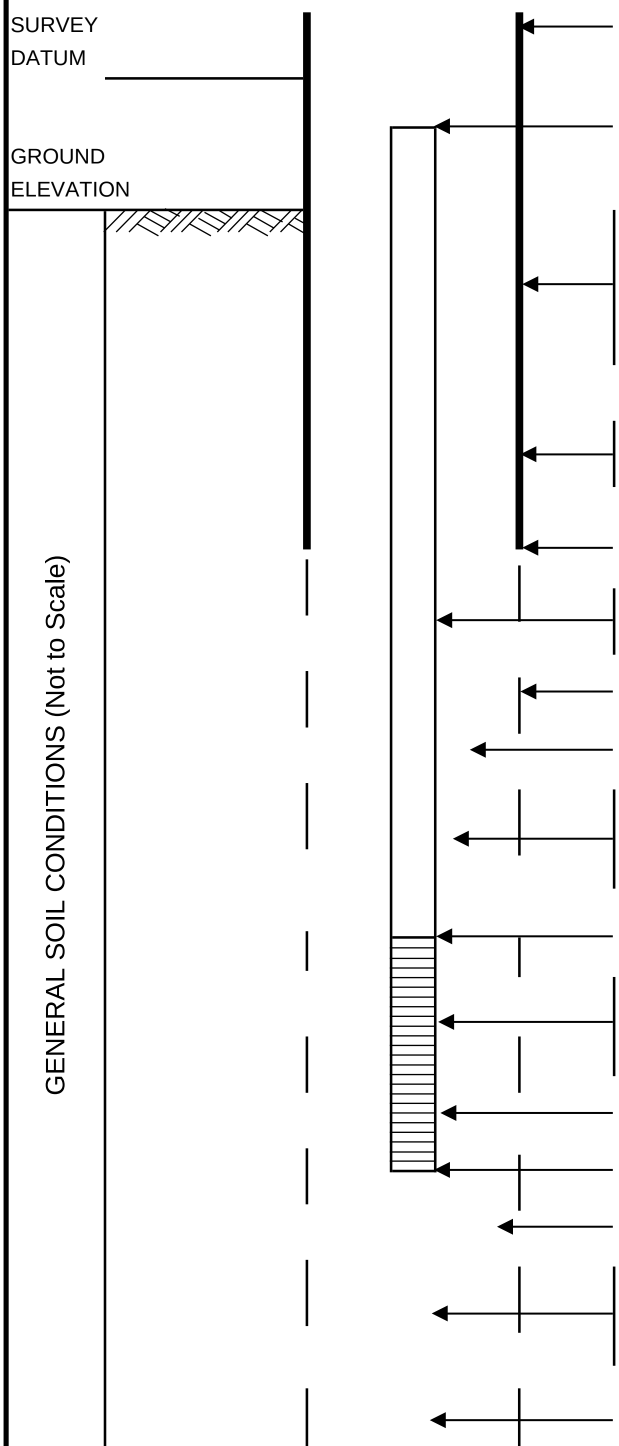
TYPICAL SHALLOW, INTERMEDIATE AND DEEP GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL

November 2010

Attachment B

WELL CONSTRUCTION FORM

Project	ID No.
Location	PG. 1 OF 1
Client	Boring No.
Contractor / Driller	Location
Inspected by / Date Started	
Checked by / Date Completed	Project No.



LENGTH OF SURFACE CASING ABOVE GROUND SURFACE (FT)

LENGTH OF RISER PIPE ABOVE GROUND SURFACE (FT)

THICKNESS OF SURFACE SEAL BELOW GROUND SURFACE, IF ANY (FT)

TYPE OF SURFACE SEAL (indicate any additional seals)

ID OF SURFACE CASING (IN)
TYPE OF SURFACE CASING

DEPTH BOTTOM OF CASING (FT)

ID and OD OF RISER PIPE (IN)
TYPE OF RISER PIPE

DIAMETER OF BOREHOLE (IN)

TYPE OF BACKFILL AROUND RISER PIPE

DEPTH TOP OF SEAL, IF ANY (FT)
TYPE OF SEAL
DEPTH BOTTOM OF SEAL (FT)

DEPTH TOP OF PERVIOUS SECTION

TYPE OF PERVIOUS SECTION
DESCRIBE OPENINGS
ID and OD OF PERVIOUS SECTION (IN)

TYPE OF BACKFILL AROUND PERVIOUS SECTION

DEPTH BOTTOM OF PERVIOUS SECTION (FT)

DEPTH BOTTOM OF SAND COLUMN (FT)

ELEV./DEPTH TOP OF SEAL, IF ANY (FT)
TYPE OF SEAL
ELEV./DEPTH BOTTOM OF SEAL (FT)

TYPE OF BACKFILL BELOW PERVIOUS SECTION, IF ANY

NOTES:

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STANDARD OPERATING PROCEDURE
DM-007 Monitoring Well Telescoping

1. Description

The method of monitoring well telescoping prevents the connection of two stratigraphic layers during monitoring well installation. Typically, these two stratigraphic layers are overburden and bedrock strata, or overburden deposits with a semiconfining layer.

2. Execution

- If work is to be conducted on private property, verify that the client has been notified (see SOP PP-001) and that access has been granted.
- Ensure that markout procedures outlined in PP-001, PP-002, and PP-003 have been completed.
  Prior to the start of drilling, the borehole location should be hand-cleared to a minimum of 5 feet below ground surface.
- Install large diameter casing (e.g., 6-inch outer diameter) to the top of the bedrock or semiconfining layer.
- Drill or core at least 10 feet into bedrock, or an appropriate thickness into the semiconfining layer, to confirm the presence of bedrock and adequately separate stratigraphic units (see precautions below).
- Freshly mixed grout is required. Depending on application, a mixture of Portland cement and bentonite meets most grouting requirements. For proper consistency, use no more than 6 gallons of water per 94-pound sack of cement. Add a few pounds of bentonite or hydrated lime per sack of cement for a better flow.
- Use a tremie pipe to deliver grout outside the casing. This method is not recommended for depths greater than 100 feet. You can use this method if the space between the casing and the borehole wall is large enough to contain a 1-inch tremie pipe. Use the following procedures to complete grouting using this method:
  - i. Lower the tremie-pipe to the bottom of the borehole outside of the well casing. Make sure that the lower end of the casing is tightly seated at the bottom of the borehole.
  - ii. Mix a sufficient quantity of grout and pump it through the tremie pipe or let it descend naturally. As the grout is placed, lift the tremie pipe slowly, but keep the lower end submerged in the grout.
  - iii. Fill the casing with water as the grout is placed to balance the fluid pressure inside and outside the casing. Doing so prevents grout from leaking under the bottom of the casing.
  - iv. Allow the grout to set for a minimum of 24 hours.

v. Drill through the existing casing into bedrock to complete monitoring well. Install additional casing, polyvinyl chloride (PVC), or open borehole into bedrock.

3. Notes

- These operating procedures include drilling the borehole used to case off the overburden a minimum of 10 feet into a semiconfining layer. However, if dense non-aqueous phase liquid (DNAPL) and/or dissolved contamination is suspected or likely to be present in the weathered bedrock, the 10-foot casing requirement will hide the DNAPL from detection. In this case, an overburden well (with casing and screen) should be installed in the weathered bedrock and an outer steel casing installed 10 feet into bedrock would not be required.

4. References

Environmental Protection Agency, Region 4, "Environmental Investigation Standard Operating Procedures and Quality Assurance Manual, Chapter 6 – Design and Installation of Monitoring Wells," November 2001.

STANDARD OPERATING PROCEDURE

DM-008 Monitoring Well Development

1. Objective

To remove drilling fluids and fine soil particles that may be trapped in the monitoring well's sand pack and screen, and to set the sand pack so that it will function properly, and create good hydraulic communication between the well and the formation.

2. Execution

- Wait at least 48 hours following monitoring well installation before beginning development activities.
- Decontaminate all development equipment prior to use with, Alconox, and deionized-water rinses. See SOP QA-001, *Equipment Decontamination*.
- Calculate the volume of water in the monitoring well (one well volume).
- Record volume on Monitoring Well Development Record (Attachment A).
- Collect a sample of water from the monitoring well with a submersible pump, a bailer, or a water pump. Record the color and turbidity of the sample.
- Utilize one of the following methods for purging:
  - Surging;
  - Bailing;
  - Using a centrifugal pump and dedicated polyethylene tubing;
  - Positive displacement pumps and dedicated polyethylene tubing; and/or
  - Other methods recommended by the field geologist and approved by the client Project Manager.
- Purge groundwater until it runs clear (<50 nephelometric turbity units [NTUs]) or until pH, temperature and specific conductivity stabilize as judged suitable by the field geologist.
- Well development should not exceed two hours for a single well.
- Measure the purge rate (gallons per minute) and total volume purged.
- Monitor the groundwater level in the well during development to determine if the pumping rate is sufficient to create a drawdown in the well.
- Collect groundwater samples every few well volumes during the pumping and record the physical properties (color and turbidity).
- Stop pumping when the purge water is relatively clear. Place a surge block in the monitoring well (if the method of development doesn't include a down-hole pump which serves as a surge block). Slowly

move the surge block up and down in the well. Periodically remove the surge block and purge the groundwater until it is relatively clear again. Start at a slow pace and progress to a faster surging action through time.

- Monitor the turbidity and color of the water during this procedure. The well is considered fully developed when all of the following criteria have been met:
  i. The volume of fluid added during drilling has been removed.
  ii. The water removed from the well is relatively free of fine-grained particles.
  iii. Record the volume of water pumped from the well and the physical properties (color, turbidity) of the water.

3. Notes

- Always remove groundwater with fine particles from the well before surging. The fine particles may be forced into the well screen by the surging action.
- Pump contaminated groundwater into an approved container (properly labeled drum or portable tank for transfer into frac tank).
- Use a bailer to develop monitoring wells that are installed in soils that are composed of fine-grained silts and clays. Pumping and mechanical surging is not recommended because these more vigorous techniques can cause fine particles to clog the filter pack.
- Sampling of groundwater should not occur within one weekafter development.

4. Calculations

To calculate the volume of water in the well, the following equation is used:
Well Volume (V) = Br^2 h (cf) **[Equation 1]**
where:

B = pi (3.14)
r = radius of monitoring well in feet (ft)
h = height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft ^{3}. [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2-, 3-, 4-, or 6-inches. A number of standard conversion factors can be used to simplify the above equation using the diameter of the monitor well. The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:
Where:

V (gal/ft) = Br^2 (cf) **[Equation 1]**

B = pi (3.14)
r = radius of monitoring well (ft)
cf = conversion factor (7.48 gal/ft^3)

For example, a 2 inch diameter well, the volume per linear foot can be calculated as follows:

V (gal/ft) = Br^2 (cf) **[Equation 2]**
= 3.14 (1/12 ft)^2 7.48 gal/ft^3
= 0.1631 gal/ft

NOTE: The diameter must be converted to the radius in feet as follows:

Well Diameter (inches) x 0.5 = Well Radius (ft) **[Equation 3]**

The volume in gallons/feet for the common size monitor wells are as follows:

Well diameter (inches)	Volume (gal/ft)
2	0.1631
3	0.3670
4	0.6524
6	1.4680

If you utilize the volumes for the common size wells above, Equation 1 is modified as follows:
Where:

Well volume = (h) (f) **[Equation 4]**

h = height of water column (ft)

f = the volume in gal/ft calculated from Equation 2

5. References

Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers (October 1990), American Society for Testing and Materials [ASTM] D5092-90.

Nielsen, D.M. (1993), Correct Well Design Improves Monitoring, Environmental Protection, July, pp. 38-49.

The Methods & Mechanics of Well Development, Part 2 of 5, National Drillers Buyers Guide, March 1993, p. 17.

Standard References for Monitoring Wells (April 1991), Commonwealth of Massachusetts Department of Environmental Protection, WSC-310-91.

U. S. EPA Environmental Response Team Standard Operating Procedure SOP: 2044 ," Monitor Well Development" REV: 0.1, 10/23/01.

6. Attachments

Attachment A - Monitoring Well Development Record

Attachment A

Monitoring Well Development Record

Project: ______________________ **Well ID:** ________________ **Date:** ____________________

Total Well Depth (from top of casing): ______________________________

Depth to Water (from top of casing): ____________________

Well Diameter: ______________________________

Pump Intake Depth: ____________________

Sampling Crew: ______________________________

Purge Time: *Start:* ____________________ *Finish:* ____________________

Purging Method: ______________________________

Sampling Method: ______________________________

Sample Time: *Start:* ____________________ *Finish:* ____________________

Sample Analysis: ______________________________

Purge Data

Sample Time	Flow Rate *(lpm/gpm)*	Volume Purged *(liters/gals.)*	pH *(std. Units)*	Conductivity *(mS/cm)*	Turbidity *(NTU)*	Dissolved Oxygen *(mg/l)*	Temperature *(Cel.)*	Salinity *(%)*	ORP *(mV)*	Comments/Observations
										Well Headspace PID =

Final Stabilization Data

Sample Time	Flow Rate *(lpm/gpm)*	Volume Purged *(liters/gals.)*	pH *(std. Units)*	Conductivity *(mS/cm)*	Turbidity *(NTU)*	Dissolved Oxygen *(mg/l)*	Temperature *(Cel.)*	Salinity *(%)*	ORP *(mV)*	Comments/Observations

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SUMMARY GUIDANCE

DM-009 General Guidance on Monitoring Well Abandonment

1. Objective

To properly abandon a monitoring well, preventing direct connections from surface conditions to the well screen zone.

When a decision is made to abandon a monitoring well, the borehole should be sealed in such a manner that the well can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. Guidelines for well abandonment are provided below but do not supersede state or local regulations. Make sure all well abandonment procedures adhere to appropriate regulations.

To properly abandon a well, the preferred method is to completely remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete. In order to comply with New York State well abandonment requirements, the New York State Department of Environmental Conservation (NYSDEC) should be notified (if applicable) of monitoring well abandonment. However, some state requirements are not explicit, so a technically sound well abandonment method should be designed based on the site geology, well casing materials, and general condition of the well(s). In New York, the NYSDEC policy document titled, CP-43: Groundwater Monitoring Well Decommissioning Policy, should be followed. The document includes a flow chart to be used in selecting the appropriate decommissioning methods based upon the geologic and hydrogeologic conditions at the well site, the presence or absence of contamination in the groundwater and the original well construction details.

Execution

In accordance with NYSDEC's policy document referenced above, the four primary well decommissioning methods are:

- Grouting in-place.
- Perforating the casing followed by grouting in-place.
- Grouting in-place followed by casing pulling.
- Overdrilling and grouting with or without a temporary casing.

The methods and rationale for each of these methods is detailed in NYSDEC's policy document.

1.1. Borehole Abandonment

All soil borings not finished as monitoring wells or piezometers will be abandoned by adding neat cement grout or cement/bentonite grout via tremie pipe from the bottom of the borehole up to the ground surface. If the boring was completed via the hollow stem auger method, the borehole will be grouted as the augers are withdrawn, in the case of a direct-push soil boring, the borehole will be redrilled and pressure-grouted from the bottom depth of the borehole up. The neat cement grout will be mixed in accordance with the manufacturer's recommendations. The bentonite/cement grout will be mixed in the following relative proportions: 30 gallons of water to three 94-pound bags of cement to 25 pounds granular bentonite.

2. References

New York State Department of Environmental Conservation, *"CP-43: Groundwater Monitoring Well Decommissioning Policy"*, November 2009.

Environmental Protection Agency, Region 4*, "Environmental Investigation Standard Operating Procedures and Quality Assurance Manual, Chapter 6 – Design and Installation of Monitoring Wells,"* November 2001.

3. Attachment

Attachment A – CP-43: Groundwater Monitoring Well Decommissioning Policy

Attachment A

CP-43:Groundwater Monitoring Well Decommissioning Policy

New York State Department of Environmental Conservation

DEC POLICY

Issuing Authority: Commissioner Alexander B. Grannis	
Date Issued: November 3, 2009	**Latest Date Revised:**

I. Summary:

Groundwater monitoring wells provide essential access to the subsurface for scientific and engineering investigations (including monitoring wells installed for leak detection purposes). To a degree, every monitoring well is an environmental liability because of the potential to act as a conduit for pollution to reach the groundwater. To limit the environmental risk, a groundwater monitoring well must be properly decommissioned when its effective life has been reached. This document provides procedures to satisfactorily decommission groundwater monitoring wells in New York State. This policy also pertains to other temporary wells such as observation wells, test wells, de-watering wells and other small diameter, non-potable water wells. It does not pertain to water supply wells.

II. Policy:

Environmental monitoring wells should be decommissioned when:

1. they are no longer needed and re-use by another program is not an option; or
2. the well's integrity is suspect or compromised.

The method for decommissioning will be determined based upon well construction and environmental parameters. The method selected must be designed to protect groundwater and implemented according to current best engineering practices while following all applicable federal, state and local regulations. *Groundwater Monitoring Well Decommissioning Procedures* shall be maintained as an addendum to this policy.

This policy is applicable to all New York State Department of Environmental Conservation (DEC) programs that install, utilize and maintain monitoring wells for the study of groundwater, except monitoring wells for landfills regulated under 6 NYCRR Part 360 decommissioned in accordance with those regulations [*see* 6 NYCRR 360-2.11(a)(8)(vi)] and wells installed under the Oil, Gas and Solution Mining Law, Environmental Conservation Law Article 23. There is no specific time frame to dictate when to decommission a well; timing is dependent upon the use and condition of the well and shall be determined on an individual basis. Best professional judgment must be exercised when using the decommissioning procedures. Outside of DEC use, this policy is mandatory when incorporated into the specifications of a state contract, an Order on Consent or a permit. In all other situations, it shall serve as guidance.

III. Purpose and Background:

This document establishes a monitoring well decommissioning policy and provides technical guidance. Synonyms for well decommissioning include “plugging,” “capping” and “abandoning. For consistency, only the term “decommissioning” is used within this document.

Unprotected, neglected and improperly abandoned monitoring wells are a serious environmental liability. They can function as a pollution conduit for surface contaminants to reach the subsurface and pollute our groundwater. They also can cause unwanted mixing of groundwater, which degrades the overall water quality within an aquifer. Improperly constructed, poorly maintained or damaged monitoring wells can yield anomalous poor data that can compromise the findings of an environmental investigation or remediation project. Unneeded or compromised monitoring wells should be properly decommissioned in order to prevent harm to our groundwater.

Since 1980, the DEC has installed, directed or overseen the installation of thousands of monitoring wells throughout New York for various state and federal programs, such as Superfund, solid waste, Resource Conservation and Recovery Act (RCRA), spill response, petroleum bulk storage and chemical bulk storage. This guidance addresses the environmental liability associated with this aging network of wells.

Within its boring zone, a successfully decommissioned well prevents the following:

1. Migration of existing or future contaminants into an aquifer or between aquifers;
2. Migration of existing or future contaminants within the vadose zone;
3. Potential for vertical or horizontal migration of fluids in the well or adjacent to the well; and
4. Any change in the aquifer yield and hydrostatic head, unless due to natural conditions.

Monitoring well construction in New York varies considerably with factors such as age of the well, local geology and either the presence or absence of contamination. The predominant type of monitoring well in New York is the shallow, watertable monitoring well constructed of polyvinyl chloride plastic (PVC). The best method for decommissioning should be selected to suit the conditions and circumstances. Each decommissioning situation is to be evaluated separately using this guidance before a method is chosen and implemented.

IV. Responsibility:

The Division of Environmental Remediation (DER) is responsible for updating this policy and the *Groundwater Monitoring Well Decommissioning Procedures* (addendum) in consultation with the Division of Solid and Hazardous Materials (DSHM) and the Division of Water (DOW). Compliance with the guidance does not relieve any party of the obligation to properly decommission a monitoring well. Oversight responsibility will be carried out by the DEC Regional Engineer.

V. Procedure:

Groundwater Monitoring Well Decommissioning Procedures, the addendum to this policy, provides guidance on proper decommissioning of monitoring wells in New York State.

VI. Related References:

- Groundwater Monitoring Well Decommissioning Procedures, October 1986. Prepared by Malcolm Pirnie, Inc. for the New York State Department of Environmental Conservation, Division of Environmental Remediation.

- Standard Guide for the Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities, ASTM D 5299-99. American Society for Testing and Materials (ASTM). Philadelphia. 2005.

- 6 NYCRR Part 360 Solid Waste Management Facilities, New York State Department of Environmental Conservation, Division of Solid and Hazardous Materials.

- Specifications for Abandoning Wells and Boreholes in Unconsolidated Materials, New York State Department of Environmental Conservation, Region 1 - Water Unit, undated.

- Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells, EPA 600/4-89/034, United States Environmental Protection Agency (EPA).

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Final - August 2009

GROUNDWATER MONITORING WELL DECOMMISSIONING PROCEDURES

New York State Department of Environmental Conservation
Division of Environmental Remediation

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FIGURES

APPENDICES

INTRODUCTION

This document, *Groundwater Monitoring Well Decommissioning Procedures,* is the addendum to CP-43, Groundwater Monitoring Well Decommissioning Policy, which provides acceptable procedures to be used as guidance when decommissioning monitoring wells in New York State. Please note that this document does not address some site-specific special situations that may be encountered in the field. Compliance with the procedures set forth in this document does not relieve any party of the obligation to properly decommission a monitoring well.

Unprotected, neglected and improperly abandoned monitoring wells are a serious environmental liability. They can function as a pollution conduit for surface contaminants to reach the subsurface and pollute our groundwater. They also can cause unwanted mixing of groundwater, which degrades the overall water quality within an aquifer. Improperly constructed, poorly maintained or damaged monitoring wells can yield anomalous poor data that can compromise the findings of an environmental investigation or remediation project. Unneeded or compromised monitoring wells should be properly decommissioned in order to prevent harm to our groundwater.

Previous versions of this guidance have been issued since 1995. Originally developed as a specification for well decommissioning at Love Canal, the procedures were rewritten to make them applicable across the state. From an engineering standpoint, the guidance has changed very little. Most situations do not require a complex procedure.

If you have any questions, please contact Will Welling at (518) 402-9814.

Sincerely,

Gerald J. Rider, Jr., P.E.
Chief, Remedial Section D
Remedial Bureau E
Division of Environmental Remediation

1.0 PREPARATION

If an unneeded monitoring well remains in good usable condition, an alternative to decommissioning might be the reuse by another agency program. DEC encourages reuse in situations where a well will continue to be used and cared for responsibly.

When reuse is not an option, the first step in the well decommissioning process is to review all pertinent well construction information. One must know the well depth and construction details. GPS coordinates and permanent labeling (if available) will be useful in confirming the well to be decommissioned. An inspection must be performed prior to decommissioning in order to verify the construction and condition of each well. Specific details and subsurface conditions form the basis for decisions throughout the decommissioning process.

Well Details

1. Is the well a single stem riser (all one diameter)?
2. Is the well a simple overburden well (no penetration into bedrock)?
3. Does the well riser consist of telescoping diameters of pipe which decrease with depth?
4. Is the well seal compromised (leaking, inadequate or damaged)?
5. If the well is PVC, is it 25 feet or shallower and not grouted into rock?
6. Can the riser be pulled and is removal of the well desired?
7. Is the well a bedrock well?
8. If the monitoring well is a bedrock well, does it have an open hole?
9. Is there a well assembly (riser and screen) installed within the bedrock hole?

Subsurface Conditions

10. Is the soil contaminated?
11. Does the well penetrate a confining layer?
12. If the well penetrates a confining layer, might overdrilling or casing pulling cause contamination to travel up or down through a break in the confining layer?
13. Does the screened interval cross multiple water-bearing zones?

For additional collection and verification of information, the "Monitoring Well Field Inspection Log" (Figure 1) can be used during a field inspection. After the well has been located and the information gathered, one is ready to select the decommissioning procedure in accordance with Section 2.

Special conditions, such as access problems, well extensions through capped and covered non-Part 360 landfills and seasonal weather patterns affecting construction, should be assessed in the planning stage. Decommissioning work requiring the use of heavy vehicular equipment on landfill caps should be scheduled during dry weather (if possible) so as to minimize damage to the cover. If work must be performed during the spring, winter or inclement weather, special measures to reduce ruts should be employed to maintain the integrity of a completed landfill cover system. As an example, placement of plywood under vehicular equipment can eliminate deep ruts that would require repair.

2.0 DECOMMISSIONING METHODS

The primary rationale for well decommissioning is to remove any potential groundwater pathway. A secondary rationale, often important to the property owner or owner of the well, is to physically remove the well. Removed well materials may be recycled and will not interfere with future construction excavation. The previous versions of these decommissioning procedures have stressed that physical removal of the well by pulling is preferable to leaving casing in the ground. Due to the added effort, expense and risk involved with pulling, the decision of whether to pull or not should be a separate consideration aside from selecting the sealing procedure.

One should select a decommissioning procedure that takes into account the geologic and hydrogeologic conditions at the well site; the presence or absence of contamination in the groundwater; and original well construction details. The selection process for well decommissioning procedures is provided by the flow chart, Figure 2. Answers to the questions in the preceding section are the input for this flow chart. The four primary well decommissioning methods are:

1. Grouting in-place;
2. Perforating the casing followed by grouting in-place;
3. Grouting in-place followed by casing pulling;
4. Over-drilling and grouting with or without a temporary casing.

In a complex situation, one or more decommissioning procedures may be used for different intervals of the same well.

The remainder of Section 2 discusses the well decommissioning methods and the selection process. Refer to Figure 2 for a flow chart diagram of the complete procedure selection process. The DEC Project Manager has the discretion to deviate from the flow chart, (Figure 2), based on site conditions and professional judgment.

2.1 Grouting In-Place

Grouting in-place is the simplest and most frequently used well decommissioning method and grouting itself is the essential component of all the decommissioning methods. The grout seals the borehole and any portion of the monitoring well that may be left in the ground. Because dirt and foreign objects can fall into an open well, whenever possible a well should be sealed first with grout before attempting subsequent decommissioning steps.

For the purpose of these decommissioning procedures, the well seal is defined as the bentonite seal above the sand pack. Aside from obvious channeling by in-flowing surface water around the well, an indication of the well seal integrity may be obtained through review of the boring logs and/or a comparison of groundwater elevations if the well is part of a cluster. Any problems noted on the boring logs pertaining to the well seal, such as bridging of bentonite pellets or running sands, or disparities between field notes (if available) and the well log would indicate the potential for a poor (compromised) well seal.

If the well seal is not compromised and there is no confining layer present, a single-stem, 2-inch PVC, monitoring well can be satisfactorily decommissioned by grouting it in-place. If the seal is compromised, casing perforation may be called for as discussed in Section 2.2.

As discussed in Section 2.4 and its sub-sections, this method is specified for the bedrock portion of a well, and is used for decommissioning small diameter cased wells. Grouting in-place involves filling the casing with grout to a level of five feet below the land surface, cutting the well casing at the five-foot depth, and removing the top portion of the casing and associated well materials from the ground. The casing must be grouted according to the procedures in Section 6. In addition, the upper five feet of the borehole is filled to land surface and restored according to the procedures described in Section 7.

For open-hole bedrock wells, the procedure involves filling the opening with grout to the top of rock according to the procedures in Section 5. A thicker grout may be required to fill any bedrock voids. If excessive grout is being lost down-hole, consider grouting in stages to reduce the pressure caused by the height of the grout column.

The standard mix with the maximum amount of allowable water will be required to penetrate the well screen and sand pack when a well assembly has been installed within a bedrock hole. For an assembly such as this, the grout should be mixed thinly enough to penetrate the slots and sand pack. The grout mixes are discussed in Sections 6.1 and 6.2.

2.2 Casing Perforating/Grouting In-Place

Casing perforation followed by grouting in-place is the preferred method to use if there is poor documentation of the grouting of the well annulus, or the annulus was allowed to be back-filled with cuttings. The grout will squeeze through the perforations to seal any porous zones along the outside of the casing. The procedure involves puncturing, cutting or splitting the well casing and screen followed by grouting the well. A variety of commercial equipment is available for perforating casings and screens in wells with four-inch or larger inside diameters. Due to the diversity of applications, experienced contractors must recommend a specific technique based on site-specific conditions. A minimum of four rows of perforations several inches long around the circumference of the pipe and a minimum of five perforations per linear foot of casing or screen is recommended (American Society for Testing and Materials, Standard D 5299-99, 1999). After the perforating is complete, the borehole must be grouted according to the procedures in Section 6 and the upper five feet of borehole restored according to the procedures in Section 7.

2.3 Casing Pulling

Casing pulling should be used in cases where the materials of the well assembly are to be recycled, or the well assembly must be removed to clear the site for future excavation or re-development. Casing pulling is an acceptable method to use when no contamination is present; contamination is present but the well does not penetrate a confining layer; and when both contamination and a confining layer are present but the contamination cannot cross the confining layer. Additionally, the well construction materials and well depth must be such that pulling will not break the riser. When contamination is likely to cross the confining layer during pulling, a temporary casing can be used. See Section 2.4.

Casing pulling involves removing the well casing by lifting. Grout is to be added during pulling; the grout will fill the space once occupied by the material being withdrawn. An acceptable procedure to remove casing involves puncturing the bottom of the well or using a casing cutter to cut away the screen, grouting, using jacks to free casing from the hole, and lifting the casing out by using a drill rig, backhoe, crane, or other suitable equipment. Additional grout must be added to the casing as it is withdrawn. Grout mixing and placement procedures are provided in Section 6. In wells or well points in which the bottom cannot be punctured, the casing or screened interval will be perforated or cut away prior to being filled with grout. This procedure should be followed for wells installed in collapsible formations or for highly contaminated wells.

At sites in which well casings have been grouted into the top of bedrock, the casing pulling procedure should not be attempted unless the casing can be first cut or freed from the rock.

2.4 Over-Drilling

Over-drilling is the technique used to physically remove an entire monitoring well, its sand pack and the old grout column and fill. In situations where PVC screens and risers are expected to sever and removal of all well materials is required, over-drilling will be required. Over-drilling is called for when a riser can't be pulled and it penetrates a confining layer. Compared to the other procedures, over-drilling is the least common method of well decommissioning.

A "temporary casing" may be necessary when extraordinary conditions are present, such as a high concentration of mobile contaminants in the overburden, depth to water is shallow, there is poor construction documentation or shoddy construction practices. The approach involves installing a large diameter steel casing around the outside of the well followed by drilling / pulling /grouting within this casing. The casing is withdrawn at the end of pulling, grouting and (perhaps) drilling. If the confining layer is less than 5 feet thick, the casing should be installed to the top of the confining layer. Otherwise, it is installed to a depth of 2 feet below the top of the confining layer. After the outer casing has been set, the well can be removed and grouted through pulling if possible or removed and grouted by drilling inside the casing.

Over-drilling is used where casing pulling is determined to be unfeasible, or where installation of a temporary casing is necessary to prevent cross-contamination, such as when a confining layer is present and contamination in the deeper aquifer could migrate to the upper aquifer as the well is pulled. The over-drilling method should:

- Follow the original well bore;
- Create a borehole of the same or greater diameter than the original boring; and
- Remove all of the well construction materials.

In over-drilling the difficulty lies in keeping the augers centered on the old well as the bit is lowered; it will tend to wander off. As a precaution, the well column should be filled with grout before over-drilling. Then without allowing the grout to dry, the driller proceeds with over-drilling the well. Grouting first guarantees that if the drill wanders off the old well and the effort is less than 100% successful, the remaining well portion will at least have been grouted. There are many methods for over-drilling. Please note that the following methods are not suitable for all types of casing, and the advice of an experienced driller should be sought.

- Conventional augering (i.e., a hollow stem auger fitted with a pilot bit). The pilot bit will grind the well construction materials, which will be brought to the well surface by the auger.
- A conventional cable tool rig to advance "temporary" casing having a larger diameter than the original boring. The cable tool kit is advanced within the casing to grind the well construction materials and soils, which are periodically removed with large diameter bailer. This method is not applicable to bedrock wells.

- An over-reaming tool with a pilot bit nearly the same size as the inside diameter of the casing and a reaming bit slightly larger than the original borehole diameter. This method can be used for wells with steel casings.

- A hollow-stem auger with outward facing carbide cutting teeth having a diameter two to four inches larger than the casing.

Prior to over-drilling, the bottom of the well should be perforated or cut away, and the casing filled with grout as with casing removal by pulling.

In all cases above, over-drilling should advance beyond the original bore depth by a distance of half a foot to ensure complete removal of the construction materials. Oversight attention should be focused on the drill cuttings, looking for fragments of well materials. Absence of these indicators is a sign that the drill has wandered off the well. If wandering is suspected, having previously filled the well with grout, the remaining portion which cannot be over-drilled can be considered grouted in-place. When the over-drilling is complete, grout should be tremied within the annular space between the augers and well casings. The grout level in the borehole should be maintained as the drilling equipment and well materials are sequentially removed. As with all the other methods, the upper five feet of borehole should be restored according to the procedures in Section 7.

3.0 SELECTION PROCESS AND IMPLEMENTATION

The decommissioning procedure selection flow chart, Figure 2, is to be used to select decommissioning methods. The selection process first identifies the basic monitoring well type. There are only two types of monitoring wells described in this guidance, overburden wells and bedrock wells. Bedrock wells typically have an overburden portion which in the selection process is to be treated as an overburden well. Techniques are specified for wells based upon their type and the other physical conditions present. Decommissioning techniques called for by the selection process have their practical limits; construction details dictate when a well stem can be pulled without breaking and when it cannot be pulled. The DEC project manager has the discretion to deviate from the flow chart, (Figure 2), based on site conditions, budgetary concerns and professional judgment. The remainder of this section will discuss types of monitoring wells in various settings along with recommended decommissioning techniques.

3.1 Bedrock Wells

Referring to Figure 2 and Section 2.1, if the well extends into bedrock, the rock hole portion of the well is to be grouted in-place to the top of the rock. The grout mix, however, may vary according to the conditions. A thicker grout may be required to fill voids and a thinner grout may be necessary to penetrate well screen and sand pack. Refer to the grout mixture specifications given in Section 6.1 and 6.2.

Prior to grouting, the depth of the well will be measured to determine if any silt or debris has plugged the well. If plugging has occurred, all reasonable attempts to clear it should be made before grouting. The borehole will then be tremie grouted according to Section 6.4 from the bottom of the well to the top of bedrock to ensure a continuous grout column.

After the rock hole is grouted, the overburden portion of the well is decommissioned using appropriate techniques described below. If the bedrock extends to the ground surface, grouting can extend to the ground surface or to slightly below so that the site can be restored as appropriate in accordance with Section 7.

3.2 Uncontaminated Overburden Wells

For overburden wells and the overburden portion of bedrock wells, the first factor in determining the decommissioning method is whether the overburden portion of the well exhibits contamination, as determined through historical groundwater and/or soil sampling results. If the overburden is uncontaminated, the next criteria considers whether the well penetrates a confining layer. In the case that the overburden portion of the well does not penetrate a confining layer, the casing can either be tremie-grouted and pulled or tremie grouted and left in place. As a general rule, PVC wells greater than 25-feet deep should not be pulled unless site-specific conditions or other factors indicate that the well can be pulled without breaking. If the well cannot be pulled, the well should be grouted in-place as accordance with Sections 2.1 and 2.2.

If a non-telescoped overburden well penetrates a confining layer, the casing should be removed by pulling (if possible) in accordance with Section 2.3. If the casing cannot be removed by pulling, the well should be grouted in-place or where complete removal is required, removed by over-drilling. Over-drilling will be based upon the site-specific conditions and requirements. If pulling is attempted and fails (i.e., a portion of the riser breaks) the remaining portion of the well should be removed by using the conventional augering procedure identified in Section 2.4. Note that if the riser is broken during pulling, it is highly unlikely that the driller will be able to target it to over-drill it. This is the reason why all wells should be grouted first. In all cases, after the well construction materials have been removed to the extent possible, the borehole will be grouted in accordance with Section 6 and the upper five feet will be restored in accordance with Section 7.

3.3 Contaminated Overburden Monitoring Wells/Piezometers

Contamination in the overburden plays a role in the selection process. Any contamination present in the overburden must not be allowed to spread as a result of the decommissioning construction. For wells and piezometers suspected or known to be contaminated with light non-aqueous phase liquid (LNAPL) and/or dense non-aqueous phase liquid (DNAPL), often referred to as “product,” the decision to decommission the well should be reviewed. Such gross contamination is a special condition and requires design of the decommissioning procedure. If decommissioning is determined to be the proper course of action, measurement of the non-aqueous phase liquid volume will be determined and this liquid will be removed.

If an overburden well (or the overburden portion of a bedrock well) is contaminated with LNAPL, DNAPL and /or dissolved fractions as indicated by historical sampling results, one must evaluate the potential for contamination to cross an overburden confining layer (if one exists) during decommissioning. A rock or soil horizon of very low permeability is known as a confining layer. Contamination in the overburden lying above a confining layer is a significant condition to recognize. To prevent mobile contaminants from crossing a confining layer during pulling or over-drilling, a temporary casing should be installed to isolate the work zone. One should follow the procedure selection flow chart. Some contaminated conditions call for over-drilling or a specially designed procedure.

A well in contaminated overburden may be grouted in-place as long as the grout fully seals the well and boring zone. If a well in contaminated overburden was constructed allowing formation collapse as annular backfill or if the well has a compromised well seal, one must either physically remove the well or thoroughly perforate the riser and grout it in-place.

If physical removal of the well is required and the overburden contaminants are likely to be dragged upward or downward during decommissioning, a temporary casing should be used to seal off the construction work zone. Casing pulling and overdrilling can be safely accomplished within the temporary casing. Section 2.4 discusses the temporary casing technique.

3.4 Telescoped Riser

If the riser is telescoped in one or more outer casings, the decommissioning approach depends upon the integrity of the well seal. If there is no evidence that the well seal integrity is compromised, the riser should be grouted in-place in accordance with Sections 2.1 or 2.2 and the upper 5 feet of the well surface should be restored in accordance with Section 7. If indications are that the well seal is not competent, it will be necessary to design and implement a special procedure to perforate and grout or remove the well construction materials. The presence and configuration of the outer casing(s) will be specific in the individual wells and will be a key factor in the decommissioning approach. The special procedure must mitigate the potential for cross-contamination during removal of the well construction materials.

4.0 LOCATING AND SETTING-UP ON THE WELL

Prior to mobilizing to decommission a monitoring well, one should notify the property owner and/or other interested parties including the governing regulatory agency. It is advisable that when at the well location, one should review the proposed well decommissioning procedure. Verify well locations and identification by their identifying markers and GPS coordinates. Lastly, verify the depth of each well with respect to depth recorded on the well construction log.

5.0 REMOVING THE PROTECTIVE CASING

Most monitoring wells installed in non-traffic locations are finished with an elevated, protective casing (guard pipe) and a concrete rain pad. Wells at gasoline stations, usually being in high-traffic areas, are typically finished with a flush-mount, curb box and protective 8" dia steel inspection plate rather than a stick-up riser. The curb box is usually easily removed from around the flush-mount well before pulling or over-drilling. In the case of stick-up wells, the riser pipe may be bonded to the guard pipe and rain pad. When the protective casing and concrete pad of a stick-up monitoring well are "yanked out," a PVC riser will typically break off at the bottom of the guard pipe several feet below grade. Once this happens, it may become impossible to center a drill rig upon the well. The riser may become splintered and structurally unstable for pulling. Unless grouted first, the well may fill with dirt. Before pulling a casing or over-drilling a well, a method must be devised for removing these protective surface pieces without jeopardizing the remaining decommissioning effort.

Generally, unless the protective casing is loose and can be safely lifted off by hand, *one* *should fill the monitoring well with grout before removing the outer protective casing*. This will ensure that the well is properly sealed regardless of any problems later when removing the protective casing. Remove the protective casing or road box vault initially only if the stick-up or vault will interfere with subsequent down-hole work which must be done before grouting. This down-hole work may include puncturing, perforating or cutting the screen or riser. But as a general procedure don't remove the protective casing or road box until after initial grouting is complete.

The procedure for removing the protective casing of a well depends upon the decommissioning method specified for the monitoring well. The variety of protective casings available preclude developing a specific removal procedure but often one can simply break up the concrete seal surrounding the casing and jack or hoist the protective casing out of the ground. A check should be made during pulling to ensure that the inner well casing is not being hoisted with the protective casing. If this occurs, the well casing should be cut off after the base of the protective casing is lifted above the land surface. At well locations where the riser has been extended, the burial of a previous concrete pad may require the excavation of soil to the top of the concrete pad to remove the well.

Steel well casing should be removed approximately five feet below the land surface so as to be below the frost line and out of the way of any subsequent shallow digging. The upper five feet of casing and the protective casing can be removed in one operation if a casing cutter is used.

Waste handling and disposal must be consistent with the methods used for the other well materials unless an alternate disposal method can be employed (i.e., steam cleaning followed by disposal as non-hazardous waste).

6.0 SELECTING, MIXING, AND PLACING GROUT

This section gives recipes for the “standard grout mixture” and the thicker “special grout mixture.” Mixing and placing grout is also discussed in this section. The goal of well decommissioning is to eliminate the capability of water to travel up or down within the volume of the former well and its boring. Success depends upon the correct grout mixture and placement where it is needed. There are two types of grout mixes that may be used to seal monitoring wells: a standard mix and a special mix. Both mixes use Type 1 Portland cement and four percent bentonite by weight. However, the special mix uses a smaller volume of water and is used in situations where excessive loss of the standard grout mix is possible (e.g., highly-fractured bedrock or coarse gravels).

6.1 Standard Grout Mixture

For most boreholes, the following standard mixture will be used:

- One 94-pound bag Type I Portland cement;
- 3.9 pounds powdered bentonite; and
- 7.8 gallons potable water.

Slightly more water may be used in order to penetrate a sand pack when a well screen transects multiple flow zones. This mixture results in a grout with a bentonite content of four percent by weight and will be used in all cases except in boreholes where excessive use of grout is anticipated. In these cases a special thicker mixture will be used.

6.2 Special Mixture

In cases where excessive use of grout is anticipated, such as high permeability formations and highly fractured or cavernous bedrock formations, the following special mixture will be used:

- one 94-pound bag type I Portland cement;
- 3.9 pounds powdered bentonite;
- 1 pound calcium chloride; and
- 6.0-7.8 gallons potable water (depending on desired thickness).

The special mixture results in a grout with a bentonite content of four percent by dry weight. It is thicker than the standard mixture because it contains less water. This grout is expected to set faster than the Standard Grout Mixture due to the added calcium chloride. The least amount of water that can be added for the mixture to be readily pumpable is 6 gallons per 94-pound bag of cement.

6.3 Grout Mixing Procedure

To begin the grout-mixing procedure, calculate the volume of grout required to fill the borehole. If possible, the mixing basin should be large enough to hold all of the grout necessary for the borehole.

Mix grout until a smooth, homogeneous mixture is achieved. Grout can be mixed manually or with a mechanized mixer. Colloidal mixers should not be used as they tend to excessively decrease the thickness of the grout for the above recipes.

6.4 Grout Placement

This guidance requires that grout be placed in the well from the bottom to the top by means of a "tremie." A tremie is a pipe, a hose or a tube extending from the grout supply to the bottom of the well. The tremie delivers the grout all the way down through the water column without its being diluted and mixed with the water that may be present in the well. The tremie pipe or tube is withdrawn as (or after) the well is filled with grout.

Using the tremie, grout is placed in the borehole filling from the bottom to the top. Two-inch and larger wells should use tremie tubing of not less than 1-inch diameter. Smaller diameter wells will call for a smaller tremie pipe. Grout will then be pumped in until the grout appears at the land surface (when grouting open holes in bedrock, the grout level only needs to reach above the bedrock surface). Any groundwater displaced during grout placement, if known to be contaminated, will be contained for proper disposal.

At this time the rate of settling should be observed. If grouting the well in place, the well casing remains in the hole. But if the decommissioning method has involved down-hole tools such as hollow-stem augers or temporary casing for overdrilling, these will be removed from the hole. As each section is removed, grout will be added to keep the level between 0 and 5 feet below grade. If the grout level drops below the land surface to an excessive degree, an alternate grouting method must be used. One possibility is to grout in stages; i.e., the first batch of grout is allowed to partially cure before a second batch of grout is added.

As previously described in Section 5.0, the outer protective casing "stick-up" should be removed only after a well has been properly filled with grout. This will ensure that the well is properly sealed regardless of any breakage which may occur when removing the stick-up. It is important to reiterate that when either casing pulling or over-drilling are required, due to the uncertainty of successfully pulling a well or over-boring a well, we insist that the driller tremie grout the well first. Then without allowing the grout to dry, the driller proceeds with pulling the casing or over-drilling the well.

Upon completion of grouting, ensure that the final grout level is approximately five feet below land surface. A ferrous metal marker will be embedded in the top of the grout to indicate the location of the former monitoring well. Lastly, a fabric "utility" marking should be placed one foot above the grout so an excavator can see it clearly.

7.0 BACKFILLING AND SITE RESTORATION

The uppermost five feet of the borehole at the land surface should be filled with material physically similar to the natural soils. The surface of the borehole should be restored to the condition of the area surrounding the borehole. For example, concrete or asphalt will be patched with concrete or asphalt of the same type and thickness, grassed areas will be seeded, and topsoil will be used in other areas. All solid waste materials generated during the decommissioning process must be disposed of properly.

8.0 DOCUMENTATION

A form which may be used in the field to record the decommissioning construction is included as Figure 3. Additional documentation may be required by a DEC project manager and samples are included in Appendix A. Programs within the DEC that maintain geographic data on monitoring wells strive to keep that data up to date. Owners of these data sets must be notified when a well is decommissioned. Historical groundwater quality data is linked to monitoring well locations so when a well is decommissioned, existing GIS data must be updated to reflect that fact but the coordinate location in the GIS database should not be eliminated. A metal detector may not be able to detect a deeply buried marker so if this locator is important for future utility runs or foundations, a map should be submitted to the property owner and the town engineer showing the decommissioned well locations. Global Positioning System (GPS) coordinates should be indicated on this map. Lastly, whatever documentation is produced should be provided to the property owner, the DEC, and all other parties involved.

9.0 FIELD OVERSIGHT

Over-drilling requires careful observation to detect whether the drill has wandered off the well. Grout preparation and tremie work should be carefully observed. The successful implementation of a decommissioning work plan depends upon proper direction, observation and oversight. Methods to be employed must be clearly worked through and all parties must understand what they have to do before going into the field. Flexibility is allowed where necessary but the work effort must be thorough and effective to protect our groundwater.

10.0 RELATED REFERENCES

- *Groundwater Monitoring Well Decommissioning Procedures*, October 1986. Prepared by Malcolm Pirnie, Inc., for the New York State Department of Environmental Conservation, Division of Environmental Remediation.

- American Society for Testing and Materials, A.S.T.M. D 5299-99, Standard Guide for the Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities. A.S.T.M.. Philadelphia. 2005.

- New York State Department of Environmental Conservation, Division of Solid and Hazardous Materials, 6 NYCRR Part 360, Solid Waste Management Facilities.

- New York State Department of Environmental Conservation, Region I - Water Unit, Specifications for Abandoning Wells and Boreholes in Unconsolidated Materials, undated.

- United States Environmental Protection Agency, The Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells, EPA 600/4-89/034.

<u>**FIGURES**</u>

<u>**APPENDICES**</u>

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FIGURE 1

MONITORING WELL FIELD INSPECTION LOG

FIGURE 1

SITE NAME:

SITE ID.: ________
INSPECTOR: ________
DATE/TIME: ________
WEll ID.: ________

MONITORING WELL FIELD INSPECTION LOG
NYSDEC WELL DECOMMISSIONING PROGRAM

	YES	NO
WELL VISIBLE? (If not, provide directions below)		
WELL I.D. VISIBLE?		
WELL LOCATION MATCH SITE MAP? (if not, sketch actual location on back)		

WELL I.D. AS IT APPEARS ON PROTECTIVE CASING OR WELL: ....

	YES	NO
SURFACE SEAL PRESENT?		
SURFACE SEAL COMPETENT? (If cracked, heaved etc., describe below)		
PROTECTIVE CASING IN GOOD CONDITION? (If damaged, describe below)		

HEADSPACE READING (ppm) AND INSTRUMENT USED... ________
TYPE OF PROTECTIVE CASING AND HEIGHT OF STICKUP IN FEET (If applicable) ________
PROTECTIVE CASING MATERIAL TYPE: .... ________
MEASURE PROTECTIVE CASING INSIDE DIAMETER (Inches): ....

	YES	NO
LOCK PRESENT?		
LOCK FUNCTIONAL?		
DID YOU REPLACE THE LOCK?		
IS THERE EVIDENCE THAT THE WELL IS DOUBLE CASED? (If yes,describe below)		
WELL MEASURING POINT VISIBLE?		

MEASURE WELL DEPTH FROM MEASURING POINT (Feet): .... ________
MEASURE DEPTH TO WATER FROM MEASURING POINT (Feet): .... ________
MEASURE WELL DIAMETER (Inches): .... ________
WELL CASING MATERIAL: .... ________
PHYSICAL CONDITION OF VISIBLE WELL CASING: .... ________
ATTACH ID MARKER (if well ID is confirmed) and IDENTIFY MARKER TYPE .... ________
PROXIMITY TO UNDERGROUND OR OVERHEAD UTILITIES... ________

DESCRIBE ACCESS TO WELL: (Include accessibility to truck mounted rig, natural obstructions, overhead power lines, proximity to permanent structures, etc.); ADD SKETCH OF LOCATION ON BACK, IF NECESSARY.

DESCRIBE WELL SETTING (For example, located in a field, in a playground, on pavement, in a garden, etc.) AND ASSESS THE TYPE OF RESTORATION REQUIRED.

IDENTIFY ANY NEARBY POTENTIAL SOURCES OF CONTAMINATION, IF PRESENT (e.g. Gas station, salt pile, etc.):

REMARKS:

FIGURE 2

DECOMMISSIONING PROCEDURE SELECTION

NYSDEC Monitoring Well Decommissioning Procedure Selection

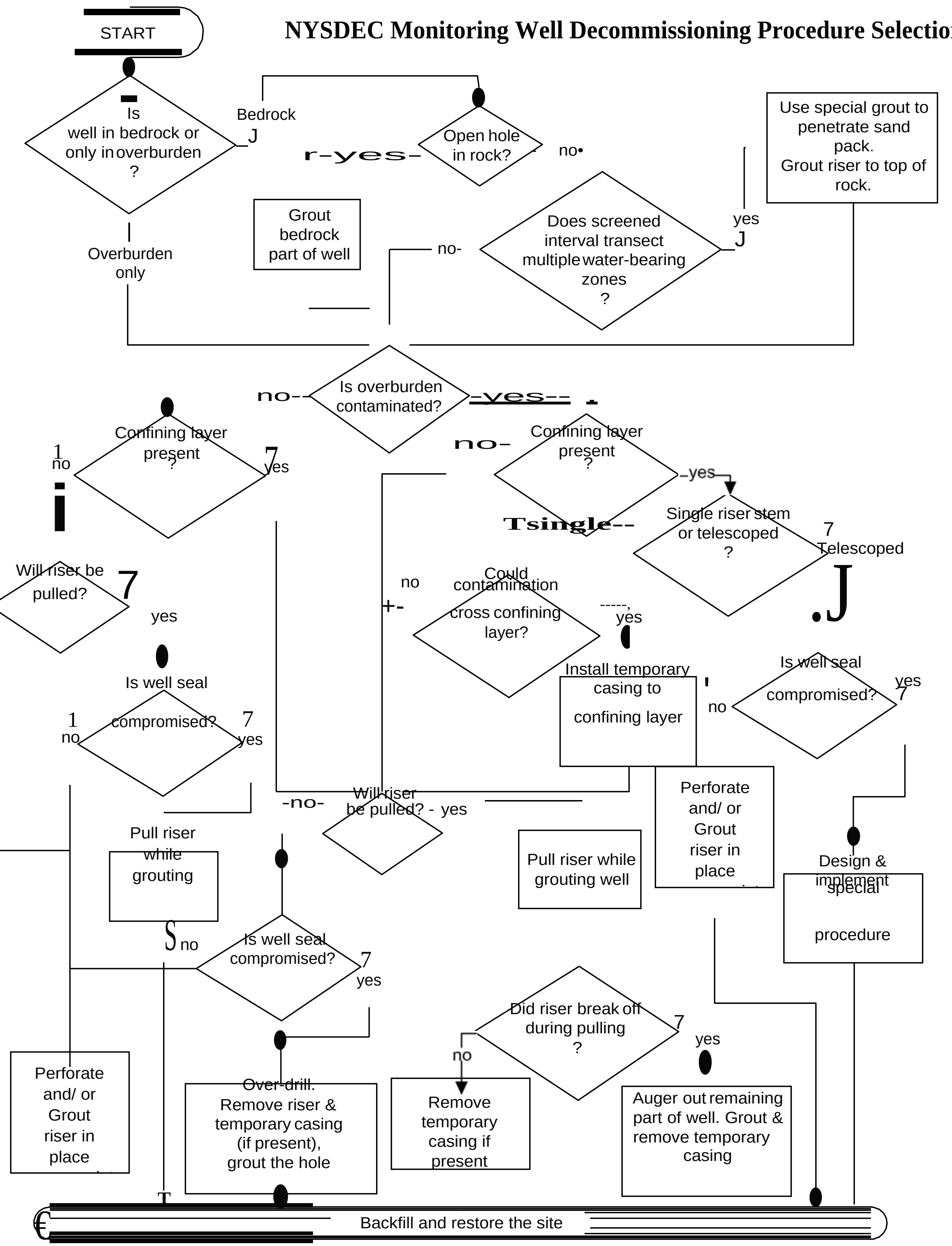


FIGURE 2

FIGURE 3

WELL DECOMMISSIONING RECORD

FIGURE 3

WELL DECOMMISSIONING RECORD

Site Name:	Well I.D.:
Site Location:	Driller:
Drilling Co.:	Inspector:
	Date:

DECOMMISSIONING DATA
(Fill in all that apply)

OVERDRILLING

Interval Drilled	
Drilling Method(s)	
Borehole Dia. (in.)	
Temporary Casing Installed? (y/n)	
Depth temporary casing installed	
Casing type/dia. (in.)	
Method of installing	

CASING PULLING

Method employed	
Casing retrieved (feet)	
Casing type/dia. (in)	

CASING PERFORATING

Equipment used	
Number of perforations/foot	
Size of perforations	
Interval perforated	

GROUTING

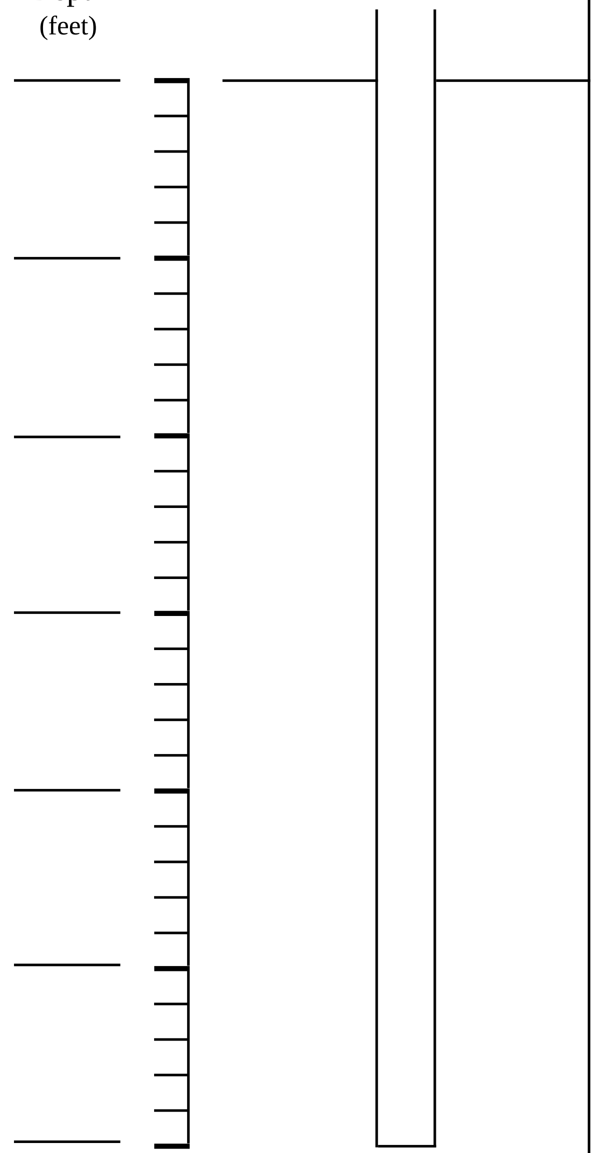
Interval grouted (FBLS)	
# of batches prepared	

For each batch record:

Quantity of water used (gal.)	
Quantity of cement used (lbs.)	
Cement type	
Quantity of bentonite used (lbs.)	
Quantity of calcium chloride used (lbs.)	
Volume of grout prepared (gal.)	
Volume of grout used (gal.)	

WELL SCHEMATIC*

Depth
(feet)



COMMENTS:

* Sketch in all relevant decommissioning data, including: interval overdrilled, interval grouted, casing left in hole, well stickup, etc.

Drilling Contractor

Department Representative

APPENDIX A - REPORTS

APPENDIX A1 - INSPECTOR'S DAILY REPORT

APPENDIX A2 - PROBLEM IDENTIFICATION REPORT

APPENDIX A3 - CORRECTIVE MEASURES REPORT

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Appendix A1

Inspector's Daily Report

CONTRACTOR:
ADDRESS:

TELEPHONE:
LOCATION ____________________ FROM __________ TO __________
WEATHER ____________________ TEMP ______ A.M. ______ P.M. ______ DATE __________

CONTRACTOR'S WORK FORCE AND EQUIPMENT

DESCRIPTION	*H*	*#*	*DESCRIPTION*	*H*	*#*	*DESCRIPTION*	*H*	*#*	*DESCRIPTION*	*H*	*#*
Field Engineer						Equipment			Front Loader Ton		
Superintendent			Ironworker			Generators			Bulldozer		
						Welding Equip.					
Laborer Foreman			Carpenter								
Laborer									Backhoe		
Operating Engineer			Concrete Finisher								
Carpenter						Paving Equip. & Roller					
						Air compressor					

SEE REVERSE SIDE FOR SKETCH YES ☐ NO ☐ ____________________

WORK PERFORMED: ____________________

PAY ITEMS

CONTRACT		STA		DESCRIPTION	QUANTITY	REMARKS
Number	ITEM	FROM	TO			

TEST PERFORMED: ____________________
PICTURES TAKEN: ____________________

VISITORS: ____________________

QA PERSONNEL
SIGNATURE

REPORT NUMBER __________
SHEET ______ Of __________

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PROBLEM IDENTIFICATION REPORT

Date ______________________

Day

Su	M	T	W	Th	F	Sa

Project ____________________ Job Number__________

Contractor ____________________

Subject ____________________

Sky/Precip.	Clear	Partly Cloudy	Cloudy	Rainy	Snow
TEMP.	<32F	32-40F	40-70F	70-80F	80-90F
WIND	No	Light	Strong		
HUMIDITY	Dry	Mod.	Humid		

PROBLEM DESCRIPTION Reference Daily Report Number 1: ____________________

PROBLEM LOCATION - REFERENCE TEST RESULTS AND LOCATION (Note: Use sketches on back of form as appropriate):

PROBABLE CAUSES: ____________________

SUGGESTED CORRECTIVE MEASURES: ____________________

APPROVALS:

QA ENGINEER: ____________________

PROJECT MANAGER: ____________________

Distribution:

1. Project Manager
2. Field Office
3. File
4. Owner

QA Personnel
Signature: ____________________

MEETINGS HELD AND RESULTS

REMARKS

REFERENCES TO OTHER FORMS

SKETCHES

SAMPLE LOG

SAMPLE NUMBER

APPROXIMATE LOCATION OF STOCKPILE

NUMBER OF STOCKPILE

DATE OF COLLECTION

CLIMATIC CONDITIONS

FIELD OBSERVATION

SHEETS OF

Appendix A3

CORRECTIVE MEASURES REPORT

Date ______________________

Project ______________________ Job Number __________

Contractor ______________________

Subject ______________________

Day	Su	M	T	W	Th	F	Sa

Sky/Precip.	Clear	Partly Cloudy	Cloudy	Rainy	Snow
TEMP.	<32F	32-40F	40-70F	70-80F	80-90F
WIND	No	Light	Strong		
HUMIDITY	Dry	Mod.	Humid		

CORRECTIVE MEASURES TAKEN (Reference Problem Identification Report No.): ______________________

RETESTING LOCATION: ______________________

SUGGESTED METHOD OF MINIMIZING RE-OCCURRENCE: ______________________

SUGGESTED CORRECTIVE MEASURES: ______________________

APPROVALS:

QA ENGINEER: ______________________

PROJECT MANAGER: ______________________

Distribution:

1. Project Manager
2. Field Office
3. File
4. Owner

QA Personnel
Signature: ______________________

Section 5

SAMPLE COLLECTION AND FIELD SCREENING (SC)

SUMMARY GUIDANCE

SC-001 General Guidance on Sample Collection

1. Overview

The primary objective of all sampling activities is to characterize a site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of material under investigation. The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures.

2. Sample Purposes

In relation to the media to be sampled, two basic types of samples can be considered:

2.1. Waste Characterization Sample

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, soil, groundwater, soil vapor, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

2.2. Environmental sSample

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

The importance of making the distinction between environmental and hazardous samples is two-fold:

- Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.
- Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or the Department of Transportation (DOT) regulations and U.S. Environmental Protection Agency (EPA) guidelines.

3. Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

3.1. Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

3.2. Composite Samples

Composites are non-discrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits. Compositing of hazardous waste is often performed after compatibility tests have been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

3.3. Types of Sampling Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling.

- Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site.
- Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established.
- When judgmental sampling is performed, samples are collected only from the portions) of the site most likely to be contaminated.

Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

4. Sample Hold Time, Container, and Preservation Methods

The following table provides general required Holding Time, Container, and Preservation Methods. Most of the information is specific to the EPA analytical method and should be pertinent to all sampling schemes. However, some analytical preservation and analytical methods are state specific. The QAPP should clearly identify preservation methods and hold times prior to sampling.

Samples should be submitted to the laboratory as soon as possible. It is preferable to send samples from the field via courier service rather than bringing to the office for later pickup.

Aqueous

Parameter	Holding Time	Container	Volume	Preservative
Acidity	14 days	P, G	100 ml	Cool, 4°C
Alkalinity	14 days	P, G	100 ml	Cool, 4°C
Biological Oxygen Demand (BOD)	48 hours	P, G	1000 ml	Cool, 4°C
Chemical Oxygen Demand (COD)	28 days	P, G	100 ml	Cool, 4°C, H_2SO_4 to pH<2
Chloride	28 days	P, G	100 ml	Cool, 4°C
Chromium, Hexavalent	24 hours	P, G	250 ml	Cool, 4°C
Cyanide				
Amenable	14 days[1]	P, G	500 ml	Cool, 4°C, NaOH to pH>12
Free	14 days[1]	P, G	500 ml	Cool, 4°C, NaOH to pH>12
Total	14 days[1]	P, G	500 ml	Cool, 4°C, NaOH to pH>12
Fluoride	28 days	P	100 ml	Cool, 4°C
Hardness, Total	6 months	P, G	100 ml	HNO_3 to pH<2
Metals (except Cr+6, Hg)	6 months	P	500 ml	Cool, 4°C, HNO_3 to pH<2
MBAS	48 hours	G	500 ml	Cool, 4°C
Mercury	28 days	P, G	500 ml	HNO_3 to pH<2
N, Ammonia	28 days	P, G	100 ml	H_2SO_4 to pH<2
N, T. Kjeldahl	28 days	P, G	500 ml	H_2SO_4 to pH<2
N, Nitrate	48 hrs/ 28 days preserved	P, G	100 ml	Cool, 4°C or add H_2SO_4 to pH<2
N, Nitrite	48 hours	P, G	100 ml	Cool, 4°C
Oil and Grease	28 days	G	1000 ml	Cool, 4°C, H_2SO_4 or HCl to pH<2
Petroleum Hydrocarbons	14 days	G	1000 ml	Cool, 4°C, H_2SO_4 to pH<2
pH	Analyze Immediately	P, G	50 ml	N/A
Phenols,Recoverable	28 days	G	500 ml	Cool, 4°C, H_2SO_4 to pH<2
Phosphorus, Ortho	48 hours	P, G	100 ml	Filter, Cool, 4°C
Phosphorus, Total	28 days	P, G	100 ml	Cool, 4°C, H_2SO_4 to pH<2
Radiological Tests				
Alpha, Beta & Radium	6 months	P, G	4 L	Cool, 4°C, HNO_3 to pH<2
Solids, Total	7 days	P, G	100 ml	Cool, 4°C

Aqueous (cont)

Parameter	Holding Time	Container	Volume	Preservative
Solids, Total Dissolved	7 days	P, G	100 ml	Cool, 4°C
Solids, Total Suspended	7 days	P, G	100 ml	Cool, 4°C
Solids, Volatile Suspended	7 days	P, G	100 ml	Cool, 4°C
Sulfate	28 days	P, G	100 ml	Cool, 4°C
Total Organic Carbon	28 days	P, G	100 ml	Cool, 4°C, H_2SO_4 to pH<2
Halogenated Volatiles	14 days	40 ml vials	2x40 ml	Cool, 4°C3
Purgeable Aromatics	14 days[4]	40 ml vials	2x40 ml	Cool, 4°C, HCl to pH<2
Phenols by GC/MS	7 days/40 days[5]	G	1 L	Cool, 4°C
Pesticides/PCBs	7 days/40 days[5]	G	1 L	Cool, 4°C
Polynuclear Aromatics	7 days/40 days[5]	G	1 L	Cool, 4°C
Acid/Base-Neutral Extractables	7 days/40 days[5]	G	1 L	Cool, 4°C

Solid

Parameter	Holding Time	Container	Volume	Preservative
Metals (except Hg)	6 months	P, G	100 g	Cool, 4°C
Mercury	28 days	P, G	100 g	Cool, 4°C
Halogenated Volatile Organics	14 days	G	10 g/10 ml methanol, 10 g/10 Ml DI water	Methanol and deionized water preserved in field[6]
Halogenated Volatile Organics	14 days	Encore Samplers	Three 5 gram samples	Must be frozen within 48 hours
Purgeable Aromatics	14 days	G	10 g/10 ml methanol, 10 g/10 Ml DI water	Methanol and deionized water preserved in field[6]
Phenols	14 days/40 days[5]	G	100 g	Cool, 4°C
Pesticides/PCBs	14 days/40 days[5]	G	100 g	Cool, 4°C
Polynuclear Aromatics	14 days/40 days[5]	G	100 g	Cool, 4°C
Acid/Base-Neutral Extractables	14 days/40 days[5]	G	100 g	Cool, 4°C

NOTES:
P = Plastic
G = Glass

Holding times in red indicate 48 hours or less holding times.

1. If residual chlorine is present, add 0.6 gm. ascorbic acid.

2. Maximum holding time is 24 hours when sulfide is present. Test with lead acetate paper prior to pH adjustment. Remove sulfide with addition of lead nitrate until a negative spot test is obtained. Filter and add NaOH to pH>12.

3. If samples contain residual chlorine, add 0.008% sodium thiosulfate at the time of sampling.

4. With pH adjustment; without, holding time is 7 days.

5. Seven days prior to extraction. Samples must be analyzed within 40 days after extraction.

6. Encore samplers may be used, but must be received in lab and extracted within 48 hours.

5. References

DER-10, Technical Guidance for Site Investigation and Remediation. New York State Department of Environmental Conservation. May 3, 2010.

Analytical Service Protocol, New York State Department of Environmental Conservation. July 2005.

New Jersey Department of Environmental Protection, Field Sampling Procedures Manual, August 2005.

Connecticut Department of Environmental Protection, Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory.

Determination of Volatile Organic Compounds, Version 2.0 February 28, 2006.

STANDARD OPERATING PROCEDURE

SC-002 Sample Handling

1. Objective

Sample handling involves the collection and shipping of environmental samples to a laboratory for chemical analysis. The overall objective of sample handling is to ensure that samples are properly:

- labeled and documented;
- preserved;
- packaged; and
- transported to laboratories.

2. Execution

- Prior to mobilizing to the field, select a shipper or arrange for a courier for sample delivery to the laboratory. If using a shipper (i.e., FedEx, or UPS) determine the time constraints for pickup requests, the location and hours of the nearest shipping office, and any size/weight restrictions.
- Label all laboratory glassware with waterproof ink prior to collecting the respective samples. The label should have an adhesive and be placed on the jar or bottle, not on the cap.
- Record the following information on the label and in the field notebook (see *Field Notebook* SOP FD-001): project number, sample identification (i.e., MW201 or SS-2), date, and time (military time) of collection, sampler's initials, and preservative, if present.
- If sample jars are not pre-preserved, add preservative as appropriate.
- At each sampling location, samples must be collected in order of volatility, most volatile first. Samples collected for volatile analysis must be placed in sample containers immediately upon retrieval of the sample.
- Aqueous samples for volatile analysis must be collected without air bubbles. Soil samples for volatile analysis should be compacted to eliminate as much headspace as possible. Other laboratory glassware should also be filled when possible. Care must be taken to avoid getting soils on the threads of sample jars, which can cause a faulty seal.
- If compositing of samples is performed in the field, specify basis for composite (i.e., volume, weight, spoon recovery, etc.) and record procedure for compositing sample in the field book.
- Once samples have been collected, place samples in a cooler with ice or a blue pack and start the chain of custody (COC) form (SOP FD-003, *Sample Handling and Chain of Custody*).

- For shipping, individually wrap each sample bottle with bubble packing or suitable packing material and place the wrapped bottles in the cooler with sufficient packing material between samples to avoid breakage.
- Place a layer of packing material above and below the sample bottles. Place blue ice packs or ice bags on top of the packing material. Fill the remaining space in the cooler with packing material to eliminate the possibility of vertical movement of samples.
- Place the completed and signed COC form in a plastic bag and place on top of the packing material in the cooler.
- Fill out the appropriate shipping or courier forms and attach to the top of the cooler. If necessary, place the proper shipping labels on the cooler. Have the courier sign the COC form (or write pickup by FedEx, UPS, etc., with date and time). Place a custody seal on the cooler.
- All samples should be submitted as soon as possible. It is preferable for samples to be mailed prior to returning to the office.
- A copy of the waybills must be kept by the field supervisor to track shipments if necessary.

3. Notes

- At all times, follow safety procedures as defined in the site-specific Work Plan and Health and Safety Plan.
- Field personnel must be aware of analyses which have short holding times and schedule sampling events and shipping accordingly. Shipment of samples for analyses with short holding times must be planned in advance. Refer to the project work plan, quality assurance project plan, or state/federal regulations for holding time and preservative information.
- In general, glassware for aqueous samples contains preservatives, (i.e., HNO3, HCl, etc). When collecting the sample, take care not to overfill the container, thus flushing the preservative out of the bottle.
- Never composite samples for volatile organic compounds (VOCs) in the field. Collect individual aliquots and direct the laboratory to perform compositing.
- Collection of aqueous samples should not be performed over the opening of a monitoring well. Preservatives from overfilling or a marker pen or other objects could fall into the well.
- If the recharge volume for a monitoring well is low, completely fill all volatile vials and then collect the minimum sample volume required for each remaining analysis.
- During subsurface soil sampling, if the recovery from the split-spoon sample is inadequate, if appropriate, resample the bottom of the borehole to obtain proper sample volume.

- Laboratories will homogenize and test the contents of the sample container, unless directed otherwise. Samples should not contain rocks, twigs, leaves, etc., unless these materials are of interest.

4. References

DER-10, Technical Guidance for Site Investigation and Remediation. New York State Department of Environmental Conservation. May 3, 2010.

Analytical Service Protocol, New York State Department of Environmental Conservation. July 2005.

New Jersey Department of Environmental Protection, Field Sampling Procedures Manual, August 2005.

Connecticut Department of Environmental Protection, Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory.

Determination of Volatile Organic Compounds, Version 2.0 February 28, 2006.

5. Attachments

Attachment A – General Guidelines for selecting equipment on the basis of construction material and target analyte(s)

Attachment A

Table 2. General Guidelines for selecting equipment on the basis of construction material and target analyte(s)

[⊔, generally appropriate for use shown; Si, silica; Cr, chromium; Ni, nickel; Fe, iron; Mn, manganese; Mo, molybdenum; CFC, chlorofluorocarbon; B, boron]

Construction material for sampling equipment		Target analyte(s)	
Material	**Description**	**Inorganic**	**Organic**
	Plastics[1]		
Fluorocarbon ploymers[2] (other varies available for differing applications)	Chemically inert for most analytes	⊔ (potential source of fluoride)	⊔ (Sorption of some organics)
Polypropylene	Relatively inert for inorganic analytes	⊔ (not appropriate for Hg)	**Do not use**
Polypropylene (linear)	Relatively inert for inorganic analytes	⊔ (not appropriate for Hg)	**Do not use**
Polyvinyl chloride (PVC)	Relatively inert for inorganic analytes	⊔ (not appropriate for Hg)	**Do not use**
Silicone	Very porous. Relatively inert for most inorganic analytes	⊔ (potential source of Si)	**Do not use**
	Metals		
Stainless steel 316 (SS 316)	SS-316-metal having the greatest corrosion resistance. Comes in various grades. Used for submersible pump casing.	⊔ (Potential source of Cr, Ni, Fe, and possible Mn and Mo) **Do not use** for surface water unless encasted in plastic.	⊔ Do not use if corroded[3]
Stainless steel 304	Similar to SS-316, but less corrosion resistant	**Do not use**	⊔ Do not use if corroded[3]
Other metals: brass, iron, copper, aluminum, galvanized and carbon steels	Refrigeration-grade copper or aluminum tubing are used routinely for collection of CFC samples	**Do not use**	⊔ Routinely used for CFCs Do not use if corroded[3]
	Glass		
Glass, borosilicate (laboratory grade)	Relatively inert. Potential sorption of analytes	⊔ **Do not use** for trace element analyses. Potential source of B and Si	⊔

[1]Plastic used in connection with inorganic trace-element sampling should be uncolored or white. Tubing used for trace metal sampling should be cleaned by soaking in 5-10 percent HCl solution for 8-24 hours, rinsing with reagent water (metals free) and allowed to air dry in mercury-free environment. After drying, the tubing is doubled-bagged in clear polyethylene bags, serialized with a unique number, and stored until used.

[2] Fluorocarbon polymers include materials such as Teflon™, Kynar™, and Tefzel™ that are relatively inert for sampling inorganic or organic analytes. Only fluoropolymer should be used for samples that will analyzed for mercury because mercury vapors can diffuse in or out of other materials, resulting in either contaminated or biased results.

[3] Corroded/weathered surfaces are active sorption sites for organic compounds.

STANDARD OPERATING PROCEDURE

SC-003 Investigation Derived Waste

1. Objective

The objective is to provide guidelines for the proper management of Investigation Derived Waste (IDW) resulting from site investigation activities. This Standard Operating Procedure (SOP) addresses IDW generated during field tasks typically performed for environmental site investigations. The intent of this SOP is to provide a set of guidelines for proper assessment and handling of these IDWs.

2. Execution

- Determine the suspected contamination type and impacted media anticipated based on previous investigations, current analytical data, and/or site history.
- Consider the following issues when selecting IDW management option(s):
    i. anticipated volume of IDW to be generated during on-site activities
    ii. potential contaminants and their concentrations
    iii. location of the nearest populations and the likelihood and/or degree of site access
    iv. potential exposures to workers
    v. potential for environmental impacts
    vi. community concerns
    vii. potential storage areas
    viii. regulatory constraints
    ix. potential on-site treatment options
- Select IDW Management Option(s) prior to the commencement of field activities that will generate waste materials.
- In addition to the issues considered above for the selection of IDW management strategies/disposal options, more specific considerations/guidelines include:

2.1. Test Pit Excavation

- Segregate contaminated soil from uncontaminated soil using visual and/or field screening methods.
- Use appropriate barrier (plastic sheeting) for temporary stockpiling of contaminated soil adjacent to test pit.
- Backfill test pits with uncontaminated soil.
- For situations where returning contaminated soil to the test pit is deemed protective by the project manager, backfill soil in the same order as the soil was excavated from the test pit.

- For contaminated soil pile, collect representative sample(s) for test pit(s) for waste disposal characterization
- Ensure that the pile is appropriately covered with polysheeting and secured until disposed offsite.

2.2. Boring/Monitoring Well Installation

- For auger borings, segregate contaminated soil (determined by visual and/or field screening methods) from uncontaminated soil during drilling. Segregate residual contaminated soil from split-spoon sampling.
- Auger cuttings or sediment generated by drive and wash may be spread around the ground surface at the boring location if deemed appropriate by the project manager. IDW may be placed in an appropriate area or container pending characterization and appropriate disposal. (A useful rule of thumb is to assume generation of one 55-gallon drum of cuttings for each 20 feet drilled with 7-¼-inch-inner diameter [ID] augers).
- Segregate contaminated drilling fluid from uncontaminated fluid for rotary wash borings.
- Drilling fluid management options include pouring the drilling fluid on the ground in the Area of Concern (AOC) or containerizing the fluid in drums or tanks.

2.3. Water Development/Sampling

- Contaminated groundwater removed from wells by pumping or bailing for the purpose of well development and sampling should be containerized at the project manager's discretion.

2.4. Decontamination Fluids

- Decontamination fluids should be containerized in drums or tanks.

2.5. Disposable Personal Protective Equipment (PPE)

- Disposable PPE must be managed like any other IDW. It should only be removed from the site with the project manager's approval, and may be disposed of as ordinary rubbish only if it has not come into contact with hazardous materials.

3. Notes

- The preferred IDW management option is to return the IDW to its source. However, this is not always an option.
- The IDW selected must be in accordance with state/federal regulations.

- The Client contracts directly with the transportation and disposal contractor for the disposal of IDW, should disposal be necessary.

4. References

Guide to Management of Investigation - Derived Wastes (April 1992), United States Environmental Protection Agency, Publication 9345.3-03FS.

Standard References for Monitoring Wells, Massachusetts Department of Environmental Protection, Publication No. WSC-310-91.

Connecticut Department of Environmental Protection Connecticut's RCRA "Contained-In" Policy, Updated June 2005

Attachment A

LABELING SPLIT SPOON SAMPLE JARS

MULTIPLE **JARS:** OPTION ONE

PROJ #
B201
S4
10.5' -- 12.5'
6-5-7-9
REC = 14"
TOP 5"

PROJ #
8201
S4
10.5' -- 12.5'
6-5-7-9
REC = 14"
MID 5"

PROJ #
8201
S4
10.5' -- 12.5'
6-5-7-9
REC = 14"
BOT 5"

MULTIPLE **JARS: OPTION TWO**

PROJ #
B201
S5
12.5' -- 14.5'
11-10-13-26
REC = 24"
1 of 5 (TOP)

PROJ #
8201
S5
12.5' -- 14.5'
11-10-13-26
REC = 24"
2 of 5

...5 of 5 (BOT)

EMPTY JAR REQUIRED IF NO RECOVERY

PROJ #
B201
S6
14.5' -- 16.5'
2-1-3-6
REC = O"

STANDARD OPERATING PROCEDURE

SC-004 Head Space VOC Screening

1. Objective

To obtain a site-specific indication of the volatile organic compounds (VOC) concentrations present in soil. This information can be used: 1) to segregate soil based on degree of contamination, 2) to identify samples for quantitative analysis of VOCs, or 3) as a qualitative method to evaluate the presence or absence of VOCs in soil.

2. Execution

- A photoionization detector (PID) or flame ionization detector (FID) instrument is used to measure VOCs in jar head space (JHS) screening. Select the appropriate instrument, lamp, and calibration gas for the site-specific contaminants. Calibrate the instrument in accordance with the manufacturer's instructions before JHS screening begins. Record the type of calibration gas, detector, and lamp in the field notebook.
- Note the highest VOC concentration that the instrument measures in air in the work area before performing JHS screening. Record this as the initial background concentration.
- Half-fill a clean, glass jar with the soil. Use a clean trowel or soil spatula. Quickly cover the open top with one or two sheets of clean, aluminum foil and screw on the cap to tightly seal the jar. Label the sample location and depth from which the sample was collected on the jar.
- Allow headspace development for at least 10 minutes at an ambient temperature of 50°F or greater. Vigorously shake the jar for 15 seconds at the beginning and end of the headspace development period. When ambient temperatures are below 50°F, place the jar in a heated van or building during the headspace development period.
- After headspace development, remove the screw cap to expose the foil seal. Quickly puncture the foil seal with the instrument's sampling probe and insert it to a point at about one-half of the headspace depth.
- Record the highest VOC concentration that the instrument displays as the JHS concentration. The highest concentration should occur between 2 and 5 seconds after probe insertion.

3. Notes

- The instruments may work poorly in the rain and in freezing temperatures. PIDs may not function in high-humidity conditions. Under such conditions, operate the instrument in a heated vehicle or building.

- Prevent water and soil particles from entering the tip of the instrument probe. Use a filter on the instrument's probe.
- Measure background VOC conditions and perform JHS screening away from non-site-related VOC sources, such as vehicle and heavy equipment exhaust.
- The VOC concentration on the instrument's display may vary when the air contains high VOC concentrations or high moisture.
- JHS screening is a guide that helps the screener to segregate soils into broadly defined categories. JHS screening results may differ by orders of magnitude from laboratory testing results.

4. References

Interim Remediation Waste Management Policy for Petroleum Contaminated Soils. (April 1994), Massachusetts Department of Environmental Protection, Policy #WSC-94-400.

STANDARD OPERATING PROCEDURE

SC-005 SiteLAB™ UVF-3100 Ultraviolet Fluorescence (UVF) detection method

1. Objective

To establish standard procedures for the field analysis of petroleum hydrocarbons in soil and water using the SiteLAB™ UVF-3100 Ultraviolet Fluorescence (UVF) detection method.

Ultraviolet Fluorescence is a very selective detection method useful for testing many types of environmental contaminants. The principle of operation relies on the electronic configuration of the molecular structure for each contaminant. When a hydrocarbon molecule is exposed to certain wavelengths of light, the molecule emits energy at a specific wavelength. The light energy emitted by an environmental sample exposed to a UV source is directly proportional to the concentration of hydrocarbons present. The fluorescence response of each sample is then quantified using a 5 point linear calibration curve. A specific range of target compounds can be quantified by first selecting the appropriate wavelengths of light to be detected by the UVF-3100 and then using certified standards sensitive to the wavelengths of interest, to establish the linear range of the calibration curve. The UVF-3100 can be calibrated to detect the following types of hydrocarbon ranges:

- Volatile Petroleum Hydrocarbons (C9-C10 molecular weights) including benzene, toluene ethylbenzene and xylene (BTEX).
- Gasoline Range Organics (C5-C10) including BTEX.
- Extractable Petroleum Hydrocarbons (C11-C22).
- Extractable Diesel Range Organics (C10-C40) (weathered Diesel).
- Polycyclic Aromatic Hydrocarbons (PAH Mix).
- #2 Fuel Oil.
- #6 Fuel Oil.
- Motor Oil Range Organics.
- Polychlorinated Biphenyls (PCBs).

After calibrating the instrument and performing the sample extraction step, the UVF-3100's actual analysis time is less than 5 seconds.

2. Execution

- On receipt of the instrument, inspect all shipping cartons to ensure that all components have been received and verify that the unit is operational.
- On site, assemble the unit according to the manufacturer's instructions. Install the UVF-3100 software onto the field notebook computer.

- The UVF-3100 is equipped with an internal battery. However, the AC adapter may be needed for extended operation. Be prepared to switch to AC power if necessary.
- Operate the UVF-3100 for 20 minutes prior to use to ensure that the instrument is operating at full performance.
- Select the applicable standards based on the target hydrocarbon range (i.e., BTEX, PAHs, etc.).
- Calibrate the UVF-3100 in accordance with the instructions provided with the appropriate calibration kit. PROPER CALIBRATION OF THE INSTRUMENT IS CRITICAL.
- For optimal use of the UVF-3100, approximately 20 samples (maximum of 20 samples) should be screened during each run.
- Extract samples using the SiteLAB™ UVF Analytical Test Kit (Product Number EXTR010-20).
- Sample extracts can be stored for up to three months if kept refrigerated.
- Field personnel should be familiar with both the sample extraction and the calibration procedure before attempting to record data.
- Operate instrument as per manufacturer's instructions.
    1. Select the appropriate optical filter for the specific test to be run.
    2. Select the proper wavelength for the specific test to be run.
    3. Perform the 5-point calibration using the appropriate standards.
    4. Perform the sample extraction procedure.
    5. Make any necessary dilutions.
    6. Analyze the samples and record the results on the record sheet included with the extraction kit. Include test run number, Sample ID, Fluorescence, Sample Concentration, and Dilution Factor on the sheet.
    7. Calculate result by multiplying the sample result by the dilution factor.
    8. Repeat for each sample. Make addition dilutions if necessary.
- **Sample dilution** – Samples exhibiting a yellowish color should be diluted until a minimal yellow tint is observed. Analyze both the diluted sample and the undiluted sample for comparison. Follow dilution procedure outlined in the manual. Addition methanol may be necessary for further dilution.
- **Field duplicate** – a duplicate sample should be collected from a sample location suspected of being contaminated with the target hydrocarbon and extracted in a manner identical to the original sample.

Field duplicates should be taken at a frequency of one per twenty samples or one per weekly sampling whichever is the greater.

3. References

Interim Remediation Waste Management Policy for Petroleum Contaminated Soils. (April 1994), Massachusetts Department of Environmental Protection, Policy #WSC-94-400.

Innovative Technology Verification Report, Field Measurement Technologies for Total Petroleum Hydrocarbons in Soil United States Office of Research and EPA/600/R-01/080.

Environmental Protection Development September 2001, Agency Washington, DC 20460
siteLAB® Corporation, siteLAB® Analytical Test Kit UVF-3100A.

Section 6

SOLID MATRIX SAMPLING (SM)

STANDARD OPERATING PROCEDURE

SM-001 Soil Sampling Techniques Including Split-Spoon

1. Objective

This Standard Operating Procedure (SOP) is used primarily to collect surface, shallow subsurface, and stockpile soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface (bgs). The shallow subsurface interval may be considered to extend from approximately 12 inches bgs to a site-specific depth at which sample collection using manual methods becomes impractical.

2. Execution

2.1. At-Depth Sampling

When sampling at depth, utilize the procedures outlined in the following SOPs for the drilling method used:

Hollow Stem Auger (split spoon): SOP DM-002
Sonic Drilling: SOP DM-003
Geoprobe or Direct Push (macrocore): SOP DM-005

2.2. Surface Soil Sampling

Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material is removed to the required depth and a stainless steel or plastic scoop is then used to collect the sample. This method can be used in most soil types but is limited to sampling at or near the ground surface. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A flat, pointed mason trowel to cut a block of the desired soil is helpful when undisturbed profiles are required.

- Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.
- Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.
- If volatile organic analysis is to be performed, transfer the sample directly into an appropriate labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly.
- Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval.

- Either place the sample into appropriate labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly.
- When compositing is complete, place the sample into appropriate labeled containers and secure the caps tightly.
- Label, preserve, and store the sample in accordance with SOP SC-002 *Sample Handling*.

2.3. Stockpile Sampling

- Collection of samples from stockpiles can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material from the stockpile is removed and a stainless steel or plastic scoop is then used to collect the sample.
- Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.
- If volatile organic analysis is to be performed, transfer the sample directly into an appropriate labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly.
- Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling stockpile.
- When collecting composite samples, place a sample from another sampling location into the homogenization container and mix thoroughly.
- When compositing is complete, place the sample into appropriate labeled containers and secure the caps tightly.
- Label, preserve, and store the sample in accordance with SOP SC-002 *Sample Handling*.

3. References

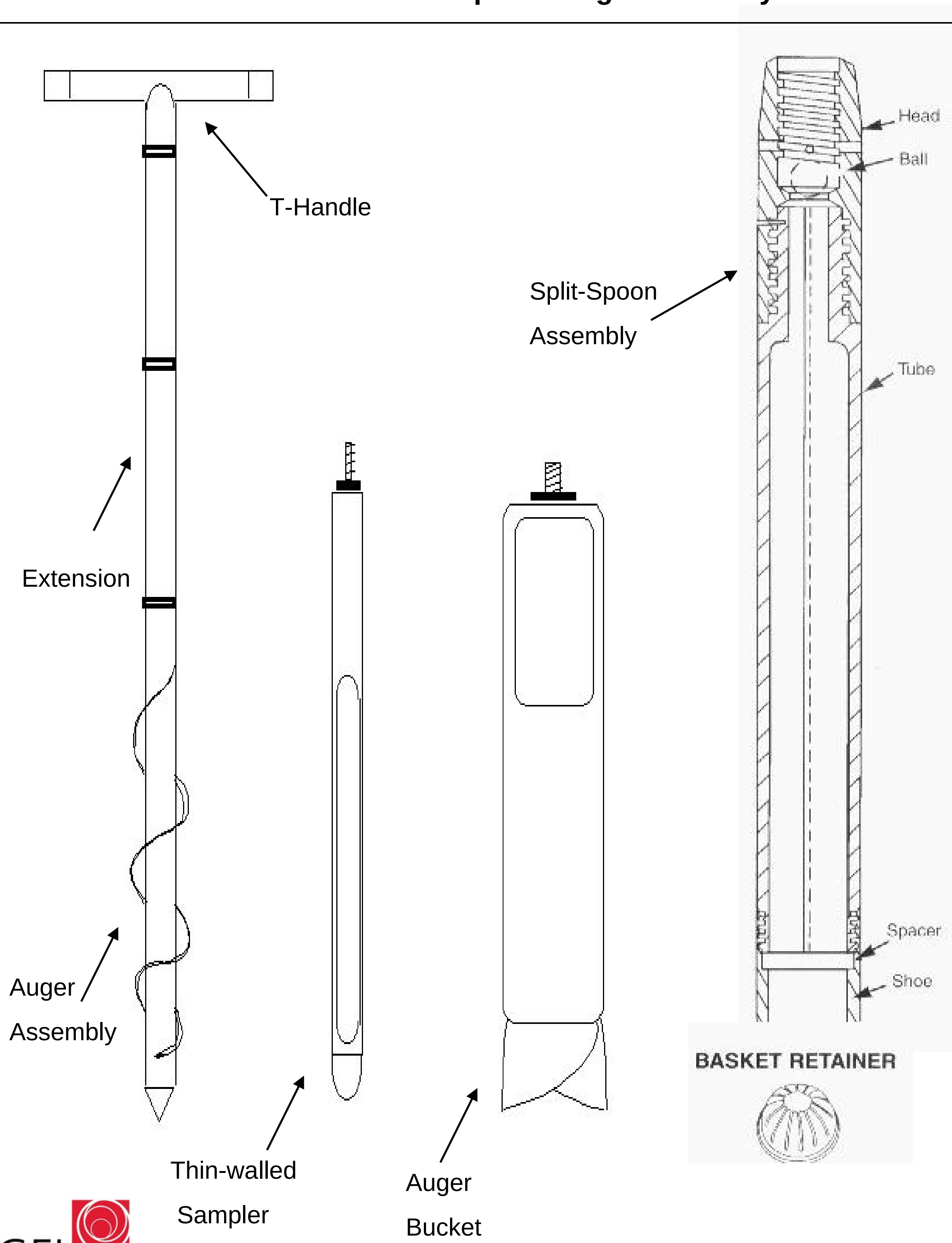
ASTM D1585-98, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils . 1998.

United States Environmental Protection Agency, SOP 2012 "Soil Sampling", Revision 0.0, February 18, 2000.

Attachment A

SM-001

Attachment A – Sampler Design Assembly



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STANDARD OPERATING PROCEDURE

SM-002 VOC Soil Collection and Preservation Method (if necessary)

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1. Objective

To establish a standard for preserving soil samples for analysis of Volatile Organic Compounds (VOCs).

2. Execution

The soil sample collection procedure for determination of VOCs is a two-step process.

- Step 1 – Collect an undisturbed soil sample from the subsurface, or expose the targeted area from where a sub-sample for lab analysis will be collected.
- Step 2 – Collect a representative sub-sample from the undisturbed sample or directly from the exposed surface.

If samples are to be analyzed for VOCs, they should be collected in a manner that minimizes disturbance of the sample. Samples for VOC analysis are not homogenized. Preservatives may be required for some samples with certain variations of Method 5035. Consult the method or the principal analytical chemist to determine if preservatives are necessary.

When the soil sample is collected for VOC analysis, it must be placed within the laboratory container immediately. It must not be allowed to sit exposed for more than 5 minutes. In addition, the sample must not be exposed to extreme weather conditions (i.e., rain, extreme sunlight, wind, etc.).

Sub-samples are a portion of the undisturbed sample that will be sent to the lab for VOC analysis. Sub-samples must be obtained utilizing a small diameter core sampler. Some of the acceptable small diameter core samplers include: a 10 milliliter (ml) plastic disposable syringe, a Purge and Trap Soil Sampler, En Core Samplers, or an Easy Draw Syringe. The En Core Sampler is the only small diameter core sampler that can be used to collect the sample, store the sample, and transport the sample to the lab.

The procedure for the collection of sub-samples is as follows:

- Once the sampling interval has been selected, trim off the exposed surface of the matrix, with a decontaminated trowel or spatula, to expose a fresh surface. Then sample immediately.
- Push the En Core sampler into the matrix to collect a volume of material that will yield the required mass of sample (wet weight) as determined by the analytical method.

- Push the En Core sampler into the material at an angle as many times as is needed to obtain the required sample weight.
- Wipe the exterior of the sampler clean.
- Seal the En Core sampler as explained in the manufacturer's instructions.
- Collect the required number of En Core samplers based on the chosen preservation and analytical methods, as discussed in the section on soil preservation methods below.
- Collect a separate sample for head space screening and moisture content determination.
- Make sure that the threads of the En Core sampler are free of particles (by cleaning with a paper towel).
- Mark the samplers with a permanent marker and not an adhesive label (due to weight considerations).
- Once the samples have been collected, sealed, and labeled, place the samples into an iced cooler. It is recommended to place each sample container in separate zip lock bag.

If collecting VOC soil samples during drilling, please refer to SM-001: *Soil Sampling Techniques Including Split-Spoon* for detailed information.

2.1. Preservation of Soil Samples

When collecting soil samples for determination of VOCs, three types of samples may be required:

- High concentration sample (Section 2.2 below).
- Low concentration sample (Section 2.3 below).
- Synthetic Precipitation Leaching Procedure/Toxicity Characteristic Leaching Procedure (SPLP/TCLP) sample (Section 2.4 below).

2.2. Two options for the collection of a suspected "high" concentration sample

- Collect one 10 gram sample in a pre-weighted vial containing 10 ml methanol.
- Use an "En Core" sampler.

2.2.1. Option 1 – Methanol Preservation Method

Supplies include: two pre-weighed vials (per sample) with 10 ml methanol, and a sampling device to collect a 10 gram sample.

Sampling Procedure:

- Label vials using permanent marker.
- Scrape away surface to be sampled to expose fresh soil.

- Collect the sample using the sampling device and extrude the sample into the preserved vial. Wipe the threads and cap clean and seal the vial.
- Store the sample in an iced cooler.
- Collect a separate sample for percent solids and head space sampling.

2.2.2. Option 2 – En Core Sampling Method

Supplies needed: One 5 or 10 ml En Core sampler.

Sampling Procedure:

- Label the En Core sampling container.
- Locate the sampling area, scrape a fresh face, collect the sample quickly, and clean and seal the sampler.
- Place sampler in a clean zip lock bag and place on ice.
- Collect separate samples in separate containers for percent solids and head space sampling.
- Samples must be frozen, or preserved, or analyzed within 48 hours (coordinated with the lab).

Option 2 (En Core Sampler) is preferred due to possible problems with minimum detection levels when using the methanol method.

2.3. Four different options for the collection of “low” concentration samples for VOC analysis

- Collect two vials each of 5 grams of sample into a pre-weighted 40 ml vial with 5 ml of water and a magnetic stirrer.
- Collect two vials each of 5 grams of sample into a pre-weighted 40 ml vial with a magnetic stirrer.
- Collect two 5 gram En-Core type samples.
- Collect two vials each of 5 grams of sample into a pre-weighted vial containing sodium bisulfate with a magnetic stirrer.

2.3.1. Option 1 – Collection in Volatile Organic Compound (VOC) vials containing water

Supplies required: an electronic field balance, two VOC 40 ml vials pre-weighted and containing 5 ml of water, a magnetic stirrer, and a sampling device.

Sampling procedure:

- Label vials using permanent marker.
- Select the area to be sampled.
- Test sample and weigh to verify the amount of sample needed.
- Scrape a clean surface to be sampled.

- Collect the sample using the sampling device and extrude the sample into one of the two vials containing water. Wipe the threads and cap clean and seal the vial.
- Repeat the last step for the second vial.
- Weigh the vials and record the weights.
- Store the sample in an iced cooler.
- Collect a separate sample for percent solids and head space sampling.

2.3.2. Option 2 – Collection in empty VOC vials

Supplies required: electronic field balance, two VOC 40 ml vials pre-weighted, a magnetic stirrer, and a sampling device.

Sampling Procedure:

- Label vials using permanent marker.
- Select the area to be sampled.
- Test sample and weigh to verify the amount of sample needed.
- Scrape a clean surface to be sampled.
- Collect the sample using the sampling device and extrude the sample into the vial. Wipe the threads and cap clean and seal the vial.
- Repeat the last step for the second vial.
- Weigh the vials and record the weights.
- Store the sample in an iced cooler.
- Collect a separate sample for percent solids and head space sampling.
- Samples must be frozen or analyzed within 48 hours.

2.3.3. Option 3 – Collection in VOC vials preserved with Sodium Bisulfate

Supplies required: electronic field balance, two VOC vials with 5 ml of sodium bisulfate, a magnetic stir bar, and a sampling device.

Sampling Procedure:

- Label vials using permanent marker.
- Select the area to be sampled.
- Test sample and weigh to verify the amount of sample needed.
- Scrape a clean surface to be sampled.
- Collect the sample using the sampling device and extrude a 5 gram sample into the vial containing the sodium bisulfate. Wipe treads and cap and seal the vial.
- Repeat the last two steps for the second vial.
- Weigh the vial and record the weight.
- Store the sample in an iced cooler.
- Collect a separate sample for percent solids and head space sampling.

2.3.4. Option 4 – Collection of the sample with an En Core Sampler

Supplies required: two 5 gram En Core samplers.

Sampling Procedure:

- Label samplers using permanent marker.
- Select the area to be sampled.
- Scrape a clean surface to be sampled.
- Collect the sample using one En Core devise, wipe the contact areas clean and seal, and place into a re-sealable zip lock bag.
- Repeat the last two steps with the second En Core device.
- Store the sample in an iced cooler.
- Collect a separate sample for percent solids and head space sampling.
- Samples must be frozen or analyzed within 48 hours.

2.4. Collection of samples being analyzed for VOCs by the TCLP or SPLP method

Supplies required: a 25 gram En Core Sampler.

Sampling Procedure

- Label sampler using permanent marker.
- Select the area to be sampled.
- Scrape a fresh surface to be sampled.
- Collect the sample using one En Core devise, wipe the contact areas clean and seal, and place into a re-sealable zip lock bag.
- Store the sample in an iced cooler.
- Samples must be frozen or analyzed within 48 hours.

To determine percent solids, approximately 20 grams of soil sample must be collected in a separate glass or plastic sampling container. The percent solids sample is **NOT** to be taken from the VOC samples.

3. Holding Times

- Field investigators should note that the holding time for an un-preserved VOC soil/sediment sample is 48 hours. Arrangements should be made to ship the soil/sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and/or analyze the sample within 48 hours of collection.

STANDARD OPERATING PROCEDURE

SM-003 Soil Classification

1. Objective

To describe and classify soil samples collected in the field in a consistent and useful manner. GEI has adopted the (ASTM) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) D2488..

2. Execution

- Describe soil samples according to the ASTM Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) D2488 (see Attachment A – Visual Manual Descriptions).
- Identify and record the soil in terms of the major and minor constituents (i.e., sand gravel, silt, clay), group symbol, group name, sample structure, plasticity and dilatancy for fine-grained soils, color, local or geologic name if known (e.g., glacial till), odor, presence of iron or other staining, and presence of organic matter, shells, debris, or other unusual characteristics of the same.
- If a soil split-spoon sample contains more than one soil type (for example, the upper portion is silty sand and the lower portion is clay) describe each type separately, and obtain separate jars of each type.
- Record sampler type, blow counts, soil description, etc., on the boring log.
- One modification to the ASTM standard: Use widely graded and narrowly graded instead of well-graded and poorly graded.
- Based on the percent volume, the following descriptions should be used:
  1. "and" = 35-50%
  2. "some" = 20-35%
  3. "little" = 10-20%
  4. "trace" = 1-10%

3. Notes

- Some soil characteristics, such as plasticity and dilatancy, are difficult to identify in the field during extremely cold or wet weather. The field classification should be verified in the office after the samples have returned to room temperature if samples were collected during extreme weather conditions.

- The ASTM Standard Test Method for Classification Soils for Engineering Purposes, D2487 may be used in conjunction with the Visual-Manual Method to confirm the soil classification.

4. References

Annual Book of ASTM Standards (1993), Section 4, v. 4.08 Soil and Rock; Building Stones; Geosynthetics, D2488-90, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), American Society of Testing Materials (ASTM).

5. Attachments

Attachment A – Visual Manual Descriptions with example boring log

Attachment A

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COARSE-GRAINED SOILS

VISUAL-MANUAL DESCRIPTIONS

YELLOW
OLIVE
LIGHT BROWN
BROWN
REDDISH BROWN
RED
GRAY
BLACK

SOILS WITH <50% FINES

GRAVEL
% Gravel > % Sand

		GROUP SYMBOL	GROUP NAME
5% Fines	WIDELY GRADED	GW	<15% Sand ---- WIDELY GRADED GRAVEL; 15% Sand ---- WIDELY GRADED GRAVEL WITH SAND
5% Fines	NARROWLY GRADED	GP	<15% Sand ---- NARROWLY GRADED GRAVEL; 15% Sand ---- NARROWLY GRADED GRAVEL WITH SAND
~10% Fines	WIDELY GRADED Fines = ML or MH	GW-GM	<15% Sand ---- WIDELY GRADED GRAVEL WITH SILT; 15% Sand ---- WIDELY GRADED GRAVEL WITH SILT AND SAND
~10% Fines	Fines = CL or CH	GW-GC	<15% Sand ---- WIDELY GRADED GRAVEL WITH CLAY; 15% Sand ---- WIDELY GRADED GRAVEL WITH CLAY AND SAND
~10% Fines	NARROWLY GRADED Fines = ML or MH	GP-GM	<15% Sand ---- NARROWLY GRADED GRAVEL WITH SILT; 15% Sand ---- NARROWLY GRADED GRAVEL WITH SILT AND SAND
~10% Fines	Fines = CL or CH	GP-GC	<15% Sand ---- NARROWLY GRADED GRAVEL WITH CLAY; 15% Sand ---- NARROWLY GRADED GRAVEL WITH CLAY AND SAND
>15% Fines	Fines = ML or MH	GM	<15% Sand ---- SILTY GRAVEL; 15% Sand ---- SILTY GRAVEL WITH SAND
>15% Fines	Fines = CL or CH	GC	<15% Sand --- CLAYEY GRAVEL; 15% Sand ---- CLAYEY GRAVEL WITH SAND

SAND
% Sand ≥ % Gravel

		GROUP SYMBOL	GROUP NAME
<5% Fines	WIDELY GRADED	SW	<15% Gravel--- WIDELY GRADED SAND; 15% Gravel--- WIDELY GRADED SAND WITH GRAVEL
<5% Fines	NARROWLY GRADED	SP	<15% Gravel--- NARROWLY GRADED SAND; 15% Gravel---- NARROWLY GRADED SAND WITH GRAVEL
~10% Fines	WIDELY GRADED Fines = ML or MH	SW-SM	<15% Gravel---- WIDELY GRADED SAND WITH SILT; 15% Gravel--- WIDELY GRADED SAND WITH SILT AND GRAVEL
~10% Fines	Fines = CL or CH	SW-SC	<15% Gravel--- WIDELY GRADED SAND WITH CLAY; 15% Gravel---- WIDELY GRADED SAND WITH CLAY AND GRAVEL
~10% Fines	NARROWLY GRADED Fines = ML or MH	SP-SM	<15% Gravel---- NARROWLY GRADED SAND WITH SILT; 15% Gravel--- NARROWLY GRADED SAND WITH SILT AND GRAVEL
~10% Fines	Fines = CL or CH	SP-SC	<15% Gravel---- NARROWLY GRADED SAND WITH CLAY; 15% Gravel--- NARROWLY GRADED SAND WITH CLAY AND GRAVEL
15% Fines	Fines = ML or MH	SM	<15% Gravel---- SILTY SAND; 15% Gravel---- SILTY SAND WITH GRAVEL
15% Fines	Fines = CL or CH	SC	<15% Gravel---- CLAYEY SAND; 15% Gravel--- CLAYEY SAND WITH GRAVEL

U.S. STANDARD SIEVE OPENING IN INCHES: 12, 3, ¾

U.S. STANDARD SIEVE NUMBERS: 4, 10, 40, 200

HYDROMETER

COBBLES — GRAVEL (COARSE, FINE) — SAND (COARSE, MEDIUM, FINE) — SILT OR CLAY

500, 100, 50, 10, 5, 1, 0.5, 0.1, 0.05, 0.01, 0.005, 0.001

GRAIN SIZE MILIMETERS

ROUNDED — SUBROUNDED — SUBANGULAR — ANGULAR

1. GROUP NAME and (SYMBOL)
2. Structure, if any. (stratified layer thicknesses, lenses, varves, gradational changes)
3. Describe sand, gravel and fines components, with percentages, in order of predominance. Include max gravel size. For test pits give percent cobbles and boulders, by volume, and include max size.
4. Color
5. Sheen, odor, roots, ash, brick, cementation, reaction with HCL, etc.
6. "Fill," local name or geologic name, if known

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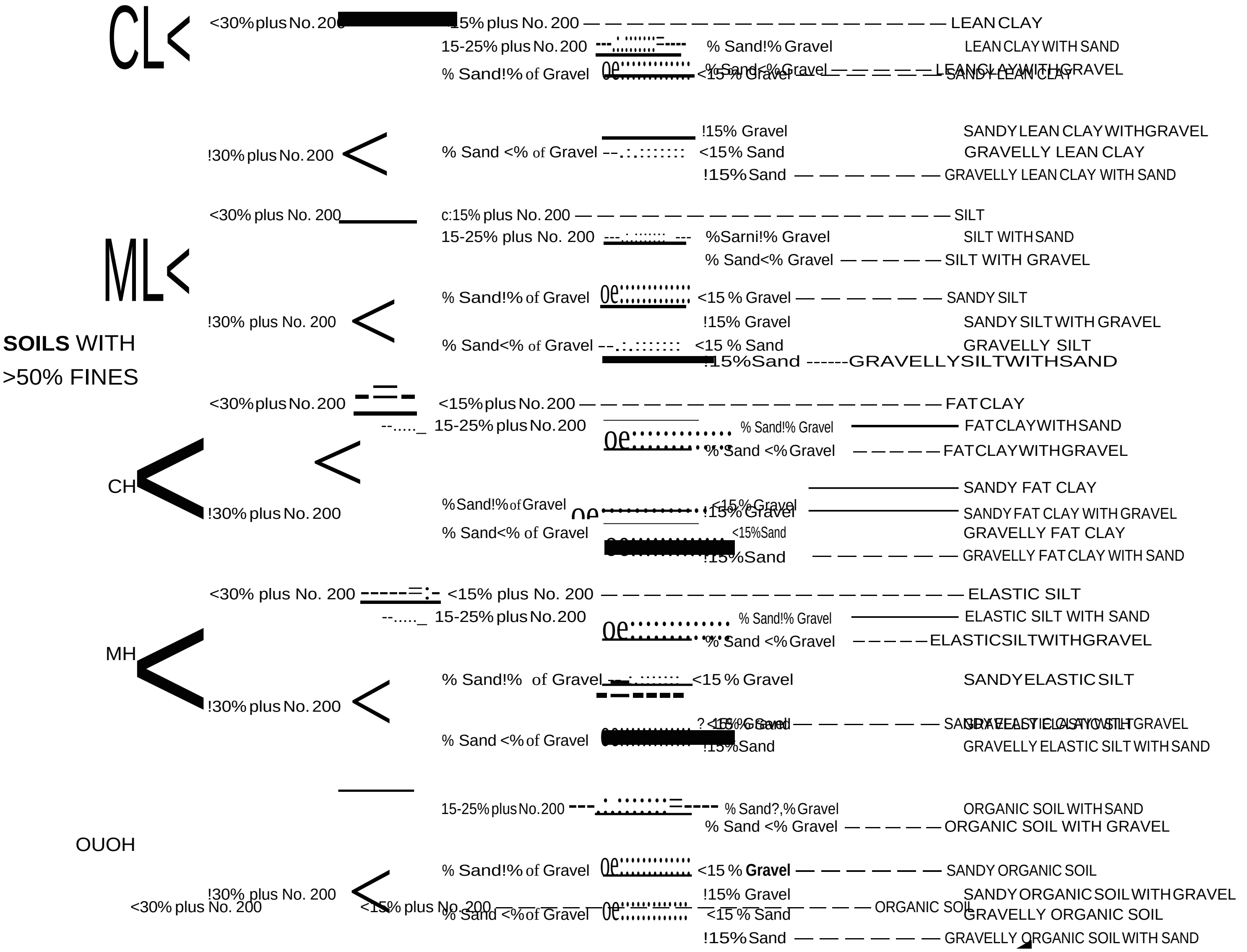
FINE-GRAINED SOILS
VISUAL-MANUAL DESCRIPTIONS



ID OF **INORGANIC** FINE SOILS **FROM MANUAL** TESTS

Symbol	Name	Dry Strength	Dilatancy	Toughness*
ML	Silt	None to low	Slow to rapid	Low or thread cannot be formed
CL	Lean Clay	Medium to high	None to slow	Medium
MH	Elastic Silt	Low to medium	None to slow	Low to medium
CH	Fat Clay	High to very high	None	High

CRITERIA FOR DESCRIBING PLASTICITY

Description	Criteria
Nonplastic **ML**	**A** 1/8-in. (3-mm) thread cannot be rolled at any water content
Low Plasticity ML, MH	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit *
Medium Plasticity MH, CL	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 Plasticity CH	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

* Toughness refers to the strength of the thread near plastic limit. The lump refers to a lump of soil drier than the plastic, similar to dry strength.

1. GROUP **NAME** and **(SYMBOL)**
2. Describe fines, sand, and gravel components, in order of predominance. Include plasticity of fines. Include percentages of sand and gravel.
3. Color
4. Sheen, odor, roots, ash, brick, cementation, torvane and penetrometer results, etc.
5. "Fill," local name or geologic name, if known

PEAT

Peat refers to a sample composed primarily of vegetable matter in varying stages of decomposition. The description should begin: PEAT (PT) and need not include percentages of sand, gravel or fines.

BORING LOCATION	Maple Ave Sidewalk	DATE START/FINISH	2/14/07 - 2/15/07	e,101
GROUND ELEVATION (NGVD)		DRIll.ED BY	Geologic: M. Costigan	
GROUNDWATER EL	DATE	LOGGED BY	T.Kahl/M. Yako TOTAL DEPTH (FT)...l2-	PG. I OF I

EL FT.	DEPTH FT.	SAMPLE TYPE and NO.	BLOWS PER 6 IN.	PEN IN.	REC IN.	PIO JAR HS / REMARKS	i:c, 9	SOIL AND ROCK DESCRIPTIONS
								r-... 4" pavement ./
		SI	13-9 17-14	24	0	0.5 ppm		SI: Redrove O.5 to 3 .5 ft. Recovery 11": WIDELY GRADED SAND (SW) ,._e,5'X, sand, "'I 0% gravel to I",<5'1nonplastiG fines, brown. Contains brick. fragment!> and ash. RII.
	2.5					hard drilling 3 to 4 ft, pos!iible boulder	0	
	5	52	7-7 11-13	24	e,	2.0 ppm	...J ...J LL	52: NAl<l<OWLY Gl<ADED SAND WITH SILT AND Gl<AVEL (SP-SM) "'65% mostly fine sand, -25% gravel to 3/ 4 inch "'I 0% non-plastic. fines, brown. RII.
	7.5	53	9-10 2-1	24	16	0.0 ppm		[\ 53 (0-10"): Similar to 52. /
	10						\S") u 2 <(Ql 0	53 (I0"-16"Y': ORGANIC SILi (OL) "'IOO'X. 56ghtly plastic fine!>, dark gray, organic odor, contain& white shell fraqment&.
	12.5	54	WOH 1-2 I	24	15	0.0 ppm		54: Similar to 53, bot 6"
	15					hard drilling at 15.5 ft		
	17.5	55	20-35 /3"	15	e,	Top of rock "'19 ft.	...J ...J \-	55: SILiY SAND WITH GRAVEL (SM) "'60% mostly fine 5and, "'25 56ghtly plastic fines, "'15 gravel to 1/2 inc.h, **o&ve.** Glacial 1ill.
	20					Roller bit to 20 ft.		Cl: SCHIST, hard, &light weathering at joint surface&, joint!> at "'.30 **degree!>** from horizontal and generally parallel to foliation, gray. Marlboroogh Formation.
	22.5	Cl	RQD 70%	60	54	lo&t -10 gallons drill fluid from 23 to 25 ft	...J u 0 Oil	
	25							Bottom of Boring 25 ft
	27.5							Truck-moonted drill *riq.* 4-inch Ga5inq to 19 ft. Safety-hammer with rope and cathead for SPi. Backfilled with drill GUttinqs.
	30							

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
PEN-PENETRATION LENGTH OF SAMPLER OR CORE BARREL
REC-RECOVERY LENGTH OF SAMPLE
ROD-LENGTH OF SOUND CORES > 4 IN./ LENGTH CORED, "
S-SPL SPOON SAMPLE
U-UNDISTURBED SAMPLES, UF-FIXED PISTON UC-OSTERBERG
¥ GROUNDWATER

NOTES:
I: Groundwater at IO ft depth at &tart of day 2/15/07.

PROJECT 07999-0
OATE

GEi

EXAMPLE SOIL DESCRIPTIONS

SANDY SILT (ML) "'60% !>liqhtly pla5tic fines, ,..,,40% mo5tly fine !:>and, I" thic layer of fine to medium !:>and with <20% fines, *qray*.

LEAN CLAY (CL) ,..,,*qo'l,* moderately plastic fines, ,..,,I**0%** fine !:>and, offve. Boston Blue Clay. Sv • 0.5, 0.5, 0.B tsf, Op • I.0, 1.5, 1.6 tsf

Stratified CLAYEY SAND (5C) and WIDE:L*Y* GRADED SAND (5W) 5C layers I to 2 inche& thic consi&t of fine 5and with ,..,,30'1, moderately pla&tic. fine5, *qray*. 5W layers I to 4 inches thick c.onsist of fine to c.oarse 5and, ,..,,10% gravel to 1/2 inch, <5% tine!>, brown. Hydrauric. Fill.

EXAMPLE ROCK DESCRIPTIONS

(0-9"): GRANITE, hard, one **piec.e,** joint surfac.e slightly weathered, pink..
(6-60"): PHYLLITE, jointe, ,..,, 45" generally parallel to foliation, *Cf'* to 44" moderate to **severe** jointinq and joint weatherinq. 44" to 60" single piec.e, green--qray.

ARGILLITE, medium hard, moderately weathered joints, gray. Cambridge Arqillite.

GEOPROBE AND ROTOSONIC

When SPTs are not perfonned, note sample density (sands) or stiffness {clays) in description.

CRITERIA FOR DESCRIBING DILATANCY OF FINE-GRAINED SOILS

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.

SPT: Standard Penetration Test

30-inch drop with 140-lb hammer
1 3/4 to 2 1/4 turns around cathead
2-inch 0.D. split spoon sampler

ENV'L TERMINOLOGY FOR SOIL DESCRIPTIONS

- **Ash** - Typically silt-size to medium sand-size.
- Do not use the term "cinders.• This is not a technical term. Instead, use·ash,·"burnt **wood,"** "burnt material," or a similar term.
- **Coal-like material** - If it looks like coal but you aren't sure.
- **Clinker-** Vitrified (glass-like) or heat-fused material. Often burned impurities in coal. Often looks like pumice, but heavier.
- **Slag** - Similar to clinker, but normally refers to residue from metal ore processing.

- **Sheen** - Iridescent petroleum-like sheen. Not to be used for a "bacterial sheen," which can be distinguished by its tendency to break up on the water surface at angles. Petroleum sheen will be continuous and will not break up.
- **Stained** - Use with a color (•brown-stained•) to indicate that the soil is stained a color other than its natural (unimpacted) color.
- **Coated** - Soil grains are coated with NAPL (oil, tar, etc.). There is not enough NAPL to saturate the pore spaces. ("Split spoon sampler coated with brown oil." "Soil grains coated with gray substance with slight gasoline-like odor:)
- **Saturated** - The entire sample pore space is saturated with NAPL. If you use this term, be sure it is not water saturating the pore spaces. Depending onviscosity, the NAPL may drain from a soil sample. (wSample saturated with green, sticky substance.")
- **Blebs** - Discrete sphericals of NAPL in a soil matrix that was not visibly coated or saturated. c·occasional blebs of reddish-brown tar.")
- **Oil** - Exhibits a petroleum odor, different from MGP odors.
- **Tar-** Exhibits an MGP odor (e.g. naphthalene-like odor).

- **Odors** - Use terms such as "naphthalene-like odor" or "petroleum-like odor: Use modifiers (strong, moderate, slight) to indicate odor intensity.

Section 7

GROUNDWATER (GW)

STANDARD OPERATING PROCEDURE

GW-001 Water Level Measurement

1. Objective

The purpose of this Standard Operating Procedure (SOP) is to set guidelines for the determination of the depth to water in an open borehole, cased borehole, monitoring well, or piezometer.

2. Execution

- Prior to mobilizing onto a site, notification requirements must be followed.
- Prior to collecting water level measurements, all wells should be opened to the atmosphere and allowed to equilibrate prior to collecting groundwater elevation measurements, if practical.
- All groundwater level measurements need to be performed in the shortest possible timeframe (no more than four hours, if practical).
- Groundwater levels are measured using a decontaminated electronic groundwater level indicator, which has a cable divided into incremental measurements of 0.01 feet and two conductors forming a probe. When groundwater is encountered, the circuit is completed and a light, meter, or audible buzzer is activated. The depth to groundwater is then measured from this point to the reference mark on the inner casing of the monitor well.
- All groundwater-level measurements should be made from the same marked reference point at the top of the inner well casing. A licensed surveyor must mark the reference point.
- If no discernable survey mark is observed on the inner casing, the groundwater-level measurement should be read from the highest point of the inner casing.
- If no survey mark is observed on the inner casing, it should be noted with the ground water-level data and the highest point of the casing must be marked for future reference.
- Measurements should be made three to four times to confirm the measurement. Each time a measurement is made, it should be determined to the nearest one-hundredth of a foot (0.01).
- Certain situations may necessitate that all water level measurements at a given site should be collected within a shorter than 24-hour period. These situations may include:
    1. The magnitude of the observed changes between wells appears too large.
    2. Changes in atmospheric pressure.
    3. Aquifers which are tidally influenced.

4. Aquifers affected by river stage, impoundments, and/or unlined ditches.
5. Aquifers stressed by intermittent pumping of production wells.
6. Aquifers being actively recharged due to precipitation events.
7. Occurrence of pumping.

- All well measurements should, if practical, be performed the same day, prior to the evacuation of any wells which may influence groundwater elevations in the area of the investigation.
- The following items should be recorded on field data sheets while collecting groundwater level measurements:
  1. Project name.
  2. Well identification.
  3. Date and time of measurements.
  4. If applicable, the time and cycle of the tide.
  5. Thickness of non-aqueous phase liquids (NAPL) product, if any. (See SOP GW-002, *NAPL Measurement*.)
  6. Note any miscellaneous information, such as recent damage, well box in need of repair, car parked over well, etc.

3. Notes

- Do not measure the total-well-depth with an electronic groundwater level indicator.
- Groundwater levels should be obtained from all wells in a network prior to sampling the first well.
- Local water body elevations may need to be measured. Check site-specific work plan for this requirement.
- Weak batteries in electronic groundwater-level indicators frequently produce weak or gradual auditory and/or visual responses, making it difficult to accurately determine when the probe of the unit has come in contact with ground water. As such, it is recommended that electronic groundwater-level indicators be tested before they are brought out into the field.
- Note that electronic groundwater-level indicators will not respond to distilled water, so distilled water should not be used to test these units.
- Wells that are not plumb may result in probe contact with the side of the well casing providing a false measurement. Once the probe has come in contact with groundwater in the well, water may be trapped by capillary action between the probe and the well casing. If this happens, the unit may continue to signal even after the probe has been raised above the ground water surface.

The deeper the well, the more likely this problem may occur. To correct this, the cable should be raised several feet above the water and shaken to remove water from the probe. A new groundwater-level measurement should then be collected. If the signals from the unit are not abrupt or reproducible, the probe may need to be reeled up to the surface and dried off before re-attempting another measurement.

- Accumulation of sediment, organic material, or floating debris on the probe may also result in gradual or non-reproducible readings. Wells that are constructed with metal inner casings may lead to difficulties in collecting reproducible groundwater-level measurements because the inner sides of the well casing are conductive.
- In some cases, a rubber grommet or metal centralizer may need to be placed on the probe so that the probe is not allowed to come in contact with the inner casing. Groundwater-level-measuring equipment should be properly decontaminated between wells and piezometers to avoid cross contamination.
- Once a well has been located and properly identified, the field measurements listed below should be noted in a field logbook. Be certain that the proper well is being measured. The misidentification of a sampling point in the field will result in erroneous data that may result in incorrectly constructed contour maps.

4. References

U. S. EPA Environmental Response Team Standard Operating Procedures SOP: 2043,"Water Level Measurement" REV: 0.0, 10/03/94.

U. S. EPA Environmental Response Team Standard Operating Procedures SOP: 2044," Monitor Well Development" REV: 0.1, 10/23/01.

5. Attachments

Attachment A – Monitoring Well Sampling Record

Attachment A

Monitoring Well Sample Data Form

Project: ______________________ **Well ID:** ______________________ **Date:** ______________________

Total Well Depth (from top of casing): ______________________

Depth to Water (from top of casing): ______________________

Well Diameter: ______________________

Pump Intake Depth: ______________________

Sampling Crew: ______________________

Purge Time: *Start:* ______________________ *Finish:* ______________________

Purging Method: ______________________

Sampling Method: Low Flow

Sample Time: *Start:* ______________________ *Finish:* ______________________

Sample Analysis: ______________________

Purge Data										
Sample Time	**Flow Rate** *(lpm/gpm)*	**Volume Purged** *(liters/gals.)*	**pH** *(std. Units)*	**Conductivity** *(mS/cm)*	**Turbidity** *(NTU)*	**Dissolved Oxygen** *(mg/l)*	**Temperature** *(Cel.)*	**Salinity** *(%)*	**ORP** *(mV)*	**Comments/Observations**
										Well Headspace PID =

Final Stabilization Data										
Sample Time	**Flow Rate** *(lpm/gpm)*	**Volume Purged** *(liters/gals.)*	**pH** *(std. Units)*	**Conductivity** *(mS/cm)*	**Turbidity** *(NTU)*	**Dissolved Oxygen** *(mg/l)*	**Temperature** *(Cel.)*	**Salinity** *(%)*	**ORP** *(mV)*	**Comments/Observations**

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STANDARD OPERATING PROCEDURE

GW-002 Non-Aqueous Phase Liquid (NAPL) Measurement

1. Objective

To obtain accurate and repeatable measurement of the thickness of Non-Aqueous Phase Liquids (NAPL) contained in monitoring wells. These methods can be applied to light non-aqueous phase liquids (LNAPL) and dense non-aqueous phase liquids (DNAPL).

2. Execution

Three procedures for measuring NAPL are provided below using a clear bailer, Interface Probe, and graduated tape.

2.1. Clear Bailer (LNAPL Measurement)

- Determine depth to the surface level of the LNAPL layer utilizing an interface probe.
- Record depth.
- Lower a clear bailer into the well and slowly into the product, being careful not to submerge the bailer.
- Raise the bailer and measure product thickness.
- Once the product thickness is known, the depth to ground water may be determined (see calculation below).
- This method has inaccuracies because successful use of the bailer is dependent upon the expertise of the operator and assumes the check valve does not leak upon retrieval.

2.2. Interface Probes (LNAPL Measurement)

- Decontaminate Interface Probe prior to use.
- Check battery and replace if necessary.
- Check the unit is functioning correctly. Note: De-ionized water will not provide a correct reading.
- Measure the hydrocarbon/air interface first by going from air to the LNAPL surface to prevent dripping hydrocarbons from enhancing the thickness reading.
- Record the reading.
- Measure the hydrocarbon/water reading by lowering the Interface Probe past the LNAPL layer quickly minimizing the contact time of the probe within the hydrocarbon phase.
- DNAPL can also be measured by quickly lowering the Interface Probe past the LNAPL layer and to the bottom of the well noting any audio or visual indications of DNAPL.

- The optical sensor on interface probes may become damaged if solvents are used to clean product from the probes.
- The optical sensor may become smeared when used to measure product, rendering pinpoint accuracy to an estimate at best.
- Close attention to decontamination procedures will improve accuracy, operational life, and reduce the risk of cross contamination with other wells.

2.3. Graduated Tape (DNAPL Measurement)

- Outfit a measuring tape with a narrow cylindrical weight that is heavy enough to sink through a viscous DNAPL.
- Open the well box or unlock the protective casing
- Lower the tape slowly through the water column in the well. When the tape reaches the bottom, stop releasing tape and measure the total well depth. Any extra tape released after the bottom of well was encountered will give a false reading of the DNAPL thickness. Repeat this procedure, if necessary.
- While extracting the tape, use absorbent rags and/ or GOJO Wipes to clean the tape. When the DNAPL line of demarcation is encountered on the measuring tape, record the thickness of DNAPL in the well.
- Clean the DNAPL from the tape over the well so excess DNAPL flows back into the well. This can lessen or eliminate the need to clean DNAPL from in or around the well box.
- Clean up any DNAPL in or around the well box.
- Repeat these steps as necessary to clean the tape and clean up the area around the well box.
- Decontaminate tape in accordance with SOP QA-001.
- Dispose of waste in accordance with SOP SC-003.
- Secure the well box or close and lock the protective casing.

3. Notes

- When measuring DNAPL, care must be taken when encountering the well bottom so a false measurement is not recorded.
- When a LNAPL thickness is measured in a monitoring well, it will usually exhibit an apparent thickness rather than an actual thickness. This apparent thickness is caused when LNAPL from within and above the capillary fringe migrates into the monitoring well causing the ground water-level to become depressed below the surrounding capillary fringe area. As a result, LNAPL will continue to flow into the well until equilibrium is reached causing

an apparent LNAPL thickness, which is greater than the actual thickness**.**

- LNAPL thickness can be affected by fluctuations in the water table. In some cases, an LNAPL's thickness may decrease when the water table rises, while its thickness increases as the water table drops. In other cases, fluctuating water tables may cause sudden appearances and disappearances of LNAPL layers.
- Monitoring points with LNAPLs can pose a problem when measuring the level of ground water. Floating LNAPLs can depress the ground water-level in a monitoring well or piezometer and distort the measurement. Therefore, the Corrected Depth (CD) formula shown below should be applied to ground water-level measurements in monitoring points where LNAPLs are present:

CDTW = Static DTW – (PT x G)

CDTW = Corrected Depth to Ground water
DTW = Depth to Ground Water (Static)
PT = Measured Product Thickness
G = Specific Gravity (density of free product / density of water)

4. References

U. S. EPA Environmental Response Team Standard Operating Procedures SOP: 2043,"Water Level Measurement" REV: 0.0, 10/03/94.

STANDARD OPERATING PROCEDURE

GW-003 Low Flow (Low Stress) Groundwater Sampling

1. Objective

Provide a method to collect groundwater samples that accurately and precisely represent the aquifer conditions. Low-flow purging is limited to wells that, with sustained pumping, exhibit no continuous drawdown.

2. Background for Implementation

- Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 nephelometric turbity units (NTUs), and stable drawdowns of less than 0.3 feet are recommended.
- It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions (e.g., insulation) will need to be taken to prevent the groundwater from freezing in the equipment.
- Direct sunlight and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, pipe insulation, etc.).
- The tubing exiting the monitoring well should be kept as short as possible to avoid sunlight or ambient air from heating up the groundwater. Tubing lengths greater than 6 feet should be fitted with 0.5-inch diameter pipe insulation.

3. Execution

- Complete site-access notification requirements prior to mobilization.
- Wait at least one week following well development before sampling.
- Record all activities in the field notebook (see SOP FD-001, *Field Notebook*) and on Attachment A – Monitoring Well Sample Data Form. Use a separate form for each sampling location and event.
- Calibrate the photoionization detector (PID), pH, temperature, specific conductance (SC), turbidity, dissolved oxygen (DO), and oxidation-reduction potential (ORP) meters and record data on Attachment B – Portable Equipment Calibration Log.
- Check the well, the lock, and the locking cap for damage or evidence of tampering.
- Record observations.

- Remove well cap and, if appropriate, measure VOCs at the rim of the well with a PID or flame ionization detector (FID) instrument and record the reading in field notebook or well logs.
- Being careful to not disturb the water column, slowly and gently measure the depth to water with a water level probe and/or oil water interface probe. Do not measure depth to well bottom at this time (wait until sampling has been completed). Measure water level to the nearest 0.01 foot from the top of casing or the highest point (or V notch) on the polyvinyl chloride (PVC). If the top of casing cannot be used, note the reference location. Mark the datum point with an indelible marker and note reference location in field book.
- Check newly constructed wells for the presence of light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquid (DNAPL) before the initial sampling event.
- If LNAPL is present, the tubing intake should be at the mid-point of the well screen. Initial purge water should not be sent through the field parameter meter flow cell but sent directly to the purge water container. After the initial column of purge water is poured, the field parameter meters may be placed inline and the collection of data may be started.
- If DNAPL is present, the tubing intake should be placed approximately 1 foot below the water table or to the approximate depth below the known drawdown depth (refer to previous sample logs).
  - Calculate the well volume (V_w [gallons]) using the measured depth to water ($Depth_{water}$ [feet]), total well depth ($Depth_{total}$ [feet]), and well diameter:

    - $V_w = n \times (Depth_{total} - Depth_{water})$

    - 1-inch well: n = 0.04
    - 2-inch well: n = 0.16
    - 4-inch well: n = 0.65
    - 6-inch well: n = 1.47

  - Purge 1.5 well volumes at low flow rates checking for DNAPL migration. If no DNAPL migration is observed during the last 15 minutes of purging, begin collecting field data. If DNAPL migration occurs during the last 15 minutes of purging, abort sampling and document on sample log.
  - For wells without LNAPL and/or DNAPL, slowly and gently insert the pump intake tubing to the middle of the saturated screened interval, open borehole, or to the pre-determined sampling depth. The pump intake must be kept at least 2 feet above the bottom of

the well to prevent disturbance or suspension of any sediment or DNAPL present in the bottom of the well. Record the depth of the pump intake.
- o Place decontaminated flow-cell inline with tubing and connect calibrated Horiba U-22 Multiparameter Water Quality Meter, or equivalent. Place flow-cell in shade or insulate.
- o Start the pump on the lowest setting and increase slowly until flow begins. Adjust the pumping rate so that drawdown in the well is minimal (0.3 feet or less, if achievable). Use a pumping rate between 100 to 1,000 milliliters per minute (mL/min). Measure rates with a graduated container.

- While purging, record water levels every five minutes, or as appropriate. A steady state flow rate will be maintained that results in a stabilized water level with a drawdown of 0.3 feet or less, if achievable.
- During purging, monitor and record, every five minutes, the water quality indicator parameters that include: pH, temperature, SC, turbidity, DO, and ORP.
- Purging is complete when, after three consecutive measurements, the water quality parameters have stabilized as follows:
  1. pH (+/- 0.1 standard units)
  2. temperature (3%)
  3. SC (3%)
  4. turbidity (10% for values greater than 5 NTU; if three turbidity values are less than 5 NTU, consider the values as stabilized)
  5. DO (10% for greater than 0.5 milligram per liter [mg/L] or 3 consecutive values less than 0.5 mg/L)
  6. ORP (+/- 20 millivolt [mV] or 10%, whichever is greater)
- Containerize purge water in tanks or 55 gallon steel drums.
- Collect the samples.
- Following purge, disconnect the flow-through cell and fill all containers from the discharge end of the tubing. Collect samples at a flow rate equal to the steady state purge rate.
- Fill sample containers directly from the sampling device in order of decreasing volatility (i.e., Volatile Organic Compounds [VOC] samples will be collected first; see SOP SC-002, *Sampling Handling*).
- Label each sample collected and store samples in a cooler (SC-002, *Sampling Handling*).
- Secure the well cap and manhole cover and restore well area to pre-sampling conditions.

4. Notes

- Prior to the field activities, obtain available information on well construction for use in field investigation (i.e., screen and riser material, well diameter and depth, screened interval, optimum sampling depth, etc.).
- If using dedicated equipment, to the extent achievable install equipment into well at least 24 hours before sample collection to minimize disturbance of the water column and/or suspension of sediments or NAPL on bottom.
- To minimize the potential of cross-contamination between wells, dedicated, in-place pumps (and tubing) can be used.
- If the water quality indicator parameters do not stabilize after 2 hours, then either continue purging or, contact the Project Manager.
- All sample containers are to be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.
- Be aware of any preservatives in the sample bottles and handle with care, in accordance with the Health and Safety Plan.

5. References

Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samles From Monitoring Wells (January 19, 2010), USEPA Region-1, EQASOP-GW 001.

Standard Reference for Monitoring Wells (April 19, 1991), Massachusetts DEP, DEP Publication No. WSC-310-91.

Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (1996), R.W. Puls and M.J. Barcelona, U.S. Environmental Protection Agency, EPA/540/S-95/504.

Reproducible Well-Purging Procedures and VOC Stabilization Criteria for Ground Water Sampling (1994), M.J. Barcelona, H. A. Wehram, and M.D. Varljen, Ground Water, Vol. 32, No. 1, 12-22.

Low-Flow Purging and Sampling of Ground Water Monitoring Wells with Dedicated Systems (1995), R.W. Puls, and C.J. Paul, Groundwater Monitoring and Review, Summer 1995 116-123.

Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, (1998), Ground-Water Sampling SOP, Final, U.S. Environmental Protection Agency, Region II, March 16, 1998.

RCRA Ground-Water Monitoring: Draft Technical Guidance, (1993), U.S. Environmental Protection Agency, EPA/530-R-93-001.

To Filter, or Not to Filter, That is the Question, (1997), Special Topics Subcommittee Letter Report EPA-SAF-EEC-LTR-97-011, April 29, 1997, Meeting, U.S. Environmental Protection Agency, Science Advisory Board Environmental Engineering Committee, September 5, 1997.

Should Filtered or Unfiltered Groundwater and Surface Water Samples be Collected for the Risk Assessment?, (1995), MCP Q&A: Subparts I and J, Special #4, Bureau of Waste Site Cleanup, Massachusetts Department of Environmental Protection (DEP), February, 1995.

6. Attachments

Attachment A – Monitoring Well Sample Data Form
Attachment B – Portable Equipment Calibration Log

Attachment A

Monitoring Well Sample Data Form

Project: ______________ **Well ID:** ______________ **Date:** ______________

Total Well Depth (from top of casing): ______________

Depth to Water (from top of casing): ______________

Well Diameter: ______________

Pump Intake Depth: ______________

Sampling Crew: ______________

Purge Time: *Start:* ______________ *Finish:* ______________

Purging Method: ______________

Sampling Method: Low Flow

Sample Time: *Start:* ______________ *Finish:* ______________

Sample Analysis: ______________

Purge Data

Sample Time	Flow Rate *(lpm/gpm)*	Volume Purged *(liters/gals.)*	pH *(std. Units)*	Conductivity *(mS/cm)*	Turbidity *(NTU)*	Dissolved Oxygen *(mg/l)*	Temperature *(Cel.)*	Salinity *(%)*	ORP *(mV)*	Comments/Observations
										Well Headspace PID =

Final Stabilization Data

Sample Time	Flow Rate *(lpm/gpm)*	Volume Purged *(liters/gals.)*	pH *(std. Units)*	Conductivity *(mS/cm)*	Turbidity *(NTU)*	Dissolved Oxygen *(mg/l)*	Temperature *(Cel.)*	Salinity *(%)*	ORP *(mV)*	Comments/Observations

GEI Consultants

Attachment B

Portable Equipment Calibration Log

Date: ______________________

Equipment Information

Equipment Type: ______________________________

Manufacturer and Model: ______________________________

Identification Number: ______________________________

Calibration Information

Time	Parameter	Initial Reading	Calibration Value	Lot No.	Expiration	Final Reading

Notes:

Record information for all calibrated parameters.

If performing zero and span calibration, use a separate line for each.

Comments/Observations

STANDARD OPERATING PROCEDURE

GW-004 pH and Temperature Measurement

1. Objective

The objective of this Standard Operating Procedure (SOP) is to provide standard methods for determining the pH and temperature of liquids using a combination pH/temperature meter.

2. Execution

- Calibrate the meter according to the equipment manufacturer's instructions at the beginning of each day of use. Calibration for pH shall be performed using at least two buffer solutions from various ranges. Solutions chosen should be similar in pH to the expected level of the samples or liquids tested (pH 7 and four buffer solutions are preferred in most cases for ground or surface water measurements). Record data on Attachment A – Portable Equipment Calibration Log.
- Calibration is checked every two hours or every five monitoring locations, whichever occurs first, and at the end of the day by measuring the two calibration solutions used. The reading and times are recorded. If the readings are outside +/– 0.2 pH units, the meter must be recalibrated.
- Immediately prior to testing a sample, decontaminate testing beaker or container and probe assembly with one rinse of sample solution. Do not use methanol to rinse the probe. Methanol rinses could damage the probe.
- Gently shake the probe and beaker to remove excess solution. Visually inspect the bottom of the probe to ensure that liquid or sediment is not trapped between outer casing and probe.
- Pour the sample into the testing container and insert both temperature and pH probe. Stir sample for 30 seconds using both probes. Let the probes equilibrate in the sample solution for another 30 seconds. Measure and record the temperature. A reading has stabilized if pH units have not changed +/– 0.1 pH units during a five second period.
- Record pH to the nearest 0.1 unit and temperature to the nearest whole number.

3. Notes

- At all times, follow safety procedures as defined in the site-specific Health and Safety Plan.

- Coatings and particulates may affect the response of the probe; more thorough cleaning with distilled water and gently wiping the probe surface may be required to clean the surface of the probe.
- Temperature affects both the response of the instrument to pH and the actual pH of the sample. The Automatic Temperature Compensation (ATC) function compensates for the variation in the response of the meter only. Therefore, the pH must always be reported with temperature.
- The probe is a fragile thin glass bulb surrounded on three sides by a plastic casing. Care must be taken in handling the probe to avoid breakage.
- Buffer solutions should not be used past their expiration date.

4. References

Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 4500-H. American Public Health Association (1992).

5. Attachment

Attachment A – Portable Equipment Calibration Log

Attachment A

Portable Equipment Calibration Log

Date: ______________________

Equipment Information

Equipment Type: ______________________________

Manufacturer and Model: ______________________________

Identification Number: ______________________________

Calibration Information

Time	Parameter	Initial Reading	Calibration Value	Lot No.	Expiration	Final Reading

Notes:

Record information for all calibrated parameters.

If performing zero and span calibration, use a separate line for each.

Comments/Observations

STANDARD OPERATING PROCEDURE

GW-005 Turbidity Measurement

1. Description

A nephelometer/turbidimeter is used in comparing the turbidity of liquids by viewing light through them and determining how much light is eliminated. Turbidity readings are required to be read using a portable (e.g. Horiba or Hach) instrument outside the flow-through cell.

2. Execution

- Turn the meter ON .
- Calibrate the meter according the manufacture's specifications and record data on Attachment A – Portable Equipment Calibration Log.
- Rinse the sample cell three times with organic free or de-ionized water.
- Fill the cell to the fill line with organic free or de-ionized water and then cap the cell.
- Use a non-abrasive lint-free paper or cloth (preferably lens paper) to wipe off excess water and streaks.
- Open the cover and insert the cell (arrow to the front) into the unit and close the cover.
- Press READ and wait for the 'light bulb' icon to go off. Record the reading.
- Using the Gelex standards, repeat steps above. Record all measurements (note anomalies).
- Collect a representative sample or use a portion of the sample that is collected for pH, temperature, or conductivity analysis, and pour off enough to fill the cell to the fill line (about 15 milliliters [ml]) and replace the cap on the cell.
- Wipe off excess water and any streaks with a soft, lint-free cloth (lens paper).
- Press "I/O" and the instrument will turn on. Place the meter on a flat, sturdy surface. Do not hold the instrument while making measurements.
- Insert the sample cell in the instrument so the diamond or orientation mark aligns with the raised orientation mark in the front of the cell compartment. Close the lid.
- Select manual or automatic range selection by pressing the range key.

- Select signal averaging mode by pressing the "Signal Average" key. Use signal average mode if the sample causes a noisy signal (display changes constantly).
- Press Read. The display will show "---- NTU" and then the turbidity in nephelometric turbidity units (NTUs). Record the result after the lamp symbol turns off.
- Rinse the cell with de-ionized water.
- Perform an operational check.
- Periodically check the turbidity meter during the day by using the Gelex secondary standards provided.
- Perform a post calibration at the end of the day and record all measurements.

3. Notes

- Turbidity measurements are reported in NTUs. It is important to note that if the turbidity measurements are for National Pollutant Discharge Elimination System (NPDES) reporting purposes, all values above 40 NTU must be diluted with turbidity free water and calculated by multiplying by a dilution factor.

4. References

Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 4500-H. American Public Health Association (1992).

STANDARD OPERATING PROCEDURE

GW-006 Specific Conductance Measurement

1. Objective

The objective of this Standard Operating Procedure (SOP) is to provide standard methods for determining the conductivity of waters using a field conductivity meter.

2. Execution

- Calibrate the meter according to equipment manufacturer's instructions at the beginning of each day of use and record data on Attachment A – Portable Equipment Calibration Log. Calibration shall be performed using a standard KCl solution of 0.20 mS/cm (200 uS/cm, S=mho).
- Calibration is checked at the beginning of the day immediately prior to sampling, after five sampling locations or two hours (whichever occurs first), and at the end of the day. If the readings are outside +/- 0.02 mS/cm, the meter must be recalibrated. Initial calibration should be conducted under the same conditions (i.e., temperature, and location) of field testing.
- Immediately prior to testing a sample, decontaminate testing beaker or container and probe assembly with one distilled water rinse, and one sample solution rinse.
- Gently shake the probe and beaker to remove excess solution.
- Pour sample into the testing container and insert probe. Stir sample with the probe for approximately 10 seconds. Let the probe equilibrate in the sample solution for another five seconds. Measure conductivity and record in the field notebook.
- Record conductivity to the nearest whole number.

3. Notes

- At all times, follow safety procedures as defined in the site-specific Health and Safety Plan.
- Coatings and particulates may affect the probe's response; more thorough cleaning using a weak alconox solution and double distilled water rinse and gently wiping the probe surface may be required to clean the surface of the probe.
- If contaminated, (e.g., stained, conductance >750 mhos/cm), rinse probe with clean water immediately after measuring sample to minimize fouling of probe.
- Calibration solutions should not be used past their expiration date and must be discarded after three months of use.

4. References

Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 4500-H. American Public Health Association (1992).

5. Attachment

Attachment A – Portable Equipment Calibration Log

Attachment A

Portable Equipment Calibration Log

Date: ____________________

Equipment Information

Equipment Type: ______________________________

Manufacturer and Model: ______________________________

Identification Number: ______________________________

Calibration Information

Time	Parameter	Initial Reading	Calibration Value	Lot No.	Expiration	Final Reading

Notes:

Record information for all calibrated parameters.

If performing zero and span calibration, use a separate line for each.

Comments/Observations

STANDARD OPERATING PROCEDURE
GW-007 Dissolved Oxygen Measurement

1. Objective

To accurately quantify dissolved oxygen (DO) in water.

2. Execution

Typically, the Horiba U-22 Multiparameter Water Quality Meter is used to measure groundwater DO during low-flow purging activities. However, a Hach DO test kit may be utilized, as necessary.

Horiba U-22 Multiparameter Water Quality Meter

1) Calibrate meter in accordance with manufactures specifications.
2) Calibrate the meter according to equipment manufacturer's instructions at the beginning of each day of use and record data on Attachment A – Portable Equipment Calibration Log.
3) In accordance with SOP GW-003, connect decontaminated meter inline with purge/sample tubing utilizing decontaminated flow-cell.
4) Record DO readings during monitoring well purging in accordance with SOP GW-003

Hach DO Test Kit

High Range Test (1 to 20 milligrams per liter [mg/L])

1) Fill the DO bottle (round bottle with glass stopper) with sampling water by allowing the sample water to overflow the bottle for 2 to 3 minutes. Avoid turbulence and bubbles in the sample while filling.
2) Incline the bottle slightly and insert the stopper with a quick thrust to avoid trapping air bubbles. If bubbles become trapped, discard the sample and repeat the test.
3) Remove the stopper and add the contents of one DO 1 Reagent Power Pillow and one DO 2 Reagent Powder Pillow. Stopper the bottle carefully to avoid trapping air bubbles. If bubbles become trapped, discard the sample and repeat the test.
4) Shake the bottle vigorously to mix. Flocculant (floc) precipitate will form. Brownish-orange precipitate indicates oxygen is present.
5) Wait for floc to settle to approximately half the bottle volume. Floc will not settle if high concentrations of chloride are present. In this case, wait 4 to 5 minutes before proceeding.
6) Shake the bottle vigorously again.
7) Wait for the floc to settle halfway. Floc will not settle if high concentrations of chloride are present. In this case, wait 4 to 5 minutes before proceeding.

8) Remove the stopper and add the contents of one DO 3 Reagent Powder Pillow. Stopper the bottle carefully to avoid trapping air bubbles. If bubbles become trapped, discard the sample and repeat the test.
9) Shake the bottle vigorously to mix. Floc will dissolve and the sample will turn yellow if oxygen is present.
10) Fill plastic tube full (to the top) with prepared sample.
11) Save the rest of the prepared sample for the Low Range Test, if necessary.
12) Pour the contents of the tube into a square mixing bottle.
13) Add Sodium Thiosulfate Standard Solution one drop at a time to the mixing bottle. Count each drop. Swirl to mix after each drop. Add drops until the sample becomes colorless. The number of drops of titrant used is equal to the total mg/L.

Low Range Test (0.2 to 4 milligrams per liter [mg/L])

1) Use the prepared sample left from Step 11 of the High Range Test. Pour off the contents of the DO bottle until the level reaches the 30 ml mark on the bottle.
2) Add Sodium Thiosulfate Standard Solution one drop at a time to the DO bottle. Count each drop. Swirl the bottle after each drop is added. Add drops until the sample becomes colorless.
3) Multiply by 0.2 the number of drops of titrant used. This is the total mg/L.

3. Notes

- Collecting measurements from samples in containers will alter the gaseous content of the sample.
- Freshwater can hold more oxygen than saltwater. The dissolved salt forces dissolved gas out of water thereby lowering the solubility of water. A known relationship between salinity and dissolved oxygen concentration allows for a correction for salinity.

4. References

Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 4500-H. American Public Health Association (1992).

5. Attachment

Attachment A – Portable Equipment Calibration Log

Attachment A

Portable Equipment Calibration Log

Date: ____________________

Equipment Information

Equipment Type: ____________________________________

Manufacturer and Model: ____________________________________

Identification Number: ____________________________________

Calibration Information

Time	Parameter	Initial Reading	Calibration Value	Lot No.	Expiration	Final Reading

Notes:

Record information for all calibrated parameters.

If performing zero and span calibration, use a separate line for each.

Comments/Observations

STANDARD OPERATING PROCEDURE

GW-008 Temporary Groundwater Sampling Points

1. Description

A well point is a small diameter (1-2 inch) probe constructed of continuously wrapped stainless steel or wrapped stainless steel gauze screen over perforated carbon steel pipe. They may be used as a screening tool to collect ground water samples and piezometric data to aid in the optimal placement of monitor wells. No filter or gravel pack is used in the installation.

2. Execution

2.1. Installation

- The well point can be placed with the use of a conventional hollow-stem auger rig, slide hammer, jack hammer, rotary hammer, or by hand.
- The well point may be driven through the unsaturated zone only in known clean soils. Driving the well point through contaminated soil may carry some contamination with the point resulting in analytical sample results which are biased high. In contaminated unsaturated zones, the well points must be placed with the aid of a hollow-stem auger.
- If the well point is to be installed in an oversized (20% larger than the well point) pre-drilled hole, the hollow-stem augers or bull drive point must be advanced to a point which is just above the targeted sample zone. The well point is then placed in the hole and advanced beyond the bottom of the hole by hammering or pushing into place. The use of pre-drilled holes will reduce clogging of well point screens when driving.
- After sample collection, the well point is removed by back hammering or pulling the tool out with the rig hydraulics.
- If the well point is to be left as a permanent installation, it must be constructed and permitted as per local regulatory monitor well requirements.
- If the well point is used for piezometeric data, a survey mark must be made on top of the casing as a reference point for water level measurements.

2.2. Sampling Procedures

2.2.1. Development

Development of a well point is not required except when performing vertical profile sampling. The well point must be developed by one of the standard methods used for well development prior to sampling. If an air lift development technique is used, the air outlet must be at a minimum of two feet above the screen. Operations must be continuous and not pulsed. The air lift pipe shall not be placed within the screen and only the double pipe method shall be used.

2.2.2. Purging

Purging of the well point is required.

2.2.3. Sampling

The acquisition of ground water samples and piezometric data must be performed by one of several recommended methods described in the associated SOP.

3. References

Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 4500-H. American Public Health Association (1992).

Ground Water and Wells. Johnson Division, UOP Inc.; St. Paul, Minn. 1982. p277-294.

Ground Water Manual - A Water Resources Technical Publication; U.S. Dept. of Interior, Bureau of Reclamation. Government Printing Office,Washington DC 1977.

Appendix C

Quality Assurance Project Plan

Consulting Engineers and Scientists

Quality Assurance Project Plan

99 GRANITE STREET
BROOKLYN, NEW YORK

Submitted to:
New York State Department of Environmental Conservation
Division of Environmental Remediation
50 Circle Road
Stony Brook, NY 11790

Submitted by:
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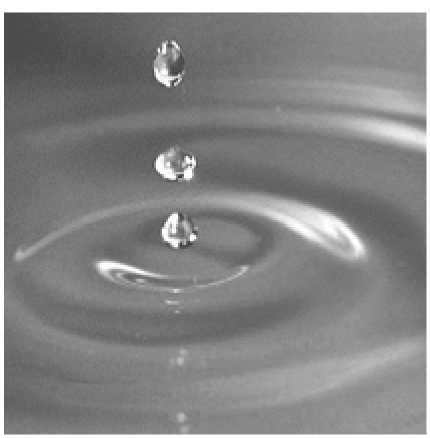
May 2018



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Tables

Appendices

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Abbreviations and Acronyms

ASP	Analytical Service Protocol
BOD	Biological Oxygen Demand
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHMM	Certified Hazardous Materials Manager
CMS	Chip Measurement System
CLP	Contract Laboratory Protocol
COC	Chain Of Custody
COD	Chemical Oxygen Demand
DQO	Data Quality Objective
DO	Dissolved Oxygen
DUSR	Data Usability Summary Report
ELAP	Environmental Laboratory Approval Program
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectroscopy
GEI	GEI Consultants, Inc.
H2M	H2M Labs, Inc.
LCS	Labortory Control Sample
LEL	Lower Explosive Limit
LEP	Licenced Environmental Professional (Connecticut)
MDL	Method Detection Limit
MPH	Master of Public Health
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NTU	Nephelometric Turbidity Unit
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	Oxidation Reductioin Potential
PAH	Polycyclic Aromatic Hydrocarbon
PCE	Perchloroethylene (also know as tetrachloroethene)
PID	Photoionization Detector
PM	Project Manager
PQL	Practical Quantification Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation Recovery Act
RIWP	Remedial Investigation Work Plan
RL	Reporting Limit
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SD	Standard Deviation
SOP	Standard Operating Procedures

SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TCL+30	Target Compound List Plus 30
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Identified Compounds
TOC	Total Organic Carbon
USDOT	United States Department of Transporation
VOC	Volatile Organic Compound

Quality Assurance Glossary

"Alteration" means altering a sample collected for analysis in any way other than by adding a preservative, such as nitric acid to lower pH. Examples of alteration include, but are not limited to: filtering, settling and decanting, centrifuging and decanting, and acid extracting.

"Analytical Services Protocol" or "ASP" means the NYSDEC's compendium of approved EPA and NYSDEC laboratory methods for sample preparation and analysis and data handling procedures.

"Correlation Sample" means a sample taken, when using a field-testing technology, to be analyzed by an ELAP-certified laboratory to determine the correlation between the laboratory and field analytical results.

"Confirmatory Sample" means a sample taken after remedial action is expected to be complete to verify that the cleanup requirements have been met. This term has the same meaning as "post remediation sample."

"Contract laboratory program" or "CLP" means a program of chemical analytical services developed by the United States Environmental Protection Agency (EPA) to support CERCLA.

"Data Usability Summary Report, (DUSR)" is a document that provides a thorough evaluation of the analytical data to determine whether or not the data, as presented, meets the site/project specific criteria for data quality and use.

"Effective solubility" means the theoretical aqueous solubility of an organic constituent in groundwater that is in chemical equilibrium with a separate phase mixed product (product containing several organic chemicals). The effective solubility of a particular organic chemical can be estimated by multiplying its mole fraction in the product mixture by its pure phase solubility.

"Environmental Laboratory Accreditation Program" or "ELAP" means a program conducted by the New York State Department of Health (NYSDOH), which certifies environmental laboratories through onsite inspections and evaluation of principles of credentials and proficiency testing.

“Filtration” means the filtering of a groundwater or surface water sample, collected for metals analysis, at the time of collection and prior to preservation. Filtering includes, but is not limited to, the use of any membrane, fabric, paper or other filter medium, irrespective of pore size, to remove particulates from suspension.

“**Final delineation sample**” means a sample taken as an endpoint sample, used to make a decision regarding the extent of contamination at a site, which is to be analyzed by an ELAP-certified laboratory.

“Intermediate Sample” means a sample taken during the investigation process that will be followed by another sampling event to confirm that remediation was successful or to confirm that the extent of contamination has been defined to below a level of concern.

“Method detection limit” or “MDL” means the minimum concentration of a substance that can be measured and reported with a 99 percent confidence that the analyte concentration is greater than zero and is determined from the analysis of a sample in a given matrix containing the analyte.

“Minimum reporting limit” means the lowest concentration at which an analyte can be detected and which can be reported with a reasonable degree of accuracy. It is the lowest concentration that can be measured, a lab-specific number, developed from minimum detection limits, and is also referred to as the practical quantitation limit (PQL).

“Nephelometric Turbidity Unit” or "NTU" is the unit by which turbidity in a sample is measured.

“Non-targeted compound” means a compound detected in a sample using a specific analytical method that is not a targeted compound, a surrogate compound, a system monitoring compound, or an internal standard compound.

“Practical quantitation level” or “PQL” means the lowest quantitation level of a given analyte that can be reliably achieved among laboratories within the specified limits of precision and accuracy of a given analytical method during routine laboratory operating conditions.

"Preservation" means preventing the degradation of a sample due to precipitation, biological action, or other physical/chemical processes between the time of sample collection and analysis. The most common examples involve refrigeration at 4 degrees Celsius and lowering sample pH by the addition of acid to keep dissolved metals in solution or to reduce the biodegradation of dissolved organic analytes.

"PAH" means polycyclic aromatic hydrocarbon as defined by USEPA Method 8270.

"Quality assurance" or "QA" means the total integrated program for assuring the reliability of monitoring and measurement data, which includes a system for integrating the quality planning, quality assessment, and quality improvement efforts to meet data end-use requirements.

"Quality assurance project plan" or "QAPP" means a document, which presents in specific terms the policies, organization, objectives, functional activities, and specific quality assurance/quality control activities designed to achieve the data quality goals or objectives of a specific project or operation.

"Quality control" or "QC" means the routine application of procedures for attaining prescribed standards of performance in the monitoring and measurement process.

"Semi-volatile organic compound" or "SVOC" means compounds amenable to analysis by extraction of the sample with an organic solvent. For the purposes of this section, semi-volatiles are those target compound list compounds identified in the statement of work in the current version of the EPA Contract Laboratory Program.

"Target analyte list" or "TAL" means the list of inorganic compounds/elements designated for analysis as contained in the version of the EPA Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration in effect as of the date on which the laboratory is performing the analysis. For the purpose of this chapter, a Target Analyte List scan means the analysis of a sample for Target Analyte List compounds/ elements.

"Targeted compound" means a hazardous substance, hazardous waste, or pollutant for which a specific analytical method is designed to detect that potential contaminant both qualitatively and quantitatively.

"Target compound list plus 30" or "TCL+30" means the list of organic compounds designated for analysis (TCL) as contained in the version of the EPA "Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration" in effect as of the date on which the laboratory is performing the analysis, and up to 30 non-targeted organic compounds (plus 30) as detected by gas chromatography/mass spectroscopy (GC/MS) analysis. For the purposes of this chapter, a Target Compound List+30 scan means the analysis of a sample for Target Compound List compounds and up to 10 non-targeted volatile organic compounds and up to 20 non-targeted semi-volatile organic compounds using GC/MS analytical methods. Non-targeted compound criteria should be pursuant to the version of the EPA "Contract Laboratory Program Statement of Work for

Organics Analysis, Multi-Media, Multi-Concentration" in effect as of the date on which the laboratory is performing the analysis.

"Tentatively identified compound or TIC" means a chemical compound that is not on the target compound list but is detected in a sample analyzed by a GC/MS analytical method. TICs are only possible with methods using mass spectrometry as the detection technique. The compound is tentatively identified using a mass spectral instrumental electronic library search and the concentration of the compound estimated.

"Unknown compound" means a non-targeted compound which cannot be tentatively identified. Based on the analytical method used, the estimated concentration of the unknown compound may or may not be determined.

"Volatile organic compounds" or "VOC" means organic compounds amenable to analysis by the purge and trap technique. For the purposes of this chapter, analysis of volatile organics means the analysis of a sample for either those priority pollutants listed as amenable for analysis using EPA method 624 or those target compounds identified as volatiles in the version of the EPA "Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration" in effect as of the date on which the laboratory is performing the analysis.

"**Waste oil"** means used and/or reprocessed engine lubricating oil and/or any other used oil, including but not limited to: fuel oil, engine oil, gear oil, cutting oil, transmission fluid, oil storage tank residue, animal oil, and vegetable oil, which has not subsequently been refined.

"Well development" means the application of energy to a newly installed well to establish a good hydraulic connection between the well and the surrounding formation. During development, fine-grained formation material that may have infiltrated the sand pack and/or well during installation is removed, allowing water from the formation to enter the well without becoming turbid and unrepresentative of groundwater in the formation.

1. Purpose

GEI Consultants, Inc. P.C. (GEI) has prepared this Quality Assurance Project Plan (QAPP) to address analytical sampling at 99 Granite Street, Brooklyn, New York (the site). The QAPP is a companion document and attachment to the *Remedial Investigation Work Plan (RIWP)*. The QAPP presents the project scope and goals, organization, objectives, sample handling procedures and Quality Assurance Quality Control (QA/QC) procedures associated with the site.

Furthermore, this QAPP identifies project responsibilities, prescribes guidance and specifications to make certain that:

- Samples are identified and controlled through sample tracking systems and chain-of-custody (COC) protocols.
- Field and laboratory analytical results are valid and usable by adherence to established protocols and procedures.
- All aspects of the investigation, from field to laboratory are documented to provide data that are technically sound and legally defensible.

The requirements of this QAPP apply to all contractor activities as appropriate for their respective tasks.

This QAPP was prepared based upon guidance provided by the United States Environmental Protection Agency (EPA) and New York State Department of Environmental Conservation (NYSDEC) including:

- *DER-10, Technical Guidance for Site Investigation and Remediation.* New York State Department of Environmental Conservation. *May 3, 2010.*
- *Analytical Service Protocol*, New York State Department of Environmental Conservation. *July 2005.*
- *US EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA QA/R-5, March 2001).*
- *Guidance for Quality Assurance Project Plans (EPA QA/G-5, December 2002).*

2. Project Goals and Objectives

An RIWP has been developed to develop a remedial analysis for onsite petroleum volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals impacts. The RIWP program will include:

- Soil borings
- Soil vapor probes
- Groundwater monitoring well installations
- Soil field screening
- Soil analytical sampling
- Soil vapor sampling
- Groundwater analytical sampling

3. Project Organization and Responsibility

GEI is responsible for the implementation of the scope of work associated with the RIWP, including the supervision of contractors, field activities, and the evaluation and interpretation of data. GEI will perform the sampling activities and coordinate submittal of samples to testing laboratories. The project organization and key personnel for GEI are listed below:

In-House Consultant: Errol Kitt
Program Manager: Gary Rozmus
Project Manager: Ed Bradshaw
Field Team Leader: To be Determined
Quality Assurance Officer: Jaimie Wargo
GEI Corporate Health & Safety Officer: Steven Hawkins
Data Manager: Brian Skelly

The primary responsibilities of each of these personnel are described in the following table.

Key Project Personnel and Responsibilities		
Position	**GEI Personnel**	**Areas of Responsibilities**
In-House Consultant	Errol Kitt	▪ Provide strategic guidance of project activities ▪ Client contact regarding strategic issues ▪ Review of project deliverables
Program Manager	Gary Rozmus	▪ Overall program oversight ▪ Project management ▪ Project schedule ▪ Client contact regarding project related issues ▪ Personnel and resource management ▪ Review of project submittals ▪ Budgeting
Project Manager	Ed Bradshaw	▪ Client contact regarding project related issues ▪ Coordination of contractors ▪ Technical development and implementation of RIWP and related documents ▪ Personnel and resource management ▪ Preparation and review of project submittals ▪ Budgeting
Field Team Leader	To be Determined	▪ Client contact regarding project related issues on day to day basis as part of field operations ▪ Coordination of contractors

Key Project Personnel and Responsibilities		
Position	**GEI Personnel**	**Areas of Responsibilities**
		▪ Implementation of RIWP and Field Sampling ▪ Plan personnel and resource management ▪ Preparation of project submittals
Quality Assurance Officer	Jaimie Wargo	▪ QA/QC for sampling and laboratory performance
Data Manager	Brian Skelly	▪ Manage raw data from the laboratory ▪ Maintain copies of COCs in the project file

Pace Analytical Services (Pace), located in Melville, New York, has been selected to perform the following standard analytical chemistry parameters for soil, soil vapor, and groundwater samples including:

- Volatile Organic Compounds (VOCs) according to EPA Method 8260
- Semi-Volatile Organic Compounds (SVOCs) according to EPA Method 8270
- Target Analyte List (TAL) Metals according to EPA Method 6010B/7470A/7471B
- VOCs in air using EPA Method TO15

Pace Analytical's (Pace) relevant certifications are summarized in the following table.

Pace Analytical's Certifications		
Location	Responsible Agency	Certification
New York	New York State Department of Health	Environmental Laboratory Approval Program (ELAP) for potable water/non-potable water, solid and hazardous waste Contract Laboratory Protocol (CLP)
	New York State Department of Conservation	July 2005 Analytical Service Protocol (ASP)
United States	United States Environmental Protection Agency	CLP-Lab: 10478 [VOCs/SVOCs/Inorganics/Pesticides/ PCBs/Herbicides]

Table 1 provides a summary of soil analyses, **Table 2** provides a summary of soil vapor analyses, **Table 3** provides a summary of groundwater analyses, and **Table 4** provides a summary of quality assurance samples, holding times, and analysis for each media.

4. Quality Assurance Objectives

This section establishes the QA objectives for measurements that are critical to the project. The QA objectives are developed for relevant data quality indicators. These indicators include the method detection limit (MDL), reporting limit (RL), precision, accuracy, completeness, representativeness, and comparability. The data quality objectives (DQOs) are based on project requirements and ensure: (1) that the data generated during the project are of known quality and (2) that the quality is acceptable to achieve the project's technical objectives.

Quantitation Limits are laboratory-specific and reflect those values achievable by the laboratory performing the analyses. However, in order to ensure that the analytical methodologies are capable of achieving the DQOs, measurement performance criteria have been set for the analytical measurements in terms of accuracy, precision, and completeness. The analytical methods to be used at this site will provide a level of data quality and can be used to evaluate potential impacts to soil, soil vapor, and groundwater compared to New York State Standards, Criteria and Guidance values, and for purposes of risk assessment.

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting which will provide results that are scientifically valid, and the levels of which are sufficient to meet DQOs. Specific procedures for sampling, chain of custody, laboratory instruments calibration, laboratory analysis, reporting of data, internal quality control, and corrective action are described in other sections of the QAPP.

The data quality indicators are presented in subsections 4.1 through 4.6. Procedures to assess the data quality indicators are given below in Section 13.

Table 5, **Table 6,** and **Table 7** provide the RLs, MDLs and the DQO's for soil, soil vapor, and groundwater samples, respectively. The DQO's for soil samples for this project include minimum RLs specified within the 2005 NYSDEC ASP as well as unrestricted use criteria listed in 6 NYCRR Part 375. The DQO's for soil vapor samples for this project include minimum RLs specified within the 2005 NYSDEC ASP PER PACE. The DQO's for groundwater samples for this project include minimum RLs specified within the 2005 NYSDEC ASP as well as GA groundwater criteria listed in the Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.

Table 8, Table 9, and **Table 10** provide the precision and accuracy DQO's for soil, soil vapor, and groundwater samples, respectively.

4.1 Required Quantification Limit

The required quantification limit is the quantitative analytical level for individual analytes needed to make decisions relative to the objectives of the project. Quantitative limits may be expressed as the MDL or some quantitative level defined in terms relative to the program. It should be noted that there is some ambiguity in the definitions and use of terms that define quantification limits. The MDL presented herein is a well-defined and accepted entity, although attainable only under ideal laboratory conditions.

Method Detection Limit: The MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. MDL is determined from analysis of a sample in a given matrix type containing the analyte.

Practical Quantitation Limit: The practical quantitation limit (PQL) [also referred to as the reporting limit (RL)] is the concentration in the sample that corresponds to the lowest concentration standard of the calibration curve.

Tables 8, Table 9, and **Table 10** provide the reporting limits and the DQO's for soil, soil vapor, and groundwater samples, respectively.

4.2 Accuracy

Accuracy is the closeness of agreement between an observed value and an accepted reference value. The difference between the observed value and the reference value includes components of both systematic error (bias) and random error.

Accuracy in the field is assessed through the adherence to all field instrument calibration procedures, sample handling, preservation, and holding time requirements, and through the collection of equipment blanks prior to the collection of samples for each type of equipment being used (e.g., sample liners, drilling shoe, or stainless–steel sampling implements).

The laboratory will assess the overall accuracy of their instruments and analytical methods (independent of sample or matrix effects) through the measurement of "standards," materials of accepted reference value. Accuracy will vary from analysis to analysis because of individual sample and matrix effects. In an individual analysis, accuracy will be measured in terms of blank results, the percent recovery (%R) of surrogate compounds in organic analyses, or %R of spiked compounds in matrix spikes (MSs), matrix spike duplicates

(MSDs) and/or laboratory control samples (LCSs). This gives an indication of expected recovery for analytes tending to behave chemically like the spiked or surrogate compounds.

4.3 Precision

Precision is the agreement among a set of replicate measurements without consideration of the “true” or accurate value: i.e., variability between measurements of the same material for the same analyte. In environmental sampling, precision is the result of field sampling and analytical factors. Precision in the laboratory is easier to measure and control than precision in the field. Replicate laboratory analyses of the same sample provide information on analytical precision; replicate field samples provide data on overall measurement precision. The difference between the overall measurement precision and the analytical precision is attributed to sampling precision. Precision is measured in a variety of ways including statistically, such as calculating variance or standard deviation. The difference between the overall measurement precision and the analytical precision is attributed to sampling precision.

Precision in the field is assessed through the collection and measurement of field duplicates. Field duplicates will be collected at a frequency of one per twenty investigative samples per matrix per analytical parameter, with the exception of the waste characterization parameters. Precision will be measured through the calculation of relative percent differences (RPDs) as described below in subsection 13.2. The resulting information will be used to assess sampling and analytical variability. Duplicate samples are described below in subsection 5.1.3. **Table 4** summarizes the number of duplicates per media sampled.

Precision in the laboratory is assessed through the calculation of RPD for duplicate samples. For organic analyses, laboratory precision will be assessed through the analysis of MS/MSD samples and field duplicates. For the inorganic analyses, laboratory precision will be assessed through the analysis of matrix duplicate pairs and field duplicate pairs. MS/MSD samples or matrix duplicate pairs will be performed at a frequency of one per twenty primary samples per matrix. Duplicate samples are described below in subsection 5.1.3. **Table 4** summarizes the number of duplicates per media sampled.

4.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. “Normal conditions” are defined as the conditions expected if the sampling plan was implemented as planned. The objective for completeness is a sufficient amount of valid data to achieve a predetermined statistical level of confidence. Critical samples must be identified and plans must be formulated to secure requisite valid data for these samples.

Field completeness is a measure of the amount of 1) valid measurements obtained from all the measurements taken in the project and 2) valid samples collected. The field completeness objective is greater than 90 percent.

Laboratory completeness is a measure of the amount of valid measurements obtained from all valid samples submitted to the laboratory. The laboratory completeness objective is greater than 95 percent.

To ensure that these percentages are met, materials for crucial parameters will be retained if re-sampling is required and strict adherence to holding times will be required.

4.5 Representativeness

Representativeness is a qualitative parameter that expresses the degree to which data accurately and precisely represents either a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary. To ensure representativeness, the sampling locations have been selected to provide coverage over a wide area and to highlight potential trends in the data.

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that any future work plans are followed and that proper sampling, sample handling, and sample preservation techniques are used.

Representativeness in the laboratory is ensured by using the proper analytical procedures, appropriate methods, and meeting sample-holding times.

4.6 Comparability

Comparability is a qualitative parameter that expresses the confidence with which one data set can be compared to another. Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the RIWP is followed and that proper sampling techniques are used. Maximization of comparability with previous data sets is expected because the sampling design and field protocols are consistent with those previously used.

Comparability is dependent on the use of recognized EPA or equivalent analytical methods and the reporting of data in standardized units. To facilitate data comparison, the data-reporting format as presented below will be used:

- Conventions (units reported as): for solids (weight/unit weight [i.e., mg/kg]); for liquids (weight/unit volume [i.e., μg/L]); for air (weight/unit volume [i.e., μg/m3]).

- Use common chemical name with corresponding chemical abstracts service (CAS) code.
- Report all data for soils on a dry-weight basis.

5. Sampling Plan

Environmental sampling will include subsurface soil, soil vapor, groundwater, and waste characterization sampling. Direct push drilling (Geoprobe®) will be the preferred method for obtaining subsurface soil samples and soil vapor probes. Soil vapor samples will be collected by the direct-push drilling method. Groundwater samples will be collected utilizing low-flow sampling methods, peristaltic pumps, bailers, whale pumps, or bladder pumps. Performing grab or composite sampling by appropriate hand-held sampling equipment will be the preferred method for waste characterization sampling. Sampling methods and procedures are presented in Appendix C of the RIWP.

5.1 Sample Type, Location, and Frequency

5.1.1 Subsurface Soil Samples

Subsurface soil samples will be collected using the Geoprobe® drilling method. The depth, location and number of soil borings will be specified in a job specific Work Plan. Soil samples will be collected and submitted for laboratory analysis in general accordance with the RIWP and Field Sampling Plan (FSP). A summary of typical subsurface soil sample naming analysis are located on **Table 1**.

5.1.2 Soil Vapor Samples

Soil vapor samples will be collected and submitted for laboratory analysis in general accordance with the RIWP. Soil vapor samples will be collected and submitted for laboratory analysis in general accordance with the RIWP and FSP. A summary of soil vapor samples and analysis as depicted on **Table 2**.

5.1.3 Groundwater Samples

Groundwater samples will be collected and submitted for laboratory analysis in general accordance with the RIWP. Water quality parameters including temperature, pH, turbidity, salinity, dissolved oxygen (DO), oxidation reduction potential (ORP), and specific conductance, will be collected prior to laboratory analysis. A summary of groundwater samples and analysis as depicted on **Table 3**.

5.1.4 Field QC Sample Collection

Field QC samples are used to monitor the reproducibility and representativeness of field sampling activities. The field QC samples are handled, transported and analyzed in the same manner as the associated field samples. Field QC samples will include equipment blanks, trip blanks, field duplicates and MS/MSDs. The quantity, field QC sample type and analysis is detailed on **Table 4**.

Equipment Blank Samples are used to monitor the adequacy of decontamination procedures and possible sources of contamination such as potential laboratory methodologies. Equipment blanks will consist of laboratory-supplied, distilled or de-ionized water and will be used to check for potential contamination of the equipment which may cause sample contamination. Equipment blanks will be collected by routing the distilled water through a decontaminated piece of sampling equipment or disposable sampling equipment into laboratory supplied bottles. Non-dedicated field equipment will be decontaminated as specified below in subsection 5.3. Equipment blanks will be submitted to the laboratory at a frequency of one per 20 samples per matrix per type of equipment being used per parameter. Equipment blanks will not be completed for waste characterization sampling activities.

Trip Blank Samples will consist of analyte free water and will be prepared by the laboratory. Trip blanks are used to assess the potential for VOC contamination of samples due to contaminant migration during sample shipment and storage. Trip blanks will be transported to the project location unopened, stored with the site characterization samples, and kept closed until analyzed by the laboratory. Trip blanks will be submitted to the laboratory at a frequency of one per cooler which contains samples submitted for VOC analysis.

Field Duplicate Samples, also referred to as blind duplicate samples, are two samples that are submitted from the same interval using the same sample procedures. Field duplicates will be used to assess the sampling and analytical reproducibility. Both samples are collected utilizing the same methods and are submitted for the same laboratory analysis however different sample identification numbers are used. Field duplicates will be submitted at a frequency of one per 20 samples for all matrices and all parameters. Field duplicates will not be completed for waste characterization sampling activities.

MS/MSD Samples are two additional aliquots of the same sample submitted for the same parameters as the original sample. However, the additional aliquots are spiked with the compounds of concern. Matrix spikes provide information about the effect of the sample matrix on the measurement methodology. MS/MSDs will be submitted at a frequency of one per 20 investigative samples per matrix for organic and inorganic parameters. MS/MSDs will not be completed for waste characterization sampling activities.

Refer to **Table 4** for a summary of QC sample preservation and container requirements.

5.2 Sample Preservation and Containerization

The analytical laboratory will supply the sample containers for the chemical samples. These containers will be cleaned by the manufacturer to meet or exceed all analyte specifications established in the latest EPA's Specifications and Guidance for Contaminant-Free Sample Containers. Certificates of analysis are provided with each bottle lot and maintained on file to document conformance to EPA specifications. The containers will be pre-preserved, where appropriate. Sample preservation and containerization details are outlined in **Table 4**.

5.3 Equipment Decontamination

All non-dedicated sampling equipment shall be cleaned between each use in the following manner:

- Wash/scrub with a biodegradable degreaser ("Simple Green") if there is oily residue on equipment surface.
- Tap water rinse.
- Wash and scrub with Alconox (or non-phosphate soap) and water mixture.
- Tap water rinse.
- Equipment will be wrapped in polyethylene plastic or aluminum foil for storage or transportation from the designated decontamination area to the sampling location, where appropriate.

The drilling equipment will be decontaminated by steam cleaning or equivalent.

Decontamination fluids will be containerized into United States Department of Transportation (USDOT)/UN-approved 55-gallon drums or containment vessels and will be characterized and disposed of by an approved disposal facility.

6. Documentation and COC

6.1 Sample Collection Documentation

6.1.1 Field Notes

Field notes documenting field activities will be maintained in a field notebook in general accordance with the FSP. Field logbooks will provide the means of recording the chronology of data collection activities performed during the investigation. The logbook will be a bound notebook with water-resistant pages. Logbook entries will be dated, legible, and contain accurate and inclusive documentation of the activity. No erasures or obliterations of field notes will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark, which is signed and dated by the sampler. The correction shall be written adjacent to the error.

Field logbooks will be reviewed at regular intervals by the field team leader, site manager, and project manager for completeness and representativeness. When necessary, logbooks will be supported by daily activity reports.

6.1.2 COC Records

Sample custody is discussed in detail below in subsection 6.2. COC records are initiated by the samplers in the field. The field portion of the custody documentation should include:

- The project name
- Signature(s) of sampler (s) responsible for sample custody
- Sample ID number
- Date and time of collection
- Whether the sample is grab or composite
- Names of individuals involved in sampling
- Air bill or other shipping number (if applicable)

On a regular basis (daily or on such a basis that all holding times will be met), samples will be transferred to the custody of the respective laboratories, via third-party commercial carriers or via laboratory courier service. Sample packaging and shipping procedures, and field COC procedures are described below in subsection 6.2.1 of this Plan. Sample receipt and log-in procedures at the laboratory are described below in subsection 6.2.2 of this Plan.

6.1.3 Sample Labeling

Each sample will be labeled with a pre-printed adhesive label using indelible ink. The label should include the date and time of collection, sampler's initials, tests to be performed, preservative (if applicable), and a unique identification. The following identification scheme will be used:

PRIMARY SAMPLES TYPES	QA/QC SAMPLE TYPES
SOIL SAMPLES Boring -ID (SAMPLE DEPTH-FEET) SB-01 (10-15) **SOIL VAPOR SAMPLES** Soil Vapor Point-ID SV-01 **GROUNDWATER SAMPLES** Monitoring Well-ID MW-01S	**FIELD BLANKS** SAMPLE-ID – [DATE] SS-FB-033110 **MATRIX SPIKE/DUP** SAMPLE [ID] [DEPTH] [EITHER MS OR MSD] SS-01 (10-15) MS/MSD **TRIP BLANKS** SAMPLE- ID [DATE] TB-033110 **BLIND DUPLICATES** SAMPLE -ID[XX][DATE] SS-XX-033110

This sample label contains the authoritative information for the sample. Inconsistencies with other documents will be settled in favor of the vial or container label unless otherwise corrected in writing from the field personnel collecting samples or the Data Manager and/or the Project QA Officer.

6.1.4 Sample Handling

Samples will be handled in general accordance with the FSP.

6.2 Sample Custody

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

A sample is considered to be under a person's custody if:

- The item is in the actual possession of a person
- The item is in the view of the person after being in actual possession of the person
- The item was in the actual physical possession of the person but is locked up to prevent tampering

- The item is in a designated and identified secure area

6.2.1 Field Custody Procedures

Samples will be collected following the sampling procedures indicated in the FSP. A summary of samples and collection methods are provided above in Section 5 of this QAPP. Documentation of sample collection is described above in subsection 6.1. Sample COC and packaging procedures are summarized below. These procedures will ensure that the samples will arrive at the laboratory with the COC intact.

- The field sampler is personally responsible for the care and custody of the samples until they are transferred or dispatched properly. Field procedures have been designed such that as few people as possible will handle the samples.
- All bottles will be identified by the use of sample labels with sample numbers, sampling locations, date/time of collection, and type of analysis. The sample numbering system is presented above in subsection 6.1.3.
- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions.
- Samples will be accompanied by a completed COC form. The sample numbers and locations will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents the transfer of custody of samples from the sampler to another person, to a mobile laboratory, and to the laboratory facility.
- All shipments will be accompanied by the COC record identifying the contents. The original record will accompany the shipment, and copies will be retained by the sampler and provided to the data manager and placed in the project files.
- Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the cooler and covered with clear plastic tape after being signed by field personnel.
- If the samples are sent by common carrier, the air bill will be used. Air bills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody forms since the custody forms will be sealed inside the sample cooler and the custody seals will remain intact.
- Samples remain in the custody of the sampler until transfer of custody is completed. This consists of delivery of samples to the laboratory sample custodian, and signature of the laboratory sample custodian on COC document as receiving the samples and signature of sampler as relinquishing samples.

6.2.2 Laboratory Custody Procedures

After accepting custody of the shipping containers, the laboratory will document the receipt of the shipping containers by signing the COC record. The laboratory will:

- Examine the shipping containers to verify that the custody tape is intact
- Examine all sample containers for damage
- Determine if the temperature required for the requested testing program has been maintained during shipment and document the temperature on the COC records
- Compare samples received against those listed on the COC
- Verify that sample holding times have not been exceeded
- Examine all shipping records for accuracy and completeness
- Determine sample pH (if applicable) and record on COC forms
- Sign and date the COC immediately (if shipment is accepted) and attach the air bill
- Note any problems associated with the coolers and/or samples on the cooler receipt form and notify the laboratory project manager, who will be responsible for contacting the GEI data manager
- Attach laboratory sample container labels with unique laboratory identification and test
- Place the samples in the proper laboratory storage.

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

- The samples will be entered into the laboratory tracking system. At a minimum, the following information will be entered: project name or identification, unique sample numbers (both client and internal laboratory), type of sample, required tests, date and time of laboratory receipt of samples, and field ID provided by field personnel.
- The completed COC, air bills, and any additional documentation will be placed in the project file.

7. Calibration Procedure

7.1 Field Instruments

Field instruments will be calibrated according to the manufacturer's specifications. Air monitoring instruments will be calibrated to a known reference gas standard and ambient air outside the work zone. Calibration will be completed daily. If concentrations of VOCs are encountered above the reference gas standard, the soil screening photoionization detector (PIDs) may be calibrated or re-checked against the reference gas standard. Water quality meters will be calibrated with known reference solutions. All calibration procedures performed will be documented in the field logbook and will include the date/time of calibration, name of person performing the calibration, reference standard used, and the readings. The following equipment may be used during sampling activities.

Subsurface Soil Sampling Activities:

- RAE Systems MiniRAE 2000 (PID) with 10.6 eV lamp or equivalent.
- MIE pDR 1200 with cyclone and pump [particulate monitor] or equivalent.

Soil Vapor Sampling Activities:

- RAE Systems MiniRAE 2000 (PID) with 10.6 eV lamp or equivalent.
- MSA LC Pump or SKC 224-PCXR4 (air pump for air purging monitoring) or equivalent.

Groundwater Sampling Activities:

- Horiba U22 or equivalent.

7.2 Laboratory Instruments

Calibration procedures for a specific laboratory instrument will consist of initial calibrations, initial calibration verifications, and/or continuing calibration verification. Detailed descriptions of the calibration procedures for a specific laboratory instrument are included in the laboratory's quality assurance plan, which describe the calibration procedures, their frequency, acceptance criteria, and the conditions that will require recalibration.

The laboratory quality plan for Pace is located in **Appendix A**.

8. Sample Preparation and Analytical Procedures

Analytical samples will be collected in general accordance with the FSP and as specified in the RIWP. **Table 1, Table 2,** and **Table 3** provide sample collection matrices for soil, soil vapor, and groundwater.

9. Data Reduction, Validation, and Reporting

Appropriate QC measures will be used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data is a primary goal in this project. Complete data packages suitable for data validation to support the generation of a Data Usability Summary Report (DUSR) according to NYSDEC requirements will be provided by the project data validator. Data Management will be performed under the direction of Jaimie Wargo, Senior Technician – Data Management.

9.1 Field Data Evaluation

Measurements and sample collection information will be transcribed directly into the field logbook or onto standardized forms. If errors are made, results will be legibly crossed out, initialed and dated by the person recording the data, and corrected in a space adjacent to the original (erroneous) entry. Reviews of the field records by the field team leader, site manager, and project manager will ensure that:

- Logbooks and standardized forms have been filled out completely and that the information recorded accurately reflects the activities that were performed.
- Records are legible and in accordance with good record keeping procedures, i.e., entries are signed and dated, data are not obliterated, changes are initialed, dated, and explained.
- Sample collection, handling, preservation, and storage procedures were conducted in accordance with the protocols described in the FSP and Work Plan, and that any deviations were documented and approved by the appropriate personnel.

9.2 Analytical Data Validation

Laboratory deliverables will consist of an original hard copy data package that is in general accordance with NYSDEC ASP Category B data deliverable requirements when validation is requested.

10. Internal Quality Control

Laboratory and field quality internal control checks will be used to ensure the data quality objectives. At a minimum, this will include:

- Matrix spike and/or matrix spike duplicate samples
- Matrix duplicate analyses
- Laboratory control spike samples
- Instrument calibrations
- Instrument tunes for VOC 8260B analyses
- Method and/or instrument blanks
- Surrogate spikes for organic analyses
- Internal standard spikes for VOC 8260B analyses
- Detection limit determination and confirmation by analysis of low-level calibration standard

Field quality control samples, as identified in **Table 4**, will include:

- Equipment blanks as outlined
- Field duplicate samples as outlined
- Trip blanks as outlined
- MS/MSDs as outlined

11. Performance and System Audits

Audits are an independent means of: 1) evaluating the operation or capability of a measurement system, and 2) documenting the use of QC procedures designed to generate data of known and acceptable quality.

Field audits may be completed to assess sample collection protocols, determine the integrity of COC procedures, and evaluate sample documentation and data handling procedures. Field audits may be scheduled by the QA officer, Project Manager (PM), site manager or in-house consultant, at their discretion. Written records of audits and any recommendations for corrective action will be submitted to the PM.

The QA officer is the interface between management and project activities in matters of project quality. The QA officer will review the implementation of the QAPP. Reviews will be conducted at the completion of field activities and will include the results of any audits and an evaluation of the data quality.

12. Preventative Maintenance

Preventative maintenance will be performed on field equipment in accordance with the manufacturer's recommendations. Preventative maintenance to rented field equipment will be provided by equipment vendor, U.S Environmental Rental Corporation, Pine Environmental Services, or other selected vendors.

Laboratory equipment calibration and maintenance procedures are specified in Pace's laboratory quality assurance manual provided in **Appendix A**.

13. Specific Procedures to Assess Data Quality Indicators

QC analyses conducted as a part of the testing program will provide a quantitative quality assessment of the data generated and their adherence to the data quality indicators. The data quality indicators ensure that the quality assurance objectives for the project are met.

13.1 Detection Limits

13.1.1 Method Detection Limit

The MDL is defined as follows for all measurements:

MDL = (t[n-1,1-a=0.99]) x (s)

where: s = standard deviation of the replicate analysis,
t(n-1, 1-a=0.99) = student's t-value for a one-sided, 99 percent confidence level and a standard deviation estimate with n-1 degrees of freedom

The MDLs calculated by the laboratory are determined under ideal conditions. MDLs for environmental samples are dependent on the sample aliquot, the matrix, the concentration of analyte, and interference present in the matrix, the percent of moisture, dilution factor, etc. The MDL for each sample analysis will be adjusted accordingly.

13.1.2 *Reporting Limit*

The RL is the concentration of an analyte in the sample that corresponds to the lowest concentration standard of the calibration curve. As with the MDLs, the RLs are dependent on the sample aliquot, the final sample volume, the percent of moisture, dilution factor, etc.

The RL is determined as follows:

$$RL = \frac{\text{Lowest conc. std (ng)}}{\text{Volume injected (uL)}} \; x \; \frac{\text{Sample aliquot (mL or g)}}{\text{Final volume (mL)}} \; x \; DF \; x \; \frac{100}{(100 - \%M)}$$

where: DF = dilution factor, including all dilutions or lost samples not accounted for in a sample aliquot/final volume ratio

%M = percent moisture for solid samples.

13.2 Precision

Variability will be expressed in terms of the RPD when only two data points exist. The RPD is calculated as:

$$RPD = \frac{\text{(Larger Value - Smaller Value)}}{\text{[(Larger Value + Smaller Value)/2]}} \; x \; 100\%$$

For data sets greater than two points, the percent relative standard deviation (percent RSD) is used as the precision measurement. It is defined by the equation:

$$\text{Percent RSD} = \frac{\text{Standard Deviation}}{\text{Mean}} \; x \; 100\%$$

Standard deviation (SD) is calculated as follows:

$$SD = \sqrt{\sum_{i=1}^{n} \frac{(y_i - y)^2}{n - 1}}$$

where: SD = standard deviation

yi = measured value of the ith replicate

y = mean of replicate measurements

n = number of replicates

For measurements such as pH, where the absolute variation is more appropriate, precision is usually reported as the absolute range (D) of duplicate measurements:

$$D = \left| \text{first measurement - second measurement} \right|$$

or as the absolute standard deviation previously given. RPD, %RSD, and D are independent of the error of the analyses and reflect only the degree to which the measurements agree with each other, not the degree to which they agree with the true value for the parameter measured.

13.3 Accuracy

Accuracy is related to the bias in a measurement system. Accuracy describes the degree of agreement of a measurement with a true value. Accuracy will be expressed as percent recovery for each matrix spike analyte by using the following equation:

$$\%\ Recovery = \frac{Css - Cus}{Csa}\ X\ 100\%$$

where:	Css	=	measured concentration in spiked sample
	Cus	=	measured concentration in unspiked sample
	Csa	=	known concentration added to the sample

Accuracy for a measurement such as pH is expressed as bias in the analysis of a standard reference sample according to the equation:

$$\text{Bias} = pH_m - pH_t$$

where:	pH_m	=	measured pH
	pH_t	=	the true pH of the standard reference sample

13.4 Completeness

Data completeness is a measure of the amount of usable data resulting from a measurement effort. For this program, completeness will be defined as the percentage of valid data obtained compared to the total number of measurements necessary to achieve our required statistical level of confidence for each test. The confidence level is based on the total number of samples.

Data completeness is calculated as:

$$Completeness = \frac{Number\ of\ valid\ data\ points}{Number\ of\ data\ points\ necessary\ for\ confidence\ level}\ x\ 100\%$$

The completeness goal is to generate a sufficient amount of valid data. It is anticipated that 95 percent of the data will be complete. Data validation criteria discussed in Section 9 of this QAPP will be used to determine data completeness. Any data deficiencies and their effect on project goals will be evaluated in the DUSR.

13.5 Representativeness

Representativeness is a qualitative statement that expresses the extent to which the sample accurately and precisely represents the characteristics of interest of the study. Representativeness is primarily concerned with the proper design of the sampling program and is best ensured by proper selection of sampling locations and the taking of a sufficient number of samples. It is addressed by describing the sampling techniques, the matrices sampled, and the rationale for the selection of sampling locations, which are discussed in the FSP and RIWP.

13.6 Comparability

Comparability is a qualitative parameter expressing the confidence that one set of data can be compared to another. Comparability is possible only when standardized sampling and analytical procedures are used.

14. Corrective Action

If unacceptable conditions are identified as a result of audits or are observed during field sampling and analysis, the PM, Field Team Leader, and QA officer will document the condition and initiate corrective procedures. The specific condition or problem will be identified, its cause will be determined, and appropriate action will be implemented.

The entire sampling program will be under the direction of the PM and QA officer. The emphasis in this program is on preventing problems by identifying potential errors, discrepancies, and gaps in the data collection, laboratory analysis, and interpretation process. Any problems identified will be promptly resolved. Likewise, follow-up corrective action is always an option in the event that preventative corrective actions are not effective.

The acceptance limits for the sampling and analyses to be conducted in this program will be those stated in the method or defined by other means in the Work Plan and FSP. Corrective actions are likely to be immediate in nature and most often will be implemented by the contracted laboratory analyst or the PM. The corrective action will usually involve recalculation, reanalysis, or repeating a sample run.

14.1 Immediate Corrective Action

Corrective action in the field may be needed when the sample requirements are changed (i.e., more/less samples, sampling locations other than those specified in the Work Plan), or when sampling procedures and/or field analytical procedures require modification, etc. due to unexpected conditions. The field team may identify the need for corrective action. The Field Team Leader, Site Manager, and PM will approve the corrective action and notify the QA officer. The PM and QA officer will approve the corrective measure. The Field Team Leader and Site Manager will ensure that the corrective measure is implemented by the field team.

Corrective actions will be implemented and documented in the field record book. Documentation will include:

- A description of the circumstances that initiated the corrective action
- The action taken in response
- The final resolution
- Any necessary approvals

Corrective action in the laboratory will be completed in accordance with the quality assurance procedures located in **Appendix A**. Any corrective actions completed by the laboratory will be documented in both the laboratory's corrective action files, and the narrative data report sent from the laboratory to the PM. If the corrective action does not rectify the situation, the laboratory will contact the PM, who will determine the action to be taken and inform the appropriate personnel.

If potential problems are not solved as an immediate corrective action, the contractor will apply formalized long-term corrective action if necessary.

Tables

Table 1. Soil and Sediment Field Sampling Matrix
99 Granite Street
Brooklyn, New York

Typical Sample I.D.	TYPICAL SOIL BORING SAMPLE SELECTION RATIONALE: 1. Soil/sediment sample within heaviest observed impacts (if present). 2. Soil/sediment sample beneath zone of deepest impacts. 3. Refer to job specific Work Plan for specific sampling details.								Analysis		
	Sample Number										
	Number Samples Proposed	Number Samples Collected	Date Collected	Within Historic Fill Layer	Heaviest Impacted Zone below 10 feet (if Present)	Water Table Interface	Subsurface soil/sediment below deepest observed visual impacts	Completion depth of boring	TCL VOCs (EPA Method 8260B)	TAL Metals (EPA Method 6010B/7470A)	TCL SVOCs (EPA Method 8270)
Subsurface Soil											
B-XX	4	3							X	X	X

Notes:
VOCs - Volatile Organic Compounds
SVOCs - Semivolatile Organic Compounds
TCL - Target Compound List
TAL - Target Analyte List
EPA - Environmental Protection Agency
Samples will be analyzed in accordance with the Field Sampling Plan

Table 2. Soil Vapor Field Sampling Matrix
99 Granite Street
Brooklyn, New York

<table>
<tr><th rowspan="3">Typical Sample I.D.</th><th colspan="6"><u>SAMPLE SELECTION RATIONALE:</u>
1. The soil vapor probes will be installed to a depth of six feet below grade, or within the backfill utility trenches.</th><th>Analysis</th><th>Soil Vapor Quality Measurements</th></tr>
<tr><th colspan="6">Sample Number</th><th rowspan="2">USEPA Method TO-15</th><th rowspan="2">Tracer Gas (Helium)</th></tr>
<tr><th>Number Samples Proposed</th><th>Number Samples Collected</th><th>Date Collected</th><th>Sampling Duration</th><th>Flow Rate</th><th>Soil Vapor Probe Installation Depth(1)</th></tr>
<tr><td colspan="9">Soil Vapor Sample</td></tr>
<tr><td>SV-XX</td><td></td><td></td><td></td><td>2 hours</td><td>0.2 L/min</td><td>6'</td><td>X</td><td>X</td></tr>
</table>

Table 3. Groundwater Field Sampling Matrix
99 Granite Street
Brooklyn, New York

Sample I.D.	Sample Location	SAMPLE SELECTION RATIONALE: 1. Groundwater Sample locations and depth intervals will be specified within a job specific Work Plan				Water Quality Measurements						Analysis		
		Sample Number			Sample Zone	pH	Specific Conductance	Temperature	Oxidation Reduction Potential (ORP)	Turbidity	Salinity	TCL VOCs (EPA Method 8260B)	TCL SVOCs (EPA Method 8270)	TAL Metals (EPA Method 6010B/7470A)
		Number Samples Proposed	Number Samples Collected	Date Collected	Water Table									
Monitoring Well Sample Locations														
MW-XX	4	3				X	X	X	X	X	X	X	X	X

Notes:
VOCs - Volatile Organic Compounds
SVOCs - Semi-volatile Organic Compounds
TCL - Target Compound List
TAL - Target Analyte List
EPA - Environmental Protection Agency
Samples will be collected in accordance with the Field Sampling Plan

Table 4. Analytical Methods/Quality Assurance Summary Table
99 Granite Street
Brooklyn, New York

Media	Number of Primary Samples	QA/QC Samples				Total Number of Samples	Analytical Parameters	Method	Preservative	Holding Time	Container
		TB	FB[1]	DUP	MS/MSD						
Shallow Subsurface & Deep Soil	TBD	1/Cooler	1/20	1/20	1/20	TBD	TCL VOCs	8260B	Cool to 4°C	5 days unpreserved, 12 days preserved	3-40 mL vials (2 with stir bars) + 2 - 1 oz jars
	TBD	1/Cooler	1/20	1/20	1/20	TBD	TAL Metals	6010B/7471B	Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	Wide mouth 8-oz. clear glass jar
	4	3	1/20	1/20	1/20	TBD	Formaldehyde	8315A	Cool to 4°C	10 days	2-oz jar
		1/Cooler	1/20	1/20	1/20	TBD	TCL SVOCs	8270C	Cool to 4°C	10 days	2-oz jar
Groundwater	TBD	1/Cooler	1/20	1/20	1/20	TBD	TCL VOCs	8260B	pH<2 with HCl, Cool to 4°C	10 days	(2) 40 mL VOA vials w/HCL
	TBD	1/Cooler	1/20	1/20	1/20	TBD	TCL SVOCs	8270C	Cool to 4°C	5 days	(2) Liter amber glass
	TBD	1/Cooler	1/20	1/20	1/20	TBD	Formaldehyde	8315AA	Cool to 4°C	5 days	(2) Liter amber glass
	TBD	1/Cooler	1/20	1/20	1/20	TBD	TAL Metals	6010B7470A	pH<2 with HNO3 Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	(1) 500 mL Polyethylene container w/HNO3
Soil Vapor	TBD	NA	NA	1/20	NA	TBD	Toxic Organic Compounds	USEPA Method TO-15	None	30 Days	(1) Stainless steel canister

Notes:
VOCs - Volatile organic compounds
SVOCs - Semivolatile organic compounds
°C- Degrees Celsius
L - Liter
oz. - Ounce
mL - Milliliter
TBD - To be Determined
TAL - Target Analyte List

Table 5. Chemical Parameters, Reporting Limits and Data Quality Objectives for Soil Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte	DQO's		Pace Analytical	
		ASP 2005	Residential Use [1]		
		CRQL	SCO	RL	MDL
TCL Volatile Organic Compounds (µg/Kg) via Method 8260 B					
71-55-6	1,1,1-Trichloroethane	3	100,000	5	0.389
79-34-5	1,1,2,2-Tetrachloroethane	10	35,000	5	0.591
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	NE	100,000	5	3.9
79-00-5	1,1,2-Trichloroethane	10	NE	5	0.699
75-34-3	1,1-Dichloroethane	10	19,000	5	0.426
75-35-4	1,1-Dichloroethene	10	100,000	5	0.355
87-61-6	1,2,3-Trichlorobenzene	10	NE	5	1.55
120-82-1	1,2,4-Trichlorobenzene	10	NE	5	1.29
96-12-8	1,2-Dibromo-3-chloropropane	100	NE	5	2.06
106-93-4	1,2-Dibromoethane (EDB)	10	NE	5	0.729
95-50-1	1,2-Dichlorobenzene	10	100,000	5	1.2
107-06-2	1,2-Dichloroethane	10	2,300	5	0.845
78-87-5	1,2-Dichloropropane	10	NE	5	1.86
541-73-1	1,3-Dichlorobenzene	10	17,000	5	1.32
106-46-7	1,4-Dichlorobenzene	10	9,800	5	1.22
123-91-1	1,4-Dioxane	NE	9,800	125	22.2
78-93-3	2-Butanone (MEK)	10	100,000	10	1.05
591-78-6	Methyl Butyl Ketone (2-Hexanone)	10	NE	10	0.212
108-10-1	4-Methyl-2-pentanone (MIBK)	10	NE	10	0.617
67-64-1	Acetone	10	100,000	10	1.42
71-43-2	Benzene	10	2,900	5	0.591
74-97-5	Bromochloromethane	10	NE	5	0.743
75-27-4	Bromodichloromethane	10	NE	5	0.412
75-25-2	Bromoform	10	NE	5	0.807
74-83-9	Bromomethane	10	NE	5	0.571
75-15-0	Carbon disulfide	10	100,000	5	0.584
56-23-5	Carbon tetrachloride	10	1,400	5	0.407
108-90-7	Chlorobenzene	10	100,000	5	0.797
75-00-3	Chloroethane	10	NE	5	0.56
67-66-3	Chloroform	10	10,000	5	0.662
74-87-3	Chloromethane	10	NE	5	0.74
156-59-2	cis-1,2-Dichloroethene	10	59,000	5	0.4
10061-01-5	cis-1,3-Dichloropropene	10	NE	5	0.363
110-82-7	Cyclohexane	NE	NE	5	4.45
124-48-1	Dibromochloromethane	10	NE	5	0.831
75-71-8	Dichlorodifluoromethane (FREON 12)	10	NE	5	1.17
100-41-4	Ethylbenzene	10	30,000	5	1.01
98-82-8	Isopropylbenzene	10	NE	5	0.734
79-20-9	Methyl Acetate	NE	NE	5	1.13
1634-04-4	Methyl tert-butyl ether (MTBE)	NE	62,000	5	0.577
108-87-2	Methylcyclohexane	NE	NE	5	1.27
75-09-2	Methylene chloride	10	51,000	5	0.649
100-42-5	Styrene	10	NE	5	0.6
127-18-4	Tetrachloroethene	10	5,500	5	1.92
108-88-3	Toluene	10	100,000	5	0.379
156-60-5	trans-1,2-Dichloroethene	10	100,000	5	0.507
10061-02-6	trans-1,3-Dichloropropene	10	NE	5	0.501
79-01-6	Trichloroethene	10	10,000	5	0.589
75-69-4	Trichlorofluoromethane (FREON 11)	10	NE	5	0.334
75-01-4	Vinyl chloride	10	210	5	0.706
1330-20-7	Total Xylene	10	100,000	5	0.732
TCL Semivolatile Organic Compounds (µg/Kg) via Method 8270					
92-52-4	1,1´-Biphenyl	NE	NE	170	48.6
95-94-3	1,2,4,5-Tetrachlorobenzene	330	NE	170	41.8
52438-91-2	2,2-oxybis[1-Chloropropane]	330	NE	170	41
95-95-4	2,4,5-Trichlorophenol	330	NE	330	60
88-06-2	2,4,6-Trichlorophenol	330	NE	170	52.1
120-83-2	2,4-Dichlorophenol	330	2,000	170	36.7
105-67-9	2,4-Dimethylphenol	330	NE	170	43.2
51-28-5	2,4-Dinitrophenol	800	NE	330	57.6
121-14-2	2,4-Dinitrotoluene	330	NE	170	41.2
606-20-2	2,6-Dinitrotoluene	330	1,030	170	43.2

Table 5. Chemical Parameters, Reporting Limits and Data Quality Objectives for Soil Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte	DQO's		Pace Analytical	
		ASP 2005	Residential Use [1]		
		CRQL	SCO	RL	MDL
91-58-7	2-Chloronaphthalene	330	NE	170	42.7
95-57-8	2-Chlorophenol	330	400,000	170	33.7
91-57-6	2-Methylnaphthalene	330	NE	170	42.1
95-48-7	2-Methylphenol (o-Cresol)	330	100,000	170	37.3
88-74-4	2-Nitroaniline	800	NE	330	38.9
88-75-5	2-Nitrophenol	330	NE	170	55.3
91-94-1	3,3-Dichlorobenzidine	660	NE	170	35.5
99-09-2	3-Nitroaniline	800	NE	330	35.1
534-52-1	4,6-Dinitro-2-methylphenol	800	NE	330	53
101-55-3	4-Bromophenyl phenyl ether	330	NE	170	49.5
59-50-7	4-Chloro-3-methylphenol	330	NE	170	46.2
106-47-8	4-Chloroaniline	330	200,000	170	36.8
7005-72-3	4-Chlorophenyl phenyl ether	330	NE	170	45.5
106-44-5	4-Methylphenol (p-Cresol)	330	100,000	170	78.8
100-01-6	4-Nitroaniline	800	NE	330	42.8
100-02-7	4-Nitrophenol	800	NE	330	42.6
83-32-9	Acenaphthene	330	100,000	170	40.2
208-96-8	Acenaphthylene	330	100,000	170	38.8
98-86-2	Acetophenone	330	NE	170	57.7
120-12-7	Anthracene	330	100,000	170	41.8
108-95-2	Atrazine	NE	NE	170	47.8
100-52-7	Benzaldehyde	NE	NE	170	107
56-55-3	Benz[a]anthracene	330	1,000	170	40.8
50-32-8	Benzo[a]pyrene	330	1,000	170	40.5
205-99-2	Benzo[b]fluoranthene	330	1,000	170	34.2
191-24-2	Benzo[g,h,i]perylene	330	100,000	170	34.6
207-08-9	Benzo[k]fluoranthene	330	1,000	170	59.5
111-91-1	Bis(2-chloroethoxy)methane	330	NE	170	44.8
111-44-4	Bis(2-chloroethyl)ether	330	NE	170	38.7
117-81-7	Bis(2-ethylhexyl)phthalate	330	50,000	170	46.9
85-68-7	Butyl benzyl phthalate	330	100,000	170	48.9
105-6--2	Caprolactam	NE	NE	170	41.7
86-74-8	Carbazole	330	NE	170	42.6
218-01-9	Chrysene	330	1,000	170	49.3
84-74-2	Di-n-butyl phthalate	330	100,000	170	38.5
117-84-0	Di-n-octyl phthalate	330	100,000	170	45.6
53-70-3	Dibenz[a,h]anthracene	330	330	170	37.9
132-64-9	Dibenzofuran	330	14,000	170	41.7
84-66-2	Diethyl phthalate	330	100,000	170	38.2
131-11-3	Dimethyl phthalate	330	NE	170	41.5
206-44-0	Fluoranthene	330	100,000	170	29.7
86-73-7	Fluorene	330	100,000	170	41.6
118-74-1	Hexachlorobenzene	330	410	170	41.2
87-68-3	Hexachlorobutadiene	330	NE	170	42.2
77-47-4	Hexachlorocyclopentadiene	330	NE	170	43.3
67-72-1	Hexachloroethane	330	NE	170	41.9
193-39-5	Indeno[1,2,3-cd]pyrene	330	500	170	36.6
78-59-1	Isophorone	330	100,000	170	45.8
621-64-7	N-Nitrosodi-n-propylamine	330	NE	170	29.6
86-30-6	N-Nitrosodiphenylamine	330	NE	170	86.1
91-20-3	Naphthalene	330	100,000	170	41.6
98-95-3	Nitrobenzene	330	3,700	170	32.7
87-86-5	Pentachlorophenol	800	2,400	330	64.6
85-01-8	Phenanthrene	330	100,000	170	42.4
108-95-2	Phenol	330	100,000	170	23.3
129-00-0	Pyrene	330	100,000	170	51.5

Table 5. Chemical Parameters, Reporting Limits and Data Quality Objectives for Soil Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte	DQO's		Pace Analytical	
		ASP 2005	Residential Use [1]		
		CRQL	SCO	RL	MDL
Inorganic Analytes (mg/Kg) via Methods 6010 & 7471					
7429-90-5	Aluminum	NE	NE	200	24
7440-36-0	Antimony	60	NE	60	4
7440-38-2	Arsenic	10	16	10	4
7440-39-3	Barium	200	350	200	16
7440-41-7	Beryllium	5	14	5	0.2
7440-43-9	Cadmium	5	2.5	**5**	0.0
7440-70-2	Calcium	NE	NE	5000	27
7440-47-3	Chromium (sum of Cr III and Cr IV)	10	NE	10	8
7440-48-4	Cobalt	50	30	**50**	1
7440-50-8	Copper	25	270	25	3
7439-89-6	Iron	NE	2,000	100	29
7439-92-1	Lead	5	400	3	24
7439-95-4	Magnesium	NE	NE	5000	34
7439-96-5	Manganese	NE	2,000	15	1
7439-97-6	Mercury	0.2	0.8	0.1	0.2
7440-02-0	Nickel	40	140	40	1
7440-09-7	Potassium	NE	NE	5000	176
7782-49-2	Selenium	5	36	5	4
7440-22-4	Silver	10	36	10	0
7440-23-5	Sodium	NE	NE	5000	338
7440-28-0	Thallium	10	NE	10	17
7440-62-2	Vanadium	50	100	50	1
7440-66-6	Zinc	20	2,200	20	2

Notes:

mg/kg - milligrams per kilogram
µg/Kg - micrograms per kilogram
RL - Reporting Limits
MDL - Method Detection Limit
DQO - Data Quality Objectives
NE - Not Established
TCL - Target Compound List
SCO - Site Cleanup Objective
1 - DQOs are based on 6 NYCRR Part 375 -6.8(b) Residential Use Soil Clean-up Objectives
2 - RLs and MDLs are based on Pace Analytical's Reporting Limits and Method Detection limits as of October 2010.

Table 6. Chemical Parameters, Reporting Limits and Data Quality Objectives for Soil Vapor Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte	PACE Labs [2]	
		RL	MDL
EPA TO-15 Compounds (ppbv)			
71-55-6	1,1,1-Trichloroethane	3.0	0.018
79-34-5	1,1,2,2-Tetrachloroethane	0.2	0.012
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	0.2	0.012
79-00-5	1,1,2-Trichloroethane	0.2	0.022
75-34-3	1,1-Dichloroethane	0.2	0.015
75-35-4	1,1-Dichloroethene	0.2	0.024
95-63-6	1,2,4-Trichlorobenzene	0.2	0.022
95-63-6	1,2,4-Trimethylbenzene	0.2	0.012
106-93-4	1,2-Dibromoethane	0.2	0.030
95-50-1	1,2-Dichlorobenzene	0.2	0.017
107-06-2	1,2-Dichloroethane	0.2	0.025
156-59-2	1,2-Dichloroethene (cis)	0.2	0.017
540-59-0	1,2-Dichloroethene (total)	0.2	0.031
78-87-5	1,2-Dichloropropane	0.2	0.034
76-14-2	1,2-Dichlorotetrafluoroethane	0.2	0.017
108-67-8	1,3,5-Trimethylbenzene	0.2	0.015
541-73-1	1,3-Dichlorobenzene	0.2	0.010
10061-01-5	1,3-Dichloropropene (cis)	0.2	0.030
10061-02-6	1,3-Dichloropropene (trans)	0.2	0.028
87-68-3	1,3-Hexachlorobutadiene	0.2	0.017
106-46-7	1,4-Dichlorobenzene	0.2	0.012
67-64-1	Acetone	0.2	0.076
71-43-2	Benzene	0.2	0.017
75-27-4	Bromodichloromethane	0.2	0.022
75-25-2	Bromoform	0.2	0.012
74-83-9	Bromomethane	0.2	0.022
75-15-0	Carbon disulfide	0.2	0.017
56-23-5	Carbon tetrachloride	0.2	0.017
108-90-7	Chlorobenzene	0.2	0.024
75-00-3	Chloroethane	0.2	0.034
67-66-3	Chloroform	0.2	0.022
74-87-3	Chloromethane	0.2	0.015
124-48-1	Dibromochloromethane	0.2	0.010
75-71-8	Dichlorodifluoromethane	0.2	0.025
100-41-4	Ethylbenzene	0.2	0.022
591-78-6	Methyl butyl ketone	0.2	0.031
78-93-3	Methyl ethyl ketone	0.2	0.018
108-10-1	Methyl isobutyl ketone	0.2	0.024
1634-04-4	Methyl tert-butyl ether	0.2	0.028
75-09-2	Methylene chloride	0.2	0.036
100-42-5	Styrene	0.2	0.015

Table 6. Chemical Parameters, Reporting Limits and Data Quality Objectives for Soil Vapor Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte	PACE Labs [2]	
		RL	MDL
EPA TO-15 Compounds (ppbv)			
127-18-4	Tetrachloroethene	0.2	0.022
108-88-3	Toluene	0.2	0.022
79-01-6	Trichloroethene	0.2	0.030
75-69-4	Trichlorofluoromethane	0.2	0.012
105-05-4	Vinyl acetate	0.2	0.040
75-01-4	Vinyl chloride	0.2	0.026
108-38-3/ 106-42-3	Xylenes (m&p)	0.2	0.012
95-42-3	Xylenes (o)	0.2	0.012
91-20-3	Naphthalene	0.5	0.022

Notes:

mg/kg - milligrams per kilogram
µg/Kg - micrograms per kilogram
ppbv - parts per billion per volume
RL - Reporting Limits
MDL - Method Detection Limit
DQO - Data Quality Objectives
1 - DQOs are based on 6 NYCRR Part 375 -6.8(b) Residential Use Soil Clean-up Objectives
2 - RLs and MDLs are based on Pace Analytical's Reporting Limits and Method Detection limits as of October 2010.

Table 7. Chemical Parameters, Reporting Limits and Data Quality Objectives for Groundwater Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte Name	DQO's		Pace Analytical	
		ASP 2005	NY AWQS GA [1]		
		CRQL	H(WS)	RL	MDL
Volatile Organic Compounds Method 8260 B (µg/L)					
71-55-6	1,1,1-Trichloroethane	3	5	5	0.06
79-34-5	1,1,2,2-Tetrachloroethane	1	5	5	0.12
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	NE	5	5	0.78
79-00-5	1,1,2-Trichloroethane	1	1	**5**	0.104
75-34-3	1,1-Dichloroethane	1	5	5	0.07
75-35-4	1,1-Dichloroethene	1	0.07	**5**	0.155
87-61-6	1,2,3-Trichlorobenzene	1	5	5	0.252
120-82-1	1,2,4-Trichlorobenzene	1	5	5	0.296
96-12-8	1,2-Dibromo-3-chloropropane	1	0.04	**5**	0.178
106-93-4	1,2-Dibromoethane (EDB)	1	0.0006	**5**	0.085
95-50-1	1,2-Dichlorobenzene	1	3	**5**	0.114
107-06-2	1,2-Dichloroethane	1	NE	5	0.087
78-87-5	1,2-Dichloropropane	1	1	**5**	0.095
541-73-1	1,3-Dichlorobenzene	1	3	**5**	0.129
106-46-7	1,4-Dichlorobenzene	1	3	**5**	0.113
123-91-1	1,4-Dioxane	NE	NE	125	28.259
78-93-3	2-Butanone (MEK)	5	50*	10	0.77
591-78-6	Methyl Butyl Ketone (2-Hexanone)	5	50*	10	0.439
108-10-1	4-Methyl-2-pentanone (MIBK)	5	NE	10	0.164
67-64-1	Acetone	5	50*	10	0.356
71-43-2	Benzene	1	1	**5**	0.074
74-97-5	Bromochloromethane	1	5	5	0.074
75-27-4	Bromodichloromethane	1	50*	5	0.063
75-25-2	Bromoform	1	50*	5	0.486
74-83-9	Bromomethane	1	5	5	0.216
75-15-0	Carbon disulfide	1	60*	5	0.543
56-23-5	Carbon tetrachloride	1	5	5	0.467
108-90-7	Chlorobenzene	1	5	5	0.034
75-00-3	Chloroethane	1	5	5	0.196
67-66-3	Chloroform	1	7	5	0.111
74-87-3	Chloromethane	1	5	5	0.181
156-59-2	cis-1,2-Dichloroethene	1	5	5	0.149
10061-01-5	cis-1,3-Dichloropropene	1	0.4	**5**	0.105
110-82-7	Cyclohexane	NE	NE	5	0.087
124-48-1	Dibromochloromethane	1	50*	5	0.174
75-71-8	Dichlorodifluoromethane (FREON 12)	1	5	5	0.102
100-41-4	Ethylbenzene	1	5	5	0.132
98-82-8	Isopropylbenzene	1	5	5	0.108
79-20-9	Methyl Acetate	NE	NE	5	0.753
1634-04-4	Methyl tert-butyl ether (MTBE)	NE	10*	5	0.031
108-87-2	Methylcyclohexane	NE	NE	5	1.27
75-09-2	Methylene chloride	2	5	5	0.169
100-42-5	Styrene	1	5	5	0.118
127-18-4	Tetrachloroethene	1	5	5	0.384
108-88-3	Toluene	1	5	5	0.077

Table 7. Chemical Parameters, Reporting Limits and Data Quality Objectives for Groundwater Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte Name	DQO's		Pace Analytical	
		ASP 2005	NY AWQS GA [1]		
		CRQL	H(WS)	RL	MDL
156-60-5	trans-1,2-Dichloroethene	1	5	5	0.075
10061-02-6	trans-1,3-Dichloropropene	1	0.4	**5**	0.144
79-01-6	Trichloroethene	1	5	5	0.08
75-69-4	Trichlorofluoromethane (FREON 11)	1	5	5	0.141
75-01-4	Vinyl chloride	1	2	**5**	0.119
1330-20-7	Total Xylene	1	5	5	0.065
Semivolatile Organic Compounds (µg/L) via Method 8270					
92-52-4	1,1´-Biphenyl	NE	5	5	0.318
95-94-3	1,2,4,5-Tetrachlorobenzene	10	5	5	0.637
52438-91-2	2,2´-oxybis(1-chloropropane)	10	NE	5	0.595
95-95-4	2,4,5-Trichlorophenol	10	NE	10	1.044
88-06-2	2,4,6-Trichlorophenol	10	NE	5	0.692
120-83-2	2,4-Dichlorophenol	10	5	5	0.784
105-67-9	2,4-Dimethylphenol	10	50*	5	0.476
51-28-5	2,4-Dinitrophenol	25	10*	10	0.866
121-14-2	2,4-Dinitrotoluene	10	5	5	0.473
606-20-2	2,6-Dinitrotoluene	10	5	5	0.701
91-58-7	2-Chloronaphthalene	10	10**	5	0.677
95-57-8	2-Chlorophenol	10	NE	5	0.82
91-57-6	2-Methylnaphthalene	10	NE	5	0.616
95-48-7	2-Methylphenol (o-Cresol)	10	1**	**5**	0.262
88-74-4	2-Nitroaniline	25	5	10	0.699
88-75-5	2-Nitrophenol	10	NE	5	1.867
91-94-1	3,3-Dichlorobenzidine	20	5	5	0.815
99-09-2	3-Nitroaniline	25	5	10	0.486
534-52-1	4,6-Dinitro-2-methylphenol	25	NE	10	2.313
101-55-3	4-Bromophenyl phenyl ether	10	NE	5	0.692
59-50-7	4-Chloro-3-methylphenol	10	NE	5	0.601
106-47-8	4-Chloroaniline	10	5	5	0.49
7005-72-3	4-Chlorophenyl phenyl ether	10	NE	5	0.594
106-44-5	4-Methylphenol (p-Cresol)	10	1**	**5**	0.253
100-01-6	4-Nitroaniline	25	5	10	0.517
100-02-7	4-Nitrophenol	25	NE	10	0.925
83-32-9	Acenaphthene	10	20**	5	0.523
208-96-8	Acenaphthylene	10	NE	5	0.604
98-86-2	Acetophenone	10	NE	5	0.711
120-12-7	Anthracene	10	50*	5	0.591
108-95-2	Atrazine	NE	7.5	5	0.341
100-52-7	Benzaldehyde	NE	NE	5	0.507
56-55-3	Benz[a]anthracene	10	0.002*	**5**	0.63
50-32-8	Benzo[a]pyrene	10	ND	5	0.511
205-99-2	Benzo[b]fluoranthene	10	0.002*	**5**	0.587
191-24-2	Benzo[g,h,i]perylene	10	NE	5	0.45
207-08-9	Benzo[k]fluoranthene	10	0.002*	**5**	0.419
111-91-1	Bis(2-chloroethoxy)methane	10	5	5	0.465
111-44-4	Bis(2-chloroethyl)ether	10	1	5	0.56
117-81-7	Bis(2-ethylhexyl)phthalate	10	5	5	1.024
85-68-7	Butyl benzyl phthalate	10	50*	5	0.447

Table 7. Chemical Parameters, Reporting Limits and Data Quality Objectives for Groundwater Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte Name	DQO's		Pace Analytical	
		ASP 2005	NY AWQS GA [1]		
		CRQL	H(WS)	RL	MDL
105-6--2	Caprolactam	NE	NE	5	0.128
86-74-8	Carbazole	10	NE	5	0.321
218-01-9	Chrysene	10	0.002*	**5**	0.657
84-74-2	Di-n-butyl phthalate	10	50	5	0.515
117-84-0	Di-n-octyl phthalate	10	50*	5	0.416
53-70-3	Dibenz[a,h]anthracene	10	NE	5	0.477
132-64-9	Dibenzofuran	10	NE	5	0.584
84-66-2	Diethyl phthalate	10	50*	5	0.555
131-11-3	Dimethyl phthalate	10	50*	5	0.564
206-44-0	Fluoranthene	10	50*	5	0.463
86-73-7	Fluorene	10	50*	5	0.532
118-74-1	Hexachlorobenzene	10	0.04	5	0.602
87-68-3	Hexachlorobutadiene	10	0.5	5	0.559
77-47-4	Hexachlorocyclopentadiene	10	5	5	0.392
67-72-1	Hexachloroethane	10	5	5	0.498
193-39-5	Indeno[1,2,3-cd]pyrene	10	0.002*	**5**	0.363
78-59-1	Isophorone	10	50*	5	0.55
621-64-7	N-Nitrosodi-n-propylamine	10	NE	5	0.626
86-30-6	N-Nitrosodiphenylamine	10	50*	5	0.438
91-20-3	Naphthalene	10	10**	5	0.526
98-95-3	Nitrobenzene	10	0.4	**5**	0.481
87-86-5	Pentachlorophenol	25	1**	**10**	1.304
85-01-8	Phenanthrene	10	50*	5	0.673
108-95-2	Phenol	10	1**	**5**	0.336
129-00-0	Pyrene	10	50*	5	0.624
Inorganic Analytes (mg/L) via Methods 6010 & 7470					
7429-90-5	Aluminum	NE	NE	200	10
7440-36-0	Antimony	60	3	**60**	3
7440-38-2	Arsenic	10	25	10	3
7440-39-3	Barium	200	1000	200	200
7440-41-7	Beryllium	5	3*	**5**	0.3
7440-43-9	Cadmium	5	5	5	0
7440-70-2	Calcium	NE	NE	5000	15
7440-47-3	Chromium (sum of Cr III and Cr IV)	10	50	10	1
7440-48-4	Cobalt	50	NE	50	1
7440-50-8	Copper	25	200	25	1
7439-89-6	Iron	NE	300	100	8
7439-92-1	Lead	5	25	3	1
7439-95-4	Magnesium	NE	35000*	5000	35
7439-96-5	Manganese	NE	300	15	0
7439-97-6	Mercury	0.2	0.7	0.1	0.3
7440-02-0	Nickel	40	100	40	1
7440-09-7	Potassium	NE	NE	5000	238

Table 7. Chemical Parameters, Reporting Limits and Data Quality Objectives for Groundwater Samples
99 Granite Street
Brooklyn, New York

CAS Number	Analyte Name	DQO's		Pace Analytical	
		ASP 2005	NY AWQS GA [1]		
		CRQL	H(WS)	RL	MDL
7782-49-2	Selenium	5	10	5	4
7440-22-4	Silver	10	50	**10**	1
7440-23-5	Sodium	NE	20000	5000	48
7440-28-0	Thallium	10	0.5*	**10**	4
7440-62-2	Vanadium	50	NE	50	1.4
7440-66-6	Zinc	20	2000*	20	1

Notes:

* = Guidance Value

mg/L - milligrams per Liter

µg/L - micrograms per Liter

RL - Reporting Limit

MDL - Method Detection Limit

DQO - Data Quality Objectives

1 - DQOs are based on TOGS Ambient Water Quality Standards and Guidance Values and Groundwater
was not available, the Aesthetic [E] type is used shown.

2 - RLs and MDLs are based on Pace Analytical's Reporting Limits and Method Detection limits as of January 2012.

Bolding - RL does not meet the DQO

Table 8. Quality Control Limits Percision and Accuracy for Soil and Sediment Samples
99 Granite Street
Brooklyn, New York

Soil/Sediment QC Limits										
			MS/MSD % Recovery			LCS % Recovery			Surrogate % Recovery	
Analytical	**Analytical Method**	**MS/MSD Compound**	Low	High	RPD	Low	High	**Surrogate**	Low	High
VOCs	8260B	1,1-Dichloroethene	59	172	22	59	172	1,2-Dichloroethane-d4	33	145
		3	66	142	21	66	142	4-Bromofluorobenzene	60	148
		Chlorobenzene	60	133	21	60	133	Toluene-d8	60	132
		Toluene	59	139	21	59	139			
		Trichloroethene	62	137	24	62	137			
SVOCs	8270	2,4-Dinitrotoluene	28	116	47	24	96	1,2-Dichlorobenzene-d4	20	130
		2-Chlorophenol	25	102	50	27	123	2,4,6-Tribromophenol	19	122
		4-Chloro-3-methylphenol	26	103	33	23	97	2-Chlorophenol-d4	20	130
		4-Nitrophenol	11	114	50	10	80	2-Fluorobiphenyl	30	115
		Acenaphthene	31	137	19	46	118	2-Fluorophenol	25	121
		N-Nitroso-di-n-propylamine	41	126	38	41	116	4-Terphenyl-d14	18	137
		Pentachlorophenol	17	109	47	9	103	Nitrobenzene-d5	23	120
		Phenol	26	90	35	12	110	Phenol-d5	24	113
		Pyrene	35	142	36	26	127			
Metals	6010B	Metals excluding Hg	75[(a)]	125	20[(b)]	Varies	Varies	NA		
	7471B	Mercury	75[(a)]	125	20[(b)]	NA	NA	NA		
Formaldehyde	8315A	Formaldehyde	50	136	40	39	153			

Notes:

(a) Matrix spike only
(b) Laboratory duplicate RPD
NA - Not Applicable
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
RPD - Relative Percent Difference

Table 9. Quality Control Limits Percision and Accuracy for Soil Vapor Samples
99 Granite Street
Brooklyn, New York

Aqueous QC Limits										
Analytical	**Analytical Method**	**MS/MSD Compound**	**MS/MSD % Recovery**			**LCS % Recovery**		**Surrogate**	**Surrogate % Recovery**	
			Low	High	RPD	Low	High		Low	High
AIR	TO-15	N/A	N/A	N/A	N/A	ALL COMPOUNDS 70-130%		4-Bromofluorobenzene	70	130

N/A - Not Applicable

Table 10. Quality Control Limits Percision and Accuracy for Groundwater Samples
99 Granite Street
Brooklyn, New York

Aqueous QC Limits										
			MS/MSD % Recovery			LCS % Recovery			Surrogate % Recovery	
Analytical	**Analytical Method**	**MS/MSD Compound**	Low	High	RPD	Low	High	**Surrogate**	Low	High
VOCs	8260B	1,1-Dichloroethene	61	145	14	61	145	1,2-Dichloroethane-d4	76	114
		3	76	127	11	76	127	4-Bromofluorobenzene	86	115
		Chlorobenzene	75	130	13	75	130	Toluene-d8	88	110
		Toluene	76	125	13	76	125			
		Trichloroethene	71	120	14	71	120			
SVOCs	8270	2,4-Dinitrotoluene	24	96	38	24	96	1,2-Dichlorobenzene-d4	16	110
		2-Chlorophenol	27	123	40	27	123	2,4,6-Tribromophenol	10	123
		4-Chloro-3-methylphenol	23	97	42	23	97	2-Chlorophenol-d4	33	110
		4-Nitrophenol	10	80	50	10	80	2-Fluorobiphenyl	43	116
		Acenaphthene	46	118	31	46	118	2-Fluorophenol	21	110
		N-Nitroso-di-n-propylamine	41	116	38	41	116	4-Terphenyl-d14	33	141
		Pentachlorophenol	9	103	50	9	103	Nitrobenzene-d5	35	114
		Phenol	12	110	42	12	110	Phenol-d5	10	110
		Pyrene	26	127	31	26	127			
Metals	6010B	Metals excluding Hg	75[(a)]	125	20[(b)]	80	120	NA	--	--
	7470A	Mercury	75[(a)]	125	20[(b)]	NA	NA	NA	--	--
Fomaldehyde	8315	Formaldehyde	46	126	40	39	153	NA	--	--

Notes:

[(a)] Matrix spike only
[(b)] Laboratory duplicate RPD
NA - Not Applicable
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
PCBs - polychlorinated biphenols

Appendix A

Pace Analytical Services Laboratory Quality Assurance Manual (electronic only)

120 Research Drive
Stratford, CT 06615
203-325-1371

Quality Manual

Lab Director	Benjamin Gulizia
Sr. Scientist/Tech Dir/CT	Robert Q. Bradley
QA/QC Officer CT/NY	Magdalena Szymczuk
Date of Issue:	February 23, 2017
Revision:	2.8

Table of Contents-York Quality Manual

Quality Manual

This Quality Manual meets the requirements of ISO 17025, ISO 9001 and NELAC. This Quality Manual is confidential and assigned as outlined below.

Issued to: ______________________________

Revision History

Revision 2.0	04/30/2010	First issue rewritten quality manual
Revision 2.1	11/13/2011	Updated Org Chart and Master List of Documents
Revision 2.2	06/29/2012	Updated Org Chart and Master List of Documents
Revision 2.3	12/26/2012	Added Data Integrity Plan, Reformatted document
Revision 2.4	04/12/2013	Added Aquatic Toxicity information
Revision 2.5	07/18/2014	Updated Org Chart and Master List of Documents
Revision 2.6	10/06/2014	Updated Org Chart and Master List of Documents
Revision 2.7	07/12/2016	Updated Org Chart and Master List of Documents
Revision 2.8	02/23/2017	Updated Org Chart and Master List of Documents Replaced printed copy with electronic.

A protected copy of the Quality Manual is available for each Employee on the York's network (G Drive, folder QUALITY MANUAL)

1. Introduction

Purpose

This Quality Manual contains all the requirements that our laboratory uses to demonstrate our quality management system, technical competence, and valid results.

Analytical data are used for many purposes, including: compliance with regulatory requirements; determination for the presence, concentration, and movement of hazardous materials in the environment; potential effects upon or protection required for persons; and the actions necessary for disposal of treatment of hazardous materials.

Analytical data may be used to support a broader-based project involved with: site characterization and/or remediation; on-site treatment; treatment and/or disposal or health and safety protection of York personnel and the public. Data may also be produced for outside commercial testing and submitted directly to clients for their decision making. In all cases, data must be of known quality.

It is the purpose of the York Quality Assurance Program, as expressed in this Quality Systems Manual, to provide all data which are of known quality. To achieve this, a system is described which controls:

- Preservation of samples
- Receipt and handling of samples
- Processing and analyses of samples
- Analytical instrumentation
- Data verification
- Data reporting

Section 4 specifies how we demonstrate sound management and maintain client satisfaction.

Section 5 specifies how we demonstrate technical competence in our laboratory.

In addition, this Quality Manual outlines how York complies with:

- ISO 17025
- ISO 9001
- NELAC

All personnel are to take an active role in establishing, implementing, and maintaining our quality management program. We do not separate quality from our daily business. Quality cannot be something that we do just to pass audits. Quality is integrated into every facet of the decision-making process in the management of our laboratory and the science that we practice.

Distribution List

The Quality Assurance Officer (QAO) maintains the distribution list for this Quality Manual.

2. Scope

This Quality Manual facilitates:

- Recognition of technical competence for standardized methods, non-routine methods, and laboratory-developed methods we perform
- Inspection and product certification capabilities and/or services we provide
- Total quality for our administrative and technical systems
- Audits by clients, regulatory authorities and accreditation bodies
- Meeting the requirements of NELAC, ISO 17025, and ISO 9001
- Client satisfaction

3. Normative References

Reference List

ISO/IEC 17000, Conformity assessment – Vocabulary and general principles

VIM, International vocabulary of basic and general terms in metrology, issued by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML.

ISO 9001:2008 – Quality Management Systems – Requirements.

ISO 17025:2005 – General Requirements for the Competence of Testing and Calibration Laboratories.
NELAC 2003 and NELAC 2009-Quality Systems

4. Management Requirements

4.1 Organization

This section discusses general positions and quality-related responsibilities which provide for the implementation of the Quality Assurance Program and completion of quality control activities. Also discussed is the role of the York Quality Assurance Officer.

4.1.1 Legal Identification / Registration

York Analytical Laboratories, Inc.
120 Research Drive
Stratford, Connecticut 06615
203-325-1371
Fax 203-357-0166
E-mail: ClientServices@yorklab.com

State of Connecticut Department of Health (CTDOH) Certification no. PH-0723
New York State Department of Health (NYSDOH) ELAP/NELAP Certification no. 10854
State of New Jersey Dept. of Environmental Protection (NJDEP) Certification no. CT-005
State of Pennsylvania Registration No. 68-04440
EPA ID NO. CT-005

4.1.2 Laboratory Requirements

The departments of York Analytical Laboratories, Inc. have been organized to satisfy the needs of the Client and regulatory authorities and to meet the NELAC and international standards ISO 17025 and ISO 9001. York Analytical Laboratories, Inc. is comprised of the following Departments or Groups:

Laboratory Director's Office

Quality Assurance Group
Client Services/Sales Groups
Sample Control Group
Classical Chemistry Group
Organic Preparations Group
Atomic Spectroscopy/Metals Group
Gas Chromatography Group
Gas Chromatography/Mass Spectrometry Groups (Volatiles, Air and Semi-Volatiles)
Report production/Data Management Group

4.1.3 Scope of Management System

The management system covers activities in the laboratory's permanent facility at 120 Research Drive, Stratford, CT 06615. The fields of activities include:

Analysis of environmental samples (water, wastewater, soil, sludge, and air) for Federal and State regulated contaminants.

The laboratory's scope of tests is listed in the our specific Certifications and encompasses volatile organics, semi-volatile organics, pesticides, herbicides, PCBs, metals, and various general chemistry parameters.

4.1.4 Potential Conflicts of Interest

York has no potential conflicts of interest since it is independently owned and operated and provides only environmental laboratory analysis services. The ownership of York does not have any other interest that would be considered a potential conflict of interest.

4.1.5 Organization

A) Management and Technical Personnel

Policy:
The laboratory managerial and technical personnel, irrespective of other responsibilities, have the necessary authority and resources needed to meet the mandates assigned to their areas.

Details:
Responsibilities are detailed in 4.1.5 (F).

Departures from the organizational and management policies in this manual can only be approved by the Laboratory Director.

Departures from quality management system procedures can only be approved by the Quality Assurance Officer or the Laboratory Director.

Departures from test methods or technical standard operating procedures (SOPs) can only be approved by the Laboratory Director. See also section 5.2.

B) Undue Pressure

Policy:
Management and personnel are to be free from any undue internal and external commercial, financial and other pressures that may adversely affect the quality of their work. The integrity of test results is the responsibility of all personnel. Management ensures that employees are never instructed or forced to alter or falsify data.

Details:
The following list provides some guidelines on how employees avoid conflict of interest situations. Employees shall not:

- falsify records, prepare fraudulent reports, or make false claims
- seek or use privileged or confidential company information, or data from any Client, for any purpose beyond the scope of employment
- conduct non-laboratory business on laboratory time, or use company facilities or instrumentation to conduct outside interests in business, unless prior approval has been obtained
- solicit business on their own behalf (rather than the laboratory) from a Client
- be employed by, or affiliated with, organizations whose products or services compete with laboratory products or services
- have employment that negatively affects or interferes with their performance of laboratory duties
- compete with the laboratory in the purchase, sale, or leasing of property or goods
- allow association, family, or friends to influence business decisions to their benefit - decisions must be made on a strictly business basis, always in the best interest of the laboratory
- make any decision that provides gains or benefits to the employee and/or others
- have personal financial dealings with an individual or company that does business with the laboratory which might influence decisions made on the laboratory's behalf

Firm adherence to this code of values forms the foundation of our credibility. Personnel involved in dishonest activities are subject to a range of disciplinary action including dismissal.

C) Client Confidentiality

Policy:
It is the policy of our laboratory to protect the confidential information and proprietary rights of our Client including the electronic storage and transmission of results.

Details and Procedures:
All employees sign an Employee Confidentiality Agreement. The signed agreement is retained in each employee's Human Resources file.

Test results are only released to the Client. Release to someone other than the Client requires the express permission of the Client, except when the situation contravenes State or Federal Legislation and the results must be provided to the appropriate agency. The release of test results to anyone other than the Client requires the permission of the Client and management. Laboratory reports are reviewed for accuracy and completeness prior to release.

D) Operational Integrity

Policy:
The laboratory will avoid involvement in any activities that would diminish confidence in its competence, impartiality, judgment, or operational integrity.

Details and Procedures:
To ensure confidence in laboratory operations a formal quality assurance program is implemented. Technical competence is ensured through check sample programs. Impartiality is assessed through audits and approvals. Judgment is ensured through the hiring of qualified personnel and by continuously refining, upgrading, and improving his or her skills. Operational integrity is reviewed by management on a regular basis at management review meetings to ensure continued suitability and effectiveness of laboratory policies and procedures. Any problems are acted on immediately through corrective action procedures.

E) Organizational Structure

Policy:
The organization and management structure of the laboratory and the relationships between management, technical operations, support services, and the quality management system is defined through the aid of an organizational chart.

Details:
Senior management keeps the most current organizational chart on file. An organizational chart is available with this manual as a reference record-ATTACHMENT A and is considered the official record on the date it is marked in the lower right corner.

F) Responsibility and Authority

Laboratory Director

- develops primary goals, operating plans, policies, and short and long range objectives for the laboratory; implements these following Board of Directors' approval
- directs and coordinates activities to achieve profit and return on capital
- establishes organizational structure and delegates authority to subordinates
- leads the laboratory towards objectives, meets with and advises other executives, and reviews results of business operations
- determines action plans to meet the needs of stakeholders
- represents organization to major Clients, government agencies, shareholders, and the public
- is knowledgeable of the scope of all processes under supervision
- provides the necessary resources (personnel, instrumentation, supplies) for the quality assurance program, in order to ensure confidence in the laboratory's results
- ensures instrumentation is maintained and calibrated, reporting all deficiencies (e.g., instrumentation malfunctions) in the appropriate manner
- ensures personnel are trained for the duties they perform - includes substitutes when regular personnel are absent
- maintains current job descriptions
- maintains records and manages all aspects of testing activities

Quality Assurance Officer (QAO)

- ensures that the Quality Management System is established, implemented and maintained in accordance with the ISO 9001, ISO 17025 and NELAC standards
- manages the internal audit program
- coordinates laboratory accreditation activities
- handles the maintenance and distribution of the Quality Manual and associated documents
- maintains a master list of current versions of quality documentation
- trains personnel on Quality Management System activities
- monitors the Quality Management System
- reports on the performance of the Quality Management System to senior management for review and as a basis for improvement of the Quality Management System
- supervises the laboratory's double-blind proficiency testing program

Group Leaders

- responds to York Client Services Group inquiries and provides professional advice
- hires personnel with Laboratory Director
- orientates new personnel

- determines technical training needs of personnel
- conducts employee performance reviews
- schedules vacation and coverage
- ensures that all health and safety regulations are followed
- ensures that all Human Rights Legislation are complied with
- prioritizes workload
- facilitates operational concerns in their area
- ensures accurate and consistent testing procedures through the validation of all current procedures and by developing, validating and implementing new procedures
- coordinates purchasing requests
- ensures that the operational needs are within budget and advising management of any discrepancies

Analysts and Technicians

- maintains records of all quality activities as documented in SOPs and test methods
- handles samples and performing analyses according to SOPs and test methods
- provide input and assists in preparation of SOPs and test methods
- maintain and calibrate instrumentation and instrumentation
- reports deficiencies or malfunctions to the Group Leader
- identifies and records nonconformities on *Corrective Action Reports*
- identifies and recording potential nonconformities on *Preventive Action Requests*
- corrects nonconformities and potential nonconformities
- improves laboratory and/or quality activities on a continuous basis

Project Managers/Client Services

- provides vision and direction for analysis activities
- Responds to Clients' and provides professional advice
- develops and reviews proposals/Quotations
- Reviews Quality Assurance Project Plans for Clients
- monitors the progress of Work-in-Process
- reviews reports for selected Clients
- oversees, standard pricing, customized quotations, and invoicing for tests performed
- controls the flow of communication between the Client and the laboratory

Administrative/Data Management Personnel

- performs work functions and keeps records as per approved SOPs and/or laboratory policies
- generate final reports, invoices and data packages for transmittal to Clients
- assist in preparation of SOPs
- identifies and records nonconformities on *Corrective Action Reports*
- identifies and records potential nonconformities on *Preventive Action Requests*
- corrects nonconformities and potential nonconformities

- improves laboratory and/or quality activities on a continuous basis

G) Laboratory Supervision

Policy:
Adequate supervision is provided in each area of the laboratory for all testing and calibration personnel, including trainees, by persons familiar with the methods and procedures.

Details:
Adequate supervision is ensured through designated supervisors as well as through documentation such as this Quality Manual, test methods and SOPs. A thorough orientation and training program is adhered to for all new employees. Ongoing training for regular personnel is required.

H) Technical Management

Policy:
A Group Leader is assigned to each major technical department of the laboratory. They have overall responsibility for the technical operations and the provision of resources needed to ensure the required quality and production of laboratory operations.

Details:
While the Group Leader may at times delegate duties to other personnel, the Group Leader is accountable for any nonconforming activities.

I) Quality Assurance Officer

Policy:
The Quality Assurance Officer is appointed by the highest level of management. The Quality Assurance Officer, who, irrespective of other duties and responsibilities, has defined responsibility and authority for ensuring that the management system related to quality is implemented and followed. The Quality Assurance Officer has direct access to the highest level of management where decisions are taken on laboratory policy or resources.

Details:
This statement notifies all laboratory personnel that Magdalena Szymczuk is the Quality Assurance Officer as authorized by the Laboratory Director. Any change in this position requires the reissue of this section to all holders of controlled copies of the Quality Manual. The following signature also serves as approval for this Quality Manual and affirms senior management's commitment to the policies and procedures set forth in this manual.

J) Managerial Substitutions

Policy:
Deputies for key personnel are appointed to fulfill the key personnel's duties in their absence.

Details:
In the absence of the Quality Assurance Officer, the Technical Director or Laboratory Director will assume his/her responsibilities.

In the absence of the Group Leader, the Laboratory Director, Technical Director or other Group Leader will assume his/her responsibilities.

Management is responsible for ensuring that current and/or increased workload requirements are met. This includes making adjustments as a result of employee absence. Only fully trained employees are utilized to fulfill the duties of personnel who are absent. If sufficient human resources are not available, management will identify the best possible solution to meet operational requirements.

K) Awareness

Policy:
Management ensures that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the objectives of the management system.

Details:
Supervisors review the details of each employee's job description with the appropriate employee and how the overall Quality Policy Statement (Section 4.2.2) relates to their activities to achieve the objectives of the management system.

4.1.6 Communication Processes

Policy and Details:
Top management ensures that appropriate communication processes are established within the laboratory and that communication takes place regarding the effectiveness of the management system.

4.2 Management System

4.2.1 Policies and Procedures

Policy:
The Quality Management System is established, implemented, and maintained by management. It is applicable to all the fields of testing and activities in which the laboratory is involved and undertakes. All policies, systems, programs, procedures and instructions are documented to the extent necessary to enable the laboratory to assure the quality of results generated. These documents are communicated to, understood by, available to, and implemented by the appropriate personnel.

Details:
The purpose of our Quality Management System is to ensure that all services and products satisfy the Client's requirements and have been designed, manufactured, and delivered under controlled conditions.

The effectiveness of the Quality Management System is assessed in several ways:

- by a program of planned internal audits, covering all aspects of the operation of the quality management system
- by regular management reviews of the suitability and effectiveness of the quality management system
- by analysis of potential and actual problems as shown by Client complaints and supplier and subcontractor assessments
- by other methods approved from time to time by the Laboratory Director

This Quality Manual and associated documents (including procedures) and records serves as the quality plan for the laboratory. Other documents and records include:

- standard operating procedures
- quality control plans in test methods
- organizational charts
- proposals and Quality Assurance Project Plans (QAPP)
- project management schemes

4.2.2 Quality Policy Statement

Policy:
The policies and objectives for laboratory operations are documented in this Quality Manual. The overall objectives are set out in the Quality Policy Statement and reviewed during management review. The Quality Policy Statement is issued under the authority of the Laboratory Director on the effective date.

Quality Policy Statement:
To ensure accurate and timely environmental laboratory analysis services and to continuously meet or exceed the stated or implied expectations of our Clients through day-to-day interactions.

Effective Date: April 30, 2010

a) *Management commitment to good professional practice and quality of services provided to the Client*: analyses and calibrations are always carried out in accordance with stated standardized methods and Clients' requirements. Requests to perform tests that may jeopardize an objective result or have a low validity are rejected.

b) *Standards of service include*:
- Client Satisfaction
- Quality
- Timeliness

Excellence in the workplace is promoted by providing all employees with the knowledge, training, and tools necessary to allow for the completion of accurate and timely work.

c) *Purpose of management system related to quality*: to manage our business by meeting the needs of our Clients.

d) *Personnel*: familiarize themselves with quality documentation and implement the policies and procedures in their work.

e) *Management is committed to complying with NELAC, ISO 17025 and ISO 9001 international standards and to continually improve the effectiveness of the management system*: the objective of this Quality Manual is to document the compliant policies and associated procedures that are integrated into our daily activities. Continual improvements are established, implemented, and integrated into the management system. Additional objectives include:

- to establish the level of the laboratory's performance
- to make test method changes to improve performance
- to participate in proficiency testing or quality evaluation programs with peer laboratories
- to ensure that all personnel are trained to a level of familiarity with the quality management system appropriate to the individual's degree of responsibility
- to improve and validate laboratory methodologies by participation in method validation collaborative tests
- to establish and report on quality savings

4.2.3 Commitment to the Management System

Policy:
Top management is committed to the development and implementation of the management system and continually improving its effectiveness.

Details:
The results of the management system are regularly reviewed during management review (see Section 4.15) and continual improvements are made as outlined in Section 4.10 – Improvements.

4.2.4 Communication of Requirements

Policy:
Top management communicates to the organization the importance of meeting Client requirements as well as statutory and regulatory requirements.

Details:
In general, the underlying message in all oral and written management communications involves meeting the aforementioned requirements. Meeting Client requirements ensures that ongoing business relationships secure the contracts that keep everyone employed. Meeting statutory and regulatory requirements ensures that laboratory operations will not be disrupted and the organization can continue to meet Client needs.

4.2.5 Quality Manual

Policy:
This Quality Manual outlines the structure of the documentation used in the quality management system. This Quality Manual makes reference to supporting procedures including technical procedures and is maintained up to date.

Details:
This quality management system is structured in three tiers of documentation. The tiers are as follows:
1. Quality Manual
2. Standard Operating Procedures and Test Methods
3. Records

For most Clients, this Quality Manual and the associated documents form a general Quality Plan. If necessary, specific Quality Assurance Project Plans (QAPP) will be prepared on a 'per-Client' basis. These QAPPs will modify the general requirements stated in the Manual and associated documents.

All of the above documents are controlled documents in yellow only.
The following records and directive documents are referenced in the Quality Manual, but maintained separately:
- organizational chart (section 4.1.5.E)
- copies of the Quality Policy Statement posted in the laboratory (section 4.2.2)
- identification of resources and management review (section 4.15.1)
- job descriptions (section 5.2.4)
- statistical techniques (section 5.9)
- test reports (section 4.13.2 and 5.10)
- identification of the laboratory's approved signatures (section 5.10.2)
- laboratory's scope of tests (section 4.1.3)
- instrumentation inventory and records (sections 5.5.4 and 5.5.5)
- calibration status indicators (section 5.5.8)
- reference standards inventory (section 5.6.3)
- verification records (section 5.9)
- quality control plan / criteria for workmanship (section 5.4.1)
- corrective action records (section 4.11)
- preventive action records (section 4.12)
- client complaint records (section 4.8.1)
- audit schedule and records (section 4.14.3)
- procurement and subcontracting records (sections 4.6 and 4.5.4)

- training records (section 5.2.5)
- master list of documentation (section 4.3.2)
- confidentiality agreements (section 4.1.5 C)
- contract review (section 4.4.2)
- validation of test methods (section 5.4.5)
- facility floor plan (section 5.3.1)

4.2.6 Technical Management and the Quality Assurance Officer

The roles and responsibilities for technical management (Group Leaders) and the Quality Assurance Officer are outlined in section 4.1.5 (F) of this manual.

Technical management (Group Leaders) ensures that section 5 of this manual is implemented and maintained. The Quality Assurance Officer ensures that section 4 of this manual is implemented and maintained.

4.2.7 Maintenance

Policy and Details:
Top management ensures that the integrity of the management system is maintained when changes to the management system are planned and implemented.

4.3 Document Control

Policy: The SOP# ADMINDOC043010 is used to control all quality management system documents. These may include documents of external origin, such as regulations,

standards, other normative documents, test and/or calibration methods, as well as drawings, specifications, instructions, and manuals.

Details:
Document means any information or instructions including policy statements, procedures, specifications, calibration tables, charts, text books, posters, notices, memoranda, software, drawings, and plans. These may be in various media, whether hard copy or electronic and they may be digital, analog, photographic or written.

The documents to be controlled include:
- Quality Manual
- Standard Operating Procedures
- Forms
- Standards

The control of data related to testing and calibration is covered in section 5.4.7. The control of records is covered in section 4.13.

4.3.1 Document Approval and Issue

4.3.1.1 Review / Approval / Master List

Policy and Details:
All documents issued to personnel in the laboratory as part of the quality management system are reviewed and approved for use by authorized personnel prior to issue (i.e., reviewed by personnel knowledgeable in the documented activity and then approved by management). A master list identifying the current revision status and distribution of documents in the quality management system is readily available in order to preclude the use of invalid and/or obsolete documents (see SOP# ADMINDOC043010). A revision history of documents is also maintained. Documents are formally reviewed on a biennial basis to ensure their continuing suitability. APPENDIX B contains a current Master List of Documents.

4.3.1.2 Availability and Obsolete Documents

Policy and Details:
The master list includes all current controlled documents. The master list document is organized with the following information:

- Description
- SOP Number
- Date of Issue (effective date of each procedure)
- Revision Number
- Date of Revision (effective date of each current revision)

Controlled documents are approved before issue.

The SOP# ADMINDOC043010 for document control ensures that:
- authorized editions of appropriate documents are available at all locations where operations essential to the effective functioning of the laboratory are performed
- documents are periodically reviewed and where necessary revised to ensure continuing suitability and compliance with applicable requirements
- invalid or obsolete documents are promptly removed from all points of issue or use to assure against unintended use
- obsolete documents retained for either legal or knowledge preservation purposes are suitably marked (i.e., stamped "OBSOLETE" and dated)

4.3.1.3 Identification

Policy and Details:
All quality management system documentation is identified by:

- date of issue and/or revision number
- page numbering
- total number of pages (e.g., page 5 of 5)
- issuing authority (i.e., approval signature)

4.3.2 Document Changes

4.3.2.1 Review / Approval

Policy:
Changes to documents are reviewed and approved by the same function (i.e., personnel or position) that performed the original review unless specifically designated otherwise.

Details:
Developments in policies and procedures require documents to be changed from time to time. Changes to documents receive the same level of review and approval as the originals.

The Quality Manual is reviewed annually by the Quality Assurance Officer. Records are kept of this review.

Test methods and SOPs are reviewed on a biennial basis. Procedures for this are outlined in SOP# ADMINDOC043010.

Obsolete documents are withdrawn, but are retained for archive purposes and clearly labeled as obsolete.

4.3.2.2 Identification of Changes

Policy:
The nature of document changes is identified in the document.

Details:
As outlined in SOP# ADMINDOC043010.

In general, the nature of changes is described in the document. Revision history is recorded at the end of the document.

4.3.2.3 Amendments by Hand

Policy and Details:

Hand-written amendments are clearly marked, initialed, and dated by the Laboratory Director and/or the QA/QC Officer on all controlled yellow copies.

4.3.2.4 Computerized Documents

Policy and Details:
The SOP# ADMINDOC043010 details how changes in documents maintained in computerized systems are made and controlled.

4.4 Review of Requests and Contracts

4.4.1 Policies and Procedures

Policy:
The SOP AMINCONTRACT043010 is used to review requests or contracts. This procedure ensures that:

a) the Client requirements including the methods to be used are adequately defined, documented and understood (see section 5.4.2)
b) the laboratory has the licensing, capability and resources to meet the requirements
c) the appropriate testing method is selected and capable of meeting the Client's requirements or data quality objectives (see section 5.4.2)

Any differences between the request and the contract are resolved before any work commences. Each contract must be acceptable by both the laboratory and the Client.

Details:
The request and contract review is conducted in a practical and efficient manner, and the effect of financial, legal, and time schedule aspects are taken into account.

The review of capability establishes that the laboratory possesses the necessary physical, personnel, and information resources, and that the laboratory's personnel have the skills and expertise necessary for the performance of the tests in question. The review may also encompass results of earlier participation in inter-laboratory comparisons or proficiency testing and/or the running of trial test using samples or items of known value in order to determine uncertainties of measurement, limits of detection, and confidence limits.

The contract review ensures that each Client's requirements are adequately defined and documented before the service or product is ordered or dispatched. This should ensure that any order, once accepted, can be completed without delay, and that the Client's requirements including delivery date, technical specification, and cost can be met.

If the contract review highlights any ambiguities or uncertainties then the Client will be contacted and the problem resolved before the order is accepted.

The SOP AMINCONTRACT043010 also describes the activities that take place should there be a subsequent amendment to a Client's order.
Typical types of contracts include:

- approved service quotations
- confidentiality agreements
- non-disclosure agreements
- sample submission requests
- memorandum of agreement
- memorandum of understanding
- research proposals and contracts
- verbal orders (oral agreements)
- activity plans

4.4.2 Records of Review

Policy:
Records of request and contract review, including significant changes, are maintained. Records of pertinent discussions with a Client relating to the Client's requirements or the work during the period of execution of the contract are also maintained.

Details:
For review of routine and other simple tasks, the date and the identification (e.g., initials) of the person in the laboratory responsible for carrying out the contracted work are considered adequate. For repetitive routine tasks, the review need be made only at the initial enquiry stage or on grant of the contract for on-going routine work performed under a general agreement with the Client, provided that the Client's requirements remain unchanged. For new, complex or advanced testing tasks, a more comprehensive record is maintained.

4.4.3 Review of Subcontracted Work

Policy:
Request and contract review also includes work that is subcontracted by the laboratory.

Details:
Subcontractor laboratories are reviewed as described in section 4.5.

4.4.4 Notification of Client

Policy and Details:
Clients are informed of deviations from the contract. This is typically communicated to the Client prior to the performing the deviation.

4.4.5 Contract Amendment

Policy and Details:
If a contract needs to be amended after the work has commenced, the same contract review process is repeated and any amendments are communicated to all affected personnel.

4.5 Subcontracting of Analyses and Calibrations

4.5.1 Subcontractor Competence

Policy:

Work that must be subcontracted due to:

- unforeseen circumstances
- workload
- large contracts
- contracts requiring some extra technical expertise
- Tests not performed in-house

is subcontracted to a technically competent laboratory.

Details:

The subcontracted laboratory demonstrates technical competence by possession or receipt of one or more of the following:

- recognized technical accreditation- NYSDOH NELAC or other NELAC accreditation body
- registration under the ISO 9001 standard
- satisfactory performance of appropriate quality control check samples, certified reference material, in-house reference material or replicate analysis
- Review of the subcontractor's quality management system by our QA Officer

It is the responsibility of the Quality Assurance Officer to assess and approve the competence level of subcontractor laboratories.

4.5.2 Client Approval

Policy:
Clients are advised of work (or any portion thereof) that is being subcontracted to another laboratory and their approval is obtained (preferably in writing). Upon log-in at the lab, a Subcontract Notification Form is generated by Sample Control and e-mailed immediately to the Client.

Details:
Clients are advised of subcontracted work through fee schedules or any type of contract listed in section 4.4.1.

4.5.3 Assurance of Subcontractor Competence

Policy:
The laboratory is responsible to the Client for the subcontractor's work. Technical competence of subcontractor laboratories is demonstrated through various records.

> **Note** – there may be circumstances where the Client specifies which subcontractor is to be used. In such cases we may not be able to demonstrate the competence of the subcontractor and therefore are not responsible for the results.

Details:
Records of subcontractor competence may include, but are not limited to, the following:
- accreditation certificates or documentation
- registration certificates
- check sample results
- audit results
- approval by the Quality Assurance Officer

4.5.4 Subcontractor Register

Policy:
A register of all subcontractors performing tests is maintained.

Details:
The approved register of subcontractors and all relevant records are maintained by the Quality Assurance Officer.

Revision History

Revision 2.0 04/30/2010 First Issue of Rewritten Quality Manual

4.6 Purchasing Services and Supplies

4.6.1 Policies and Procedures

Policy:
The SOP ADMINPURCHASESING043010 is used to select and purchase services and supplies. The SOP ADMINPURCHASESING043010 is used for procurement, reception, and storage of supplies.

Details:
Consumable materials are stored according to the appropriate test method, SOP, or work instruction.

4.6.2 Specifications

Policy:
Only services and supplies of the required quality are used. These quality requirements are detailed in laboratory SOPs under the "*Materials Required*" section and will identify the appropriate minimum specifications when necessary.

Details:
Packing slips are checked against package content labels and matched with the Purchase Order if accepted. Once accepted, the packing slip is dated and initialed as evidence of compliance. Certificates of analysis (COA) are maintained on file after the COA is checked to ensure the received item meets minimum specifications.

Chemicals are purchased with manufacturer's certificates where possible. Uncertified chemicals are purchased from ISO 9000 registered companies where possible. Whatever the source, the laboratory verifies the quality of the standards by comparing the new batch of standards to the old. Due regard is paid to the manufacturer's recommendations on storage and shelf life.

Reagents are generally purchased from manufacturers who have a quality management system based on ISO 9000. The grade of any reagent used (including water) is stated in the method together with guidance on any particular precautions to be observed in its preparation or use.

Where no independent assurance of the quality of procured goods or services is available or the supplier's evidence is insufficient the laboratory ensures that purchased goods and services comply with specified requirements. Where possible and practical the laboratory ensures that goods are inspected, calibrated, or are otherwise in compliance with any standard specification relevant to the calibrations or tests concerned.

4.6.3 Purchasing Documents

Policy:
Purchasing requests are recorded on the Purchase Order form and contain data describing the product ordered. The Purchase Order is reviewed and approved for technical content prior to release.

Details:
The description may include type, class, grade, precise identification, specifications, drawings, inspection instructions, other technical data including approval of test results, quality required and quality management system standard under which they were produced.

The completion of the Purchase Order is the responsibility of the originator.

4.6.4 Approved Suppliers

Policy:
Suppliers of critical services are evaluated and approved before use. An approved supplier list is maintained.

Details:
Audits or tender evaluation is conducted to qualify suppliers of critical services prior to use. The criteria for evaluation may include, but is not limited to the following:

- references
- accreditation
- formal recognition

The records are maintained by purchasing personnel. SOPs detail the acceptable vendors for all materials.

4.7 Service to the Client

4.7.1 Service

Policy:
Client requests are clarified for the Clients or their representatives. Furthermore the Client or their representative will be afforded the right to monitor the performance of the laboratory in relation to the work performed, provided that the laboratory ensures confidentiality to other Clients.

Details and Procedures:
Service to the Client includes:

- Affording the Client or the Client's representative reasonable access to relevant areas of the laboratory for the witnessing of work performed for the Client; it is understood that such access should not conflict with rules of confidentiality of work for other Clients or with safety.

- Preparing, packaging, and dispatching of test data needed by the Client for verification purposes.

- Maintaining of open contacts. The Client values advice and guidance in technical matters, and opinions and interpretations based on results. Contact with the Client, especially in large assignments, should be maintained throughout the work by Client Services personnel. The laboratory should inform the Client of any delays or major deviations or issues encountered during the performance of the tests.

4.7.2 Feedback

Policy and Details:
The laboratory seeks feedback from the Client. Positive and negative feedback can be obtained passively through ongoing communications with the Client (e.g., review of test reports with Clients) or actively through Client satisfaction surveys. The feedback is used to improve the quality management system, testing activities, and Client service.

4.8 Complaints

4.8.1 Policies and Procedures

Policy:
The SOP ADMINCOMPLAINTS 04302010 is used for resolving complaints received from Clients or other parties. Records are maintained of all complaints and follow-up.

Details:
Records of complaints include the following information:

- details of the complaint
- investigation
- corrective action
- follow-up verification

See also section 4.11.

All personnel are responsible for recording and responding to complaints.

4.9 Control of Nonconforming Analyses

4.9.1 Procedures to Control Nonconforming Work

Policy:
The SOP ADMINNONCONFORM 04302010 is used to control any aspect of testing, or the results of this work, when they do not conform with the test methods, SOPs or the agreed to requirements of the Client.

Details:
The procedure ensures that:
- Responsibilities and authorities for the management of nonconforming work are designated and actions (including halting of work and withholding of test reports as necessary) are defined and taken into consideration when nonconforming work is identified
- an evaluation of the significance of the nonconforming work is made
- correction is taken immediately, together with any decision about the acceptability of the nonconforming work
- where necessary, the Client is notified and the work is recalled
- the responsibility for authorizing the resumption of work is defined

Identification of nonconforming work or problems with the quality management system or with testing activities can occur at various locations within the quality management system and technical operations such as:
- Client complaints
- quality control
- instrument calibration
- checking of consumable materials
- staff observations or supervision
- test report review
- management reviews
- internal or external audits

4.9.2 Root Cause Analysis

Policy:
Where evaluation indicates that nonconforming work could recur or that there is doubt about the compliance of the laboratory's operations with its own policies and procedures,

the corrective action procedures given in 4.11 are followed to identify the root cause(s) of the problem and to eliminate cause(s).

Details:
The SOP ADMINCORRACTION043010 outlines the recording of the root cause analysis for investigating nonconforming work.

Situations warranting corrective action investigation include:
- failure to comply with test method including all applicable procedures necessary to ensure the integrity and representative nature of the sample
- presentation of uncertain knowledge as to compliance with test methods including all applicable procedures necessary to ensure the integrity and representative nature of the sample
- failure or suspected failure in method performance as demonstrated by results provided by quality control samples
- lack of relevant evidence provided by quality audit, proficiency testing, or Client feedback
- lack of relevant evidence provided by data validation
- neglect to check the inherent property of the sample that compromises the testing

4.10 Improvements

4.10.1 Policies and Procedures

Policy:
The laboratory continually improves the effectiveness of its management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective actions, and management review.

Details:
The laboratory has implemented a continual improvement philosophy within the management system. Every employee in the laboratory is encouraged to suggest new ideas for improving services, processes, systems, productivity, and the working environment.

Opportunities for improvement of operations and processes are identified by managers on a continual basis from ongoing feedback on operations and through management reviews. Opportunities for improvement of services are identified by anyone within the organization including Sales, Marketing and Client Services.

Inputs for improvement opportunities are obtained from the following sources:
- Client satisfaction surveys and any other Client feedback
- market research and analysis
- employees, suppliers, and other interested parties
- internal and external audits of the management system
- records of service nonconformities
- data from process and service characteristics and their trends

Opportunities for improvement may also be identified on a special project basis. The following are listed only as examples:
- improving usefulness of bench space
- reducing excessive inspection/analysis
- reducing excessive handling and storage
- reducing test/calibration failures

Opportunities for improvement from daily feedback on operational performance (i.e., internal audits, Client feedback, test/calibration failures) are evaluated by the Laboratory Director or Quality Assurance Officer. Typically, they are implemented through the corrective and preventive action system.

Opportunities for improvement from analysis of longer-term data and trends are evaluated and implemented through the management review process. They are prioritized with respect to their relevance for achieving quality objectives. When opportunities for improvement are no longer supported by the current policy and objectives, management will establish new quality objectives, and possibly change the policy. The process for this evaluation is described in Section 4.15. Longer-term improvement projects are initiated through the management review process, as well as the corrective and preventive action system.

Service improvement opportunities are evaluated by management. They are implemented through the supervisor of the laboratory who ensures that the improvements are validated as outlined in Section 5.4 of this manual and appropriate level of quality control is performed on an ongoing basis.

4.11 Corrective Action

4.11.1 General

Policy:
The SOP ADMINCORRACTION043010 is utilized for implementing corrective action when nonconforming work or departures from policies and procedures in the quality management system or technical operations have been identified. The procedure requires that appropriate authority be designated for the implementation of corrective actions. The procedure includes cause analysis, selection and implementation of corrective action, and monitoring of actions.

Details:
Problems with the quality management system or technical operations of the laboratory may be identified through a variety of activities, such as control of nonconforming work, internal or external audits, management reviews, feed-back from Clients, or staff observations.

Corrective action investigations are documented and required changes to operational procedures are implemented. The corrective action request (CAR), investigation and resolution are recorded on a CAR form.

4.11.2 Cause Analysis

Policy:
Corrective action always begins with an investigation to determine root cause(s) of the problem (see SOP ADMINCORRACTION043010).

Details:
Potential causes of the problem could include Client requirements, the samples, sample specifications, methods and procedures, personnel skills and training, consumable materials, or instrumentation and its calibration.

4.11.3 Selection and Implementation of Corrective Actions

Policy and Details:

After determining the cause(s) of the problem, potential corrective actions are identified. The most likely action(s) (this includes practical and/or reasonable) are selected and implemented to eliminate the problem and to prevent recurrence. It should be noted that any corrective actions taken to eliminate the cause(s) of nonconformities or other departures are to a degree appropriate to address the magnitude of the problem and commensurate with the risks encountered (Note – in plain language, this means determine whether the benefit outweighs the cost). Controls are applied to prevent recurrence. The laboratory documents and implements the required changes resulting from corrective action investigations.

4.11.4 Monitoring of Corrective Action

Policy:
After implementing the corrective action(s), the laboratory monitors the results to ensure that the actions taken have been effective in overcoming the problems originally identified.

Details:
Monitoring is assigned to an appropriate individual such as the originator of the CAR or the originator's manager. Changes resulting from corrective action are documented.

4.11.5 Additional Audits

Policy:
Where the identification of nonconformities or departures casts doubts on compliance of policies, procedures, regulations, international quality standards, the appropriate areas of activity are promptly audited in accordance with section 4.14.

Details:
Special audits follow the implementation of corrective actions to confirm their effectiveness. A special audit is only necessary when a serious issue or risk to the business is identified. Special audits are carried out by trained and qualified personnel who are [whenever resources permit] independent of the activity to be audited. See section 4.14 for more details.

4.12 Preventive Action

4.12.1 Preventive Action Identification

Policy:
Opportunities for needed improvement and potential sources of nonconformities, either technical or with the quality management system shall be identified. If action is required, action plans are developed, implemented and monitored, to reduce the likelihood of occurrence of such nonconformities and to take advantage of the improvement opportunities.

Details:

Records of preventive action include the following information:

- details of potential nonconformities
- investigation
- preventive action
- follow-up verification

These records are maintained in the Preventive Action Request (PAR) form/binder.

4.12.2 Preventive Action Plans

Policy:
The preventive action procedure includes the initiation of such actions and application of controls to ensure that they are effective.

Details:
Preventive action may result from the review of operational procedures and analysis of data. Analysis of data includes trend analysis, analysis of proficiency testing results, and risk analysis.

The SOP ADMINPREVACTION043010 is utilized to implement opportunities for needed improvement and prevent potential sources of nonconformities.

4.13 Control of Records

The York Quality Assurance Program has been developed to provide analytical results of known quality. To demonstrate that quality has been achieved, York maintains a record management system that includes documents pertinent to the analytical performance of the laboratory. Laboratory records are maintained in two broad categories.

- Documents which are specific to a project or a group of samples within an ongoing project, such as chain-of-custody, and raw analytical data.
- Documents which demonstrate overall laboratory operation, such as instrument log books and control charts. These records will directly affect the data for a specific project, but in general their applicability is not limited to one project.

This procedure addresses identification, collection, indexing, access, file, store, maintain, protect, backup, and disposal of quality and technical records. To outline procedures for the protection and backup of data/records held on computers.

4.13.1 General

This procedure applies to all quality and technical records. Quality records include audit reports, management review, corrective action requests, and preventive action requests. Technical records include observations, calculations, derived data, calibration records, personnel records, and test reports.

4.13.1.1 Procedures

Policy:
The SOP ADMINRECORDS043010 is used to identify, collect, index, access, file, store, maintain, protect, backup, and dispose quality and technical records. Quality records include reports from internal audits and management reviews as well as corrective and preventive action records.

Details:
Records are available to demonstrate conformance to requirements and effective operation of the Quality Management System. Quality records from suppliers are also controlled.

All records, (electronic and hard copy) including test reports, are safely stored and held secure in locked areas, and in confidence to the Client. Records are maintained in the designated archival area for **five (5)** years.

4.13.1.2 PROJECT RECORDS

Separate files are maintained for each project. Filing of records for a specific project shall be by the unique project identification number assigned by the laboratory for that project. Within a project file, categories of information are filed separately. Upon completion of all projects (SDGs), the file contents are scanned to an unalterable image file (.pdf) and archived removable hard disk media. Such media are held for a period of 5 years. Paper copy is maintained for three months after data submission. Following is a brief discussion of each item that is maintained for each project file.

A - Correspondence

All correspondence pertinent to the analytical program shall be maintained. This includes letters to and from clients and internal memorandums. Correspondence should be filed chronologically.

B - Chain-of-Custody

Chain-of-custody records shall be maintained by the laboratory. The chain-of-custody forms should be filed for samples as received and should be placed in the project file immediately after they are signed by Sample Control personnel.

C - Request for Analysis

Analysis requests provided by the field personnel are maintained in this file. Also, any changes or additions to the analytical program should be documented in this file.

D - Calibration Records

In general, calibration records are maintained with laboratory operation records. However, if an analytical program requires a calibration which is performed solely for a project, the records shall be maintained in this file. If calibration is performed as an integral part of the analytical process, the calibration records should be maintained with the analytical data.

E - Analytical Data

Analytical data files should be complete for a group of samples. The file should contain raw analytical data, processing of the data and/or data reduction, and any data validation. It should be possible to use data files to completely demonstrate that the data have been adequately obtained, processed, and reviewed.

G - Quality Control Samples

If quality control samples, such as field blanks, are processed for a specific project, the data shall be maintained with the project file. The results of quality control samples processed on a general basis are included in the laboratory operations files. Statistical evaluation of quality control sample data for a project shall also be maintained in this file.

If quality control samples are processed as an integral part of a group of samples such that the data cannot be readily separated, the quality control sample data can be stored with the analytical data.

H - Data Reports

Complete copies of all reports issued by the laboratory are accessible on the Network and are not stored with the project files.

I - Project-Specific Requirements

If a project requires analytical procedures other than what is adopted in the York Quality Assurance Program, the requirements shall be included in this file. Specific requirements may be due to government regulations, specific contracts, or project need. Changes from stated practice can be, for example, frequency of QC sample analysis, test method, statistical data evaluation, and reporting format.

If it is necessary to adopt a new analytical procedure, a procedure different than conventionally used, or alter an existing procedure, the method used for the project must be documented. If the analytical procedure is developed by York as part of the analytical program, the procedure shall be documented and included. If an existing procedure is altered, the Analyst or Group Leader shall prepare a memorandum to the project file stating what the changes were and the justification for change.

J - Nonconformance
Nonconformances and subsequent corrective actions which are specific to a project are included in this file. The record should be in the form of a memorandum (or

copy of other records discussed in this manual) with the nonconformance stated, how it was corrected, and the approval for the correction. A separate file for each incidence is not required, the file should be maintained chronologically.

K - QA Plan

If a specific Quality Assurance Project Plan, and revisions, are prepared for a project, they shall be stored in this file.

L - Miscellaneous

The miscellaneous file includes all records not applicable to the previous categories.

4.13.1.3 GENERAL LABORATORY OPERATIONS RECORDS

General laboratory records document overall laboratory performance and operations. These records are filed separately from project records and will be maintained so they can be referenced to project records if necessary. Examples of general records pertinent to project records are instrument log books and computer software verifications.

There are two types of general laboratory records:

< Documents which demonstrate laboratory performance

< Reference documents for laboratory operations

Records which demonstrate laboratory performance shall be filed in categories in a manner similar to project files. Reference documents are not indexed and their usage is not controlled.

Many of the laboratory operations records are in daily use, such as the Master Log Book, instrument calibration logs, and control charts. It is not intended that the records be stored daily while they are in use. However, when individual log books, etc. are filled, they shall be placed in the files.

Following is a brief discussion of the General Lab Operations records:

A - Sample Log Books

The Sample Log Books chronologically record all samples entering the laboratory, independent of project designation.

B - Instrument Calibration Logs

All calibration performed independent of a specific project shall be recorded by instrument. A separate file should be maintained for each instrument subject to calibration. These files are scanned and archived on the network by instrument and date.

C - Instrument Maintenance Logs

Separate maintenance files should be kept for each instrument incorporated in the preventive maintenance program. The file shall include records of maintenance performed in-house or by outside groups.

D - Performance Evaluation Records

Laboratory participation in Performance Evaluation Programs shall be documented in this category. If performance standards are analyzed as part of the overall quality control sample program, the results should be included in Category G.

E - Certification Program (NY, CT, NJ , PA) Records

If the laboratory participates in certification programs, such as the NELAP, ELAP, etc. program, the results shall be maintained in this category. Records should include all correspondence, analytical data, agency results, etc.

F - Control Charts

Control charts are generated and maintained on the Element LIMS.

G- Purchased Material Certificates

All information which verifies that purchased materials meet the requirements of the laboratory should be maintained. Certification may be supplied by a vendor or from in-house verification analysis. Separate files should be kept for chemicals, gases, water, glassware, etc.

4.13.1.4 RECORD CONTROL

The individual responsible for the records management system is part of the Data Management Group. This person shall:

- Initiate new project files including project index
- Add new records to existing files, initiate new files within a category, and update the index
- Assist laboratory personnel in withdrawing and returning records.

To maintain control of hard copy records within the laboratory, a Records Accession LOG is maintained. The LOG indicates:

- Project from which file is borrowed
- Date and person borrowing record
- Date returned to the record system

The dating format for records is MM/DD/YYYY.

4.13.2.1 Record Integrity

Policy:
All records are to be legible and shall be retained in such a way that they are readily retrievable in facilities that provide a suitable environment to prevent damage or deterioration and to prevent loss.

Details:
The retention time for records is set at **five** years.

Records may be in the form of any type of media, such as hard copy or electronic media.

4.13.2.2 Record Security

Policy:
All records are held secure and in confidence.

Details:
Access to records is secured through limited access areas and computer access via user defined privileges.

4.13.2.3 Record Backup

Policy:
The SOP ADMINRECORDS043010 is followed to protect and backup data/records held on computers at all times and to prevent unauthorized access to or amendment of data/records on computers.
Details:
Data is password protected.

Backups ensure integrity and availability of data / information in the event of a system / power failure.

4.13.3 Technical Records

4.13.3.1 Record Information

Policy:
Original observations, calculations, derived data and sufficient information to establish an audit trail, calibration records, personnel records and a copy of each test report issued are retained for five years.

The records for each test shall contain sufficient information to facilitate, if possible, identification of factors affecting the test uncertainty and to enable the test or calibration to be repeated under conditions as close as possible to the original. The records include the identity of personnel responsible for sampling, performing of each test and/or calibration and checking of results.

Details:
Technical records are accumulations of data (see 5.4.7) and information that result from carrying out tests and/or calibrations and which indicate whether specified quality or process parameters are achieved. They may include forms, contracts, work sheets, work books, note books, instrument printouts, magnetic media, check sheets, work notes, control graphs, test reports, calibration certificates, Client's notes, papers and feedback, and test reports to Clients.

The records for each test contain sufficient information to permit its repetition. Records include:

- date of sampling
- sample receipt
- sample handling, storage, and disposal

- identification of personnel
- analyst proficiency
- instrumentation identification and performance
- calibration records
- media performance, where appropriate
- test batch # or lot #, where appropriate
- results
- reports (mailed, e-mailed, faxed)
- review

Note – the above records may be stored in separate locations. They are cross-referenced for easy retrieval.

4.13.3.2 Recording

Policy:
Observations, data, and calculations are clearly and permanently recorded and identifiable to the specific job at the time they are made.

Details:
Handwritten records must be legible and made with indelible ink immediately after an observation, after data is collected and/or after calculations are made.

4.13.3.3 Corrections to Records

Policy:
Changes to test data are made so as not to obscure or delete the previous data entry.

Details:
Mistakes are crossed out and the correct value entered alongside. Mistakes are not erased, made illegible, or deleted. All alterations to records are signed or initialed by the person making the correction. In the case of computer-collected data, similar measures are taken to avoid loss or change of original data.

4.14 Internal Audits

4.14.1 Internal Audit Program

Policy:
The internal audit program involves periodic audits conducted according to a predetermined schedule for each year. This program is defined on an annual basis and conducted as outlined in this section with further details found in SOP ADMININTAUDIT043010. All elements of this Quality Manual will be audited each year and all relevant laboratory records are available to personnel conducting the audit. These audits are performed to verify operations continue to comply with the requirements of this Quality Manual and are effective.

Details:
The Quality Manual, test procedures, and laboratory results are verified for compliance. It is the responsibility of the Quality Assurance Officer to plan and organize audits as required by the schedule and requested by management. Audits are carried out by trained and qualified personnel who are independent of the activity to be audited. Personnel are not to audit their own activities except when it can be demonstrated that an effective audit will be carried out (see also 4.11.5). Audits are performed through the aid of a checklist prepared in advance to minimize the possibility of overlooking any details during the audit.

Generally, the types of audits include:
- quality management system
- processes and procedures
- services and reports

4.14.2 Corrective Action

Policy:
When audit findings cast doubt on the effectiveness of the operations or on the correctness or validity of test or calibration results, timely corrective action is taken and Clients are notified if investigations show that laboratory results may have been affected.

Details:
Nonconformities that can be resolved easily are to be corrected immediately, ideally during the audit. Records are made on the audit checklist. Nonconformities that require a

more involved resolution are recorded on a CAR and resolved as described in section 4.11.

Corrective actions and Client modifications must be kept on record for each audit deviation that casts doubt as described in this section.

4.14.3 Records and Management

Policy:
Records are made of the activity being audited, the audit findings, and corrective actions that arise. Management ensures that corrective actions are discharged within an appropriate and agreed timeline.

Details:
A report is prepared by the auditors and distributed to those audited and/or the area manager/supervisor within an appropriate and agreed timeline. The audit report may include the following sections, as appropriate:

- audit objective and scope
- area or section audited
- personnel involved – auditors and auditees
- date of audit
- reference documents
- observations including nonconformities and commendations
- opening and closing meetings
- recommendations
- audit report distribution

The appropriate manager is responsible for ensuring that corrective actions are sufficiently recorded. Follow-up is performed by the auditor and recorded when corrective action is complete and deemed effective. The audit records are kept in the laboratory.

4.14.4 Follow-up Audits

Policy:
Follow-up audits are performed to verify and record the implementation and effectiveness of the corrective action taken.

Details:
The follow-up audit is performed at a mutually acceptable time between the area implementing corrective action and the auditor. This time is determined when the CAR is issued.

4.15 Management Reviews

4.15.1 Review of Quality Management System and Testing

Policy:
Top management periodically (at least annually) and in accordance with a predetermined schedule and SOP ADMINMGMTREV043010, conduct a review of the laboratory's quality management system and testing activities to ensure their continuing suitability and effectiveness and to introduce any necessary changes or improvements.

Details:
The review takes account of:
- suitability of policies and procedures
- reports from managerial and supervisory personnel
- the outcome of recent internal audits
- corrective and preventive actions
- assessments by external bodies
- results of inter-laboratory comparisons or proficiency tests
- changes in the volume and type of work undertaken
- feedback from Clients, including complaints and Client satisfaction surveys
- recommendations for improvement
- other relevant factors, such as quality control activities, resources and personnel training

A minimum period for conducting a management review is once a year. Results of the review feed into the laboratory planning system and include goals, objectives and action plans for the coming year.

A management review can be supplemented by consideration of related subjects at regular management meetings.

4.15.2 Findings, Actions, and Records

Policy and Details:
Findings from management reviews and the actions that arise are recorded in the minutes of the meeting. Management will ensure that the actions are discharged within an appropriate and agreed upon timeline.

4.16 Data Integrity Plan

4.16.1 Purpose

The purpose of the Data Integrity Plan is four-fold:

(a) to describe the laboratory's data integrity system,
(b) to emphasize the paramount importance of ethics in the performance of all analytical work,
(c) to obtain the commitment of laboratory staff to the principle that all analyses shall be performed in a controlled and documented manner, and
(d) to ensure that laboratory staff consistently meet the specific ethical requirements defined in this data integrity plan.

4.16.2 Scope

This procedure applies to all analyses and activities performed within the laboratory's scope of accreditation.

4.16.3 Responsibilities

Senior managers support and provide initial data integrity training and on-going annual training to laboratory managers and staff. Senior managers ensure that only staff who sign the ethics agreement are allowed to work in the laboratory.

The QAO shall maintain records of ethics/data integrity training and data integrity monitoring.

4.16.4 Procedure

Ethics Training

Ethics training is a required part of new employee orientation and is provided on an annual basis for all laboratory managers and staff by senior laboratory management. Initial training during orientation includes the overall organizational mission and its relationship to the absolute need for honesty and full disclosure in all analytical reporting and record-keeping. Resources where applicable ethics policy and law can be found are made available and copies are distributed. Examples are described that illustrate unethical behavior and ethical behavior related to laboratory data manipulation. Laboratory standard operating procedures are reviewed with respect to proper procedure, data qualifiers, and adequacy of record keeping. Management will disclose that reports and the data generated to support them are subject to routine in-depth review.

The organizations response to infractions of the data integrity plan will be discussed and the trainee shall understand that infractions will be investigated in a detailed way. The consequences to an employee found to be in violation of the data integrity plan may result in immediate termination, debarment, and/or civil/criminal prosecution. Confidentiality is assured during this process.

Employee attendance or participation is documented.

Ethics Agreement

Following initial ethics training and on-going annual training for laboratory managers and staff, trainees shall sign a written ethics agreement. Senior managers who provide the training shall also sign the agreement. The agreement states that the signers will not engage in any unethical practices with respect to data integrity nor will they tolerate improper behavior in others if it is observed or suspected. By signing, senior managers acknowledge their duties in upholding the spirit and intent of the data integrity system and in effectively implementing the specific requirements of the plan.

Monitoring

Data integrity monitoring is accomplished by periodic data package and manual integration reviews by the QAO and/or Laboratory Director, annual internal audits, and monthly QC sample tracking. Therefore the QAO, shall have an in-depth understanding of typical inappropriate analytical behavior and be trained in the data integrity system. Refer to the laboratory's SOP for data review.

Blind known reference samples may be submitted for analysis as real samples by the QAO, (blind to the analyst) as part of any project or event Data and results of the reference sample are reviewed by the QAO to verify that all data integrity requirements are met.

Documentation

All data integrity incidents must be documented, including investigative findings and disciplinary actions. Corrective actions are recorded. Confidentiality is critical and maintained by use of locked filing cabinets and password protected electronic files. If client disclosure is determined to be necessary by senior laboratory management, then such disclosures and outcomes are recorded.

All data integrity documents, plans, SOPs, personal records and records of investigations shall be maintained for a period of five years. Documents are subject to the document control system and records are subject to the records management system as described in the laboratory's quality manual and related SOPs.

4.16.5 References

Internal
York Data Integrity and Ethics Training SOP (ADMIN Ethics 040102)
York Internal Quality Audit SOP (ADMIN Audit 043010)
York Manual Integration Review SOP (ADMIN ManIntReview 043010)

External
NELAC Quality Systems, Chapter 5, Sections *5.4.2.3, 5.4.2.6, and 5.4.15*, June 5, 2003 and Module 2, *Sections 4.2.8.4, 4.2.8.1, 5.2.7, and 4.16*, August 24, 2009.

5.1 Technical Requirements

5.2 General

5.2.1 .1 Correctness and Reliability

Policy and Details:
Correctness and reliability of the tests and/or calibrations performed have many contributing factors including:

- human factors (see section 5.2)
- accommodation and environmental conditions (see section 5.3)
- test and calibration methods and method validation (see section 5.4)
- instrumentation (see section 5.5)
- measurement traceability (see section 5.6)
- sampling (see section 5.7)
- handling of test and calibration items (see section 5.8)

5.2.2 Measurement Uncertainty

Policy:
When developing test and calibration methods and procedures, total measurement uncertainty must be accounted for in the training and qualification of personnel, and in the selection and calibration of instrumentation.

Details:
The extent to which the factors contribute to total measurement uncertainty differs between (types of) tests and between (types of) calibrations.

See section 5.4.6 for more details.

5.2 Personnel

York recognizes that all laboratory personnel affect data quality. This manual has been prepared so that staff members will be cognizant of the procedures adopted by York for the production of analytical data, and so they will be aware of their responsibilities.

Staff are properly trained and qualified for their positions and specific procedures.

5.2.1 Competence and Qualification

Policy:
Management ensures the competency of all personnel charged with analysis and those evaluating results and signing test reports. Appropriate supervision is provided for employees undergoing training. Personnel performing specific tasks are qualified on the basis of appropriate education, training, experience and/or demonstrated skills, as required.

In addition, personnel responsible for the opinions and interpretations included in test reports also have:

- relevant knowledge of the technology used for the analysis, materials
- knowledge of the general requirements expressed in the legislation and standards
- an understanding of the significance of deviations found with regard to the normal use of the data

Details:
Management defines the minimum levels of qualification and experience necessary for all posts within the laboratory. In some technical areas it may be required that the personnel performing certain tasks be certified. The laboratory is responsible for fulfilling specified certification requirements of personnel. The requirements for personnel certification might be regulatory, might be included in the standards for the specific technical field, or required by the client.

Continued competence is monitored and where this is not achieved, the need to retrain personnel is considered. Where a method or technique is not in regular use, verification of personnel performance prior to testing may be necessary.

5.2.2 Training Policies and Procedures

Policy:
Management will formulate the goals with respect to the education and the skills of the laboratory personnel. The training program is relevant to the present and anticipated tasks

of the laboratory. SOP# ADMIN Training Revision No. 1.4 09/04/2014 is utilized to identify training needs and providing the necessary training for personnel. The effectiveness of the training actions taken is evaluated.

Details:
The skills and knowledge are defined in the job description for each job function as described in section 5.2.4. Management compares the job description to the skills and knowledge of the new incumbent to determine the training needs.

Training in the laboratory must include all methods or parts of methods and techniques that personnel are asked to perform. Minimally, the analyst must demonstrate competency (Initial Demonstration of Capability) through observation by management and verification using replicate and/or check samples. For technicians who perform only parts of the method, confirmation of competency may be verified by observation only. Re-verification of all personnel must be performed annually on all methods or techniques pertinent to their job description.

In some cases it may be appropriate to define competence related to a particular technique or instrument rather then methods. If so, it will be necessary to define for each method, the necessary technique-based competence required together with any additional requirements.

5.2.3 Employees

Policy:
Competent permanent or part-time employees are employed in the laboratory. No contract labor is used. The Managing Director ensures that all technical employees, and key support personnel are supervised and work in accordance to the policies and procedures of this Quality Manual.

Details:
Testing must be either performed or supervised by an experienced person qualified to degree level. Personnel have relevant practical work experience and training before being allowed to perform accredited work.

5.2.4 Job Descriptions

Policy:
Current job descriptions for managerial, technical and key support personnel involved in laboratory analyses are maintained centrally on the Network with appropriate access.

Details:
Minimum contents of job descriptions include:
- the duty of performing preparation/analysis
- the act of planning analyses and evaluation of results
- the responsibility of developing and validating new methods as / when requested
- expertise and experience
- qualifications and training programs
- managerial duties if applicable

Job descriptions are dated and signed to demonstrate that each incumbent has read it and is in agreement. They are maintained current on the Network.

5.2.5 Authorized Personnel

Policy:
Management authorizes specific personnel to perform particular types of analysis, to issue test reports, to give opinions and interpretations and to operate particular types of instrumentation. Records of the relevant competence, educational and professional qualifications, training, skills and experience of all technical personnel and contracted personnel are maintained. This information is readily available and includes the date on which authorization and/or competence was confirmed and the criteria on which the authorization is based and the confirming authority.

Details:
The purpose of these records is to provide evidence that personnel have been adequately trained and their competence to perform particular tests has been assessed. In some cases it may be pertinent to state any particular limitations to competence. The records are maintained in a registry of skills and include:
- academic and professional qualifications
- external and internal courses attended
- relevant on-the-job training and retraining as necessary (i.e., demonstration of capability)
- skills and experience (i.e., resume-maintained in employee administration file)
- relevant authorizations

Records are held centrally in the Employee Training Records Log.

5.3 Accommodation and Environmental Conditions

5.3.1 Facility

Policy:
Laboratory facilities are appropriate to attain correct performance of all analyses. This may include, but not limited to, energy sources, lighting, heating, ventilation and any other environmental conditions.

Appropriate care is taken to ensure that the environment does not invalidate the results or adversely affect the required quality of any measurement. The technical requirements for accommodation and environmental conditions that can affect the results of tests and calibrations are documented.

Details:
This section deals with the test areas in the laboratory and premises for support such as sample receipt and storage. Central laboratory supplies and services, such as water purification systems, air supply, vacuum source, and sample storage, are appropriate to facilitate proper performance of analyses.

5.3.2 Monitoring

Policy:
Critical environmental conditions are monitored, controlled and recorded as required by the relevant specifications, methods, and procedures or where they may influence the quality of the results. Due attention is paid, for example, to the potential for cross contamination by methylene chloride, acetone and hexanes which are used in the Extractions processes, as appropriate to the technical activities concerned. Analyses are stopped when the environmental conditions jeopardize the results. O

Details:
Laboratories are ventilated to reduce the levels of contamination, lower humidity, and control temperature. Laboratories' test areas are air-conditioned. The relative humidity in test areas is 45-50 and the temperature is 20-25 °C. Volatiles analyses are conducted in a separate laboratory where the air conditioning system produces a positive pressure in the laboratory and the air intake (economizer) is disabled. In addition, samples for volatiles are stored in a separate Sample Control room in their own refrigerators to minimize potential for cross contamination.

Bench tops and floors are made of impervious, smooth easily cleaned materials. There is at least two linear meters workspace per analyst while working. Walls and ceilings are made of materials that are smooth and easily cleaned.

5.3.3 Separation of Incompatible Activities

Policy:
Effective separation between neighboring areas is made when the activities are incompatible. Measures are taken to prevent cross-contamination.

Details:
Reference materials and certified reference materials must be kept separated from samples (log-in and storage). Sample log-in and storage must are segregated, in separate areas from the testing laboratory, and include proper sanitation to exclude the possibility of cross-contamination. Segregation of activities is achieved through time and space allocations.

An example of space segregation would be for a trace volatiles analysis. Physical separation of the trace volatiles analysis from Extractions using solvents is achieved through the use of separate rooms. This also applies to samples for VOA analysis.

An example of time segregation would be the coordination of activities at different times. It may be appropriate to perform work on "cleaner" samples first before starting "dirtier" type samples.

5.3.4 Controlled Access

Policy:
Access to and use of areas affecting quality of the analyses is defined and controlled.

Details:
Access to the laboratory is restricted to authorized personnel. The authorized personnel are made aware of the following items:

- the intended use of the area
- the restrictions imposed on working within such areas
- the reasons for imposing the restrictions

5.3.5 Good Housekeeping

Policy:
Measures are taken to ensure good housekeeping in the laboratory. Special procedures are prepared when necessary.

Details:
Controlled use of cleaning and pest control materials is exercised. The laboratory complies with the local health and safety requirements.

5.4 Tests and Calibration Methods and Method Validation

5.4.1 General

Policy:
Methods and procedures used for all analyses are appropriate as per:
- courier handling, transport, storage, and preparation of items to be tested
- an estimation of the measurement of uncertainty as well as statistical techniques for analysis of test data where appropriate

Instructions on the use and operation of all relevant instrumentation and on the handling and preparation of items for testing are available. All instructions, standards, manuals and reference data relevant to the work of the laboratory are maintained current and readily available to personnel. Deviation from SOP and test methods must be documented, technically justified, authorized, and accepted by the client.

Details:
There are SOPs for sample handling, transport, storage, preparation, QA/QC procedures, and standards for approving / rejecting results. These may be combined with or separate from the method. The content of a test method or SOP generally includes:
- scope
- description of test items
- holding times
- quantities to be tested
- materials and instrumentation required
- physical environmental conditions required (temperatures, pH requirements)
- description of procedures

- sample identification
- method of recording observations and results
- safety measures
- waste management/pollution prevention
- documentation
- method for data analysis and presentation
- sensitivity of method
- quality control plan

National or state standards or other recognized specifications that contain sufficient and concise information on how to perform the analyses are not necessarily supplemented or rewritten as an internal procedure when they are written in a way that can be used as published by laboratory staff. Consideration may need to be given to providing additional documentation for optional steps in the method.

5.4.2 Selection of Methods

Policy:
Preparation and analysis methods meet the needs of the client and are appropriate for the analysis undertaken. Preference is given to reference methods published as international, Federal, or State standards. The laboratory ensures that the latest edition of a standard is used unless it is not appropriate or possible to do so. When necessary, the standard is supplemented with additional details to ensure consistent application.

Details:
Methods that have been published either in international, Federal, or State standards, or by reputable technical organizations, or in relevant scientific texts or journals, or as specified by the manufacturer are selected when the client does not specify the method to be used. These methods may be adopted from the Environmental Protection Agency, ASTM, Standard Methods for the Examination of Water and Wastewater, Various State agencies, etc.
The ability of the laboratory to achieve satisfactory performance against documented performance characteristics is verified before samples are analyzed.

Laboratory-developed methods or methods adopted by the laboratory may also be used if they are appropriate for the intended use and if they are validated. The client is informed as to the method chosen. The laboratory confirms that it can properly operate standardized methods before introducing the samples for analysis.

The client is informed when the method proposed by the client is considered to be inappropriate or out of date.

5.4.3 Laboratory-Developed Methods

Policy:
Introduction of test methods developed internally is a planned activity and is assigned to qualified personnel equipped with adequate resources. Plans are updated as development proceeds and ensure effective communication among all personnel involved.

Details:
Methods developed in-house are validated and authorized before use. Where available, Certified Reference Materials (CRMs) are used to determine any systemic bias, or where possible results are compared with other techniques, preferably based on different principles of analysis. Determination of uncertainty must be part of this validation process and is essential for ongoing quality control.

5.4.4 Non-Standard Methods

Policy:
Utilization of non-standard methods is subject to agreement with the client and includes a clear specification of the client's requirements and the purpose of the test. The developed method is validated appropriately before use.

Details:
Discussion and agreement for the use of non-standard methods is recorded as part of contract review procedures (see section 4.4).

All non-standard and new tests are validated for their intended purpose. Qualitative test methods must be validated to demonstrate estimated sensitivity and specificity, relative accuracy to official methods (if appropriate), positive and negative deviation, limit of detection, matrix effect, repeatability, and reproducibility.

Quantitative test methods are validated to demonstrate specificity, sensitivity, relative accuracy, positive and negative deviation, repeatability, reproducibility, and limit of determination.

For new methods where procedures are developing rapidly, especially for emergency situations, it may be necessary to circumvent normal validation procedures. Minimally, this must be a demonstrated recovery in replicate.

New test and/or calibration methods are documented prior to providing test and/or calibration results to clients and contain at least the following information:

- appropriate identification
- scope
- description of the type of item to be tested or calibrated
- parameters or quantities to be determined
- apparatus and instrumentation, including technical performance requirements
- reference standards and reference materials required
- environmental conditions required and any stabilization period needed
- description of the procedure, including:
  - affixing identification marks, handling, transporting, storing and preparing of items
  - ensuring checks are made before the work is started
  - checking that the instrumentation is working properly and, where required, calibrating and adjusting the instrumentation before each use
  - listing method of recording the observations and results
  - indicating any safety measures to be observed
- criteria and/or requirements for approval/rejection (quality control plan)
- data to be recorded and method of analysis and presentation
- uncertainty or procedure for estimating uncertainty

5.4.5 Validation of Methods

5.4.5.1 Performance Characteristics

Policy:

Validation of a method establishes, by systematic laboratory studies, that the performance characteristics of the method meet the specifications related to the intended use of the test results.

Details:

The performance characteristics of a validation plan includes, as applicable:

- selectivity and specificity
- range
- linearity
- sensitivity
- limit of detection
- limit of quantitation
- ruggedness
- accuracy
- precision
- reporting limit
- repeatability
- reproducibility
- recovery

- confirmation techniques
- criteria for the number of samples tested to validate method as per defined scope of method
- action levels where defined by regulation
- quality control incorporating statistics as applicable
- interpretation of population results as applicable

Performance characteristics that are selected take into account the intended use of the method, whether for screening, confirmatory analysis, or quantitation.
The design, verification of the method and documentation procedures for validation are planned and conducted by qualified personnel, equipped with adequate resources.

This section lists a few acceptable validation procedures. The choice of the procedure depends on the extent of the deviation from the published method.
Validation of methodology is a value judgment in which the performance parameters of the method are compared with the requirements for the test data. A prerequisite for a valid method is that data produced by the method must attain a state of statistical control.
Such a state is obtained when the mean value of a large number of individual values tends to approach a limiting value called the limiting mean.

Methods may be validated by one or more alternative procedures. Some of these procedures are described below. Apparent differences can be analyzed statistically to confirm their significance. In all cases, the reasons for choosing one or more alternatives must be documented.

- analysis of standard reference materials (SRM) that are identical or almost identical to the test samples
- in the absence of suitable SRMs, analysis of reference materials that are similar in all respect to the test samples; the use and validity of this reference material must be documented
- using an alternative method to measure the same parameter provides a very high level of confidence if results are confirmed
- recovery studies by the addition of a known concentration of the parameter of interest to some of the replicates being measured

The parameters to be determined include:

- the scope of the method and any known interference
- detection limit
- the range of concentration where the method is valid
- precision and bias
- intra-laboratory variations
- inter-laboratory variations

Judgment is required to determine if some or all of the above is required. Requirements will depend largely on the extent of deviation from the original method.

Developments in methodology and techniques require methods to be changed from time to time. The difference in performance between revised and obsolete methods is established so that it is possible to compare old and new data.

Where a change in method involves only minor adjustments, such as sample size, or different reagents, the amended method is validated and the changes brought to the attention of the accreditation body at the next accreditation audit. Where the proposed change involves technology or methodology, the laboratory seeks the approval of the accreditation body.

Records are kept on all validation activities. The records include any of the performance characteristics chosen, reference procedures or guidance documents followed to validate the method or custom validation procedure, and a final confirmation (memo to file) that the method validation results are acceptable for continued use of the method. An example statement would be "This memo serves as record that the validation of the XYZ Test Method has been approved for use by [name and title of approver]".

5.4.5.2 Fit for Use

Policy:
The laboratory validates non-standardized methods, laboratory-designed/developed methods, standardized methods used outside their intended range, and amplifications of standard methods to confirm that the methods are fit for the intended use. The validation is as extensive as is necessary to meet the needs in the given application or field of application (may include procedures for sampling, handling, and transportation). The laboratory records the results obtained, the procedure used for the validation, and a statement as to whether the method is fit for the intended use.

Details and Procedure:
Validation records are kept as in section 5.4.5.1. Included in these records is the validation procedure. The procedure used for the validation is likely to vary between different methods. Therefore, the procedures included in the laboratory records are not as detailed as a typical SOP, but are sufficient enough to re-create how the method was validated.

The techniques used for the determination of the performance of a method, are one of, or a combination of, the following:

- calibration using reference standards or reference materials

- comparison of results achieved with other methods
- inter-laboratory comparisons
- systematic assessment of the factors influencing the result
- assessment of the uncertainty of the results based on scientific understanding of the theoretical principles of the method and practical experience

When changes are made in the validated non-standard method, the influence of such changes carried out is documented and if appropriate a new validation is performed.

5.4.5.3 Client's Needs

Policy:
The range and accuracy of the values obtainable from validated methods (e.g., the uncertainty of the results, detection limit, selectivity of the method, linearity, limit of repeatability and/or reproducibility, robustness against external influences and/or cross-sensitivity against interference from the matrix of the sample/test object) as assessed for the intended use is relevant to the client's needs.

Details:
Validation includes the specification of the requirements, determination of the characteristics of the methods, the comparison of the requirements with the values of the characteristics of the method, and a statement on the validity.

As method development proceeds, regular review is required to verify that the needs of the client are still being fulfilled. Changing requirements requiring modifications to the development plan are approved and authorized.

Validation is always a balance between costs, risks, and technical possibilities.

5.4.6 Uncertainty of Measurement

5.4.6.1 Calibration

Policy:
Physical and chemical standards and instrumentation are calibrated or characterized internally and by subcontractors where appropriate.

Details and Procedures:
Repeatability and reproducibility data are components of measurement uncertainty and are determined as a first step towards producing estimates of this parameter. The uncertainty of measurement is available on the certificate of analysis or calibration certificate from a subcontractor.
Note – in-house calibrations include procedures for uncertainty of measurement estimates where this is common practice.

5.4.6.1.1 CALIBRATION PRACTICES

Instruments and instrumentation used at York are controlled by a formal calibration program. The program verifies that instrumentation is of the proper type, range, accuracy, and precision to provide data compatible with specified requirements. All instruments and instrumentation which measure a quantity, or whose performance is expected at a stated level, are subject to calibration. Calibration may be performed by York personnel using reference standards, or externally by calibration agencies or instrumentation manufacturers.

This section of the Quality Manual prescribes the practices used by York to implement a calibration program. Specifics are not provided herein because the requirements for the calibration of instruments and instrumentation are dependent upon the type and expected performance of individual instruments and instrumentation. Such details are provided in the specific SOPs. Implementation is the responsibility of the Group Leaders and Analysts. The Quality Assurance Officer shall review the implementation of the program as discussed in previously.

Two types of calibration are discussed in this section:

- Operational calibration which is routinely performed as part of instrument usage, such as the development of initial calibration curves for GC, GC/MS, etc. Operational calibration is generally performed for instrument systems.

- Periodic calibration which is performed at prescribed intervals for instrumentation, such as balances and critical temperature measurement devices.

5.4.6.1.2 CALIBRATION SYSTEM

The following is a discussion of the elements comprising the calibration system.

5.4.6.1.3 Calibration Procedures

Written procedures are developed by York within the requirements of this manual for all instruments and instrumentation subject to calibration. Whenever possible, recognized procedures, such as those published by ASTM or the USEPA, or procedures provided by manufacturers are adopted. If established procedures are not available, a procedure shall be developed considering the type of instrumentation, stability characteristics of the instrumentation, required accuracy, and the effect of operational error on the quantities measured. As a minimum, the procedures shall include:

- Instrumentation to be calibrated
- Reference standards used for calibration
- Calibration technique and sequential actions
- Acceptable performance ranges
- Frequency of calibration
- Calibration documentation format

5.4.6.1.4 Instrumentation Identification

Instrumentation that is subject to calibration shall be uniquely identified so that calibration records can be designated with a specific instrument. Instrumentation identification can be by manufacturer's serial number, York inventory control number, or a unique number assigned by York.

5.4.6.1.5 Calibration Frequency

Instruments and instrumentation shall be calibrated at prescribed intervals and/or as part of the operational use of the instrumentation. Frequency shall be based on the type of instrumentation, inherent stability, manufacturer's recommendations, values provided in recognized standards, intended use, effect of error upon the measurement process, and prior experience.

5.4.6.1.6 Calibration Reference Standards

Two types of reference standards are used within the York laboratory for calibration:

- Physical standards, such as weights for calibrating balances and certified thermometers for calibrating working thermometers and ovens, which are generally used for periodic calibration.

- Chemical standards such as Standard Reference Materials (SRMs) provided by the National Bureau of Standards NIST or NIST-traceable standards which are primarily used for operational calibration.

Whenever possible, physical reference standards shall have known relationships to nationally recognized standards (e.g., NIST) or accepted values of natural physical constants. If national standards do not exist, the basis for the reference standards shall be documented.
Whenever possible, chemical references standards shall be directly traceable to NIST SRMs and/or EPA. If SRMs are not available, compounds of certified high purity will be used to prepare calibration standards.

5.4.6.1.7 Calibration Failure

Instrumentation that fails calibration or becomes inoperable during use shall be removed from service and segregated to prevent inadvertent use, or shall be tagged to indicate it is out of service. Such instrumentation shall be repaired and satisfactorily recalibrated before reuse

Scheduled calibration of instrumentation does not relieve the laboratory staff of the responsibility for using properly functioning instrumentation. If an instrumentation malfunction is suspected, the instrumentation shall be tagged and removed from service and recalibrated. If it fails recalibration, the above process shall apply.

5.4.6.1.8 Calibration Records

Records shall be prepared and maintained for each piece of instrumentation subject to calibration. Records demonstrating accuracy of reference standards shall also be maintained.

Records for periodically calibrated instrumentation shall include, as appropriate:

- Identification number of instrumentation and type of instrumentation.

- Calibration frequency and acceptable tolerances.

- Identification of calibration procedure used.

- Date calibration was performed.
- Identity of York personnel and/or external agencies performing the calibration.
- Reference standards used for calibration.
- Calibration date.
- Certificates or statements of calibration provided by manufacturers and external agencies, and traceability to national standards.
- Information regarding calibration acceptance or failure and any repair of failed instrumentation.

Records for periodically calibrated instrumentation shall be maintained in the Quality Assurance Folder Records. Records for each instrument/instrumentation and physical reference standard shall be kept in a separate folder. The title sheet for each file shall be a summary of calibrations performed. It is recommended that an index precede the instrumentation files which lists in matrix form all instrumentation and physical standards, calibration frequency, and dates for upcoming calibration. The use of a calibration due date matrix provides ready reference so that calibration can be maintained by the Group Leaders.

For instruments and instrumentation that are calibrated on an operational basis, calibration generally consists of determining instrumental response against compounds of known composition and concentration or the preparation of a standard response curve (either linear or average response factor) of the same compound at different concentrations. Records of these calibrations are be maintained in several ways:

- The calibration data for all GC, GC/MS, ICP/ICPMS, Ion Chromatography is kept in a uniquely numbered QUALITY BATCH (QB) file. These files include all initial calibrations and continuing calibrations, as well as method blanks, spikes, duplicates and control (LCS) data. The nomenclature for these files follows this example:
  - For a volatiles run on April 1, 2010 on Volatiles GC/MS # 1, the batch QA/QC data is placed in a QB file identified as QBV1040110A. The A represents the first batch of the day. If two batches are run, a B is affixed, etc.

- This unique QB number appears on all sample headers to allow for cross referencing all QA data for a particular batch to each sample.

➢ A log book for each parameter documents all calibration and QA data for each wet chemistry, gravimetric or spectrophotometric analysis.

For operational calibration, the following is recommended:

As above, calibration data must be included in a batch file system. If samples from different projects are processed together, calibration data is included in a batch folder.

- The specific SOPs detail:

- Calibration instructions (curve preparation, linear ranges, etc.).

- Procedures for chemical standards preparations.

5.4.6.1.9 OPERATIONAL CALIBRATION

Operational calibration is generally performed as part of the analytical procedure. Included may be the analysis of a method blank and the preparation of continuing calibration verification standard or curve. Operational calibration is dependent upon the instrumentation within York, and as previously discussed, the laboratory uses a specific SOP for this purpose.

Following is a brief discussion of the analysis of method blanks and preparation of calibration curves. Guidelines for the major instrument systems within the York laboratory follow:

5.4.6.1.10 General Calibration Procedures

The initial phase of a laboratory testing program requires the selection and certification of the method best suited for an individual parameter. Certification, or verification, is the elimination, or minimizing, of determinate errors which may be due to Analyst's error, the use of less-than-optimum instrumentation, reagents, solvents, or gases. The quality of materials, even though they are AR grade or better, may vary from one source to another. The Analyst must determine, through the use of reagent and/or solvent blanks, if materials are free from interfering substances which could affect the analysis. Other steps in certifying the method include the determination of a method blank and the preparation of a standard calibration curve.

5.4.6.1.11 Method Blank

After determining the individual reagent or solvent blanks, the Analyst defines the method blank to determine if the cumulative blank interferes with the analysis. The method blank is defined by following the procedures step by step, including the addition of all of the reagents and solvents, in the quantity required by the method. If the cumulative blank interferes with the determination, steps must be taken to eliminate or reduce the interference to a level that will permit the combination of solvents and reagents to be used. If the blank interference cannot be eliminated, the magnitude of the interference must be considered when calculating the concentration of specific constituents in the samples analyzed.

A method blank must be determined whenever an analysis is made. The number of blanks is determined by the method of analysis and the number of samples analyzed at a given time, but is typically one per 20 samples or one per batch whichever is less.

5.4.6.1.12 Preparation of Standard Calibration Curve

Concurrent with the preparation of reagent and method blanks, a standard calibration curve is accomplished by using calibration standards. The process is summarized as:

- Preparation of a standard calibration curve is accomplished by using five calibration standards prepared by mixing the species to be analyzed into the "solvent" that is to be introduced into the instrument.
- The concentration of the calibration standards are chosen to cover the working range of the instrument.
- All sample measurements are made within this working range.
- The calibration curve is prepared by plotting instrument response versus concentration of the species analyzed. Acceptable linearity or RSDs are defined in the analysis specific SOPs.
- Concentrations of the sample prepared with the same procedure are read directly from the calibration curve or average response factor as detailed in the SOPs.

5.4.6.1.13 GC/MS CALIBRATION PROCEDURES

This section outlines the minimum operations necessary to satisfy analytical requirements associated with the determination of various target lists of organics compounds in air, water and soil/sediment samples. The following operations must be performed routinely (as specified in the SOPs) in the laboratory:

- Documentation of GC/MS mass calibration and abundance pattern.
- Documentation of GC/MS response factor stability.
- Internal standard response and retention time monitoring.

6.2.2.1 Tuning and GC/MS Mass Calibration

Prior to initiating data collection, it is necessary to establish that a given GC/MS meets the standard mass spectral abundance criteria. This is accomplished through the analysis of decafluorotriphenylphosphine (DFTPP) for base/neutral and acid (BNA) compounds or p-bromofluorobenzene (BFB) for volatile compounds. The ion abundance criteria as listed in the methods or SOPs for each calibration compound should be met before samples, blanks, or standards can be analyzed.

DFTPP (decafluorotriphenylphosphine)

Each GC/MS system used for the analysis of semivolatile compounds must be tuned to meet the abundance criteria of the method for a 50 nanogram (ng) injection of DFTPP. DFTPP may be analyzed separately or as part of the calibration standard, and the criteria must be demonstrated each (12) hours of use. Documentation of the calibration must be provided in the form of a bar graph plot and as a mass listing.

BFB (p-bromofluorobenzene)

Each GC/MS system used for the analysis of volatile compounds must be tuned to meet the proper abundance criteria for a 50 ng injection of BFB. The criteria should be demonstrated each (12) hours of use. Documentation of the calibration should be provided in the form of a bar graph plot and as a mass listing.

Analysts obtain a system generated GC/MS Tuning and Mass Calibration each time an analytical system is tuned.

5.4.6.1.14 Calibration of the GC/MS System

Prior to the analysis of samples and after tuning criteria have been met, the GC/MS system must be initially calibrated at a minimum of five concentrations to determine the linearity of response utilizing standards. For GC/MS analysis, typical linear ranges are 0.05(SIM) to 200 ng for base neutrals, 5 to 400 ng for certain phenols, and 0.1 to 1,000 ng for volatiles.

Calibration standards are prepared to cover the linear range and are detailed in the SOPs.

Semivolatiles (B/N/A)

Initial calibration of semivolatile compounds is recommended at 5 to 140 ng for SCAN analysis with SIM covering the range 0.05 to 2 ng.

Pesticides & PCB

Pesticides by GC/ECD are calibrated at five levels from 0.001 ng to 0.2 ng.

PCB's by GC/ECD are calibrated at five levels from 1 ng to 10 ng.

In all cases reference is made to the specific SOP for preparation directions.

Continuing Calibration (GC/MS and GC)

A continuing calibration standard containing all volatile or semivolatile compounds as well as all required internal standards and surrogates, is performed each 12 hours during analysis. This applies to all matrices except air, whose requirements are detailed in EPA methods TO14A/15. Compare the RF data from the standards each 12 hours with the average RF from the initial calibration for a specific instrument. A system performance check must also be made each 12 hours. If the SPCC criteria are met, a comparison of RFs is made for all compounds. This is the same check that is applied during the initial calibration. If the minimum response factors are not met, the system should be evaluated and corrective action should be taken before sample analysis begins. See the specific SOP for criteria.

5.4.6.1.15 Calibration of the Gas Chromatograph

Calibration of the gas chromatograph (GC) for pesticide and polychlorinated biphenyl (PCB) or other organic compound analyses is performed with the standardization of the instrument. A five-point standard curve is utilized.

Response factors are to be calculated for each compound at each concentration level. These RF will be averaged to generate the mean daily RF for each compound over the range of the standard curve. The mean response factor will be used to calculate the sample concentration of the compound of interest. When sample responses exceed the range of the standard curve, the sample will be diluted to fall within range of the standard curve and be reanalyzed. The results of the daily GC standardization will be tabulated and filed with the corresponding sample analyses or batch file.

5.4.6.1.16 <u>Calibration of Inductively Coupled Plasma Spectrometer (ICP) and Inductively Coupled Argon Plasma/Mass Spectrometer (ICP/MS) and Cold Vapor AAS</u>

The ICP and ICP/MS are standardized for the metal of interest by the analysis of a set of calibration standards prepared by diluting a stock solution of known concentration. A single standard is used to calibrate the ICP, three standards are used for ICP/MS, while five working standards of mercury (Cold Vapor AAS) are prepared by dilution of the stock standard. The concentration of the calibration standards is chosen so as to cover the working range of the instrument. Subsequently all sample measurements are made within this working range. Once the working standards are prepared, they are analyzed on the ICP or AAS and the instrument response is calibrated to provide a direct readout in micrograms of metal per milliliter of water or parts per million.

Once the instrument has been initially calibrated, the analysis of initial calibration verification (ICV) is performed. Continuing calibration verification (CCV) standards are repeated after every ten samples during sample analysis to verify instrument response during analysis and to confirm the calibration. A typical analysis sequence is presented below:

< Working standards are prepared by dilution of a stock standard solution of the metal of interest.

< A calibration curve within the working range of the instrument is established by analysis of five working standards (one for ICP).

< The working standards (ICV, CCV and blank) are reanalyzed to confirm calibration. If the calibration is not confirmed, within SOP limits, the instrument is recalibrated.

< The samples are analyzed for the metals of interest.

< Following completion of the sample analyses, the working standards are reanalyzed to confirm calibration. If calibration is confirmed, the analysis is

completed. However, if the calibration is not confirmed, the problem is corrected, and the affected samples are reanalyzed.

5.4.6.1.17 PERIODIC CALIBRATION

Periodic calibration shall be performed for instrumentation such as balances, thermometers, ovens, and furnaces that are required in analytical methods, but which are not routinely calibrated as part of the analytical procedure. Documentation of calibration is kept for each instrumentation item.

Calibration requirements are determined within the York laboratory depending upon the instrumentation used and its operating function. Following are brief example discussions for the calibration of balances and thermometers with examples of calibration data sheets to serve as a guideline for the preparation of laboratory-specific procedures.

5.4.6.1.18 Balances (Example Procedure)

All balances are verified by using weights traceable to the National Bureau of Standards (NIST) on use. Calibration weights shall be Class S or better and shall be recertified every year. If balances are calibrated by an external agency, verification of their weights shall be provided.

Calibration of balances shall be over the range in which they are most commonly used. The weighs used for calibration of each balance shall be 0.5g, 2.0g, 10.0g, 20.0g, and 100g. Acceptance for balances which are direct reading to 0.01 gram shall be $\pm$0.01g, to 0.0001g shall be $\pm$0.007g, and to 0.00001g shall be $\pm$0.0007g.

5.4.6.1.19 Thermometers (Example Procedure)

Certified, or reference, thermometers shall be maintained for use in calibrating working thermometers including other temperature measurement devices such as thermocouples, probes and infrared temperature sensors. Reference thermometers shall be provided with NIST traceability for initial calibration and shall be recertified every year with instrumentation directly traceable to the NIST. Working thermometers shall be compared with reference thermometers every 12 months. In addition, working thermometers shall be visually inspected by laboratory personnel prior to use.

Calibration temperatures and acceptance criteria shall be based upon the working range of the thermometer and the accuracy required for its use.

5.4.6.2 Testing Uncertainties

Policy:
The SOP ADMINESTUNCERT043010 is utilized to estimate uncertainties of measurement in testing, except when the test methods preclude such rigorous calculations. For most environmental analyses these uncertainties have been established and this procedure will be unnecessary.

In certain cases it is not possible to undertake metrologically and statistically valid estimations of uncertainty of measurement. In these cases the laboratory attempts to identify all the components of uncertainty and make the best possible estimation, and ensure that the form of reporting does not give an exaggerated impression of accuracy. Reasonable estimation is based on knowledge of the performance of the method and on the measurement scope and makes use of previous experience and validation data.

Details:
The degree of rigor needed in an estimation of uncertainty of measurement depends on factors such as:

- requirement of the test method
- requirement by the client
- if there are narrow limits on which decisions on conformity to a specification are based

In cases where a well-recognized test method specifies limits to the values of the major sources of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory is considered to have satisfied the estimation uncertainty of measurement by following the reporting instructions (see section 5.10).

5.4.6.3 Uncertainty Components

Policy:
When estimating the uncertainty of measurement, all uncertainty components that are of importance in the given situation are taken into account using accepted methods of analysis.

Details:
Sources contributing to the uncertainty include, but are not necessarily limited to, the reference standards and reference materials used, methods and instrumentation used, the environmental conditions, the item being tested or calibrated and the operator.

The predicted long-term behavior of the tested and/or calibrated item is normally not taken into account when estimating the measurement uncertainty.

For further information, see ISO 5725 and the Guide to Expression of Uncertainty in Measurement.

5.4.7 Control of Data

5.4.7.1 Calculations and Data Transfers

Policy:
Calculations and data transfers are subject to appropriate checks in a systematic manner.

Details:
Test data are validated through the following to determine accuracy of calculations, conversions, and data transfers
- checks for transcription errors, omissions, and mistakes
- checks to determine consistency with normal or expected values

For those analyses where manual data reduction is required, it is performed according to the instructions provided in the test method or SOP.

5.4.7.2 Computers and Automated Instrumentation

Policy:
When computers or automated instrumentation are used for the acquisition, processing, manipulation, recording, reporting, storage or retrieval of test or calibration data, the laboratory ensures that:
- computer software developed by the user is documented in sufficient detail and suitably validated or otherwise checked as being adequate for use
- procedures are established and implemented for protecting the integrity of data; such procedures include, but are not be limited to, integrity and confidentiality of data entry or collection, data storage, data transmission, and data processing (see section 4.13.1.4)
- computers and automated instrumentation are maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of test and calibration data
- data is securely maintained by preventing unauthorized access to, and unauthorized amendment of, computer records
- Data are backed up both on-site and off site at a frequency that allows minimal loss in the event of catastrophic failure

Details and Procedures:
Data generated using computer software programs that are interfaced directly to instruments incorporates all dilutions and calculations, thereby eliminating the need for manual data reduction. This coupled with preparation parameters done through the LIMS system yield the final results.

Commercially developed software in general use within its designed application range may be considered sufficiently validated. Laboratory software configuration / modifications are validated and documented.

Electronic records, electronic signatures, and handwritten signatures executed to electronic records must be equivalent to proper records and handwritten signatures to paper and are validated by procedures in 21 CFR. Part II (Docket No. 92NO251) RIN0910-AA29; Federal Register: March 20, 1997, Volume 62, Number 54), Rules and Regulations, pages 13429-13466. For further details see:

http://www.fda.gov/ora/compliance_ref/part11/

Revision History

Revision 2.0	04/30/2010	First Issue of Rewritten Quality Manual
Revision 2.1	06/29/2012	Modified balance calibration procedure, tolerances.

5.5 Instrumentation

5.5.1 Required Instrumentation

Policy:
The laboratory is furnished with all items for preparation and analysis required for the correct performance of the analyses. When instrumentation is used outside the laboratory's permanent control, it ensures that the requirements of this Quality Manual are met.

Details:
Instrumentation is used in an environment appropriate to its proper performance. All instrumentation required by a test is described in each method, including the instrumentation's tolerances.

5.5.2 Required Accuracy

Policy:
Instrumentation and software used for testing are capable of achieving the accuracy required and comply with specifications relevant to the tests and/or calibrations concerned. Calibration programs are established for key quantities or values of the instruments where these properties have a significant affect on the results. When received, instrumentation, including that used for sampling, is checked to establish that it meets the laboratory's specification requirements, complies with the relevant standard specifications, and is checked and/or calibrated in accordance with section 5.6 before use.

Details:
The procedures for checking newly received instrumentation are as determined by manufacturers' specification and/or those determined by the laboratory during procurement.

5.5.3 Authorized Personnel

Policy:
Instrumentation is operated by authorized personnel. Up-to-date instructions on the use and maintenance of instrumentation (including any relevant manuals provided by the manufacturer of the instrumentation) are readily available for use by the appropriate laboratory personnel.

Details:
Access to laboratory instrumentation is controlled to ensure that only authorized personnel use instrumentation.

5.5.4 Unique Identification

Policy:
Each item of instrumentation used for testing is uniquely identified as appropriate.

Details:
Measuring and testing instrumentation is uniquely identified through an asset number of ID. Measuring and testing instrumentation includes any instrument that could affect the quality of test results. Components that can be interchanged between various instruments are tracked in instrumentation logbooks but are not assigned individual asset numbers.

5.5.5 Inventory and Maintenance Records

Policy:
Records are maintained for each item of instrumentation significant to the tests and/or calibrations performed. The records include the following:
- identity of the item of instrumentation (and its software)
- manufacturer's name, type identification, and serial number and/or other unique identification
- checks that instrumentation complies with the specification (see section 5.5.2)
- current location, where appropriate
- the manufacturer's instructions, if available, or reference to their location
- dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and due date of next calibration
- maintenance carried out to date and the maintenance plan (includes calibration)
- damage, malfunction, modification or repair to the instrumentation

Details:
Either manual log books are maintained or a database is used to capture the above inventory information. The above information related to service and maintenance is kept in individual instrumentation files and/or binders. Other information kept in these files and/or binders may include:
- date received and date placed in service
- condition when received (e.g., new, used, refurbished)
- dates and results of calibration and/or verification and date of next calibration and/or verification
- performance history, where appropriate (e.g., response time, drift, noise level)

5.5.6 Instrumentation Procedures

Policy:
The laboratory has as an established plan for use and maintenance (including calibration) of measuring instrumentation, and appropriate use of correction factors to ensure proper functioning and in order to prevent contamination or deterioration.

Details and Procedures:
The procedures for each piece of measuring instrumentation are located in the appropriate room where the instrumentation is located or in the SOP. These procedures detail any information for safe handling, transport, storage, use, and maintenance of measuring instrumentation.

5.5.7 Out of Service Instrumentation

Policy:
Instrumentation that has either been subjected to overloading or mishandling, or gives suspect results, or has been shown to be defective or outside specified limits, is taken out of service, clearly marked, and appropriately stored until it has been repaired and shown by calibration or test to perform correctly.

Details:
Routine testing work is completely discontinued on instrumentation that even shows minor nonconformances. Not only do we do this for ethical reasons in support of our client, but minor nonconformances are often indicative of major breakdowns in expensive instrumentation. These breakdowns need to be avoided wherever possible.

Out of service instrumentation is clearly marked as outlined in section 5.5.8.

The laboratory examines the effect of the defect or departure from specified limits on previous test and/or calibrations and institutes the "Control of Nonconforming Work" procedure as outlined in section 4.9.

5.5.8 Calibration Status

Policy:

Instrumentation requiring calibration is labeled to indicate the calibration status and/or operational status and the date when re-calibration is due when appropriate. This is not normally applicable to organics analysis instrumentation.

Details:
Calibration labels have a write-on surface and a pressure sensitive adhesive. The areas that are filled out include the person who performed the calibration, the date it was performed, the date it is due for re-calibration, and the instrumentation's identification number.

Date Calibrated:	ID#
Performed by:	
Correction:	
Calibration due:	

Measuring instrumentation that has failed calibration or is deemed out of service is labeled with one of the following labels:

CALIBRATION VOID

DO NOT USE

OUT OF SERVICE

DO NOT USE

A piece of instrumentation that is not calibrated or checked is labeled with the following label:

FOR REFERENCE ONLY

5.5.9 Return to Service

Policy:
When instrumentation goes outside the direct control of the laboratory for a period, the laboratory ensures that the function and calibration status of the instrumentation are checked and validated and shown to be satisfactory before the instrumentation is returned to service.

Details and Procedures:
The procedures used to check and ensure that the function and calibration status of the instrumentation are satisfactory before the instrumentation is returned to service are

outlined in the manufacturer's instrumentation manual. Any additional quality control checks are outlined in the applicable section of the appropriate SOP and/or test method.

5.5.10 Periodic Checks

Policy:
When intermediate checks are needed to maintain confidence in the calibration status of instrumentation, these checks are carried out periodically according to defined procedure.

Details and Procedures:
As stated in section 5.5.6, the procedures for each piece of measuring instrumentation are detailed in the related SOPs. Internal quality control checks are specified in individual test methods that are located in the appropriate laboratory areas thereby providing procedures for intermediate checks.

5.5.11 Correction Factors

Policy
Calibrations that give rise to a set of correction factors are updated along with all copies of this data (e.g., in computer software).

Details and Procedures:
The updating of correction factors, including all copies, is assured by following the appropriate test method or SOP. It is the responsibility of the Group Leaders to ensure that all copies are updated.

5.5.12 Safeguards against Adjustments

Policy:
Test instrumentation, including hardware and software, are safeguarded from adjustments that invalidate test and/or calibration results/status.

Details:
Safeguards against adjustment for laboratory instrumentation include:
- detailed SOPs and manufacturer's manuals on the operation of the instrumentation
- policies permitting only fully trained and competent personnel to operate instrumentation
- access to the laboratory is restricted to authorized personnel

Safeguards against adjustment for software include:

- password protection for important files and packages
- access to the laboratory is restricted to authorized personnel

5.6 Measurement Traceability

5.6.1 General

Policy:
All measurement and test instrumentation having an effect on the accuracy or validity of tests is calibrated and/or verified before being put into service.

Details:
The program includes a system for selecting, using, calibrating, checking, controlling, and maintaining:
- measurement standards
- reference standards used as measurement standards
- measuring and test instrumentation used to perform tests and calibrations

Procedures are documented where appropriate. All measurements that play a defining role in testing accuracy are based directly or indirectly on reference standards, reference materials, certified reference materials, or other standards or materials having appropriate traceability.

Records are maintained for each standard. These records include, as applicable:
- supplier, grade, batch#
- dates of preparation or verification
- measurement of weights, volumes, time intervals, temperatures, and pressures and related calculations
- relevant processes (e.g., pH adjustment, extraction)
- verification results
- identification of personnel involved

Reagents prepared in the laboratory are labelled to identify substance, concentration, solvent (where not water), any special precautions or hazards, restrictions of use, Lot no., and date of preparation and/or expiry. The person responsible for the preparation of the reagent is identified either from the label or from records.

5.6.2 Specific Requirements

5.6.2.1 Calibration

Policy:
The program for calibration of instrumentation is designed and operated to ensure that calibration measurements are traceable to the Système International (SI) units of measurement or NIST, where appropriate or practical.

Details:
Traceability of measurement is assured by the use of calibration services, internal and from sources that can demonstrate competence, measurement capability and traceability. The calibration certificates issued by these sources show that there is a link to a primary standard traceable to NIST. The calibration certificates contain the measurement results including the measurement uncertainty and/or a statement of compliance with an identified metrological specification (see also section 5.10.4.2).

Calibration vendors accredited to ISO 17025 or A2LA or equivalent are considered competent to provide the appropriate calibration services.

The term "identified metrological specification" means that it must be clear from the calibration certificate against which specification the measurements have been compared with, by including the specification or by giving an unambiguous reference to the specification.

When the terms "international standard" or "national standard" are used in connection with traceability, it is assumed that these standards fulfil the properties of primary standards for the realization of SI units.

Maintain certificates of all reference standards, measuring instrumentation, or certified reference material used in ensuring traceability. Where traceability to national standards of measurement is not applicable, the laboratory provides satisfactory evidence of correlation of results, for example by participation in a suitable program of inter-laboratory comparisons or proficiency testing.

Reference standards, such as thermometers and weights, are traceable to a national or international standard (e.g., NIST).

5.6.2.2 Testing

5.6.2.2.1

Policy:
The requirements given in section 5.6.2.1 apply to measuring and test instrumentation with measuring functions used, unless it has been established that the associated calibration uncertainty contributes little to the total uncertainty of the test result. When this situation arises, the laboratory ensures that instrumentation used can provide the accuracy of measurement needed.

Details:
The extent to which the requirements in section 5.6.2.1 are followed depends on the relative contribution of calibration uncertainty to the total uncertainty. If calibration is the dominant factor, the requirements are strictly followed. If, however, calibration is not one of the major contributors to the total uncertainty, other ways for providing confidence may be used, as given in section 5.6.2.2.2.

5.6.2.2.2

Policy:
Where traceability to SI units of measurement is not possible and/or not relevant, other means for providing confidence in the results are applied such as:

- the use of suitable reference materials certified to give a reliable characterization of the material
- mutual-consent standards or methods which are clearly specified and agreed upon by all parties concerned
- participation in a suitable program of inter-laboratory comparisons or proficiency testing

Details:
Reliable characterization involves an estimate of recovery.

The laboratory participates in proficiency testing and/or check sample programs. The list of programs is maintained by the Quality Assurance Officer and includes NYSDOH NELAP, CTDOH Proficiency Program, and NJDEP Office of Quality Assurance for TO-15 air.

5.6.3 Reference Standards and Reference Materials

5.6.3.1 Reference Standards

Policy:
Reference standards are obtained or calibrated by a body that can provide traceability as described in section 5.6.2.1. For our use traceability to NIST is acceptable for most applications. Such reference standards of measurement held by the laboratory are used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

Details:
Reference standards are obtained from the National Institute of Standards and Technology (NIST), if applicable.

5.6.3.2 Reference Materials

Policy:
Where possible, reference materials are traceable to SI units of measurement, or to certified reference materials. Internal reference materials are checked as far as is technically and economically practicable.

Details:
Reference materials, including calibration standards, used in chemical measurement are prepared so that the point of measurement is similar or equivalent to that of the samples. The matrix, prior to the addition of the analyte does not have a detectable concentration of the analyte. Reagents used in the preparation of reference materials, including calibration standards are of certified purity.

5.6.3.3 Intermediate Checks

Policy:
Checks needed to maintain confidence in the calibration status of reference, primary, transfer or working standards and reference materials are carried out according to defined procedures and schedules.

Details and Procedures:
The control check standards (Laboratory Control Samples) used to verify the accuracy of all the other standards are prepared independently from all the other standards used to establish the original calibration. These control check standards are prepared from a separate lot # or second source. It is the responsibility of the Group Leader to establish and maintain the individual schedule for each SOP and/or test method.

5.6.3.4 Transport and Storage

Policy:
The safe handling, transport, storage and use of reference standards and reference materials in order to prevent contamination or deterioration and in order to protect their integrity are defined.

Details:
Proper conditions are established for housing, handling, and care of reference standards/reference materials. All information needed to properly identify references appears on their housing, containers or in the SOP where applicable.

5.7 Sample Handling, Receipt and Initiation

Laboratory analyses are performed to produce data representative of conditions when the sample was obtained. To provide representative samples for analysis, both field and laboratory personnel must satisfactorily perform their activities. Although the purpose of this manual is to define the laboratory Quality Systems, the interrelationship of field and laboratory operations in maintaining sample integrity is briefly discussed because the effect of field operations upon resulting data quality cannot be totally separated from laboratory operations.

5.7.1 CHAIN-OF-CUSTODY

An overriding consideration for resulting data is the ability to demonstrate that the samples have been obtained from the locations stated and that they have reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt and laboratory custody until disposal must be documented to accomplish this. Documentation is accomplished through a chain-of-custody record that records each sample and the individuals responsible for sample collection, shipment, and receipt.

- A sample is considered in custody if it is:
- In a person's actual possession.
- In view after being in physical possession.

- Secured so that no one can tamper with it after having been in physical custody.
- In a secure area, restricted to authorized personnel.

A chain-of-custody form is used by York personnel when shipping samples to subcontractors. This form is also used by all York's clients when submitting samples procured by the client. York does not accept samples collected by any outside or inside source without a correctly prepared chain-of-custody form.

The chain-of-custody form shall be signed by each individual who has the samples in their possession. Preparation of the chain-of-custody shall be as follows:

- The chain-of-custody record shall be initiated in the field by the person collecting the sample, for every sample. Every sample shall be assigned a unique identification number or name that is entered on the chain-of-custody form. Samples can be grouped for shipment and use a common form. The form allows for ten samples per page. If more than ten samples are shipped in the same container, more than one chain-of-custody form is required.
- The record shall be completed in the field to indicate project, sampling location, etc.
- If the person collecting the sample does not transport the samples to the laboratory or deliver the sample containers for shipment, the first block for Relinquished By , Received By shall be completed in the field.
- The person transporting the samples to the laboratory or delivering them for shipment shall sign the record form as Relinquished By .
- If the samples are shipped to the laboratory by commercial carrier, the chain-of-custody form shall be sealed in a watertight zip-lock bag, placed in the shipping container, and the shipping container sealed prior to giving it to the carrier.
- If the samples are directly transported to the laboratory, the chain-of-custody may be kept in possession of the person delivering the samples.
- For samples shipped by commercial carrier, the waybill shall serve as an extension of the chain-of-custody record between the final field Control Group and receipt in the laboratory.
- Upon receipt in the laboratory, the Sample Control Group, or representative, shall open the shipping containers, compare the contents with the chain-of-

custody record, and sign and date the record. Any discrepancies shall be noted on the chain-of-custody form. Discrepancies are immediately discussed with the Project Manager for resolution.

- Chain-of-custody and any shipping records shall be maintained with the records for a specific project, becoming part of the project file.

5.7.2 FIELD COLLECTION AND SHIPMENT

York does not provide Field Collection services. Prior to collecting samples, the client'scollection team must consider the analyses to be performed so that proper sample containers and shipping containers can be assembled and the proper preservatives added to containers. In addition, field logs and record sheets, chain-of-custody forms, and analysis request records must be assembled.

All records required for documentation of field collection must be completed by the client field team. Several of the documents that affect laboratory operations are discussed herein. The primary documenting record is the chain-of-custody as discussed above.

In addition to initiating the chain-of-custody form, field personnel are responsible for uniquely identifying (required on the chain-of-custody form) and labeling samples, providing proper preservation, and packaging samples to preclude breakage during transit by York couriers or client shipment.

Every sample shall be labeled to identify:

- Unique sample number (ex. 11F0565-01, -02, etc.)
- Sample Description (such as MW-1, etc.)
- Sampling date and time
- Person obtaining sample
- Container types and methods of sample preservation/conditioning
- Analyses required (e.g., VOC 8260B, etc.)

Samples must be placed in containers compatible with the intended analysis and properly preserved. Also, collection of samples must consider the time interval between acquiring the sample and analysis (holding time) so that the sample is representative. The requirements for various analytical parameters with respect to the type of container, quantity of sample, preservation method, and maximum holding time between collection and analysis, quantity of sample, are dictated by the Federal Register, EPA SW-846 or the specific Quality Assurance Project Plan (QAPP).

It is recommended to field personnel that shipping containers are to be sealed prior to shipment, whether shipped by direct transport by field personnel or commercial carrier. The only exception to this is if sufficient holding time exists so that the samples can be held in the field and it is necessary to re-ice the containers prior to or during transport.

As soon as field personnel are ready to hand off samples from the field to the courier, the courier takes custody of them and transfers them into a cooler containing ice or ice packs sufficient to maintain 2-6°C until arrival at the laboratory. Upon receipt at the laboratory, the temperature (as measured by an infrared temperature probe) is recorded on the Chain-of-Custody form. In the LIMS log-in module, all other sample related conditions are noted in the appropriate fields.

It is imperative that the analyses requested by the client be clearly provided so that analytical requirements are maintained with respect to sample holding times and limits of detection needed.

5.7.3 LABORATORY SAMPLE RECEIPT

The first step in the laboratory receipt of samples is obtaining the proper information. The information is taken by the Client Services group, documented in ELEMENT and passed on (if not) immediately to the Sample Control. The Sample Control Group shall note that the shipment is expected and notify the Client Service sand Group Leaders when samples are received. This is especially important for HOLDING TIMES SENSITIVE parameters and RUSH requests where coordination is essential to meet project deadlines. These communications are done via the RUSH NOTIFICATION and HOLDING TIME SENSITIVE parameters forms.

Upon sample receipt, the Sample Control Group performs the following:

< 5.7.3.1 Examine all samples and determine sample temperature using an Infrared thermometer. This documents that proper temperature has been maintained during shipment (if applicable). Note this on the Chain-of-Custody. If samples have been damaged during shipment, the remaining samples shall be carefully examined to determine whether they were affected. Any samples affected shall be also considered damaged. It will be noted on the chain-of-custody record that specific samples were damaged and that the

samples were removed from the sampling program. Field personnel will be notified as soon as possible that samples were damaged and that they must be re-sampled, or the testing program changed, and an estimate of the cause of damage.

5.7.3.2< Compare samples received against those listed on the chain-of-custody. Note any deviations or problems and clarify with the Project Manager or Client Services. CONFIRM preservations has been properly done (chemical preservation) by the client in the field. If this is not the case, enter this into the appropriate field in Element and preserve the samples accordingly. The client receives a Sample Condition/Receipt Report detailing any issues encountered. The lab does not confirm the following chemical preservations upon receipt which are done at the bench: Oil & Grease and Volatile Organics.

5.7.3.4 Sign and date the chain-of-custody form and attach any shipping receipts to the chain-of-custody.

5.7.3.5 Log the project into the lab LIMS system.

<
< 5.7.3.6 Open a laboratory project number and pendaflex file which will contain:

- Project identification number
- Completed Chain-of-Custody record
- Shipping receipts
- Any correspondence related to the project
- WORK ORDER which will include:
    - Client Name
    - Client Project ID
    - Lab Sample numbers
    - Client Sample Identifiers
    - Type of samples (matrix)
    - Date received in laboratory
    - Parameters to be analyzed
    - Project Pricing
    - Any special instructions (such as EDDs, ASP B deliverables, etc.)

If samples collected by Clients arrive without chain-of-custody or incorrect chain-of-custody records, the following shall be done by the Sample Control Group:

If the chain-of-custody is incorrect, a memorandum to the Project Management/Client Services is prepared stating the inaccuracy and correction in the form of a Corrective Action (CA). The CA must be signed and dated by the person originating the chain-of-custody and the Sample Control Group. The memorandum will serve as an amendment to the chain-of-custody. If the information on the chain-of-custody form cannot be corrected by the Sample Control Group or the field personnel, the samples affected shall be removed from the sampling program.

< If the chain-of-custody is not shipped with the samples, the Client personnel shall be contacted and a memorandum prepared which lists the persons involved in collecting, shipping, and receiving the samples and the times, dates, and events. Each person involved must sign and date this memorandum. The complete memorandum will be maintained in lieu of the chain-of-custody.

5.7.4 LABORATORY STORAGE OF SAMPLES

The primary considerations for sample storage are:

< Maintenance of prescribed temperature, if required, which is typically $4^{o}C \pm 2^{o}C$; some parameters may require freezing (<0.0C)

< Extracting and/or analyzing samples within the prescribed holding time for the parameters of interest.

The requirements for temperatures and holding times shall be met. Placing of samples in the proper storage environment is the responsibility of the Sample Control Group, who should notify the Group Leaders if there are any samples which must be analyzed immediately because of holding time requirements. This is accomplished by issuing a HOLDING TIME SENSITIVE NOTIFICATION FORM.

5.7.5 INITIATION OF TESTING PROGRAM

As stated previously, the chain-of-custody form is prepared by the client and submitted with the samples to the laboratory. If the analytical program is not defined with the sample shipment, Sample Control shall immediately notify the Client Services who will contact the client to determine/clarify the testing program.

The analytical program or any changes requested shall be re-entered onto the original chain-of-custody form, signed and dated. This record serves as the master analytical request form for samples and the clients' authorization to proceed.

Client Services and the Group Leaders are responsible for prioritizing samples on the basis of holding time and required reporting time into the laboratory sample stream.

5.7.6 SAMPLE DISPOSAL

The LIMS allows us to set a sample status for disposal. These records are then maintained on a sample basis in the database. There are several possibilities for sample disposition:

< The sample may be completely consumed during analysis.

< Samples may be returned to the client or location of sampling for disposal.

< The samples may be stored after the analysis. Proper environmental control and holding time must be observed if reanalysis is anticipated. If reanalysis is not anticipated, environmental conditions for storage will not be observed.

The samples may be transferred to proper drums or waste containers for final disposal by licensed waste disposal firms.

The Sample Control Group shall determine disposition of samples if not specified in the project file.

In general, York will not maintain samples and extracts longer than thirty (30) days beyond completion of analysis, unless otherwise specified.

5.8 Assuring the Quality of Test and Calibration Results

5.8.1 Quality Control / Quality Assurance

Policy:
Quality control procedures are utilized to monitor the validity of test results. These procedures are for each test method utilized in the laboratory. The resulting data are recorded so that trends are detectable (and where practicable, statistical techniques are applied to the reviewing of the results). This monitoring is planned and reviewed and may include, but not limited to, the following:

- regular use of certified reference materials and/or internal quality control using secondary reference materials
- participation in inter-laboratory comparisons or proficiency testing programs
- replicate tests or calibrations using the same or different methods
- re-testing or re-calibration of retained items
- correlation of results for different characteristics of an item

Details:
The methods utilized from the above list will be appropriate for the type and volume of the work undertaken. Records are maintained of assurance activities and any actions taken.
As a guide, for routine analyses the level of internal quality control is typically 5% of the sample throughput. For more complex procedures, 20% is not unusual and on occasions even 50% may be required. For analyses performed infrequently the use of a reference material containing a certified or known concentration of analyte, followed by replicate analyses of the sample and spiked sample is done. For analyses undertaken more frequently, systematic quality control procedures incorporating the use of control charts and check samples are implemented. These procedures are documented in the SOP for each test method.

Internal quality control schemes using statistics include:

- design of experimental/factorial analysis
- variation/regression analysis
- safety evaluation/risk analysis
- tests of significance
- quality control charts
- statistical sampling inspection

Proficiency testing helps to highlight not only repeatability and reproducibility performance between laboratories, but also systematic errors such as bias. It is important to monitor proficiency testing results as a means of checking quality assurance and take action as necessary.

The Quality Assurance Officer maintains a list of all the current proficiency testing programs the laboratory participates in, monitors the results, and notifies the appropriate personnel of both problematic and successful results.

Technical personnel use certified reference materials and reference materials to evaluate test performance on a daily basis and include daily process control checks. These data are used to evaluate the validity of the test results.

Replicate tests may be used if suitable reference material is available. These materials and proficiency test materials are available for improving repeatability.

Re-testing of test items is performed occasionally at the discretion of the supervisor or when test results seem anomalous.

5.8.2 Correction and Prevention

Policy and Details:
Quality control data are analyzed and, where they are found to be outside pre-defined criteria, planned action is taken to correct and to prevent incorrect results from being reported.

5.9 Reporting of Results

Policy:
The results of each test or series of tests are reported accurately, clearly, unambiguously and objectively, and in accordance with any specific instructions in the test or calibration methods.
The results are reported, normally in a Technical Report and include all the information requested by the client and necessary for the interpretation of the test results and all information required by the method used or regulatory body reviewing the data. This information may include what is outlined in section 5.9.2, 5.9.3 and 5.9.4.
In the case of tests performed for internal purposes, and in the case of a written agreement with the client, the results may be reported in a simplified way. The information listed in section 5.9.2 to 5.9.4, and not reported, is kept readily available.

Details:
Test reports are issued as either hard copy, by electronic data transfer (email or web access).

5.9.2 Test reports

Policy:
Test reports (Technical Reports) include the following information, as appropriate:
- a title (e.g., "Technical Report"
- name and address of laboratory, and location where tests were carried out if different from the address of the laboratory
- unique identification of the test report (such as a project no.), and on each page an identification in order to ensure that the page is recognized as a part of the test report, and a clear identification of the end of the test report
- name and address of the client
- identification of the method(s) used
- description, condition, and unambiguous identification of the sample(s) tested
- date of receipt of samples and date(s) of performance of the analyses
- reference to sampling procedures used by the laboratory or other bodies where these are relevant to the validity or application of the results
- test results with, where appropriate, units of measurement
- the name(s), function(s) and signature(s) or equivalent of person(s) authorizing the test report
- a statement to the effect that the results relate only to the items tested
- Notations for Certification by analyte, data qualifiers, and sample qualifiers

Details:
Signing authority for test reports is the responsibility of the Laboratory Director. Records for individuals with signing authority for test reports are approved by the Laboratory Director and maintained by the Quality Assurance Officer.

Hard copies and electronic copies of test reports include the page number and total number of pages.

A statement is included specifying that the test report is not to be reproduced except in full, without written approval of the laboratory. Data reported to the client contains the appropriate significant digits for each test method. Low level data are identified as being below specified limits by utilizing appropriate flags.

5.9.3 Test Reports

5.9.3.1

Policy and Details:
In addition to the requirements listed in section 5.9.2, test reports include the following, where necessary for the interpretation of results:
- deviations from, additions to, or exclusions from the test method
- where relevant, a statement of compliance/non-compliance with requirements and/or specifications
- where applicable, a statement on the estimated uncertainty of measurement of the test result; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a client's instruction so requires, or when uncertainty affects compliance to a specification limit
- where appropriate and needed opinions and interpretations (see section 5.9.5)
- additional information required by specific methods, clients, or regulatory authorities.

5.9.3.2

Policy and Details:
In addition to the requirements listed in sections 5.9.2 and 5.9.3.1, test reports containing the results of sampling include the following, where necessary for the interpretation of test results:
- date of sampling
- unambiguous identification of substance, matrix, material sampled

- details of any environmental condition during sampling that may affect the interpretation of the test results
- any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned

5.9.5 Opinions and Interpretations

Policy:
When opinions and interpretations are included in the test report, the basis upon which the opinions and interpretations have been made is documented. Opinions and interpretations are clearly marked as such in the test report.

Note - Opinions and interpretations should not be mixed-up with inspections and product certifications as intended in ISO/IEC 17020 and ISO/IEC Guide 65.

Details:
Opinions and interpretations included in a test report may comprise, but not be limited to the following:
- opinion on conformity of the results with requirements
- fulfilment of contractual requirements
- recommendations on how to use the results
- guidance to be used for improvements

In many cases it is appropriate to communicate the opinions and interpretations by direct dialogue with the client. This dialogue is documented in writing.

5.9.6 Test Results Obtained from Subcontractors

Policy and Details:
Test reports containing the results of tests performed by subcontractors are clearly identified for the subcontracted results. The subcontractor reports the results either in writing or electronically to our laboratory.

5.9.7 Electronic Transmission of Results

Policy:
In the case of transmission of test results by telephone, facsimile or other electronic or electromagnetic means, the requirements of the policies and procedures of this Quality Manual continue to apply (see also 5.4.7).

Details:
Reports that are "published" electronically contain a digital signature.

5.9.8 Format of Reports

Policy:
The format of reports is designed to accommodate each type of test carried out and to minimize the possibility of misunderstanding or misuse.

Details:
The layout of the test report is such that the presentation of the test data facilitates ease of assimilation by the reader.

The headings are standardized as far as possible.

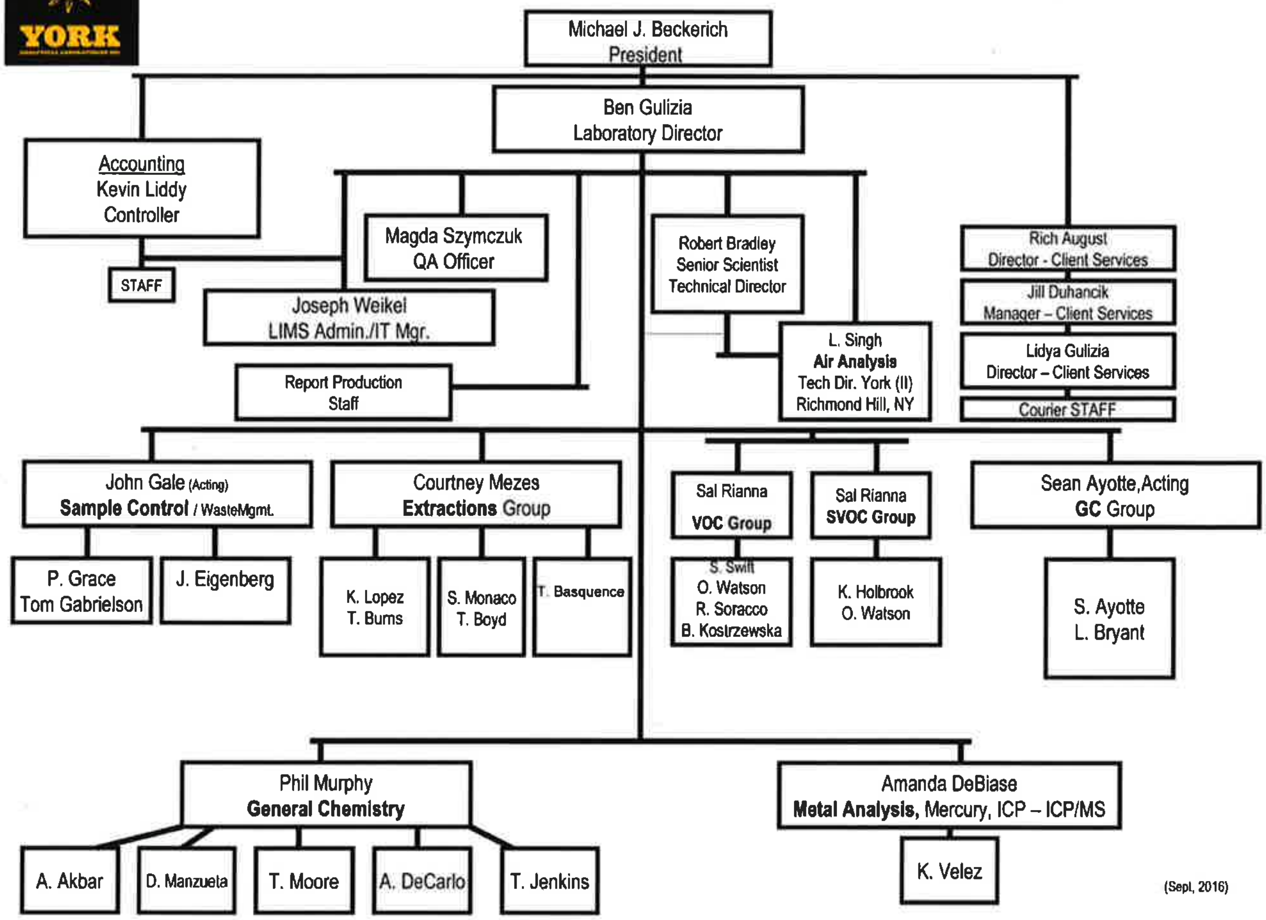
5.9.9 Amendments to Reports

Policy:
Material amendments to a test report after issue are made only in the form of a further document, or data transfer, which includes the statement "Revision no. and includes a description of the revision in the notes section of the report.. Such amendments meet all the requirements in this Quality Manual.

Details:
When it is necessary to issue a complete new test report, it is uniquely identified and contains a reference to the original that it replaces.

ATTACHMENT A

LABORATORY FUNCTIONAL ORGANIZATIONAL CHART



(Sept, 2016)

ATTACHMENT B

York Analytical Laboratories
SOP LISTING as of 02/23/2017

	Description	SOP Name	Revision Date
	GC/MS - Volatiles		
1	Volatile Organics using GC/MS	GCMS VOC 011700-Rev 3.4	3/16/2016
2	Volatile Organics in Drinking Water using GC/MS by EPA 524.2	GCMS VOC524.2 011700-Rev 2.0	10/7/2015
3	Soil Sampling Procedure by EPA method 5035A	GCMS VOC5035 060712-Rev 1.0	6/7/2012
4	Screening of Aqoeous and Soil Samples for Volatile Compounds by Dynamic Headspace/GC/FID	VOASCREEN121615-Rev.1.1	11/17/2016
5	Determination of Gasoline Range Organics in Aqueous and Solid Samples by method 8015D	GC GROFID 022715-Rev. 1.0	3/18/2015
	GC/MS - Semi-volatiles		
1	Semi-Volatiles using GC/MS by EPA 8270C and 8270D	GCMS SVOC-Rev 2.9	12/23/2014
	Gas Chromatography		
1	PCBs using GC/ECD by EPA 8082	GC PCB 011799-Rev 1.7	12/1/2014
2	TPH-DRO using GC/FID by EPA 8015D	GC TPHDRO 091009 Rev.1.5	1/10/2017
3	Pesticides (Chlorinated) using GC/ECD by EPA 8081	GC Pest 011799-Rev 1.6	8/5/2015
4	Herbicides using GC/ECD by EPA 8151A	GC Herb-Rev1.6	12/19/2014
6	CT ETPH	GC ETPH 111704-Rev 1.6	2/29/2012
7	NJ EPH	GC NJEPH 031313-Rev 1.0	3/13/2013

8	EDB, DBCP	GC EDB,DBCP 102413-Rev 1.3	8/27/2015

Extractions

1	Herbicide Extraction of Solids	EXT Herb-Rev 1.5	11/22/2012
1a	Extraction of Chlorinated Herbicides from Aqueous Samples and TCLP extracts by EPA SW-846 Method 8151A	EXT AQ TCLP Herb- Rev 1.3	3/5/2015
2	UltraSonic Extraction of Solids [EPA 3550]	EXT SSVOC-Rev 2.7	2/10/2017
3	ASE Extraction of Solids [EPA 3545]	EXT SVOCASE-Rev 2.4	2/10/2017
4	Aqueous Extraction [EPA 3510C]	EXT AqSVOC -Rev 2.9	5/24/2016
5	Microwave Extraction of Solids [EPA 3546]	EXT SSVOCMAE-Rev.1.1	5/24/2016
6	Extraction Laboratory Glassware Washing Procedure	EXTGP052600Rev1.1	4/3/2012
7	Soxhlet Extraction of Solids for PCBs [3540C]	EXT PCBSox-Rev 1.1	1/5/2014
8	MA EPH Extraction from Waters and Soils	EXTMAEPHAQASE121207Rev2.0	10/22/2009
9	Spike and Surrogate Standard Preparation for Extractable Organics	EXT SVOCStds-Rev 1.3	5/31/2016
10	NJEPH Extraction from Waters and Soils	EXT NJEPH-Rev 1.1	1/15/2014
11	Extraction of Herbicides [SM 6640B]	EXT HerbSM-Rev 1.1	12/3/2014
12	Glycols Extraction with SPE Tubes	EXT GlyLL-Rev 1.1	7/13/2015

	Metals		
1	ICP/MS Analysis of Sample Digestates by EPA 200.8 and SW-846 6020A	ICPMS 080106-Rev1.4	6/1/2013
2	Preparation of Samples for Metals Analysis by ICP and ICP/MS by SW-846 3010A and 3050B	M SPrep 030695-Rev1.7	6/15/2015
3	ICP Analysis of Sample Digestates by EPA 200.7 and SW-846 6010C	M ICP 031195-Rev1.7	10/9/2015
4	Mercury by Cold Vapor Technique EPA SW-846 7470 annd 7471	M Hg 120998-Rev 1.7	6/17/2014
5	Mercury by Direct Technique EPA SW-846 7473	M Hg2-Rev 1.2	6/17/2014
6	Preparation of Aqueous Environmental Samples for Target Trace Metals Analysis by ICP and ICP/MS using Microwave Assisted Digestion EPA SW846-3015A	SOP M PrepMAD 071715	7/17/2015
	Wet Chemistry		
1	Chemical Oxygen Demand	WC COD Rev 2.3	4/29/2014
2	TKN, Ammonia and TON	WC TKN-Rev. 1.6	1/5/2014
3	Reactivity-Cyanide	WC CNR-Rev 1.3	10/22/2015
4	Hexavalent Chromium	WC Cr+6-Rev 1.5	1/5/2014
5	Total Cyanide	WC CNT-Rev1.8	10/13/2015
6	Reactivity-Sulfide	WC ReacSulf-Rev 1.4	10/22/2015

7	Alkalinity	WC T-Alk 022600-Rev 1.5	6/16/2015
8	Hexane Extactable Material (O&G)	WC HemGrav-Rev.1.8	6/8/2015
9	Ion Chromatography	WC IC-Rev2.0	10/22/2015
10	Biochemical Oxygen Demand (BOD)	WC BOD-Rev1.6	2/10/2015
11	TSS / VSS in Aqueous Samples	WC TSS-Rev1.6	8/27/2014
12	pH	WC pH-Rev1.6	1/15/2014
13	Total Phosphorous and Ortho-Phosphate	WC Phos 051000-Rev-1.5	5/1/2015
14	TCLP / SPLP Extraction	WC TCLPEX-Rev1.5	11/20/2014
15	Cyanide Amenable to Chlorination	WC CNA-Rev1.4	10/15/2014
16	Flash Point	WC FP-Rev1.5	1/15/2014
17	Methylene Blue Active Substances (MBAS)	WC MBAS-Rev1.2	1/15/2014
18	TS, VS, TDS in Aqueous Samples	WC TSTDS-Rev1.5	2/15/2016
19	Color	WC COLOR 04262010 Rev1.1	12/12/2013
20	Glassware Washing	WC GlassPrep 090299Rev2.1	12/17/2232
22	Total Phenols (low level)	WC PhenolsLL-Rev1.5	1/5/2014

23	Total Phenols	WC Phenols-Rev 1.4	1/5/2014
24	Conductivity	WCCond-Rev 1.3	1/5/2014
25	Turbidity	WC Turbidity-Rev 1.5	1/28/2014
26	TS, FS, VS and % Moisture in Solid Samples	WC TS%M 022912-Rev 1.1	9/18/2012
27	Extractable Organic Halogens (EOX) in Soil Samples	WC EOX 041112-Rev 1.2	11/9/2012
28	Total Organic Carbon (TOC) in Aqueous Samples	WC TOC Rev 1.3	4/29/2014
29	Oxidation-Reduction Potential (ORP)	WC ORP 031213-Rev 1.0	3/12/2013
30	Settleable Solids	WC SetSol-Rev 1.2	1/5/2014
31	Sulfide	WC Sulfide-Rev 1.1	1/5/2014
32	Chlorine Demand	WC Cl Demand-Rev 1.0	4/9/2014
33	TKN by Skalar	WC TKN SK- Rev 1.3	2/23/2017
	General Laboratory		
1	MDL Studies, Organics	GL MDL 113005-Rev.1.3	3/12/2012
2	Chemical Expiration Dates	GL ExpDt 041812 Rev1.0	4/18/2012
3	LOQ/LOD Determination and Verification	GL LODLOQ 122812-Rev 1.4	1/27/2017

4	Balance Calibration Check Procedure	GL Balance 082514-Rev 1.0	8/25/2014
		Sample Control	
1	Sample Control Procedures (Receipt, Log-in, Storage, Archival, Disposal)	SC Proc 011501-Rev 2.5	5/27/2015
3	Sample Handling and Chain-of-Custody for Sample Couriers	Couriers091207Rev1.1	3/25/2015
		Administration	
1	Laboratory Safety and Health	ADMINSAFETY011600Rev1.1	6/8/2015
2	Purchasing	ADMIN Purchasing 043010-Rev1.2	4/11/2013
3	Contract Review	ADMINCONTRACT043010 Rev. 1.1	10/17/2014
4	QC Review/Evaluation of Data	QC040202Rev1.1	9/28/2016
5	Education and Training in Ethics and Legal Responsibilities	ADMIN Ethics-Rev1.5	9/27/2016
6	Training of Personnel	ADMIN Training-Rev 1.4	9/4/2014
7	Manual Integration of Chromatographic Data	Admin Integration 091107 Rev. 2.2	9/28/2016
8	Laboratory Notebook Control and Use	ADMIN LabNote 091107-Rev 1.1	1/13/2013
9	Control of Records	ADMIN Records 043010-Rev 1.1	11/9/2012
10	Control of Nonconforming Work	QSP 4-9-1 Rev1.1	11/9/2012
11	Management Review	ADMINMGMTREVIEW043010Rev1.1	9/27/2016
12	Internal Quality Audit	ADMIN IntAudit 043010Rev	2/22/2017

13	Estimation of Uncertainty	ADMINESTUNCERT043010 rev 1.1	10/17/2014
14	Document Control	ADMINDOC043010Rev1.2	6/2/2012
15	Corrective/Preventive Action	ADMIN CorrAction 043010 Rev 1.2	6/15/2016
16	Complaints	·COMPLAINTS043010 Rev. 1.1	9/12/2016
17	Review of Chromatographic Data for Detection of Manual Re-Integration Issues	SOP ADMINManINTReview04302010 Rev 1.0	4/30/2010
18	Additional Policies/Procedures	Additional Policies 05/07/10 Rev1.2	10/17/2014
19	EDDs and Reports for Client Connect	ADMIN REPORT100714 Rev1.0	9/16/2010
20	Preparation of CTDEP RCP Deliverables	ADMINRCPDELIVS Rev1.0	8/2/2010
21	Preparation , Documentation and Traceability of Standards within the Element LIMS	ADMIN_STDS031816 Rev 1.0	4/15/2016
		Quality Systems	
1	York Quality Systems Manual-ISO- 17025/NELAC	Quality Manual Rev.2.8	2/23/2017

Appendix D

Community Air Monitoring Plan

Appendix 1A
New York State Department of Health
Generic Community Air Monitoring Plan

Overview

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate DEC/NYSDOH staff.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

<u>VOC Monitoring, Response Levels, and Actions</u>

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

<u>Particulate Monitoring, Response Levels, and Actions</u>

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (DEC and NYSDOH) and County Health personnel to review.

December 2009

Appendix E

Health and Safety Plan

Consulting
Engineers and
Scientists

Health and Safety Plan

99 Granite Redevelopment

99 Granite Street
Brooklyn, New York

Prepared For:
Medford Ber LLC
c/o Par Group Development LLC
60 North Prospect AveClient Address
Lynbrook, NY 11563

Submitted by:
GEI Consultants, Inc.
110 Walt Whitman Road, Suite 204
Huntington Station, NY 11746
631.760.9300

May 2018

Project No. 1704281

Edward Bradshaw
Senior Practice Leader

Jeena Sheppard
Regional Health and Safety Officer

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Tables

Appendices

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1. Emergency Contact Information

Table 1. Emergency Contact Information

Important Phone Numbers	
Local Police:	911
Fire Department:	911
Ambulance:	911
Hospital and Occupational Clinic Information *(See Attached Maps and Directions in Appendix A)*	
NYC Health and Hospital: 1218 Prospect Pl Brooklyn, NY 11213 **Brookdale Family Care Center:** 1883 Eastern Pkwy Broklyn, NY 11233	(718) 735-0567 (718) 240-8700
Contacts	
Project Manager: Edward Bradshaw	(631) 759-2977 office (914) 879-1759 cell
Corporate Health and Safety Officer: Steve Hawkins	(860) 368-5348 office (860) 916-4167 cell
Regional Health and Safety Officer: Jeena Sheppard	(856) 291-5663 office (856) 298-7138 cell
GEI People Team:	(781) 721-4117 Boston (916) 631-4596 Sacramento
Medcor Triage	1-800-775-5866
Client Contact: David Levine	(516) 394-2081 office
Other Information	
Contractor Requesting/Performing Utility Clearance: Land Air Water Environmental Services Utility Clearance Ticket Number:	 TBD
Nearest Telephone Location (or alternate means of communication)	Cell Phone 914 879-1759

2. Background

Project Name: 99 Granite Redevelopment

Project Location: 99 Granite Street Brooklyn, NY

GEI Project No: 1704281

This Health and Safety Plan (HASP) establishes policies and procedures to protect GEI personnel from the potential hazards posed by the activities at the 99 Granite Street Brooklyn, New York property. Reading of the HASP is required of on-site GEI personnel and will be reviewed by GEI subcontractors. Subcontractors will prepare their own Site-specific HASP and may use this as a guide. The plan identifies measures to minimize accidents and injuries, which may result from project activities or during adverse weather conditions. A copy of this HASP will be maintained on site for the duration of the work.

Included in Section 1 and Appendix A is a route to the nearest medical facility from the Site with directions and contact information. Safety data sheets (formerly known as Material Safety Data Sheets [MSDS]), specific to chemicals that may be encountered while working at the Site, are in Appendix B. Appendix C details the signs, symptoms, care and procedures to both heat and cold stress. Appendix D includes the Tailgate Safety Briefing form, the Project Safety Briefing form, the Accident/Incident Report Form and the Near Miss Reporting Form. Appendix E contains the GEI Health and Safety (H&S) Standard Operating Procedures (SOPs) that apply to this project.

2.1 Scope of Field Work

The environmental program will consist of soil boring, groundwater samples from groundwater monitoring wells and sediment sampling.

2.2 Site Description

The site is approximately 0.18-acre irregularly-shaped parcel of land, located on the west side of Granite Street in the borough of Brooklyn, Kings County, New York City, NY. The Property is situated in a built-up urban mixed-use residential and commercial area in the borough of Brooklyn. The Site is currently vacant.

The subject property is indicated to be undeveloped prior to a 2-story residential building with a 1-story garage/carport on the 1932 Sanborn. These structures appear on subsequent Sanborn Maps from 19510 to 2007 and appear to be the buildings that were previously demolished. While the Site is currently vacant and no structures are present, the Site was most recently occupied by a 2-story rental apartment building with a basement that contained two residential apartments units (99 Granite Street). In addition, the Site contained a rear paved parking area with three brick masonry carport buildings, which were constructed on-grade (101 Granite Street). The Site is situated in a developed urban mixed-use residential and commercial area in the borough of Brooklyn. Adjacent and nearby uses include of a combination of 2- and 3-story dwellings, a 1-story commercial building, sub-grade railroad tracks, public facilities and a cemetery.

3. Statement of Safety and Health Policy

GEI is committed to providing a safe and healthy work environment for its employees. To maintain a safe work environment, GEI has established an organizational structure and a Corporate Health and Safety Program to promote the following objectives:

- Reduce the risk of injury, illness, and loss of life to GEI employees.
- Maintain compliance with federal, state, and other applicable safety regulations; and minimize GEI employees' work exposure to potential physical, chemical, biological, and radiological hazards.

Safety policy and procedure on any one project cannot be administered, implemented, monitored, and enforced by any one individual. The total objective of a safe, accident free work environment can only be accomplished by a dedicated, concerted effort by every individual involved with the project from management down to all employees.

Each GEI employee must understand their value to the company; the costs of accidents, both monetary, physical, and emotional; the objective of the safety policy and procedures; the safety rules that apply to the safety policy and procedures; and what their individual role is in administering, implementing, monitoring, and compliance of their safety policy and procedures. This allows for a more personal approach to compliance through planning, training, understanding, and cooperative effort, rather than by strict enforcement. If for any reason an unsafe act persists, strict enforcement will be implemented.

4. Hazard/Risk Analysis

The potential hazards associated with site conditions and activity hazards related to GEI on-site activities have been identified in this section.

4.1 Special Site Conditions or Concerns

- Traffic – The majority of traffic on the project site will be construction traffic.
- Drill Rig/Equipment – Drilling contractor will use truck-mounted rotary drill rigs. Specific attention given to rotating equipment, pinch points, and overhead equipment.
- Bio hazards (insect bites, poison ivy, etc.) – Poison ivy is present along with black flies.
- Summer weather conditions – Heat Stress and dehydration are concerns during the summer. Truck heat or air conditioners may be necessary and plenty of water will be taken onsite.

Safety equipment will include: First aid kit, fire extinguisher, eye wash bottles, adequate supply of drinking water and electrolyte fluids, hand cleaner, insect repellent, sunscreen, and cell phone.

4.2 Activity Hazard Analysis

The potential hazards for this project associated with site conditions and activity hazards associated with GEI on-site activities have been identified in Table 2. General hazards and control measures that are applicable to all site activities are identified in the General Hazards section. The site-specific tasks, potential hazards, and control measures established to reduce the risk of injury or illness are identified in the Activity Hazard section of Table 2. Health and Safety SOPs for routine hazards and common site conditions are referenced in the table below and included in Appendix E.

Table 2. Activity Hazard Analysis

General Hazards These Hazards Apply to All Site Activities	Control Measure
Chemical / Contaminant Exposure – Skin and eye injury/irritation	• Wear protective coveralls (e.g. Tyvek ®) with shoe covers, safety glasses, face shield, Nitrile gloves. • Dispose of gloves after use and wash hands. • Avoid contact with pooled liquids and limit contact with contaminated soils/groundwater. • See SOP HS-009

General Hazards These Hazards Apply to All Site Activities	Control Measure
Driving	• Employees must wear their safety belt while in a moving vehicle. • Vehicle accidents will be reported in accordance with GEI's accident reporting procedures. • Vehicles will be properly maintained and safely operated (refer to GEI's Fleet Maintenance Program). • Employees will follow safe driving behaviors, which include limiting distractions such as manipulating radios or other equipment that may cause a distraction. Employees should not exceed the posted speed limit and should maintain a safe distance between other vehicles. • Use defensive driving techniques. • Driving distance and time after a 12-hour shift should not exceed 30 miles or 30 minutes (whichever is greater). • See SOP HS-004
Dusty Conditions – Eye and respiratory irritation	• Avoid travel at extreme times • Wear protective gear – dust masks, safety glasses
Heat stress – Fainting, Fatigue, Heat Stroke	• Increase water intake while working. • Increase number of rest breaks and/or rotate workers in shorter work shifts. Rest in cool, dry areas. • Watch for signs and symptoms of heat exhaustion and fatigue. • Plan work for early morning or evening during hot months. • Use ice vests when necessary. • In the event of heat stroke, bring the victim to a cool environment and initiate first aid procedures. • See Appendix C of the HASP
Inclement Weather	• Listen to local forecasts for warnings about specific weather hazards such as tornados, thunder storms, and flash floods. • If the storms produce thunder and/or lightning, leave the work area immediately and move to a safe area. • Discuss an action plan prior to the severe weather. • Wear appropriate PPE for the type of weather that could be encountered. • Stop work until conditions are suitable. Take cover in vehicles or shelter as appropriate. • See SOP HS-010

General Hazards These Hazards Apply to All Site Activities	Control Measure
Insects – Bites, Stings, Allergic Reactions	• Apply insect repellent prior to performing field work and as often as needed throughout the work shift • Wear proper protective clothing (work boots, socks and light colored clothing) • Wear shoes, long pants with bottoms tucked into boots or socks, and a long-sleeved shirt when outdoors for long periods of time, or when many insects are most active (between dawn and dusk). • When walking in wooded areas, avoid contact with bushes, tall grass, or brush as much as possible • Field personnel who may have insect allergies should have bee sting allergy medication on site and should provide this information to the SSO and the CHSO prior to commencing work. • Field personnel should perform a self-check at the end of the day for ticks. • See SOP HS-001
Physical Injury – Slips, Trips and Falls	• Wear PPE that properly fits, is in good condition and appropriate for the activities and hazards. • Maintain good visibility of the work area. • Avoid walking on uneven, steeply sloped or debris ridden ground surfaces. • Plan tasks prior to preforming them including an activity hazard analysis. • Keep trafficked areas free from slip/trip/fall hazards. • Maintain weed growth in sampling areas, especially on slopes. • Wear shoes with traction. • Avoid traversing steep areas in slippery conditions. • Do not carry heavy objects to sampling areas, on steeply sloped areas, or where steep areas must be traversed to arrive at sample points.

Activity	Potential Hazard	Control Measures
Carrying Equipment	Heavy lifting, strains/sprains, slips/trips/falls, pinch points	• Use proper lifting techniques as defined in the heavy lifting activity analysis below • Wear the proper type of glove to protect hands against sharp edges and skin/soft tissue injuries • Wear appropriate footwear • Be aware of hard to grip and hold items that may force your hand or wrist into awkward, stressful positions and cause disorders like tendinitis or carpal tunnel syndrome • Take breaks when carrying items frequently and/or for long distances • Do not over reach when picking up or placing items. • Use the buddy system when necessary • When climbing ladders, maintain three points of contact at all times. DO NOT carry equipment up or down ladders unless it is in a secure backpack or similar hands-free shoulder-strap bag or case. Lower or raise larger equipment by crane or rope
Construction Site Entry	Struck-by, caught-in-between equipment, crushing, pinch points	• Wear hardhat; high visibility reflective safety vest; steel-toed, steel-shank boots or (electrical hazard) EH-rated safety boots with composite toe and shank; safety glasses; nitrile/neoprene gloves; and earplugs. • Identify yourself and your work location to heavy equipment operators, so they may incorporate you into their operations. • Coordinate hand signals with operators. • Stay Alert! Pay attention to equipment backup alarms and swing radii. • Wear a high-visibility, reflective vest when working near equipment or motor vehicle traffic. • Position yourself in a safe location when filling out logs talking with the contractor. • Notify the contractor immediately if any problems arise. • Do not stand or sit under suspended loads or near any pressurized equipment lines. • Do not operate cellular telephones in the vicinity of heavy equipment operation. • See HS-018
Drilling Oversight/ Sampling	Contaminant Exposure, Noise, Contact with Utilities, Cuts/Scrapes, Heavy Lifting, Repetition, Slips/Trips/Falls	• Wear hardhat; high visibility reflective safety vest; steel-toed, steel-shank boots or composite toe and shank; safety glasses; Nitrile/neoprene gloves; and earplugs. • Confirm utility locate has been completed. • Confirm adequate clearance from overhead utilities. • Dispose of gloves after use and wash hands. • Take regular breaks and do not work in unusual positions for long periods of time. • Keep trafficked areas free from slip/trip/fall hazards. • If cutting through concrete, follow the work practices and respiratory protection recommended in Table 1 of the GEI Silica Program based on the type of equipment being used to cut through the concrete.

Activity	Potential Hazard	Control Measures
Groundwater Sampling	Contaminant Exposure, Heavy Lifting, Repetition, Slips/Trips/Falls	• Wear hardhat; high visibility reflective safety vest; steel-toed, steel-shank boots or composite toe and shank; safety glasses and Nitrile/neoprene gloves. • Dispose of gloves after use and wash hands. • User proper lifting techniques. • Take regular breaks and do not work in unusual positions for long periods of time. • Keep trafficked areas free from slip/trip/fall hazards.
Soil Sampling/Soil Vapor Sampling	Contaminant Exposure, Cuts/Scrapes, Heavy Lifting, Repetition, Slips/Trips/Falls	• Wear hardhat; high visibility reflective safety vest; steel-toed, steel-shank boots or composite toe and shank; safety glasses; Nitrile/neoprene gloves; and earplugs as necessary. • Dispose of gloves after use and wash hands. • Wear work gloves over nitrile gloves. • Excavation entry will be allowed only with proper sloping or shoring. • Take regular breaks and do not work in unusual positions for long periods of time. • Keep trafficked areas free from slip/trip/fall hazards.
Waste Characterization	Contaminant Contact Cuts or Abrasions, Slips/Trips/Falls	• Wear proper PPE during sampling including nitrile gloves and safety glasses. • Dispose of gloves after use and wash hands. • Wear work gloves over nitrile gloves. • Keep trafficked areas free from slip/trip/fall hazards.

Personal Protective Equipment (PPE) is the initial level of protection based on the activity hazards and Site conditions which have been identified. Upgrades to respiratory protection may be required based on the designated Action Levels found in Section 9. General on-site provisions will include: extra nitrile, leather, and/or Kevlar gloves, extra protective coveralls (e.g. Tyvek®) with boot covers, drinking water and electrolyte fluids, reflective vest, first aid kit, fire extinguisher, hearing protection, and washing facilities.

If Site conditions suggest the existence of a situation more hazardous than anticipated, the Site personnel will evacuate the immediate area. The hazard, the level of precautions, and the PPE will then be reevaluated with the assistance and approval of the CHSO and the Project Manager (PM).

4.3 Personal Safety

Field activities have the potential to take employees into areas which may pose a risk to personal safety. The following websites (sources) have been researched to identify potential crime activity in the area of the project:

- www.crimereports.com: No crimes identified in the past 30 days within a mile of the Site.

- www.cityrating.com/crimestatistics.asp: Crime in New York City is less than the New York State and national averages.
- www.crimemapping.com: No crimes identified in the past 30 days within a mile of the Site.

To protect yourself, take the following precautions:

- If deemed necessary by the PM, use the buddy system (teams of a minimum of two persons present);
- Let the Site Safety Officer (SSO) know when you begin work in these areas and when you leave;
- Call in regularly;
- Pay attention to what is going on around you; and
- If you arrive in an area and it does not look safe to get out of your vehicle, lock the doors and drive off quickly but safely.

Employees must not knowingly enter into a situation where there is the potential for physical and violent behaviors to occur. If employees encounter hostile individuals or a confrontation develops in the work area, suspend work activities, immediately leave the area of concern, and contact local 911 for assistance. Notify the SSO and Safety Team (Corporate Health and Safety Officer and Regional Health and Safety Officers – SafetyTeam@geiconsultants.com) of any incidents once you are out of potential danger.

In the event of an emergency, prompt communications with local emergency responders is essential. At least one charged and otherwise functioning cell phone to facilitate emergency communications will be on-site. Confirmation of cellular phone operation will be confirmed at the start of each working day.

4.3.1 Handling Drums and Containers

Regulations for handling drums and containers are specified by Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120(j). Potential hazards associated with handling drums include vapor generation, fire, explosions, and possible physical injury. Handling of drums/containers during the Site investigation and remediation activities may be necessary. If drum/container handling is necessary, it will be performed in accordance with applicable regulations.

4.3.2 Electrical Hazards

4.3.2.1 Utilities

The Site may have shallow, buried utilities and also overhead utilities in certain areas. It will be necessary for parties disturbing the existing ground surface and conducting operations with heavy equipment having high clearances to exercise caution in performing project-related work with respect to the presence of utilities. Utility companies with active, buried lines in the Site area will be asked by the Contractor performing intrusive activities to mark their facilities. Employees will use these data to choose work locations.

4.3.2.2 Underground Utilities

No excavating, drilling, boring, or other intrusive activities will be performed until an underground utility survey, conducted by knowledgeable persons or agencies, has been made. This survey will identify underground and in-workplace utilities such as the following:

- Electrical lines and appliances;
- Telephone lines;
- Cable television lines;
- Gas lines;
- Pipelines;
- Steam lines;
- Water lines;
- Sewer lines; and/or
- Pressurized air lines.

The location of utilities will be discussed with GEI employees and subcontractors during a Site Safety Briefing. Identified utilities should be marked or access otherwise restricted to avoid chance of accidental contact.

Even when a utility search has been completed, drilling, boring, and excavation should commence with caution until advanced beyond the depth at which such utilities are usually located. Utilities will be considered “live” or active until reliable sources demonstrate otherwise.

4.3.2.3 Overhead Utilities

Overhead transmission and distribution lines will be carried on towers and poles which provide adequate safety clearance over roadways and structures. Clearances will be adequate for the safe movement of vehicles and for the operation of construction equipment.

Overhead or above-ground electric lines should be considered active until a reliable source has documented them to be otherwise. Elevated work platforms, ladders, scaffolding, man-lifts, and drill or vehicle superstructures will be erected a minimum of 20 feet (the actual distance is dependent upon the voltage of the line) from overhead electrical lines until the line is de-energized, grounded, or shielded so arcing cannot occur between the work location or superstructure.

4.3.3 Excavations and Trenches

The safety requirements for excavations and trenches must be determined by a competent person who is capable of identifying existing and predictable hazards and work conditions that are unsanitary, hazardous, or dangerous to GEI employees. The competent person must also have the authorization to take prompt corrective measures to eliminate unsatisfactory conditions. GEI employees will not enter trenches.

The following are general requirements for work activities in and around excavations:

- Prior to initiation of excavation activity (or ground intrusive activity, such as drilling), the location of underground installations will be determined. The <One-Call/Dig-Safe> center will be contacted by the Contractor/Subcontractor a minimum of 72 hours prior to excavation activities. It may also be necessary to temporarily support underground utilities during excavation. When excavations approach the estimated location of underground installations, the exact location of the underground installations will be determined by means that are safe for GEI employees, i.e., hand dig, test pits, etc.
- Excavations should be inspected daily by the excavating company’s competent person prior to commencement of work activities. Evidence of cave-ins, slides, sloughing, or surface cracks or excavations will be cause for work to cease until necessary precautions are taken to safeguard employees.
- Excavated and other materials or equipment that could fall or roll into the excavation, and vehicular traffic and heavy equipment will be placed at least 5 feet from the edge of the excavation.
- Excavation operations will cease immediately during hazardous weather conditions such as high winds, heavy rain, lightning, and heavy snow.

Employees will refer to GEI's Excavation Safety SOP for further information.

4.3.4 Fire and Explosion

When conducting excavating activities, the opportunity for encountering fire and explosion hazards exists from contamination in soil and the possibility of free product in underground structures and pipelines. Additionally, the use of diesel-powered excavating equipment could present the possibility of encountering fire and explosion hazards.

4.3.5 Heat Stress

Employees may be exposed to the hazards associated with heat stress when ambient temperatures exceed 70ºF. Employees should increase water intake while working in conditions of high heat. Enough water should be available so that each employee can consume 1 quart of water per hour. In addition, they should increase number of rest breaks and/or rotate employees in shorter work shifts. Employees should rest in cool, dry, shaded areas for at least 5 minutes. Employees should not wait until they feel sick to cool down. Watch for signs and symptoms of heat exhaustion and fatigue. In the event of heat stroke, bring the victim to a cool environment, call for help, and initiate first aid procedures

The procedures to be followed regarding avoiding heat stress are provided in Appendix C – Heat Stress Guidelines and in GEI's Heat Stress program.

4.3.6 Cold Stress

Employees may be exposed to the hazards of working in cold environments. Potential hazards in cold environments include frostbite, trench foot or immersion foot, hypothermia, as well as slippery surfaces, brittle equipment, and poor judgment. The procedures to be followed regarding avoiding cold stress are provided in Appendix C – Cold Stress Guidelines and in GEI's Cold Stress program.

4.3.7 Noise

Noise is a potential hazard associated with the operation of heavy equipment, power tools, pumps, and generators. Employees who will perform suspected or established high noise tasks and operations will wear hearing protection. If deemed necessary by the SSO, the CHSO will be consulted on the need for additional hearing protection and the need to monitor sound levels for Site activities. Other employees who do not need to be in proximity of the noise should distance themselves from the equipment generating the noise.

4.3.8 Hand and Power Tools

In order to complete the various tasks for the project, personnel may use hand and power tools. The use of hand and power tools can present a variety of hazards, including physical harm from being struck by flying objects, being cut or struck by the tool, fire, and electrocution. Work gloves, safety glasses, and hard hats will be worn by the operating personnel when using hand and power tools and Ground Fault Circuit Interrupter (GFCI)-equipped circuits will be used for power tools.

4.3.9 Slips, Trips, and Falls

Working in and around the Site may pose slip, trip, and fall hazards due to slippery and uneven surfaces. Excavation at the Site may cause uneven footing in trenches and around the soil piles. Steep slope and uneven terrain conditions at the Site are also a primary concern. GEI employees will wear proper foot gear and will employ good work practice and housekeeping procedures to minimize the potential for slips, trips, and falls.

4.3.10 Manual Lifting

Manual lifting of objects and equipment may be required. Failure to follow proper lifting technique can result in back injuries and strains. Employees should use a buddy system and/or power equipment to lift heavy loads whenever possible and should evaluate loads before trying to lift them (i.e., they should be able to easily tip the load and then return it to its original position). Carrying heavy loads with a buddy and proper lifting techniques include: 1) make sure footing is solid; 2) make back straight with no curving or slouching; 3) center body over feet; 4) grasp the object firmly and as close to your body as possible; 5) lift with legs; and 6) turn with your feet, don’t twist.

4.3.11 Projectile Objects and Overhead Dangers

Overhead dangers, including but not limited to falling debris and equipment, can occur while operating drill rigs. GEI employees will maintain a minimum distance from large overhead operations and to maintain proper communication with heavy equipment operators and their handlers, should work necessitate their presence beyond the minimum safety distance. Proper PPE will be worn during these types of activities including steel-toed/shank boots, safety vests, and hard hats.

4.3.12 Cuts and Lacerations

The core sampling program may require employees to use powered cutting tools (circular saw or shears) or a hooked knife to cut open the sample liner. Safety box cutters will be utilized for routine operations such as opening boxes of supplies or cutting rope or string. When using cutting tools, follow the safety precautions listed below:

- Keep free hand out of the way.
- Secure work if cutting through thick material.
- Use only sharp blades; dull blades require more force that results in less knife control.
- Pull the knife through the object and away from your body; pulling motions are easier to manage.
- Do not put the knife in your pocket.
- Wear leather or Kevlar® gloves when using knives or blades, or when removing sharp objects caught or dangling in sampling gear.

4.4 Chemical Hazards

The characteristics of compounds at the Site are discussed below for information purposes. Adherence to the safety and health guidelines in this HASP should reduce the potential for exposure to the compounds discussed below.

Chlorinated Hydrocarbons

Chlorinated hydrocarbons (organochlorides) are a very large and diverse group of hydrocarbon molecules that also have at least one covalently bound chlorine atom chemically bonded to them. Chlorinated hydrocarbons are used predominantly as solvents and have historically been used as industrial degreasers, dry cleaning solvents, anesthetic agents and as refrigerants. They are colorless, volatile liquids with a moderately sweet aroma and partially soluble in but denser than water. They are the most common DNAPL.

The more common forms of chlorinated solvent contamination of soils and ground waters include:

- Tetrachloroethene (PCE, Tetrachloroethylene)
- Carbon tetrachloride (Tetrachloromethane or carbon tet)
- Trichloroethylene (TCE,Trichloroethene)
- 1,1,1-TrichloroMethane (Chloroform)
- 1,1,1 - Trichloroethane (TCA, methyl chloroform, chlorothene, Solvent 111)
- Dichloromethane (DCM or methylene chloride)

As a class, the chlorinated hydrocarbons are potent central nervous system depressants or stimulants. They also cause greater liver and kidney damage compared to other organic solvents. Many have been shown to cause cancer in laboratory animals; due to widespread industrial use, the issue of carcinogenic risk to humans is one of the most controversial issues in regulatory toxicology.

Exposure to chlorinated hydrocarbon compounds in the occupational setting is primarily through inhalation. Skin absorption is variable and usually insignificant, although dermal absorption following prolonged or extensive skin contact can cause systemic toxicity.

4.4.1 Heavy Metals

Exposure to lead may cause acute symptoms such as eye irritation, weakness, weight loss, abdominal pain, and anemia. Chronic exposure to lead may result in kidney disease, effects to the reproductive system, blood forming organs, and CNS.

Lead and arsenic are regulated by specific OSHA standards. They are 29 CFR 1910.1025/1926.52 and 29 CFR 1910.1018/1926.1118, respectively. These standards include specific requirements for air monitoring, signs and labels, training and medical surveillance.

These metals are at environmental concentrations and are not expected to be at concentrations that exposure symptoms would occur. As with SVOCs, the primary route of exposure is through inhalation of dust particles when soil is disturbed and becomes airborne.

Semi-Volatile Organic Compounds

Semi-volatile organic compounds (SVOCs) usually consist of a mixture of acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluorethene, benz(a)pyrene, benzo(e)pyrene, benzo(g,h,i)peryline, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3cd)pyrene, 2-methyl naphthalene, naphththalene, phenanthrene, phenols, and pyrene.

These SVOCs are present at the Site within impacted soil and groundwater.

These compounds are at environmental concentrations and are not expected to be at concentrations that exposure symptoms would occur. SVOCs such as those listed above may cause contact dermatitis. Direct contact can be irritating to the skin and produce itching, burning, swelling, and redness. Direct contact or exposure to the vapors may be irritating to the eyes. Conjunctivitis may result from prolonged exposure. Many SVOCs are considered to be very toxic, if ingested. High levels of exposure to SVOCs, though not anticipated during work activities conducted during this project, may increase the risk of cancer including lung, kidney, and skin cancer. Naphthalene is also an eye and skin irritant and can cause nausea, headache, fever, anemia, liver damage, vomiting, convulsions, and coma. Poisoning may occur by ingestion of large doses, inhalation, or skin absorption.

The major route of entry for the work activities to be conducted at this Site is through direct contact. Exposure is most likely when handling soil and water samples. Inhalation may occur when the soil is disturbed causing respirable and nuisance dust particles to become airborne.

Volatile Organic Compounds

Volatile organic chemicals (VOCs), such as benzene, toluene, ethyl benzene, and xylene (BTEX) are present as soil and groundwater contaminants. These compounds are at environmental concentrations and are not expected to be at concentrations that exposure symptoms would occur. These compounds generally have a depressant effect on the Central Nervous System (CNS), may cause chronic liver and kidney damage, and some are suspected human carcinogens. Benzene is a known human carcinogen. Acute exposure may include headache, dizziness, nausea, and skin and eye irritation. The primary route of exposure to VOCs is through inhalation and therefore respiratory protection is the primary control against

4.4.2 Evaluation of Organic Vapor Exposure

Air monitoring reduces the risk of overexposure by indicating when action levels have been exceeded and when PPE must be upgraded or changed. Action Levels for VOCs and associated contingency plans for the work zone are discussed within Section 9 of this HASP.

Exposure to organic vapors will be evaluated and/or controlled by:

- Monitoring air concentrations for organic vapors in the breathing zone with a photoionization detector (PID) or a flame ionization detector (FID).
- When possible, engineering control measures will be utilized to suppress the volatile organic vapors. Engineering methods can include utilizing a fan to promote air circulation, utilizing volatile suppressant foam, providing artificial ground cover, or covering up the impacted material with a tarp to mitigate volatile odors.
- When volatile suppression engineering controls are not effective and organic vapor meters indicate concentrations above the action levels, then appropriate respiratory protection (i.e., air purifying respirator with organic vapor cartridge) will be employed.

4.4.3 Evaluation of Skin Contact and Absorption

Skin contact by contaminants may be controlled by use of proper hygiene practices, PPE, and good housekeeping procedures. The proper PPE (e.g., Tyvek®, gloves, safety glasses) as described in Section 5 will be worn for activities where contact with potential contaminated media or materials are expected.

SDSs for decontamination chemicals and laboratory reagents that may be used on Site are included in Appendix B. Specific chemical hazards information from the occupational health sources are summarized in Table 3.

Table 3. Chemical Data

Compound	CAS #	ACGIH TLV	OSHA PEL	Route of Exposure	Symptoms of Exposure	Target Organs	Physical Data
Lead	7439-92-1	0.050 mg/m^3	0.05 mg/m^3 A.L. 0.03 mg/m3	Inhalation Ingestion Skin Contact	Weakness, insomnia; facial pallor; pal eye, anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis of wrist and ankles; irritates eyes, hypo tension	Eyes, GI tract, CNS, kidneys, blood, gingival tissue	A heavy, ductile, soft, gray solid. FP: NA IP: NA LEL: NA UEL: NA VP: 0 mm
VOCs1	NA	0.5 ppm (Skin)	0.5 ppm TWA 2.5 ppm STEL	Inhalation, Skin Absorption, Ingestion, Skin Contact	Irritate eyes and skin; headaches; dizziness; nausea; kidney; liver damage; depress CNS	Skin, eyes, liver, kidney, CNS	Colorless volatile liquid, sometimes with a sweet or solvent odor

Abbreviations:

°F = degrees Fahrenheit
ACGIH = American Conference of Industrial Hygienists
A.L. = Action Level
atm = atmosphere
C = ceiling limit, not to be exceeded
CAS # = chemical abstract services number
CNS = Central Nervous System
CTPV = Coal Tar Pitch Volatiles
CVS = Cardiovascular System
eV = electron volt
f/cc = fibers per cubic centimeter
FP = Flash point
GI = Gastro-intestinal
H2S = Hydrogen Sulfide
HCN = Hydrogen Cyanide
hr = hour
IP = Ionization Potential
LEL = Lower explosive limit
mg/m^3 = micrograms per cubic meter
min = minute
mm = millimeter
mmHg = millimeters of mercury
N/A = not applicable
OSHA = Occupational Safety and Health Administration
PAH = Polycyclic Aromatic Hydrocarbons
PCB = Polychlorinated Biphenyls
PEL = Permissible exposure limit
ppm = parts per million
Skin = significant route of exposure
STEL = Short-term exposure limit (15 minutes)
TWA = Time-weighted average (8 hours)
VP = vapor pressure approximately 68°F in mm Hg

4.5 Biological Hazards

Therefore, employees working on this project should be aware of the potential biological hazards at this Site. Each is discussed in detail below:

4.5.1 Ticks

4.5.1.1 Lyme Disease

Ticks are bloodsuckers, attaching themselves to warm-blooded vertebrates to feed. Deer ticks are associated with the transmission the bacteria that causes Lyme disease. Female deer ticks are about ¼-inch in length and are black and brick red in color. Males are smaller and all black. If a tick is not removed, or if the tick is allowed to remain for days feeding on human blood, a condition known as tick paralysis can develop. This is due to a neurotoxin, which the tick apparently injects while engorging. This neurotoxin acts upon the spinal cord causing incoordination, weakness, and paralysis.

The early stages of Lyme disease, which can develop within a week to a few weeks of the tick bite, are usually marked by one or more of these signs and symptoms:

- Tiredness
- Chills and fever
- Headache
- Muscle and/or join pain
- Swollen lymph glands
- Characteristic skin rash (i.e. bullseye rash)

4.5.1.2 Rocky Mountain Spotted Fever

Rocky Mountain spotted fever is spread by the American dog tick, the lone-star tick, and the wood tick, all of which like to live in wooded areas and tall, grassy fields. The disease is most common in the spring and summer when these ticks are active, but it can occur anytime during the year when the weather is warm.

Initial signs and symptoms of the disease include sudden onset of fever, headache, and muscle pain, followed by development of a rash. Initial symptoms may include fever, nausea, vomiting, severe headache, muscle pain, and/or lack of appetite.

The rash first appears 2 to 5 days after the onset of fever and is often not present or may be very subtle. Most often it begins as small, flat, pink, non-itchy spots on the wrists, forearms, and ankles. These spots turn pale when pressure is applied and eventually become raised on the skin. Later signs and symptoms include rash, abdominal pain, joint pain, and/or diarrhea.

The characteristic red, spotted rash of Rocky Mountain spotted fever is usually not seen until the 6th day or later after onset of symptoms, and this type of rash occurs in only 35% to 60% of patients with Rocky Mountain spotted fever. The rash involves the palms or soles in as many as 50% to 80% of patients; however, this distribution may not occur until later in the course of the disease.

4.5.1.3 Prevention

Tick season lasts from April through October; peak season is May through July. You can reduce your risk by taking these precautions:

- During outside activities, wear long sleeves and long pants tucked into socks. Wear a hat, and tie hair back.
- Use insecticides to repel or kill ticks. Repellents containing the compound n,n-diethyl-meta-toluamide (DEET) can be used on exposed skin except for the face, but they do not kill ticks and are not 100% effective in discouraging ticks from biting. Products containing permethrin kill ticks, but they cannot be used on the skin -- only on clothing. When using any of these chemicals, follow label directions carefully.
- After outdoor activities, perform a tick check. Check body areas where ticks are commonly found: behind the knees, between the fingers and toes, under the arms, in and behind the ears, and on the neck, hairline, and top of the head. Check places where clothing presses on the skin.
- Remove attached ticks promptly. Removing a tick before it has been attached for more than 24 hours greatly reduces the risk of infection. Use tweezers, and grab as closely to the skin as possible. Do not try to remove ticks by squeezing them, coating them with petroleum jelly, or burning them with a match. Keep ticks in a zip-lock baggie in case testing needs to be performed.
- Report any of the above symptoms and all tick bites to the PM and Safety Team for evaluation.

4.5.2 Mosquito- Borne Disease – West Nile Virus

West Nile encephalitis is an infection of the brain caused by the West Nile virus, which is transmitted by infected mosquitoes. Following transmission from an infected mosquito, West Nile virus multiplies in the person's blood system and crosses the blood-brain barrier to reach the brain. The virus interferes with normal CNS functioning and causes inflammation of the brain tissue. However, most infections are mild and symptoms include fever, headache, and body aches. More severe infections may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and rarely, death. Persons over the age of 50 have the highest risk of severe disease.

Prevention centers on public health action to control mosquitoes and on individual action to avoid mosquito bites. To avoid being bitten by the mosquitoes that cause the disease, use the following control measures:

If possible, stay inside between dusk and dark. This is when mosquitoes are most active. When outside (between dusk and dark), wear long pants and long-sleeved shirts. Spray exposed skin with an insect repellent, preferably containing DEET.

4.5.3 Wasps and Bees

Wasps (hornets and yellow-jackets) and bees (honeybees and bumblebees) are common insects that may pose a potential hazard to the field team if work is performed during spring, summer, or fall. Bees normally build their nests in the soil. However, they use other natural holes such as abandoned rodent nests or tree hollows. Wasps make a football-shaped, paper-like nest either below or above the ground. Yellow-jackets tend to build their nests in the ground but hornets tend to build their nests in trees and shrubbery. Bees are generally more mild-mannered than wasps and are less likely to sting. Bees can only sting once while wasps sting multiple times because their stinger is barbless. Wasps sting when they feel threatened. By remaining calm and not annoying wasps by swatting, you lessen the chance of being stung.

Wasps and bees inject a venomous fluid under the skin when they sting. The venom causes a painful swelling that may last for several days. If the stinger is still present, carefully remove it with tweezers. Some people may develop an allergic reaction (i.e. anaphylactic shock) to a wasp or bee sting. If such a reaction develops, seek medical attention at once. If a GEI employee is allergic to bees or wasps notify the SSO and if, needed, the location of the epi pen.

4.5.4 Sun Exposure

Employees are encouraged to liberally apply sunscreen, with a minimum sun protection factor (SPF) of 15, when working outdoors to avoid sunburn and potential skin cancer, which is associated with excessive sun exposure to unprotected skin. Additionally, employees should wear safety glasses that offer protection from ultraviolet A and B (UVA/UVB) rays.

5. Personal Protective Equipment

The PPE specified in Table 4 represents PPE selection required by 29 CFR 1910.132, and is based on the Activity Hazard Analysis of Section 4 (Table 2). Specific information on the selection rationale activity can be found in the GEI Health and Safety Manual.

The PPE program addresses elements, such as PPE selection based on Site hazards, use and limitations, donning and doffing procedures, maintenance and storage, decontamination and disposal, training and proper fitting, inspection procedures prior to / during / and after use, evaluation of the effectiveness of the PPE program, and limitations during temperature extremes, heat stress, and other appropriate medical considerations. A summary of PPE for each level of protection is in Table 4.

Table 4. Site-Specific PPE

Task	PPE Level	Site-Specific Requirements	Respirator
Mobilization/Demobilization			
Reconnaissance	D	Hard hat, safety glasses, steel toe/shank safety boot, reflective vest, leather work gloves, hearing protection as needed	D - None
Mobilization/Demobilization of Equipment and Supplies	D	Hard hat, safety glasses, steel toe/shank safety boot, reflective vest, leather work gloves, hearing protection as needed	D – None
Establishment of Site Security, Work Zones, and Staging Area	D	Hard hat, safety glasses, steel toe/shank safety boot, reflective vest, leather work gloves, hearing protection as needed	D - None
Construction			
Drilling, Groundwater Well Installation, Excavation, Digging Test Pits, Backfilling, Grading Observation, Sampling	D	Hard hat, safety glasses, steel toe/shank safety boot with overboot as needed, reflective vest, leather work gloves as needed, nitrile gloves, hearing protection as needed, Tyvek as needed	Level D initially, Level C-If action levels exceeded (see Section 9 of HASP)
Demolition/Remediation Observation			
Observe Contractor Activities	D	Hard hat, safety glasses, steel toe/shank safety boot with overboot as needed, reflective vest, leather work gloves as needed, nitrile gloves, hearing protection as needed, Tyvek as needed	D - None

Use of Level A or Level B PPE is not anticipated. If conditions indicating the need for Level A or Level B PPE are encountered, personnel will leave the Site and this HASP will be revised with oversight of the CHSO or GEI personnel will not re-enter the Site until conditions allow.

For most work conducted at the site, Level D PPE will include long pants, hard hats, safety glasses with side shields, and steel toe/shank or EH-rated safety boots.

5.1 OSHA Requirements for PPE

Personal protective equipment used during the course of this field investigation must meet the following OSHA standards:

Table 5. OSHA Standards for PPE

Type of Protection	Regulation	Source
Eye and Face	29 CFR 1910.133	ANSI Z87.1 1968
Respiratory	29 CFR 1910.134	ANSI Z88.1 1980
Head	29 CFR 1910.135	ANSI Z89.1 1969
Foot	29 CFR 1910.136	ANSI Z41.1 1999 or ASTM F-2412-2005, and ASTM F-2413-2005

CRF = Code of Federal Regulations
ANSI = American National Standards Institute
ASTM = American Society For Testing and Materials

On-site GEI personnel who have the potential to don a respirator must have a valid fit test certification and documentation of medical clearance. The CHSO will maintain such information on file for on-site personnel. The PM will obtain such information from the subcontractor's site supervisor prior to the initiation of such work. Both the respirator and cartridges specified for use in Level C protection must be fit-tested prior to use in accordance with OSHA regulations (29 CFR 1910.134). Air purifying respirators cannot be worn under the following conditions:

- Oxygen deficiency (less than 20.7%).
- Imminent Danger to Life and Health (IDLH) concentrations.
- If contaminant levels exceed designated use concentrations.

6. Key Project Personnel/Responsibilities and Lines of Authority

6.1 GEI Personnel

• Edward Bradshaw	Project Manager
• Jordanna Kendrot	Project Engineer
• Jordanna Kendrot	Site Safety Officer
• Bill Fitchett	Field Personnel
• Steve Hawkins	Corporate Health and Safety Officer
• Jeena Sheppard	Regional Health and Safety Officer

The implementation of health and safety at this project location will be the shared responsibility of the PM, the CHSO, Regional Health and Safety Officer (RHSO), the SSO, other GEI personnel implementing the proposed scope of work.

6.1.1 GEI Project Manager

The PM, Ed Bradshaw, is responsible for confirming that the requirements of this HASP are implemented. Some of the PM's specific responsibilities include:

- Conducting and documenting the Project Safety Briefing for GEI project employees and forwarding the signed form (Appendix D) to the Safety Team;
- Verifying that the GEI staff selected to work on this program are sufficiently trained for Site activities;
- Assuring that personnel to whom this HASP applies, including subcontractor personnel, have received a copy of it;
- Providing the CHSO with updated information regarding conditions at the Site and the scope of Site work;
- Providing adequate authority and resources to the on-site SSO to allow for the successful implementation of necessary safety procedures;
- Supporting the decisions made by the SSO and CHSO;
- Maintaining regular communications with the SSO and, if necessary, the CHSO;
- Verifying that the subcontractors selected by GEI to work on this program have completed GEI environmental, health and safety requirements and has been deemed acceptable for the proposed scope of work; and

- Coordinating the activities of GEI subcontractors and confirming that they are aware of the pertinent health and safety requirements for this project.

6.1.2 GEI Corporate Health and Safety Officer

The CHSO is the individual responsible for the review, interpretation, and modification of this HASP. Modifications to this HASP which may result in less stringent precautions cannot be undertaken by the PM or the SSO without the approval of the CHSO. Specific duties of the CHSO include:

- Writing, approving, and amending the HASP for this project;
- Advising the PM and SSO on matters relating to health and safety on this Site;
- Recommending appropriate PPE and safety equipment to protect personnel from potential Site hazards;
- Conducting accident investigations; and
- Maintaining regular contact with the PM and SSO to evaluate Site conditions and new information which might require modifications to the HASP.

6.1.3 GEI Site Safety Officer

GEI field staff are responsible for implementing the safety requirements specified in this HASP. However, one person will serve as the SSO. For this program, Jordanna Kendrot, will serve as the SSO. The SSO will be on-site during all activities covered by this HASP. The SSO is responsible for enforcing the requirements of this HASP once work begins. The SSO has the authority to immediately correct situations where noncompliance with this HASP is noted and to immediately stop work in cases where an immediate danger is perceived. Some of the SSO's specific responsibilities include:

- Conducting/attending the Project Safety Briefing prior to beginning work, and subsequent safety meetings as necessary;
- Conduct daily Safety Tailgate meeting in accordance with Par Development Group's requirements (can be combined with "pre-entry") briefing for Site-related work;
- Verifying that personnel to whom this HASP applies have attended and participated in the Project Safety Briefing and subsequent safety meetings that are conducted during the implementation of the program;
- Maintaining a high level of health and safety consciousness among employees implementing the proposed activities;

- Procuring the air monitoring instrumentation required and performing air monitoring for investigative activities;
- Procuring and distributing the PPE and safety equipment needed for this project for GEI employees;
- Verifying that PPE and health and safety equipment used by GEI is in good working order;
- Verifying that the selected contractors are prepared with the correct PPE and safety equipment and supplies;
- Notifying the PM of noncompliance situations and stopping work in the event that an immediate danger situation is perceived;
- Monitoring and controlling the safety performance of personnel within the established restricted areas to confirm that required safety and health procedures are being followed;
- Stopping work in the event that an immediate danger situation is perceived; and
- Reporting accident/incident and preparing accident/incident reports, if necessary.

6.1.4 GEI Field Personnel

GEI field personnel covered by this HASP are responsible for following the health and safety procedures specified in this HASP and for performing their work in a safe and responsible manner. Some of the specific responsibilities of the field personnel are as follows:

- Reading and signing the HASP in its entirety prior to the start of on-site work;
- Attending and actively participating in the required Project Safety Briefing prior to beginning on-site work and any subsequent safety meetings that are conducted during the implementation of the program;
- Stopping work in the event that an immediate danger situation is perceived;
- Bringing forth any questions or concerns regarding the content of the HASP to the PM or the SSO, prior to the start of work;
- Reporting accidents, injuries, and illnesses, regardless of their severity, to the SSO, CHSO, and HR; and
- Complying with the requirements of this HASP and the requests of the SSO.

6.1.5 Lines of Authority will be as follows:

On Site – GEI will have responsibility for safety of its employees during the work performed at the Site 99 Granite Street Redevelopment. GEI's field representative will have a cell phone available to contact the appropriate local authorities, in the event of an emergency. GEI's field representative will be available for communication with the GEI PM and with the Par Development Group representative.

GEI employees have the authority to stop work activities if an unanticipated hazard is encountered or a potential unsafe condition is observed. The GEI employee should contact the Corporate Health and Safety Officer and the Project Manager to discuss the stop work conditions and potential control methods that can be implemented.

6.2 Subcontractors

GEI has subcontracted the following firms to assist in performing work on this project:

Subcontractor Name	Contact Name
Land Air Water Environmental Services 32 Chichester Ave Center Moriches, NY	John Lamprecht **Office:** (631) 874-2112

GEI requires its subcontractors to work in a responsible and safe manner. Subcontractors hired by GEI are required to submit documentation of their safety practices as part of GEI's Subcontractor Management Program for evaluation and approval before the start of work. Subcontractors for this project will be required to develop their own HASP for protection of their employees, but, at a minimum, must adhere to applicable requirements set forth in this HASP.

7. Training Program

7.1 HAZWOPER Training

In accordance with OSHA Standard 29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response" (HAZWOPER) responders will, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations. At a minimum, the training will have consisted of instruction in the topics outlined in the standard. Personnel who have not met the requirements for initial training will not be allowed to work in any Site activities in which they may be exposed to hazards (chemical or physical). Proof of training will be submitted to the PM or his/her representative prior to the start of field activities.

7.2 Annual 8-Hour Refresher Training

Annual 8-hour refresher training will be required of hazardous waste site field personnel in order to maintain their qualifications for fieldwork. The training will cover a review of 29 CFR 1910.120 requirements and related company programs and procedures. Proof of current 8-hour refresher training will be submitted to the PM or his/her representative prior to the start of field activities.

7.3 Supervisor Training

Personnel acting in a supervisory capacity will have received 8 hours of instruction in addition to the initial 40-hour training. In addition supervisors will have 1 year of field experience and training specific to work activities (i.e., sampling, construction observation, etc.)

7.4 Site-Specific Training

Prior to commencement of field activities, the PM or the SSO will verify GEI field personnel assigned to the project will have completed training that will specifically address the activities, procedures, monitoring, and equipment used in the Site operations. It will include Site and facility layout, hazards, and emergency services at the Site, and will highlight the provisions contained within this HASP and applicable GEI H&S SOPs (Appendix E). This training will be documented on the Project Safety Briefing Form Appendix D). The signed form will be forwarded to the Safety Team at SafetyTeam@geiconsultants.com. In addition, GEI personnel will sign the plan to document that they understand the hazards and control measures presented and agree to comply with the procedures established in the HASP. Personnel that have not received project-specific training will not be allowed on-site.

7.5 On-Site Safety Briefings

Other GEI personnel will be given health and safety briefings daily by the SSO or field representative to assist GEI personnel in safely conducting work activities. The briefing will include GEI subcontractors. The briefings can include information on new operations to be conducted, changes in work practices, or changes in the Site's environmental conditions, as well as periodic reinforcement of previously discussed topics. The briefings will also provide a forum to facilitate conformance with safety requirements and to identify performance deficiencies related to safety during daily activities or as a result of safety inspections. Documentation of these briefings will be recorded in the GEI field book, if the project duration is less than 5 days. If the project is longer than 5 days, the Tailgate Safety Briefing Form (Appendix D) will be used to document briefings. The meetings will also be an opportunity to periodically update the employees on monitoring results.

7.6 First Aid and CPR

The PM will verify that GEI field staff has current certifications in first aid and Cardiopulmonary Resuscitation (CPR), so that emergency medical treatment is available during field activities. The training will be consistent with the requirements of the American Red Cross Association. GEI employees also attend annual Bloodborne Pathogens training in compliance with OSHA regulations.

7.7 OSHA 10-hour Construction Safety Training

GEI employees will have received 10-hour construction safety training through the OSHA Outreach Training Program when required for a specific site, client, or based on the type work activities that are being performed. This training provides employees with an awareness level training in recognizing and preventing the hazards associated with the construction industry. Employees receive training in hazard identification, avoidance, control, and prevention; not OSHA standards. The training implies an increased level of safety training has become a widely known standard for OSHA orientation training in the construction industry. The PM will verify that GEI staff requiring this training has an OSHA issued completion card.

8. Medical Surveillance Program

GEI maintains a continuous, corporate, medical surveillance program that includes a plan designed specifically for field personnel engaged in work at sites where hazardous or toxic materials may be present. GEI's CHSO and is responsible for the administration and coordination of medical evaluations conducted for GEI's employees at branch office locations. Comprehensive examinations are given to GEI field personnel on an annual or biennial basis (as determined to be appropriate by the CHSO) participating in hazardous waste operations. The medical results of the examinations aid in determining the overall fitness of employees participating in field activities.

Under the CHSO's supervision, field personnel undergo a complete initial physical examination, including a detailed medical and occupational history, before they participate in hazardous waste site investigations. Extensive annual/biennial reexaminations are also performed. Upon completion of these tests, personnel are certified by an occupational health physician as to whether they are fit for field work in general, and fit to use respiratory protection.

If a GEI employee or other project worker shows symptoms of exposure to a hazardous substance and wishes to be rechecked, he/she will be directed to the nearest area hospital or medical facility.

GEI subcontractor personnel that will enter any active waste handling or other active non-"clean" area must certify that they are participating in a medical surveillance program that complies with OSHA regulations for hazardous waste operations (i.e., 29 CFR 1910.120 and 29 CFR 1926.65). Proof of medical clearance will be submitted to the GEI PM or SSO prior to the start of field activities.

9. Atmospheric Monitoring

Air monitoring will be performed to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of worker protection needed on-site in the event that intrusive work is conducted. Work requiring air monitoring includes the installation and/or abandonment of monitoring wells, DNAPL recovery wells, oxygen injection wells, and soil vapor points. Additionally, PID screening of the well head space will be conducted during groundwater sampling activities.

GEI will conduct work zone monitoring for on-site GEI employees during intrusive activities only. GEI will monitor and document daily Site conditions and operations and inform field representatives of results. ***If Action Levels are exceeded, the SSO will immediately implement Site action(s) according to Table 6 below and notify the PM and Safety Team***.

The following air monitoring equipment will be on site:

- PID with 10.6 eV lamp or equivalent
- Particulate Meter (PM-10 capable)

9.1 Equipment Use

9.1.1 Calibration

Air monitoring equipment will be calibrated and maintained in accordance with manufacturer's requirements. Calibrations will be recorded in the project notes daily or on a daily calibration form.

9.1.2 Photoionization Detector

Organic vapor concentrations will be measured using a PID during intrusive activities. During intrusive operations, organic vapor concentrations will be measured continuously. Organic vapor concentrations will be measured upwind of the work site(s) to determine background concentrations at least twice a day, (once in the morning and once in the afternoon). The SSO will interpret monitoring results using professional judgment and according to the alert and Action Limits set forth in the associated Site Work Plan.

9.2 Particulate Meter

A particulate meter will be used to measure airborne particulate matter during intrusive activities. Monitoring will be continuous and readings will be averaged over a 15-minute period for comparison with the Action Levels. Monitoring personnel will make a best effort to collect dust monitoring data from downwind of the intrusive activity. If off-site sources are considered to be the source of the measured dust, upwind readings will also be collected.

9.3 Action Levels

Table 6 provides a summary of real time air monitoring Action Levels and contingency plans for work zone activities. The below Action Levels are determined by halving the Permissible Exposure Limits (PELs) or Threshold Limit Values (TLVs) as set forth by OSHA and the American Conference of Government Industrial Hygienists (ACGIH). O_2 values are based on the maximum use limits of a full face respirator if oxygen were being displaced by a chemical.

Table 6. Real-Time Work Zone Air Monitoring Action Levels

Air Monitoring Instrument	Action Level (above background)	Site Action
PID	1.0 ppm	Use detector tube for benzene or zNose® to verify if concentration is benzene. No respiratory protection is required if benzene is not present, or levels return below the determined action level.
PID	1.0 - 10 ppm	Use Sensidyne detector tube for naphthalene or zNose® to verify if concentration is naphthalene. No respiratory protection is required if naphthalene is not present, or levels return below the determined action level.
	10 – 50 ppm	No respiratory protection is required if benzene or naphthalene is not present, or levels return below the determined action level.
	50 – 100 ppm	Stop work, withdrawal from work area, institute engineering controls, if levels persist, upgrade to Level C.
	> 100 ppm	Stop work, withdraw from work area, notify PM and Safety Team.
Particulate Meter	150 µg/m^3	Implement work practices to reduce/minimize airborne dust generation, e.g., spray/misting of soil with water.

10. Site Control Measures

10.1 Buddy System

GEI personnel should be in line-of-site or communication contact with another on-site person. The other on-site person should be aware of his or her role as a "buddy" and be able to provide assistance in the event of an emergency. A copy of this plan will be given to any person acting as a GEI "buddy" for informational purposes.

10.2 Sanitation for Temporary Work Sites

Sanitation requirements identified in the OSHA Standard 29 CFR 1926.51 "Sanitation" specifies that employees working at temporary project sites have at least one sanitary facility available to them. Temporary sanitary facilities including toilets will be available on-site.

10.3 Illumination

Illumination requirements identified by OSHA are directed to work efforts inside buildings and/or during non-daylight hours. Activities planned for the Site are anticipated to occur outside during daylight hours. However, if work areas do not meet illumination requirements, they will be equipped with appropriate illumination that meets or exceeds requirements specified in OSHA Standard 29 CFR 1926.56 "Illumination." Employees will not work on sites that are not properly lighted.

10.4 Smoking

Smoking is prohibited at or in the vicinity of hazardous operations or materials. Where smoking is permitted, safe receptacles will be provided for smoking materials.

10.5 Alcohol and Drug Abuse Prevention

Alcohol and drugs will not be allowed on the Site. Project personnel under the influence of alcohol or drugs will not be allowed to enter the Site.

11. Incident Reporting

GEI will report incidents involving GEI personnel or subcontractor personnel, such as: lost time injuries, injuries requiring medical attention, near miss incidents, fires, fatalities, accidents involving the public, chemical spills, vehicle accidents, and property damage. The following steps must be followed when an incident occurs:

1. In life-threatening situations, immediately call 9-1-1.
2. Stop work activity to address any injury, illness, property damage, spill or other emergency.
3. **Immediately** report any incidents to your Supervisor/Project Manager and Regional Health & Safety Officer.
4. If your injury or illness is not life-threatening, call Medcor Triage at 1-800-775-5866 to speak with a medical professional.
5. Complete an Incident Report Form **immediately** after addressing the incident.

For vehicle accidents involving another vehicle or damage to property, the employee will take pictures of each vehicle or property involved in the incident and obtain a police report. In some municipalities police will not be dispatched to a non-injury accident, but every effort needs to be made to try and obtain the report.

The Incident Report Form and the Near Miss Reporting Form can be found in Appendix D, on the GEI Health and Safety smartphone app, or on the Safety page of the GEI Intranet. To report subcontractor injuries or incidents, follow the same verbal reporting procedures and submit an email describing the event to the PM and the Safety Team.

11.1 Injury Triage Service

If a GEI employee experiences a work related injury that is not life-threatening, the employee will initiate a call to Medcor Triage at 1-800-775-5866. The injured employee will detail any medical symptoms or complaints which will be evaluated by a Registered Nurse (RN) specially trained to perform telephonic triage. The RN will recommend first aid self-treatment or refer the injured employee for an off-site medical evaluation by a health professional at a clinic within GEI's workers compensation provider network. GEI employees are still required to follow our Accident Reporting procedures as listed above.

12. Decontamination Procedures

12.1 Heavy Equipment Decontamination

Heavy equipment decontamination will be performed by the Contractor within the limits of the on-site decontamination pad in accordance with the contract specifications. A steam generator and brushes will be used to clean demolition equipment and other tools. No heavy equipment will be permitted to leave the Site unless it has been thoroughly decontaminated.

Wastewater from the heavy equipment and personnel decontamination areas will be collected and disposed of in accordance with applicable state and federal regulations. The Contractor will be responsible for ultimate disposal of investigation-derived wastes.

12.2 Decontamination Equipment Requirements

The following equipment, if required, should be in sufficient supply to implement decontamination procedures for GEI’s equipment.

- Buckets
- Alconox™ detergent concentrate
- Hand pump sprayers
- Long handled soft bristle brushes
- Large sponges
- Cleaning wipes for respirators
- Bench or stool(s)
- Methanol and/or Nitric Acid
- Liquid detergent and paper towels
- Plastic trash bags

The Contractor performing decontamination procedures is responsible for verifying that the above materials, as required for their operation, are in sufficient supply.

13. Supplemental Contingency Plan Procedures

13.1 Hazard Communication Plan

GEI personnel have received hazard communication training as part of their annual health and safety training and new employee health and safety orientation training. Hazardous materials used on the Site will be properly labeled, stored, and handled. SDS will be available to potentially exposed employees.

13.2 Fire

In the event of a fire personnel will evacuate the area. GEI's field representative will contact the local fire department with jurisdiction and report the fire. Notification of evacuation will be made to the PM and the Safety Team. The field representative will account for GEI personnel and subcontractor personnel and report their status to the PM.

13.3 Medical Support

In case of minor injuries, on-site care will be administered with the Site first aid kit. For serious injuries, call 911 and request emergency medical assistance. Seriously injured persons should not be moved, unless they are in immediate danger. Notify the PM and the Safety Team of the emergency.

Section 1 and Table 1 of this HASP contain detailed emergency information, including directions to the nearest hospital, and a list of emergency services and their telephone numbers. In addition, Appendix A includes maps to the hospital and/or occupational health clinic. GEI field personnel will carry a cellular telephone.

13.4 Severe Weather

The contingency plan for severe weather includes reviewing the expected weather to determine if severe weather is in the forecast. Severe weather includes high winds over 30 miles per hour (mph), heavy rains or snow squalls, thunderstorms, tornados, and lightning storms. If severe weather is approaching, the decision to evacuate GEI personnel and subcontractor personnel from the Site will be the responsibility of GEI's field representative. Notification of evacuation will be made to the PM and the Safety Team. The field representative will account for GEI personnel and subcontractor personnel and report their status to the PM. If safe, work can resume 30 minutes after the last clap of thunder or flash of lightening.

13.5 Spills or Material Release

If a hazardous waste spill or material release occurs, if safe, the SSO or their representative will immediately assess the magnitude and potential seriousness of the spill or release based on the following:

- SDS for the material spilled or released;
- Source of the release or spillage of hazardous material;
- An estimate of the quantity released and the rate at which it is being released;
- The direction in which the spill or air release is moving;
- Personnel who may be or may have been in contact with the material, or air release, and possible injury or sickness as a result;
- Potential for fire and/or explosion resulting from the situation; and
- Estimates of area under influence of release.

If the spill or release is determined to be within the on-site emergency response capabilities, the SSO will verify implementation of the necessary remedial action. If the release is beyond the capabilities of the Site personnel, personnel will be evacuated from the immediate area and the local fire department will be contacted. The SSO will notify the PM and the Safety Team.

14. Health and Safety Plan Sign-Off

GEI personnel conducting site activities will be familiar with the information in this HASP. After reviewing this plan, please sign the copy in the project files, and bring a copy of the plan with you to the Site. By signing this site-specific HASP you are agreeing that you have read, understand, and will adhere to the provisions described in this plan while working on the Project Site below.

Site Name: 99 Granite Street Brooklyn, NY

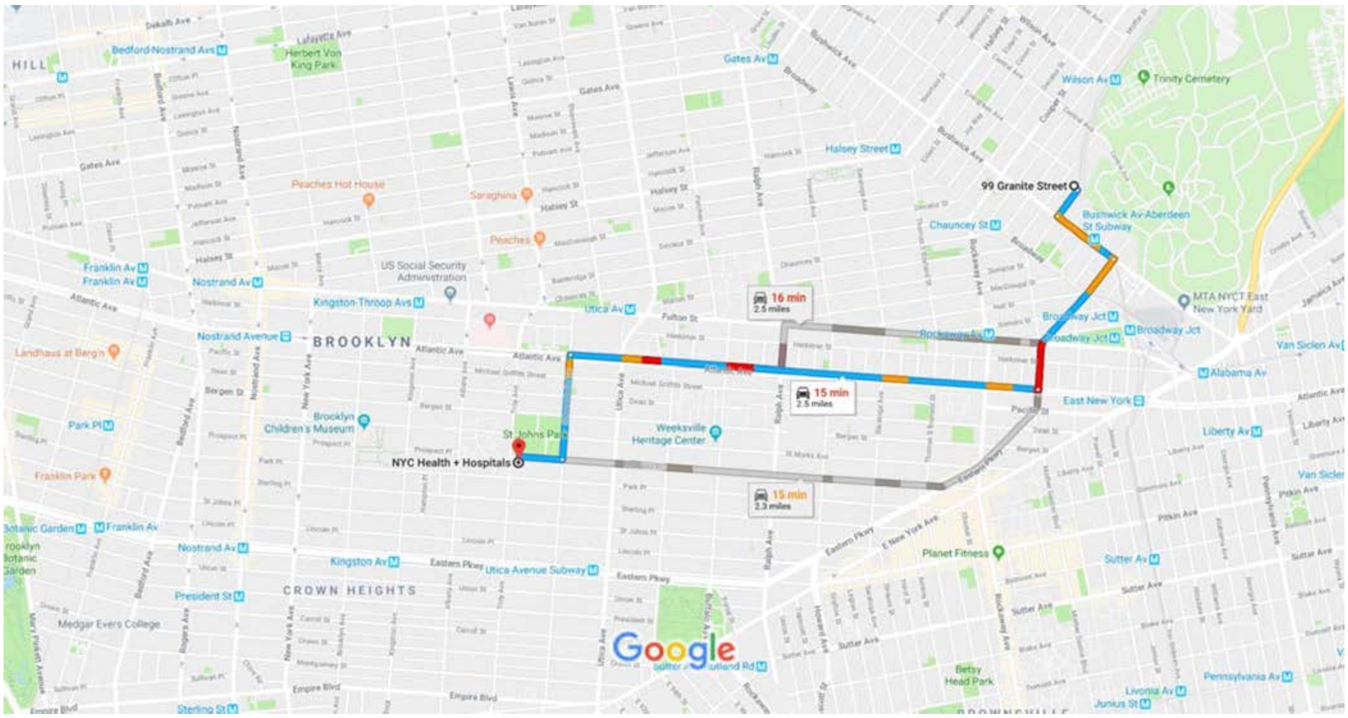
Investigation: Remedial Investigation

GEI Project No: 1704281

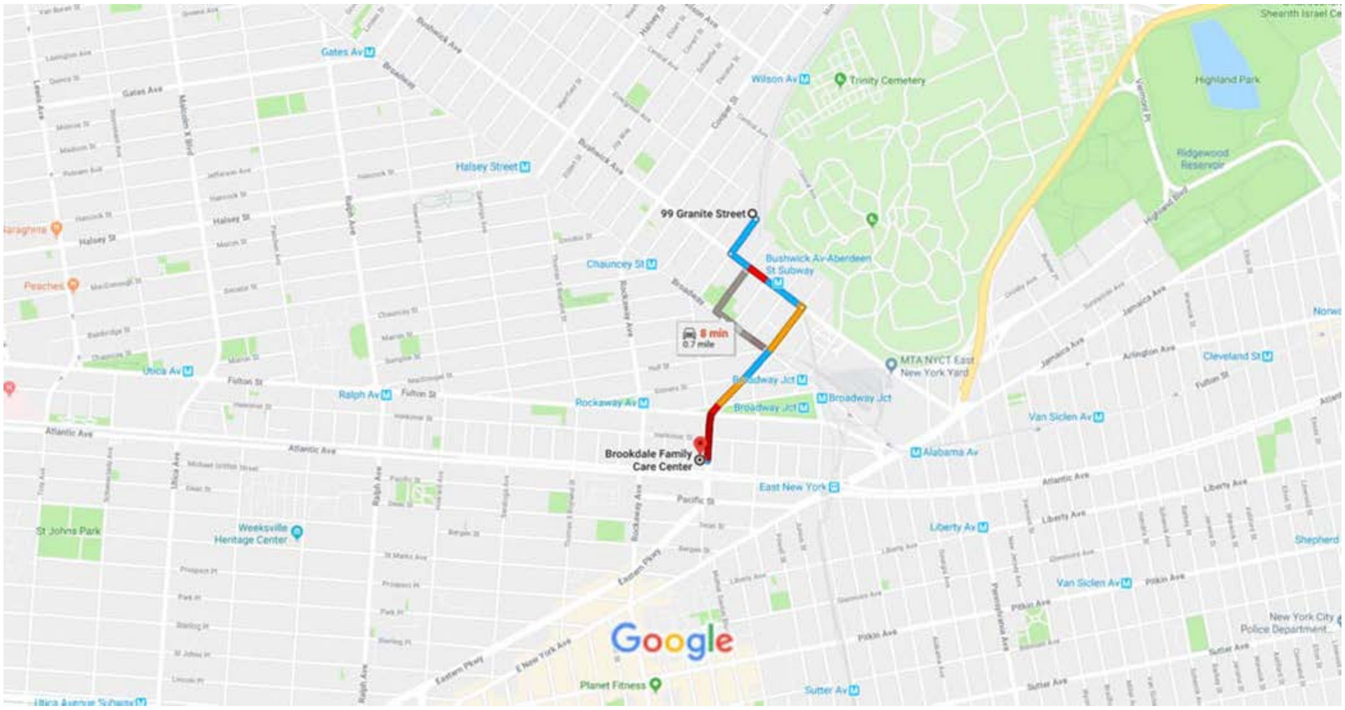
Print Name	Signature
Project Manager: Edward Bradshaw	

Appendix A

Map to Hospital and Occupational Health Clinic



Head southwest on Granite Street toward Bushwick Ave
Turn left at the 1st cross street onto Bushwick Ave
Turn right onto Eastern Parkway
Turn right onto Atlantic Ave
Turn left onto Schenectady Ave
Turn Right onto Prospect Pl



Head southwest on Granite Street toward Bushwick Ave
Turn left at the 1st cross street onto Bushwick Ave
Turn right onto Eastern Parkway

Appendix B

Safety Data Sheets

MATERIAL SAFETY DATA SHEET

ALCONOX®

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS, Australian WorkSafe, Japanese Industrial Standard JIS Z 7250:2000, and European Union REACH Regulations

SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	**ALCONOX®**	
CHEMICAL FAMILY NAME:	Detergent.	
PRODUCT USE:	Critical-cleaning detergent for laboratory, healthcare and industrial applications	
U.N. NUMBER:	Not Applicable	
U.N. DANGEROUS GOODS CLASS:	Non-Regulated Material	
SUPPLIER/MANUFACTURER'S NAME:	Alconox, Inc.	
ADDRESS:	30 Glenn St., Suite 309, White Plains, NY 10603. USA	
EMERGENCY PHONE:	**TOLL-FREE in USA/Canada**	800-255-3924
	International calls	813-248-0585
BUSINESS PHONE:	914-948-4040	
DATE OF PREPARATION:	May 2011	
DATE OF LAST REVISION:	February 2008	

SECTION 2 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: This product is a white granular powder with little or no odor. Exposure can be irritating to eyes, respiratory system and skin. It is a non-flammable solid. The Environmental effects of this product have not been investigated.

US DOT SYMBOLS

Non-Regulated

CANADA (WHMIS) SYMBOLS

EUROPEAN and (GHS) Hazard Symbols

Signal Word: **Warning!**

EU LABELING AND CLASSIFICATION:

Classification of the substance or mixture according to Regulation (EC) No1272/2008 Annex 1
EC# 205-633-8 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 268-356-1 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 231-838-7 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 231-767-1 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 207-638-8 Index# 011-005-00-2
EC# 205-788-1 This substance is not classified in the Annex I of Directive 67/548/EEC

GHS Hazard Classification(s):
Eye Irritant Category 2A

Hazard Statement(s):
H319: Causes serious eye irritation

Precautionary Statement(s):
P260: Do not breath dust/fume/gas/mist/vapors/spray
P264: Wash hands thoroughly after handling
P271: Use only in well ventilated area.
P280: Wear protective gloves/protective clothing/eye protection/face protection/

Hazard Symbol(s):
[Xi] Irritant

Risk Phrases:
R20: Harmful by inhalation
R36/37/38: Irritating to eyes, respiratory system and skin

Safety Phrases:
S8: Keep container dry
S22: Do not breath dust
S24/25: Avoid contact with skin and eyes

HEALTH HAZARDS OR RISKS FROM EXPOSURE:

ACUTE: Exposure to this product may cause irritation of the eyes, respiratory system and skin. Ingestion may cause gastrointestinal irritation including pain, vomiting or diarrhea.

CHRONIC: This product contains an ingredient which may be corrosive.

TARGET ORGANS: ACUTE: Eye, respiratory System, Skin CHRONIC: None Known

SECTION 3 - COMPOSITION and INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS:	CAS #	EINECS #	ICSC #	WT %	HAZARD CLASSIFICATION; RISK PHRASES
Sodium Bicarbonate	144-55-8	205-633-8	1044	33 - 43%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium (C10 – C16) Alkylbenzene Sulfonate	68081-81-2	268-356-1	Not Listed	10 – 20%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium Tripolyphosphate	7758-29-4	231-838-7	1469	5 - 15%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Tetrasodium Pyrophosphate	7722-88-5	231-767-1	1140	5 - 15%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium Carbonate	497-19-8	207-638-8	1135	1 - 10%	HAZARD CLASSIFICATION: [Xi] Irritant RISK PHRASES: R36
Sodium Alcohol Sulfate	151-21-3	205-788-1	0502	1 – 5%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Balance of other ingredients are non-hazardous or less than 1% in concentration (or 0.1% for carcinogens, reproductive toxins, or respiratory sensitizers).					

NOTE: ALL WHMIS required information is included in appropriate sections based on the ANSI Z400.1-2004 format. This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR, EU Directives and the Japanese Industrial Standard *JIS Z 7250: 2000*.

SECTION 4 - FIRST-AID MEASURES

Contaminated individuals of chemical exposure must be taken for medical attention if any adverse effect occurs. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to health professional with contaminated individual.

EYE CONTACT: If product enters the eyes, open eyes while under gentle running water for at least 15 minutes. Seek medical attention if irritation persists.

SKIN CONTACT: Wash skin thoroughly after handling. Seek medical attention if irritation develops and persists. Remove contaminated clothing. Launder before re-use.

INHALATION: If breathing becomes difficult, remove victim to fresh air. If necessary, use artificial respiration to support vital functions. Seek medical attention if breathing dificulty continues.

INGESTION: If product is swallowed, call physician or poison control center for most current information. If professional advice is not available, do not induce vomiting. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or who cannot swallow. Seek medical advice. Take a copy of the label and/or MSDS with the victim to the health professional.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing skin, or eye problems may be aggravated by prolonged contact.

RECOMMENDATIONS TO PHYSICIANS: Treat symptoms and reduce over-exposure.

SECTION 5 - FIRE-FIGHTING MEASURES

FLASH POINT: Not Flammable

AUTOIGNITION TEMPERATURE: Not Applicable

FLAMMABLE LIMITS (in air by volume, %): Lower (LEL): NA Upper (UEL): NA

FIRE EXTINGUISHING MATERIALS: As appropriate for surrounding fire. Carbon dioxide, foam, dry chemical, halon, or water spray.

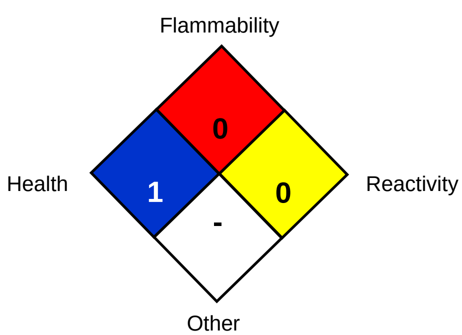
UNUSUAL FIRE AND EXPLOSION HAZARDS: This product is non-flammable and has no known explosion hazards.

Explosion Sensitivity to Mechanical Impact: Not Sensitive.

Explosion Sensitivity to Static Discharge: Not Sensitive

SPECIAL FIRE-FIGHTING PROCEDURES: Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Isolate materials not yet involved in the fire and protect personnel. Move containers from fire area if this can be done without risk; otherwise, cool with carefully applied water spray. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas.

NFPA RATING SYSTEM



HMIS RATING SYSTEM

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM

HEALTH HAZARD (BLUE)	**1**
FLAMMABILITY HAZARD (RED)	**0**
PHYSICAL HAZARD (YELLOW)	**0**

PROTECTIVE EQUIPMENT

EYES	RESPIRATORY	HANDS	BODY
	See Sect 8		See Sect 8

For Routine Industrial Use and Handling Applications

Hazard Scale: 0 = Minimal **1** = Slight **2** = Moderate **3** = Serious **4** = Severe * = Chronic hazard

SECTION 6 - ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Personnel should be trained for spill response operations.

SPILLS: Contain spill if safe to do so. Prevent entry into drains, sewers, and other waterways. Sweep, shovel or vacuum spilled material and place in an appropriate container for re-use or disposal. Avoid dust generation if possible. Dispose of in accordance with applicable Federal, State, and local procedures (see Section 13, Disposal Considerations).

SECTION 7 - HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting this product ON YOU or IN YOU. Wash thoroughly after handling this product. Do not eat, drink, smoke, or apply cosmetics while handling this product. Avoid breathing dusts generated by this product. Use in a well-ventilated location. Remove contaminated clothing immediately.

STORAGE AND HANDLING PRACTICES: Containers of this product must be properly labeled. Store containers in a cool, dry location. Keep container tightly closed when not in use. Store away from strong acids or oxidizers.

SECTION 8 - EXPOSURE CONTROLS - PERSONAL PROTECTION

EXPOSURE LIMITS/GUIDELINES:

Chemical Name	CAS#	ACGIH TWA	OSHA TWA	SWA
Sodium Bicarbonate	144-55-8	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust
Sodium (C10 – C16) Alkylbenzene Sulfonate	68081-81-2	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust
Sodium Tripolyphosphate	7758-29-4	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust
Tetrasodium Pyrophosphate	7722-88-5	5 mg/m³	5 mg/m³	5 mg/m³
Sodium Carbonate	497-19-8	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust
Sodium Alcohol Sulfate	151-21-3	10 mg/m³ Total Dust	15 mg/m³ Total Dust	10 mg/m³ Total Dust

Currently, International exposure limits are not established for the components of this product. Please check with competent authority in each country for the most recent limits in place.

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation to ensure exposure levels are maintained below the limits provided below. Use local exhaust ventilation to control airborne dust. Ensure eyewash/safety shower stations are available near areas where this product is used.

The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EU member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection), and those of Japan. Please reference applicable regulations and standards for relevant details.

RESPIRATORY PROTECTION: Based on test data, exposure limits should not be exceeded under normal use conditions when using Alconox Detergent. Maintain airborne contaminant concentrations below guidelines listed above, if applicable. If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, the European Standard EN149, or EU member states.

EYE PROTECTION: Safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or appropriate Canadian Standards.

HAND PROTECTION: Use chemical resistant gloves to prevent skin contact.. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate to prevent contact (e.g. lab coat, overalls). If necessary, refer to appropriate Standards of Canada, or appropriate Standards of the EU, Australian Standards, or relevant Japanese Standards.

SECTION 9 - PHYSICAL and CHEMICAL PROPERTIES

PHYSICAL STATE:	Solid
APPEARANCE & ODOR:	White granular powder with little or no odor.
ODOR THRESHOLD (PPM):	Not Available
VAPOR PRESSURE (mmHg):	Not Applicable
VAPOR DENSITY (AIR=1):	Not Applicable.
BY WEIGHT:	Not Available
EVAPORATION RATE (nBuAc = 1):	Not Applicable.
BOILING POINT (C°):	Not Applicable.
FREEZING POINT (C°):	Not Applicable.
pH:	9.5 (1% aqueous solution)
SPECIFIC GRAVITY 20°C: (WATER =1)	0.85 – 1.1
SOLUBILITY IN WATER (%)	>10% w/w
COEFFICIENT OF WATER/OIL DIST.:	Not Available
VOC:	None
CHEMICAL FAMILY:	Detergent

SECTION 10 - STABILITY and REACTIVITY

STABILITY: Product is stable
DECOMPOSITION PRODUCTS: When heated to decomposition this product produces Oxides of carbon (COx)
MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Strong acids and strong oxidizing agents.
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: Contact with incompatible materials and dust generation.

SECTION 11 - TOXICOLOGICAL INFORMATION

TOXICITY DATA: Toxicity data is available for mixture:

CAS# 497-19-8 LD50 Oral (Rat)	4090 mg/kg
CAS# 497-19-8 LD50 Oral (Mouse)	6600 mg/kg
CAS# 497-19-8 LC50 Inhalation (Rat)	2300 mg/m³ 2H
CAS# 497-19-8 LC50 Inhalation (Mouse)	1200 mg/m³ 2H
CAS# 7758-29-4 LD50 Oral (Rat)	3120 mg/kg
CAS# 7758-29-4 LD50 Oral (Mouse)	3100 mg/kg
CAS# 7722-88-5 LD50 Oral (Rat)	4000 mg/kg

SUSPECTED CANCER AGENT: None of the ingredients are found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, IARC and therefore is not considered to be, nor suspected to be a cancer-causing agent by these agencies.
IRRITANCY OF PRODUCT: Contact with this product can be irritating to exposed skin, eyes and respiratory system.
SENSITIZATION OF PRODUCT: This product is not considered a sensitizer.
REPRODUCTIVE TOXICITY INFORMATION: No information concerning the effects of this product and its components on the human reproductive system.

SECTION 12 - ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.
ENVIRONMENTAL STABILITY: No Data available at this time.
EFFECT OF MATERIAL ON PLANTS or ANIMALS: No evidence is currently available on this product's effects on plants or animals.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on this product's effects on aquatic life.

SECTION 13 - DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations, those of Canada, Australia, EU Member States and Japan.

SECTION 14 - TRANSPORTATION INFORMATION

US DOT; IATA; IMO; ADR:
THIS PRODUCT IS NOT HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.
PROPER SHIPPING NAME: Non-Regulated Material
HAZARD CLASS NUMBER and DESCRIPTION: Not Applicable
UN IDENTIFICATION NUMBER: Not Applicable
PACKING GROUP: Not Applicable.
DOT LABEL(S) REQUIRED: Not Applicable
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2004): Not Applicable
MARINE POLLUTANT: None of the ingredients are classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B)

U.S. DEPARTMENT OF TRANSPORTATION (DOT) SHIPPING REGULATIONS:
This product is not classified as dangerous goods, per U.S. DOT regulations, under 49 CFR 172.101.

TRANSPORT CANADA, TRANSPORTATION OF DANGEROUS GOODS REGULATIONS:
This product is not classified as Dangerous Goods, per regulations of Transport Canada.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA):
This product is not classified as Dangerous Goods, by rules of IATA:

INTERNATIONAL MARITIME ORGANIZATION (IMO) DESIGNATION:
This product is not classified as Dangerous Goods by the International Maritime Organization.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR):

This product is not classified by the United Nations Economic Commission for Europe to be dangerous goods.

SECTION 15 - REGULATORY INFORMATION

UNITED STATES REGULATIONS

SARA REPORTING REQUIREMENTS: This product is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act., as follows: None

TSCA: All components in this product are listed on the US Toxic Substances Control Act (TSCA) inventory of chemicals.

SARA 311/312:

Acute Health:	Yes	Chronic Health:	No	Fire:	No	Reactivity:	No

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for this product. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) may apply, per 40 CFR 370.20.

U.S. CERCLA REPORTABLE QUANTITY (RQ): None

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): None of the ingredients are on the California Proposition 65 lists.

CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: All of the components of this product are on the DSL Inventory

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: No component of this product is on the CEPA First Priorities Substance Lists.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS: This product is categorized as a Controlled Product, Hazard Class D2B as per the Controlled Product Regulations

EUROPEAN ECONOMIC COMMUNITY INFORMATION:

EU LABELING AND CLASSIFICATION:

Classification of the mixture according to Regulation (EC) No1272/2008. See section 2 for details.

AUSTRALIAN INFORMATION FOR PRODUCT:

AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES (AICS) STATUS: All components of this product are listed on the AICS.

STANDARD FOR THE UNIFORM SCHEDULING OF DRUGS AND POISONS: Not applicable.

JAPANESE INFORMATION FOR PRODUCT:

JAPANESE MINISTER OF INTERNATIONAL TRADE AND INDUSTRY (MITI) STATUS: The components of this product are not listed as Class I Specified Chemical Substances, Class II Specified Chemical Substances, or Designated Chemical Substances by the Japanese MITI.

INTERNATIONAL CHEMICAL INVENTORIES:

Listing of the components on individual country Chemical Inventories is as follows:

Asia-Pac:	Listed
Australian Inventory of Chemical Substances (AICS):	Listed
Korean Existing Chemicals List (ECL):	Listed
Japanese Existing National Inventory of Chemical Substances (ENCS):	Listed
Philippines Inventory if Chemicals and Chemical Substances (PICCS):	Listed
Swiss Giftliste List of Toxic Substances:	Listed
U.S. TSCA:	Listed

SECTION 16 - OTHER INFORMATION

PREPARED BY: Paul Eigbrett Global Safety Management, 10006 Cross Creek Blvd. Suite 440, Tampa, FL 33647

ANNEX:

IDENTIFIED USES OF ALCONOX® AND DIRECTIONS FOR USE

Used to clean: Healthcare instruments, laboratory ware, vacuum equipment, tissue culture ware, personal protective equipment, sampling apparatus, catheters, tubing, pipes, radioactive contaminated articles, optical parts, electronic components, pharmaceutical apparatus, cosmetics manufacturing equipment, metal castings, forgings and stampings, industrial parts, tanks and reactors. Authorized by USDA for use in federally inspected meat and poultry plants. Passes inhibitory residue test for water analysis. FDA certified.

Used to remove: Soil, grit, grime, buffing compound, slime, grease, oils, blood, tissue, salts, deposits, particulates, solvents, chemicals, radioisotopes, radioactive contaminations, silicon oils, mold release agents.

Surfaces cleaned: Corrosion inhibited formulation recommended for glass, metal, stainless steel, porcelain, ceramic, plastic, rubber and fiberglass. Can be used on soft metals such as copper, aluminum, zinc and magnesium if rinsed promptly. Corrosion testing may be advisable.

Cleaning method: Soak, brush, sponge, cloth, ultrasonic, flow through clean-inplace. Will foam—not for spray or machine use.

Directions: Make a fresh 1% solution (2 1/2 Tbsp. per gal., 1 1/4 oz. per gal. or 10 grams per liter) in cold, warm, or hot water. If available use warm water. Use cold water for blood stains. For difficult soils, raise water temperature and use more detergent. Clean by soak, circulate, wipe, or ultrasonic method. Not for spray machines, will foam. For nonabrasive scouring, make paste. Use 2% solution to soak frozen stopcocks. To remove silver tarnish, soak in 1% solution in aluminum container. RINSE THOROUGHLY—preferably with running water. For critical cleaning, do final or all rinsing in distilled, deionized, or purified water. For food contact surfaces, rinse with potable water. Used on a wide range of glass, ceramic, plastic, and metal surfaces. Corrosion testing may be advisable.

Appendix C

Heat Stress and Cold Stress Guidelines

Heat Stress Guidelines

Form	Signs & Symptoms	Care	Prevention[3]
Heat Rash	Tiny red vesicles in affected skin area. If the area is extensive, sweating can be impaired.	Apply mild lotions and cleanse the affected area.	Cool resting and sleeping areas to permit skin to dry between heat exposures.
Heat Cramps	Spasm, muscular pain (cramps) in stomach area and extremities (arms and legs).	Provide replacement fluids with minerals (salt) such as Gatorade.	Adequate salt intake with meals[1]. ACCLIMATIZATION[2]
Heat Exhaustion	Profuse sweating, cool (clammy) moist skin, dizziness, confusion, pale skin color, faint, rapid shallow breathing, headache, weakness, and/or muscle cramps.	Remove from heat, sit or lie down, rest, replace lost water with electrolyte replacement fluids (water, Gatorade) take frequent sips of liquids in amounts greater than required to satisfy thirst.	ACCLIMATIZATION[2] Adequate salt intake with meals[1], only during early part of heat season. Ample water intake, frequently during the day.
Heat Stroke	HOT Dry Skin. Sweating has stopped. Mental confusion, dizziness, nausea, chills, severe headache, collapse, delirium, and/or coma.	HEAT STROKE IS A MEDICAL EMERGENCY • Remove from heat. • COOL THE BODY AS RAPIDLY AS POSSIBLE by immersing in cold (or cool) water, or splash with water and fan. • Call for Emergency Assistance. • Observe for signs of shock.	ACCLIMATIZATION[2] Initially moderate workload in heat (8 to 14 days). Monitor worker's activities.

Footnotes:

1.) American diets are normally high in salt, sufficient to aid acclimatization. However, during the early part of the heat season, (May, June), one extra shake of salt during one to two meals per day may help, so long as this is permitted by your physician. Check with your personal physician.

2.) ACCLIMATIZATION - The process of adapting to heat is indicated by worker's ability to perform hot jobs less fluid loss, lower concentrations of salt loss in sweat, and a reduced core (body) temperature and heart rate.

3.) Method to Achieve Acclimatization - Moderate work or exercise in hot temperatures during early part of heat season. Adequate salt (mineral) and water intake. Gradually increasing work time in hot temperatures. Avoid alcohol. Normally takes 8 to 14 days to achieve acclimatization. Lost rapidly, if removed from strenuous work (or exercise) in hot temperature for more than approximately 5 days.

Cold Stress Guidelines

Stress	Symptoms	What to do
Mild Hypothermia	• Body Temp 98 to 90°F • Shivering • Lack of coordination, stumbling, fumbling hands • Slurred speech • Memory loss • Pale, cold skin	• Move to warm area • Stay active • Remove wet clothes and replace with dry clothes or blankets • Cover the head • Drink warm (not hot) sugary drink
Moderate Hypothermia	• Body temp 90 to 86°F • Shivering stops • Unable to walk or stand • Confused and/or irrational	• All of the above, plus: o Call 911 o Cover all extremities completely o Place very warm objects, such as hot packs on the victim's head, neck, chest, and groin
Severe Hypothermia	• Body temp 86 to 78°F • Severe muscle stiffness • Very sleepy or unconscious • Ice cold skin • Death	• Call 911 • Treat victim very gently • Do not attempt to re-warm
Frostbite	• Cold, tingling, stinging, or aching feeling in the frostbitten area, followed by numbness • Skin color turns red, then purple, then white or very pale skin • Cold to the touch • Blisters in severe cases	• Call 911 • Do not rub the area • Wrap in soft cloth • If help is delayed, immerse in warm (not hot) water
Trench Foot	• Tingling, itching, or burning sensation • Blisters	• Soak feet in warm water, then wrap with dry cloth bandages • Drink a warm (not hot) sugary drink

Appendix D

Forms

Safety Briefing Log

GEI Consultants

Project Number:	**Project Name:**
Date:	**Time:**
Briefing Conducted by:	**Signature:**

This sign-in log documents the tailgate briefing conducted in accordance with the HASP. Personnel who perform work operations on site are required to attend each briefing and to acknowledge receipt of each briefing.

TOPICS COVERED (check all those covered):

☐ General PPE Usage	☐ Confined Space	☐ Excavation Safety
☐ Hearing Conservation	☐ Slips, Trips, Falls	☐ Confined Space
☐ Respiratory Protection	☐ Heat Stress	☐ Traffic Safety
☐ Personal Hygiene	☐ Cold Stresses	☐ Changes to the HASP
☐ Exposure Guidelines	☐ Site Control	☐ Initial Review of Hazard Evaluation
☐ Decon Procedures	☐ Work Zones	☐ Other (Specify):
☐ Emergency Procedures (include route to hospital)	☐ Lockout/Tagout	☐ Other (Specify):

Personnel Sign-in List

Printed Name	Signature	Company Name

Project Safety Briefing Form

GEI Consultants

Project Number:	**Project Name:**	
Date:	**Time:**	**Project Manager:**
Briefing Conducted by:		**Signature:**

This sign-in log documents the project specific-briefing conducted in accordance with the HASP and GEI H&S policy. GEI personnel who perform work on site are required to attend the Project briefing and to acknowledge it's receipt. Applicable health and safety SOPs are also required to be reviewed in this briefing and attached as an appendix to the HASP. Prior to the start of the project **or upon the start of a new on-site project team member**, this form must be completed. Please email this completed form to Health&SafetyCommittee@geiconsultants.com.

TOPICS COVERED (check all those covered):

☐	General PPE Usage	☐	Excavation Safety	☐	SOP:
☐	Hearing Conservation	☐	Confined Space	☐	SOP:
☐	Respiratory Protection	☐	Traffic Safety	☐	SOP:
☐	Personal Hygiene	☐	Changes to the HASP	☐	SOP:
☐	Exposure Guidelines	☐	Site Control	☐	SOP:
☐	Decon Procedures	☐	Work Zones	☐	SOP:
☐	Emergency Procedures (include route to hospital)	☐	Lockout/Tagout	☐	SOP:
		☐	Review of Hazard Evaluation	☐	SOP:
☐	Confined Space			☐	SOP:
☐	Slips, Trips, Falls	☐	Other (Specify):	☐	SOP:
☐	Heat Stress	☐	Other (Specify):	☐	SOP:
☐	Cold Stress	☐	Other (Specify):	☐	SOP:

Personnel Sign-in List

Printed Name	Signature

Please complete this form and send it to your Branch Manager, HR and CHSO ***within 24 hours*** of the incident.

GEI Consultants

Accident/Incident Report Form

SECTION A — ACCIDENT/INCIDENT DETAILS

EMPLOYEE INFORMATION:

Name: ______________________

Home Address: ______________________
Street Address City State Zip Code

Contact Information: ( ) ________ ( ) ________
Primary Secondary

Date of Birth: ______________________

Date of Hire: ______________________

Branch: ______________________

Supervisor: ______________________

OTHER INJURED (IF APPLICABLE):

Name: ______________________

Home Address: ______________________
Street Address City State Zip Code

Contact Information: ( ) ________ ( ) ________
Primary Secondary

Date of Birth: ______________________

Date of Hire: ______________________

Branch: ______________________

Supervisor: ______________________

Date and Time Accident/Incident	Date and Time Reported
____ /____ /____ Month Day Year ____ A.M. ____ P.M.	____ /____ /____ Month Day Year ____ A.M. ____ P.M.

LOCATION OF INCIDENT/ACCIDENT

Project Name: ______________________

Client and Location: ______________________

or ______________________

Office Location: ______________________

INCIDENT TYPE:
(Check All That Applies)

- ☐ **Personal Injury/Illness**
- ☐ **Vehicle Accident**
- ☐ **Property Damage**
- ☐ **Environmental Spill**
- ☐ **Other**

WITNESS INFORMATION

Name: ______________________

Contact Number: ______________________

Company: ______________________

WHAT HAPPENED TO THE INJURED PARTY: ☐First Aid Administered ☐Refused Treatment/Transport ☐Transported to Hospital ☐Returned to Work ☐ Went Home ☐ Went to Physician ☐ Unknown

Clinic/Hospital or
Treating Physician: ______________________ Phone: ________
Name Street Address City State Zip Code

SECTION B — PERSONAL INJURY

Cause of Injury: ______________________

Part of Body Injured: ______________________ Multiple Injuries: ☐Y ☐N

Was PPE worn when injured? : ☐Y ☐N What PPE was worn? ______________________

WAS INJURY A RESULT OF THE USE A MOTOR VEHICLE: ☐ **YES** ☐ **NO** **(If yes, complete Section C)**

Please complete this form and send it to your Branch Manager, HR and CHSO ***within 24 hours*** of the incident.

GEI Consultants

Accident/Incident Report Form

SECTION C AUTO ACCIDENT ONLY

DRIVER/VEHICLE INFORMATION

Name of Insured: ____________________

Department: ____________________

Driver's License Number: ____________________

DOB: ____/____/____ State: ____________________

Description of Vehicle: License Plate Number: __________

Make: ________ Model: ________ Year:_____ Color:________

Owner: ____________________

Name of Other Driver: ____________________

Driver's License Number: ____________________

State: ____________________

Description of Vehicle: License Plate Number: __________

Make: ________ Model:______ Year:_____ Color:________

Insurance Carrier: ____________________

Policy Number: ______________Ph. Number:______________

SECTION D PROPERTY DAMAGE OR CHEMICAL RELEASE ONLY

Type of Damage(s): ____________________

Cause of Damage(s): ____________________

Type of Chemical Released (if known): ____________________

Quantity of Chemical Released: ____________________

Spill Measures Employed: ____________________

SECTION E NATURE OF ACCIDENT/INCIDENT AND EXTENT OF INJURIES/DAMAGES

(Please give a detailed description of what happened. Attach a sketch or picture if applicable)

I hereby certify that the above information is true and correct to my understanding of this accident/incident.

Employee/Preparer's Name ____________________ **Date and Time** ____________________

NEAR MISS REPORT

A near miss is a potential hazard or incident that has not resulted in any personal injury. Unsafe working conditions, unsafe employee work habits, improper use of equipment, or use of malfunctioning equipment have the potential to cause work related injuries. It is everyone's responsibility to report and/or correct these potential accidents/incidents immediately. Please complete this form as a means to report these near-miss situations. Send a copy of the completed form to the Project Manager, Regional Health and Safety Officer and the Corporate Health and Safety Officer.

Location: _____ Site Name: _____

Date: _____ Time: _____ ☐ a.m. ☐ p.m.

Weather conditions, site operations taking place during near miss. _____

Please check all appropriate conditions:

- ☐ Unsafe Act
- ☐ Unsafe equipment
- ☐ Unsafe Condition
- ☐ Unsafe use of equipment

Description of incident or potential hazard: _____

Employees or sub-contractors involved if applicable._____

Employee Signature ______________________________ Date _____

Print Name _____

NEAR MISS INVESTGATION

Description of the near-miss condition: _____
Causes (primary & contributing) _____
Corrective action taken (Remove the hazard, replace, repair, or retrain in the proper procedures for the task) _____
Actions not yet taken_____

Signed: ________________________________ Date Completed: _____

Print Name
Not completed for the following reason: ______Date:______

Appendix E

GEI's Health and Safety SOPs

STANDARD OPERATING PROCEDURE

DM-006 Geoprobe® Direct Push Boring

1. Objective

Describe standard operating procedures (SOP) for drilling of overburden soil borings using Geoprobe® and MacroCore® technologies.

2. Execution

- Confirm that appropriate measures have been taken for clearance of potential subsurface utilities. The responsibility for clearance may vary, depending on the client.
- Inspect the drilling rig to make sure it is clean and that the down-hole equipment has been decontaminated (QA-001). Record condition of all down-hole drilling equipment.
- Make sure the sampler is fitted with a piston rod assembly to block the sample tube until the desired subsurface sample interval is attained. Upon reaching the target sample depth, the piston tip will be released and the discrete sampler device is then advanced to collect the representative sample. This reduces the volume of slough that is collected.
- When the sampler is brought to the ground surface, it should be opened immediately, and the length of recovery should be measured and recorded.
- Log the soil sample using USCS procedures (SOP SM-003). Collect analytical samples if necessary (SOP SM-001).
- Decontaminate the cutting shoe if necessary (SOP QA-001 Equipment Decontamination) and have driller reassemble the parts with a new liner.
- Repeat the procedure described above until refusal or the boring is terminated.
- Periodically verify that depths cited by drillers are accurate.

3. Limitations

- If significant unanticipated contamination is encountered during drilling, stop drilling to confer with the project manager and re-evaluate health and safety conditions.
- Arrange for the storage of contaminated soil cuttings and water in drums or other appropriate containers in a secure place at the site (see SOP SC-003, *Investigation Derived Waste Management*).
- If possible, plan the drilling program to drill borings from the least to most contaminated areas. Be prepared in advance and know where alternative drilling locations are in the event that problems are encountered at soil boring locations. These locations must also have been cleared by the state or local utility service prior to drilling.

4. References

ASTM D6001-05 Guide for Direct Push Water Sampling for Geoenvironmental Investigations, April 2005

Geoprobe Systems, "Geoprobe MacroCore MC-5 1.25-inch Light Weight Center Rod Soil Sample System SOP", Technical Bulletin No. MK 3139, November 2006

5. Attachments

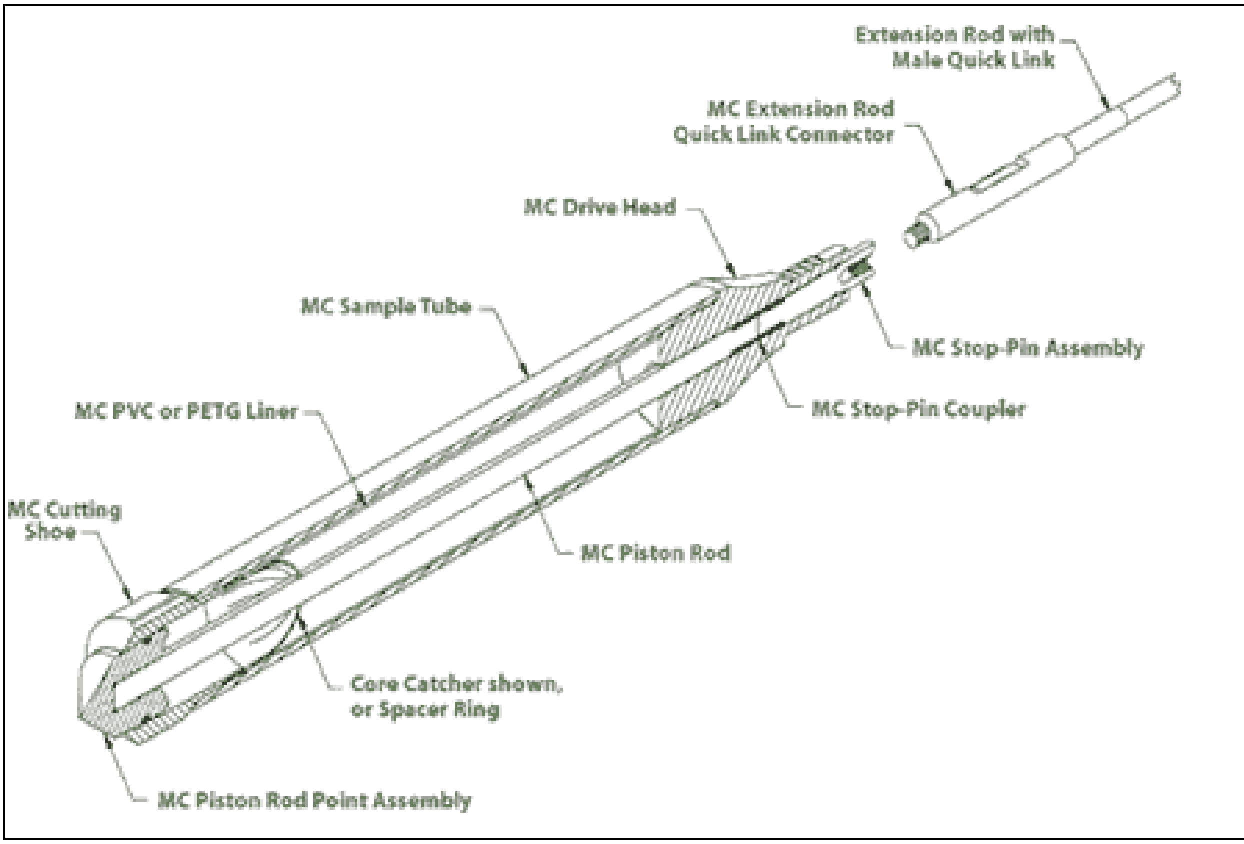
Attachment A – Geoprobe® with Macrocore® Sampler Assembly

6. Contact

Melissa Felter
Cathy Johnson

SOP DM-006

Attachment A – GeoProbe® with Macrocore® Sampler Assembly



Above: Diagram of a Macrocore® sampler

Right: A track-mounted GeoProbe ® Rig

GEI Consultants

STANDARD OPERATING PROCEDURE

GW-003 Low Flow (Low Stress) Groundwater Sampling

1. Objective

Describe methods to collect groundwater samples most likely to produce results that represent aquifer conditions.

Low-flow purging is limited to wells that, with sustained pumping, exhibit no continuous drawdown.

2. Execution

- Prior to groundwater sampling consult with the project manager to confirm that the type of pump is appropriate and consistent with the approved work plan.
- Record activities in the field notebook (see SOP FD-001 Field Notebook) and on a Monitoring Well Sampling Record such as the examples in Attachment A. Use a separate form for each sampling location and event. You may forego the forms and record all information in the field notebook if the Project Manager approves.
- Calibrate pH, temperature, Specific Conductance (SC), turbidity, Dissolved Oxygen (DO), and Oxidation-Reduction Potential (ORP) on the meter(s). Use calibration methods provided by the manufacturer of the equipment. Note that appropriate calibration for dissolved oxygen requires a water saturated air environment, along with measured temperature and barometric pressure.
- Begin with the monitoring well believed to have the least contaminated groundwater and proceed systematically to the well with the most contaminated groundwater. Check the well, the lock, and the locking cap for damage or evidence of tampering.
- Slowly and gently measure the depth to water with a water level probe and/or oil-water interface probe. Do not measure depth to well bottom at this time (wait until sampling has been completed). Measure water level in accordance with SOP GW-001 Water Level Measurement.
- Attach new polyethylene or Teflon lined tubing to the sampling pump and the flow-through cell that contains the meter probes.
- Slowly and gently insert new polyethylene or Teflon lined tubing to the pump intake (or use dedicated tubing that remains in the well) and to the middle of the saturated screened interval or to the pre-determined sampling depth.
- The tubing intake should be kept at least two (2) feet above the bottom of the well to prevent disturbance or suspension of any sediment or Non-Aqueous Phase Liquid (NAPL) present in the bottom of the well. Record the depth of the pump intake.

- If possible, position your sampling equipment and tubing so that it is in the shade. The goal is to minimize the effect of sunlight raising the temperature of water being collected.
- Start the pump on the lowest setting and increase slowly until flow begins. Adjust the pumping rate so that drawdown in the well is minimal (0.3 feet or less, is desirable but not mandatory). Use a pumping rate between 100 to 1,000 milliliters per minute (mL/min) (or approximately 0.1 to 1 quarts per minute). Measure flow rate on the pump or using a graduated container every 3 to 5 minutes and record. The minimum purge volume will be twice the combined volumes of the sampling string (i.e. pump, tubing, and flow-through cell).
- While purging, record water levels every 3 to 5 minutes and monitor and record the water quality indicator parameters: pH, temperature, specific conductance (SC), dissolved oxygen (DO), and turbidity. If specified in the field sampling plan also include ORP.
- Purging is complete when, after three consecutive measurements, the water quality parameters have stabilized as follows:
    - pH (+/- 0.1 standard units)
    - temperature (+/- 3%)
    - SC (+/- 3%)
    - turbidity (+/- 10% if >5 NTU; if 3 values are <5 NTU, consider the values as stabilized)
    - DO (+/-10% if >0.5 mg/L; if 3 values are <0.5 mg/L, consider the values as stabilized)
    - ORP (+/- 10 mV)
- Dispose of purge water according to the field plan.

Sample Collection:

- Following purge, remove the discharge tubing from the flow-through cell. Do not disturb pump and tubing between stabilization and sample collection.
- Fill sample containers directly from the sampling device in order of decreasing volatility (i.e., Volatile Organic Compounds (VOC) samples are collected first; see SOP SC-002 Sampling Handling). Fill all containers from the discharge end of the tubing. Collect samples at a flow rate equal to the steady state purge rate.
- If not using a dedicated pump, remove sampling device and decontaminate (see SOP QA-001 Equipment Decontamination). Discard used tubing.
- Store samples in a cooler on ice for transport to the laboratory.
- Measure depth to bottom of well.

- Secure the well cap.

3. Limitations

- Prior to departure for the field, obtain available information on well construction for use in field investigation (i.e., screen and riser material, well diameter and depth, screened interval, optimum sampling depth, etc.).
- If possible, when using dedicated equipment, install equipment into well at least 24 hours before sample collection to minimize disturbance of the water column and/or suspension of sediments or NAPL on bottom.
- If water quality indicator parameters do not stabilize after removing 3 to 5 well volumes or 2 hours, contact the Project Manager. Three options will be available: 1) continue purging until stabilization; 2) discontinue purging and do not sample; or 3) discontinue purging and sample.
- The key indicator parameter for VOCs is DO. The key indicator parameter for all other samples is turbidity.
- Fill all sample containers with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.
- Consult with the project manager before field filtering samples for metals if using low-flow sampling.
- Be aware of any preservatives in the sample bottles and handle with care, in accordance with the Health and Safety Plan.

4. References

Standard Reference for Monitoring Wells (April 19, 1991), Massachusetts DEP, DEP Publication No. WSC-310-91.

Reproducible Well-Purging Procedures and VOC Stabilization Criteria for Ground Water Sampling (1994), M.J. Barcelona, H. A. Wehram, and M.D. Varljen, Ground Water, Vol. 32, No. 1, 12-22.

Low-Flow Purging and Sampling of Ground Water Monitoring Wells with Dedicated Systems (1995), R.W. Puls, and C.J. Paul, Groundwater Monitoring and Review, Summer 1995 116-123.

Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (2010), EQASOP-GW 001 Low Stress (Low Flow) SOP, Revision 3, U.S. Environmental Protection Agency, Region I, January 19, 2010.

Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, (1998), Ground-Water Sampling SOP, Final, U.S. Environmental Protection Agency, Region II, March 16, 1998.

RCRA Ground-Water Monitoring: Draft Technical Guidance, (1993), U.S. Environmental Protection Agency, EPA/530-R-93-001.

To Filter, or Not to Filter, That is the Question, (1997), Special Topics Subcommittee Letter Report EPA-SAF-EEC-LTR-97-011, April 29, 1997, Meeting, U.S. Environmental Protection Agency, Science Advisory Board Environmental Engineering Committee, September 5, 1997.

Should Filtered or Unfiltered Groundwater and Surface Water Samples be Collected for the Risk Assessment?, (1995), MCP Q&A: Subparts I and J, Special #4, Bureau of Waste Site Cleanup, Massachusetts Department of Environmental Protection (DEP), February, 1995.

5. Attachments

Attachment A - Monitoring Well Sampling Record

6. Contacts

Brian Conte
Saskia Oosting

MONITORING WELL SAMPLING RECORD

PID Reading ____________________ Job Name ________________________________

Job Number ____________________ By ____________________ Date ________________

Location ____________________ Measurement Datum ____________________________

Well Number ____________________

Pre-Development Information Time (start) ____________________________

Water Level ____________________ Total Depth of Well ____________________________

One Purge Vol ____________________ Three Well Volume ____________________________

Water Characteristics

Color ____________________ ________ Clear _____ Cloudy

Odor _____ None _____ Weak ________ Moderate _____ Strong

Any films or immiscible material ____

***Volume* (gal)**	**Time**	**pH**	**Temp (°C)**	**Spec. Conductance (µS/cm)**	**Turbidity (NTU)**	**DO Conc. (mg/L)**	**ORP (mV)**	**TDS**

Total Volume Removed (gal) ______________ pH ______________

Temperature (°C) ______________ Specific Conductance (µS/cm) ______________

DO Concentration (mg/L) ______________ ORP (mV) ______________

TDS ______________

Post Development Information

Time (Finished) ____________

Water Level ____________

Total Depth of Well ____________

Approximate Volume Removed (gal) ____________________________

Water Characteristics

Color ____________________ ____ Clear ____ Cloudy

Odor ____ None ____ Weak ____ Moderate ____ Strong

Any films or immiscible material ____

Comments

Low-Flow Groundwater Sampling Form

Project number and name ______ Sampling personnel ______ Sample date ______ Well ID ______

Well location description: ______

Well Construction

Well diameter ______

Well measurement point ______

Roadbox condition ______

Well screen interval ______

Well depth ______

Sampling Information

Initial depth to water ______ Time: ______

Sample intake depth ______

Pump type and ID ______

Stabilized flow rate ______

Stabilized flow rate = flow rate with no further drawdown

Samples Collected

VOCs 8260	
SVOCs 8270	
VPH	
EPH	
Metals	
PCBs	
Other	

Field values at time of sample collection:

Time: ______ Depth to water:

Sp.Cond. ______ mS/cm ______

DO ______ mg/L

ORP ______ mV

pH ______ s.u.

Temp. ______ °C

Turb. ______ NTU

Cumulative Time (min.)	**Volume (gal)**	**Water depth (ft)**	**Temp. (°C)**	**Sp.Cond. (mS/cm)**	**D.O. (mg/L)**	**pH (s.u.)**	**ORP (mV)**	**Turb. (NTU)**
Typical Groundwater Values			5 to 15	0.05 to 5	0 to 4	5 to 7	-100 to +500	aim for <10

Notes: ______

Sample Information:

Sample ID ______

Sample Time: ______

Color: ______

Turbidity: ______

Field Filtered YES / NO Analyses: ______

Filter type: ______

Odor/Sheen/NAPL ______

Duplicate Collected YES / NO

If yes, duplicate ID: ______

Purge water disposal? to ground drummed other:

Well Volume Conversion:

Diam. (in)	Factor (gal/ft)
1	0.04
1.5	0.09
2	0.16
4	0.65
6	1.50

well volume =
3.14 x (r)^2 x 7.48 gal/ft
where r = 1/2 diameter in ft

Stabilization Criteria:
Sp.Cond. +/- 3%
DO +/- 10%
ORP +/- 10 mV
pH +/- 0.1 Std Units
Temp. +/- 3%
Turb. +/- 10% if values >1 NTU

Guidance:

1 Position tubing at midpoint of saturated screened interval

2 Minimize drop in water level and purge until parameters are stable

3 Disconnect flow thru cell during sampling

4 Call Project Manager if issues arise (e.g. stabilization takes more than 2 hrs, well goes dry, odd data).

5 For VPH and VOC samples, if stabilization flow rate is less than 200 ml/min, contact PM

STANDARD OPERATING PROCEDURES

SOP No. HS-001 Biological Hazards

1.1 Objective

The objective of this standard operating procedure (SOP) is to prevent or limit the potential for GEI personnel to encounter biological hazards during field activities.

1.2 General

This SOP is intended for use by employees engaged in work with the potential for contact with biological hazards such as animals, insects, plants, and sewage. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the potential for encounters with biological hazards and the control methods to be implemented by GEI employees. These hazards should be reviewed in the project safety briefing and documented on the Project Safety Briefing form, found on the Health and Safety page of the GEI intranet.

1.2.1 Animals

During some site operations, animals such as stray or domesticated dogs or cats, raccoons, snakes, bears, rats, bats, etc. may be encountered. Employees should use discretion and attempt to avoid contact with animals. If these animals present a problem, efforts will be made to remove these animals from the site by contacting a licensed animal control technician.

1.2.1.1 Rabies

The rabies virus is transmitted through the bite of an infected animal or contact with saliva or brain/nervous system tissue of an infected animal. The rabies virus infects the central nervous system causing disease in the brain. The early symptoms of rabies in people are fever, headache, and general weakness or discomfort. As the disease progresses, more specific symptoms appear and may include insomnia, anxiety, confusion, slight or partial paralysis, excitation, hallucinations, agitation, hypersalivation (increase in saliva), difficulty swallowing, and hydrophobia (fear of water). Death usually occurs within days of the onset of these symptoms.

If you are bitten or think you may be exposed, wash any wounds immediately and thoroughly with soap and water. Then notify the Project Manager and Corporate Health and Safety Officer (CHSO) and go to the hospital emergency room. The doctor, possibly in consultation with the state or local health department, will decide if you need a rabies vaccination. Decisions to start vaccination will be based on your type of exposure and the animal you were exposed to, as well as laboratory and surveillance information for the geographic area where the exposure occurred. An Accident Report Form should be completed and submitted per GEI's accident reporting procedures.

1.2.2 Insects

Insects, including bees, wasps, hornets, mosquitoes, ticks, spiders, etc may be present at a job site making the chance of a bite/sting possible. Some individuals may have a severe allergic reaction to an insect bite or sting that can result in a life threatening condition. Some insect bites can transmit diseases such as Lyme disease or a virus such as West Nile. The following is a list of preventive measures:

- Apply insect repellent prior to performing field work and as often as needed throughout the work shift
- Wear proper protective clothing (work boots, socks and light colored clothing)
- Wear shoes, long pants with bottoms tucked into boots or socks, and a long-sleeved shirt when outdoors for long periods of time, or when many insects are most active (between dawn and dusk).
- When walking in wooded areas, avoid contact with bushes, tall grass, or brush as much as possible
- Field personnel who may have insect allergies should have bee sting allergy medication on site and should provide this information to the Site Safety Officer (SSO) and the CHSO prior to commencing work.
- Field personnel should perform a self-check at the end of the day for ticks.

1.2.3 Tick-borne Diseases

Lyme disease is caused by infection from a deer tick that carries a spirochete. During the painless tick bite, the spirochete may be transmitted into the bloodstream often after feeding on the host for 12 to 24 hours. The ticks that cause the disease are often no bigger than a poppy seed or a comma in newsprint. The peak months for human infection are from May to September.

Symptoms appear in three stages. First symptoms usually appear from 2 days to a few weeks after a person is bitten by an infected tick. Symptoms usually consist of a ring-like red rash on the skin where the tick was attached. The rash is often bulls-eye like with red around the edges and clear in the center. The rash may be warm, itchy, tender, and/or "doughy." Unfortunately, this rash appears in only 60 to 80 percent of infected persons. An infected person also has flu-like symptoms of a stiff neck, chills, fever, sore throat, headache, fatigue and joint pain. These symptoms often disappear after a few weeks.

The second stage symptoms, which occur weeks to months later include meningitis, severe headache, drooping of the muscles on the face, called Bell's Palsy, encephalitis, numbness, withdrawal and lethargy. These symptoms may last for several weeks to several months. Third stage symptoms, which occur months or years later include arthritis, heart problems, and loss of memory. The third stage symptoms may mimic multiple sclerosis and Alzheimer's disease.

Personnel should check themselves when in areas that could harbor deer ticks, wear light color clothing and visually check themselves and their buddy when coming from wooded or vegetated areas. If a GEI employee has been bitten by a tick, the CHSO should be contacted immediately. An Accident Report form must be completed by the individual in compliance with the Accident Reporting procedure outlined in the Corporate Health and Safety Manual.

From left to right: The deer tick adult female, adult male, nymph, and larva on a centimeter scale.

The tick can be removed by pulling gently at the head with tweezers. If tweezers are not available, cover your fingers with tissue paper and use them to grasp the tick. It is important to grasp the tick as close to the site of attachment and use a firm steady pull to remove it. Wash hands immediately after with soap and water. The affected area should then be disinfected with an antiseptic wipe. All mouth parts must be removed from the skin. If the tick is removed by breaking off the mouth parts, an irritation or infection may occur. Also, the organism that is causing the disease can still enter the body through the skin. The employee will be offered the option for medical treatment by a physician, which typically involves antibiotics. If personnel feel sick or have signs similar to those above, they should notify the SSO and the CHSO immediately.

Treatment with antibiotics is effective and recovery is usually complete. In the first stage antibiotics are usually given orally. Second and third stage treatment, however is prolonged and recovery may take longer. Antibiotic treatment is usually provided intravenously for second and third stage Lyme disease.

The deer tick can also cause **Babesiosis**, an infection of the parasite Babesia Microti. Symptoms of Baesiosis may not be evident, but may also include fever, fatigue and hemolytic anemia lasting from several days to several months. Babesiosis is most commonly diagnosed in the elderly or in individuals whose immune systems are compromised.

Ehrlichiosis is a tick-borne disease which can be caused by either of two different organisms. Human monocytic ehrlichiosis (HME) is caused by *Ehrlichia chaffeensis*, which is transmitted by the lone star tick (*Amblyomma americanum*). Human granulocytic anaplasmosis (HGA), previously known as human granulocytic ehrlichiosis (HGE), is caused by *Anaplasma phagocytophilia*, which is transmitted by the deer tick (*Ixodes scapularis*).

In New York State, most cases of ehrlichiosis have been reported on Long Island and in the Hudson Valley. Ehrlichiosis is transmitted by the bite of infected ticks, including the deer tick and the lone star tick. The symptoms of HME and HGE are the same and usually include fever, muscle aches, weakness and headache. Patients may also experience confusion, nausea, vomiting and joint pain. Unlike Lyme disease or Rocky Mountain spotted fever, a rash is not common. Infection usually produces mild to moderately severe illness, with high fever and headache, but may occasionally be life-threatening or even fatal. Symptoms appear one to three weeks after the bite of an infected tick. However, not every exposure results in infection.

Rocky Mountain spotted fever (RMSF) is a tick-borne disease caused by a rickettsia (a microbe that differs somewhat from bacteria and virus). Fewer than 50 cases are reported annually in New York State. In the eastern United States, children are infected most frequently, while in the western United States, disease incidence is highest among adult males. Disease incidence is directly related to exposure to tick-infested habitats or to infested pets. Most of the cases in New York State have occurred on Long Island. RMSF is characterized by a sudden onset of moderate to high fever (which can last for two or three weeks), severe headache, fatigue, deep muscle pain, chills and rash. The rash begins on the legs or arms, may include the soles of the feet or palms of the hands and may spread rapidly to the trunk or rest of the body. Symptoms usually appear within two weeks of the bite of an infected tick.

*(Information on Ehrlichiosis, Babesiosis, and Rocky Mountain Spotted Fever was derived from the New York State Department of Health).

1.2.4 West Nile Virus

West Nile Virus (WNV) is a mosquito-borne infection transmitted through the bite of an infected mosquito. The symptoms of WNV can be asymptomatic (no symptoms) or in more serious cases can lead to West Nile Fever. West Nile Fever can include fever, headache, tiredness, body ache, an occasional rash on the trunk of the body, and swollen lymph glands, In severe cases, people have developed West Nile Encephalitis or

Meningitis which symptoms include fever, headache, neck stiffness, tremors, coma and in some cases death. The incubation period for the disease is usually 2 to 15 days. The symptoms can range from a few days to several weeks. Most mosquitoes are not infected and the chance of infection from a mosquito bite of an on-site employee is very small.

The following precautions will be used to help reduce the risk of mosquito bites:

- Reduce mosquito-breeding areas by making sure wheelbarrows, buckets, and other containers are turned upside down when not used so that they do not collect standing water.
- Wear shoes, long pants with bottoms tucked into boots or socks, and a long-sleeved shirt when outdoors for long periods of time, or when many mosquitoes are most active (between dawn and dusk).
- Use mosquito repellant according to the manufacturer's directions when outdoors for long periods of time and when mosquitoes are most active.

Centers for Disease Control and Prevention (CDC) evaluation of information contained in peer-reviewed scientific literature and data available from the Environmental Protection Agency (EPA) has identified several EPA registered products that provide repellent activity sufficient to help people avoid the bites of disease carrying mosquitoes. Products containing these active ingredients typically provide reasonably long-lasting protection:

- **DEET** (Chemical Name: N,N-diethyl-m-toluamide or N,N-diethly-3-methyl-benzamide) 20 to 30 percent DEET
- **Picaridin** (KBR 3023, Chemical Name: 2-(2-hydroxyethyl)-1-piperidinecarboxylic acid 1-methylpropyl ester)
- **Oil of Lemon Eucalyptus** or **PMD** (Chemical Name: para-Menthane-3,8-diol) the synthesized version of oil of lemon eucalyptus
- **IR3535** (Chemical Name: 3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester)
- **Permethrin** (3-Phenoxybenzyl (1RS)-cis,trans-3-(2,2-dichlorovinyl) -2,2-dimethylcyclopropanecarboxylate) **-** Permethrin kills ticks and can be used on clothing (but not skin)

EPA characterizes the active ingredients DEET and Picaridin as "conventional repellents" and Oil of Lemon Eucalyptus, PMD, and IR3535 as "biopesticide repellents", which are derived from natural materials.

In general, higher concentrations of active ingredient provide longer duration of protection, regardless of the active ingredient, although concentrations above approximately 50 percent do not offer a marked increase in protection time. Products with less than 10 percent active ingredient may offer only limited protection, often from 1 to 2 hours. Products that offer sustained release or controlled release (micro-encapsulated) formulations, even with lower active ingredient concentrations, may provide longer protection times. Regardless of what product you use, if you start to get mosquito bites reapply the repellent according to the label instructions or remove yourself from the area with biting insects if possible.

Clothing and other products can be purchased pre-treated, or products can be treated using EPA-registered products. Permethrin is the only pesticide approved by the EPA for these uses. Permethrin binds tightly to the fabrics, resulting in little loss during washing and minimal transfer to the skin. Permethrin is poorly absorbed through the skin, although sunscreens and other products may increase the rate of skin absorption.

If you decide to use permethrin-treated clothing, consider these tips:

- Read the application instructions carefully and apply the product according to the label directions. Do not over-treat products.
- Permethrin treatments are only intended for use on fabrics; do not apply them directly to the skin or other items.
- Do not apply permethrin to clothing while it is being worn.
- Apply the products outdoors in well ventilated areas that are protected from wind.
- Hang treated fabrics outdoors and allow them to dry completely before wearing them.
- Wash permethrin treated clothing separately from other clothing items.

1.2.5 Plants

The potential for contact with poisonous plants, such as poison ivy, sumac, and oak, exists when performing fieldwork in wooded or boggy areas. These plants can cause allergic reaction when in contact with the leaves or vines.

Poison ivy can be found as vines on tree trunks or as upright bushes. Poison ivy consists of three leaflets with notched edges. Two leaflets form a pair on opposite sides of the stalk, and the third leaflet stands by itself at the tip. Poison ivy is red in the early spring and turns shiny green later in the spring. Poison ivy grows throughout much of North America, including all states east of the Rocky Mountains. It is normally found in wooded areas, especially along edge areas where the tree line breaks and allows sunshine to filter through. It also grows in exposed rocky areas, open fields and disturbed areas.

Poison sumac can be present in the form of a flat-topped shrub or tree. It has fern-like leaves, which are velvety dark green on top and pale underneath. The branches of immature trees have a velvety "down." Poison sumac has white, "hairy" berry clusters. Poison sumac grows exclusively in very wet or flooded soils, usually in swamps and peat bogs, in the eastern United States.

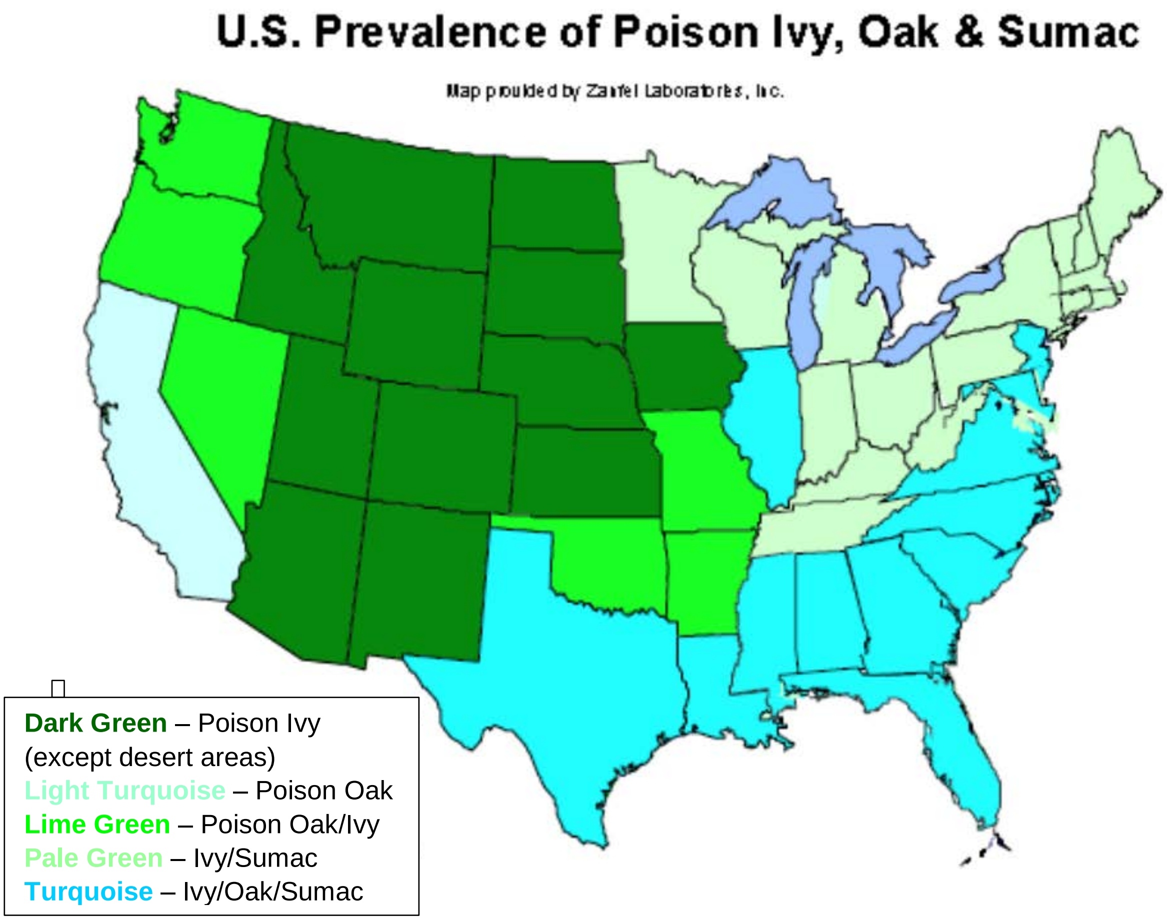
Poison oak can be present as a sparingly branched shrub. Poison oak can grow anywhere in the United States with the exception of Hawaii, Alaska, and some southwest areas that have desert climates. Poison oak is similar to poison ivy in that it has the same leaflet configuration; however, the leaves have slightly deeper notches.

Keep in mind that for each of these plants,

Poison Oak

Poison Ivy

Poison Sumac



Source: United States Department of Agriculture Plants Database, http://plants.usda.gov/

To prevent exposure to these poisonous plants:

- Barrier skin creams, such as lotion containing bentoquatum (Tecnu®), may offer some protection prevent the occurrence of exposure symptoms.
- Wear long sleeves, long pants, boots, and gloves.

Contact with poison ivy, sumac, or oak may lead to a skin rash, characterized by reddened, itchy, blistering skin which needs first aid treatment. Susceptible individuals should identify themselves to the SSO or GEI Project Manager. If you believe you have contacted one of these plants:

- Immediately wash skin thoroughly with soap and water, taking care not to touch your face or other body parts.
- Wash exposed clothing separately in hot water with detergent.
- After use, clean tools, and soles of boots with rubbing alcohol or soap and lots of water. Urushiol can remain active on the surface of objects for up to 5 years.

- If a rash occurs, contact the CHSO and complete and submit an Accident Report Form.

1.2.6 Sewage and Bacterial Impacted Sediments

Some project work may be conducted at sites that serve or have served as a combined sewer overflow (CSO) and consequently may have received untreated sanitary sewage from numerous sources. Decomposed sewage can potentially be encountered within sites and their sediments. Sediments could contain soil and marine microorganisms, and bacterium associated with sewage. Many of these bacterium can cause illness through ingestion, direct contact, or the inhalation of a bio-aerosol. Potential respiratory exposure to biological agents can also occur through the inhalation of aerosols produced during sediment handling activities. Personal protective equipment as identified in the site-specific HASP will be worn to minimize potential exposures. Employees will follow the decontamination or disposal procedures identified in the HASP.

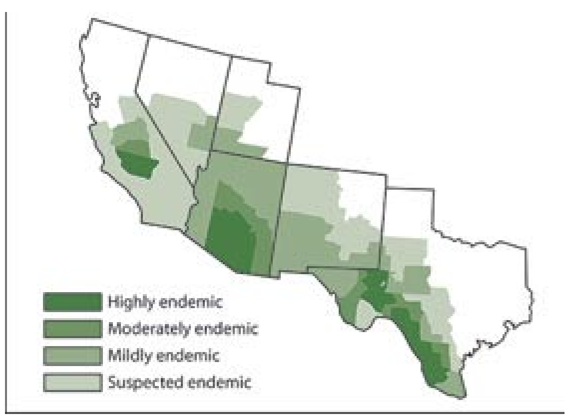
1.2.6 Fungal Spores in Soil – Valley Fever

Valley Fever is an illness that usually affects the lungs. It is caused by the fungus Coccidioides immitis that lives in the top 2 to 12 inches of soil in many parts of California. When fungal spores are present, any work activity that disturbs the soil, such as digging, grading or other earth moving operations, or vehicle operation on dirt roads, can cause the spores to become airborne, therefore increasing the risk of Valley Fever. All employees on sites where the fungus is present, and who are exposed to dusty conditions and wind-blown dusts are at increased risk of becoming infected.

Valley Fever fungal spores are too small to be seen, and there is no reliable way to test the soil for spores before working in a particular place. Valley Fever can be found throughout the southwestern United States, parts of Mexico and South America. Some California counties consistently have Valley Fever fungus present in the soil. In these regions Valley Fever is considered endemic. Health departments track the number of cases of Valley Fever illness that occur. This information is used to map illness rates as seen on the figure below.

California county-specific coccidioidomycosis incidence rates, 2011

Center for Infectious Diseases - Division of Communicable Disease Control
Infectious Diseases Branch - Surveillance and Statistics Section



When present, symptoms usually occur between seven to 21 days after breathing in spores, and can include:

- Cough
- Fever
- Chest pain
- Headache
- Muscle aches
- Rash on upper trunk or extremities
- Joint pain in the knees or ankles
- Fatigue

Symptoms of Valley Fever can be mistaken for other diseases such as the flu (influenza) and TB (tuberculosis), so it is important for employees to obtain medical care for an accurate diagnosis and possible treatment.

While there is no vaccine to prevent Valley Fever, the following steps are important to take in order to limit risk:

- Determine if the worksite is in an endemic area. Contact the local health department for more information about the risk in the county GEI is performing work that may disturb soils.
- Prepare work plans and work practices that reduce employee's exposure, which may include:
    - Provide air conditioned cabs for vehicles that generate heavy dust and make sure employees keep windows and vents closed.
    - Suspend work during heavy winds.
- When exposure to dust is unavoidable, provide National Institute for Occupational Safety and Health (NIOSH)-approved respiratory protection with particulate filters rated as N95, N99, N100, P100, or High Efficiency Particulate Air (HEPA). Employers must develop and implement a respiratory protection program in accordance with California's Occupational Safety and Health Administration (Cal/OSHA's) Respiratory Protection standard (8 CCR 5144).
- Take measures to reduce transporting spores off site, such as:
    - Clean tools, equipment, PPE and vehicles before transporting off site.
    - If employee's clothing is likely to be heavily contaminated with dust, provide coveralls and change rooms, and showers where possible.

1.3 Limitations

Follow safety procedures as defined in the site-specific HASP. Appropriate PPE must be worn correctly to provide the intended level of protection.

1.4 References

http://www.cdc.gov/ncidod/dvbid/westnile/index.htm
http://www.cdc.gov/ncidod/dvbid/westnile/qa/insect_repellent.htm
http://www.epa.gov/pesticides/health/mosquitoes/insectrp.htm
http://www.cdc.gov/niosh/topics/lyme/
Protecting Yourself From Ticks and Mosquitoes, NIOSH Fast Facts, Publication No. 2010-119
http://npic.orst.edu/pest/mosquito/ptc.html

1.5 Attachments

None

1.6 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

STANDARD OPERATING PROCEDURE

HS-004 Driver Safety

1.1 Objective

GEI has implemented a Safe Driving Program to encourage safe driving habits and promote the ongoing safety of our staff and the communities where we work. For more information, refer to the Operation of Vehicles section of GEI's Employee Handbook.

This standard operating procedure (SOP) provides requirements and recommendations to minimize the potential risks while operating or riding in a motor vehicle.

1.2 General

GEI employees will adhere to the following requirements when operating a vehicle while conducting business on behalf of GEI. These requirements apply to GEI owned, rental, and personal vehicles used to conduct GEI business:

- Employees must maintain a valid and current driver's license.
- Employees using a personal vehicle for work-related travel must have proper insurance coverage that meets the requirements in the state in which they reside.
- Employees must wear their safety belt while in a moving vehicle.
- Vehicle accidents will be reported in accordance with GEI's accident reporting procedures. .
- Vehicles will be properly maintained and safely operated (refer to GEI's Fleet Maintenance Program).
- Employees will follow safe driving behaviors, which include limiting distractions such as manipulating radios or other equipment that may cause a distraction. Employees should not exceed the posted speed limit and should maintain a safe distance between other vehicles.
- When parking a vehicle at a job site, the employee should position the vehicle in a manner to reduce or eliminate the need to operate the vehicle in reverse. A safety cone should be placed at the rear of the vehicle after parking the vehicle and be removed prior to moving the vehicle. This procedure makes the employee aware of other vehicles, equipment, and structures within the backup radius of the vehicle.

When driving a rental vehicle or GEI vehicle that you are unfamiliar with orient yourself to the vehicle by:

- Walking around the vehicle to observe the condition of the vehicle and hazards that could be within the travel path.
- Becoming familiar with the size of the vehicle.

- Adjusting mirrors (rear and side).
- Becoming familiar with dashboard, center console, and steering controls.
- Locating the turn signals, windshield wipers, lights, emergency flashers, and the heating, air conditioning, and defrost controls.

1.3 Driving Defensively

Driving defensively means not only taking responsibility for yourself and your actions but also keeping an eye on "the other guy." Good defensive drivers may be able to anticipate what the other driver will do next. GEI recommends the following guidelines to help reduce your risks on the road.

Do not start the vehicle until each passenger and their belongings are secured in the vehicle.

- Remember that driving above or below the speed limit can increase the likelihood of a collision.
- If you notice that a car is straddling the center line, weaving, making wide turns, stopping abruptly or responding slowly to traffic signals, the driver may be impaired or using a cellular telephone.
- Avoid an impaired driver by turning right at the nearest corner or exiting at the nearest exit. If it appears that an oncoming car is crossing into your lane, pull over to the roadside, sound the horn and flash your lights.
- Notify the police if you observe motorist who is driving suspiciously.
- Follow the rules of the road. Do not contest the "right of way" or try to race another car during a merge. Be respectful of other motorists.
- Allow large vehicles, including tractor trailers, extra breaking distance, turning radius, and avoid traveling in their blind spots.
- Do not follow too closely. GEI employees should use a "three-second following distance" or a "three-second plus following distance."
- While driving be cautious, aware, and responsible.
- Use extra caution and reduce speed in construction areas and school zones.
- Be aware of pedestrians, bicyclists, and motorcyclists.

1.4 Cellular Phone Use and Other Distractions

Refer to the Human Resources policy on use of cellular telephones while operating a vehicle on company business.

1.5 Drugs and Alcohol

The use of illegal drugs or alcohol is prohibited when driving a vehicle on GEI business. Be aware of the side effects of prescription and over-the-counter medications which can impair an employee's ability to drive.

1.6 Adverse Driving Conditions

1.6.1 Driving at Night

Vision maybe limited at night due to impairment of the driver's depth perception, color recognition, and peripheral vision. Another factor adding danger to night or early morning driving is fatigue. Drowsiness makes driving more difficult by dulling concentration and slowing reaction time.

Effective measures to minimize these hazards by preparing your car and following guidelines:

- Have your headlights properly aimed. Misaimed headlights blind other drivers and reduce your ability to see the road.
- Alcohol severely impairs your driving ability and acts as a depressant.
- Avoid smoking when you drive. Smoke's nicotine and carbon monoxide hamper night vision.
- Lights will not help the driver see better in early twilight, but they will make it easier for other drivers to see you. Do not overdrive your headlights. You should be able to stop inside the illuminated area. If you do not, you create a blind crash area in front of your vehicle.
- If an oncoming vehicle does not lower beams from high to low, avoid glare by watching the right edge of the road and using it as a steering guide.
- Make frequent stops for light snacks and exercise. If you are too tired to drive, stop in a safe area and get some rest.
- Observe driving safety as soon as the sun goes down. Twilight is one of the most difficult times to drive, because your eyes are constantly changing to adapt to the growing darkness.

1.6.2 Snow/Freezing Conditions

When snow and ice are present, be prepared by following these winter driving safety tips.

1.6.2.1 Prepare the Vehicle Before a Snowstorm

- Check under the hood and take a look at the vehicles cooling system. Make sure the vehicle contains adequate antifreeze and the hoses are in good condition.
- Test heaters and defrosters ahead of time to make sure they are in good working condition.
- Test your windshield wipers and check the condition of your wiper blades. If wipers leave streaks on your windshields, replace the blades.
- It is recommended that a windshield washer/antifreeze solution is used during winter conditions.
- Check your lights and periodically clear them of snow and dirt.
- Car batteries need extra power in cold conditions. Make sure the battery's terminals are clean and cables are secure.

- Keep your gas tank at least half full in the winter to help avoid gas line freeze up.

1.6.2.2 Driving During and After a Snowstorm

- Wear sunglasses to aid in limiting reflection from snow.
- Be aware of blind spots created by snow banks.
- Be extra cautious of pedestrians and other vehicles in intersections.
- Allow extra time for braking and increase the distance between you and the car ahead of you.
- Reduce your speed and do not exceed the posted limit.
- If you start to lose traction take your foot off the gas and gradually reduce your speed. Accelerate slowly once you feel traction is regained.
- If you start to skid, steer in the direction of the skid. Remember, steering can be more important than braking on slippery roads.

1.6.3 Driving In the Rain

To prevent losing control of your car on wet pavement, take these preventive measures.

- Prevent skids by driving slowly and carefully, especially on curves.
- Steer and brake with a light touch.
- When you need to stop or slow, do not brake hard or lock the wheels.
- Maintain mild pressure on the brake pedal.

If you skid, ease your foot off the gas, and carefully steer in the direction you want the front of the car to go. For cars without anti-lock brakes, avoid using your brakes. This procedure, known as "steering into the skid," will bring the back end of the car in line with the front. If your car has anti-lock brake systems (ABS), brake firmly as you "steer into the skid."

Hydroplaning happens when the water in front of your tires builds up faster than your car's weight can push it out of the way. The water pressure causes your car to lose contact with the road surface and slide on a thin layer of water between your tires and the road. At this point, your car can be completely out of contact with the road, and you are in danger of skidding or drifting out of your lane, or even off the road.

To avoid hydroplaning, keep the tires properly inflated and maintain good tread on the tires. If tires need to be replaced on a company vehicle, notify the branch manager or their designee. Slow down when roads are wet, and stay away from puddles. Try to drive in the tire tracks left by the cars in front of you. If you begin to hydroplane, do not brake or turn suddenly. This could throw your car into a skid. Ease your foot off the gas until the car slows and you can feel the road again. If you need to brake, do it gently with light pumping actions. If your car has ABS, then brake normally; the car's computer will mimic a pumping action, when necessary.

If weather conditions worsen to the point where the driver is not comfortable driving, pull the vehicle over to a safe location until conditions improve. Do not drive during severe weather conditions. Do not attempt to drive on roads with standing water or that have been flooded. Find an alternate route if these conditions exist.

1.6.4 Off Road

If operation of a vehicle is required off publicly or privately maintained roads or in situations where four-wheel-drive vehicles are required, the appropriate vehicle for the situation will be used.

1.7 Driver Training

GEI employees are required to complete driver safety training every 3 years. Employees will complete the examination at the end of each module and forward the training certificate to Human Resources.

1.8 Limitations

Follow safety procedures as defined in the site-specific HASP.

1.9 References

National Safety Council
Oklahoma Safety Council
GEI Consultants, Inc. Employee Handbook

1.10 Attachments

1.11 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

STANDARD OPERATING PROCEDURES

HS-007 General Safety Requirements

1.1 Objective

GEI is committed to providing its employees with a safe and healthy work environment. To maintain a safe work environment, GEI has established general safety requirements to promote safe work practices.

1.2 General Health and Safety Training

GEI requires employees to complete Health and Safety Training on an annual basis. Project employees must have completed, at a minimum, GEI's General 4-Hour Health and Safety Training or when required, HAZWOPER training before beginning on-site work activities. In addition, field staff must be current in First Aid and CPR Training. Site-specific safety training will also be completed before beginning work on each project site. Further Health and Safety training requirements can be found in Section 2 of the GEI Health and Safety Manual.

1.3 Tailgate Meetings

Health and Safety tailgate meetings will be conducted by the GEI Project Manager or Site Safety Officer (SSO), and be recorded in the GEI field book or on the GEI daily safety briefing log. Employees on-site will sign the daily safety briefing log to indicate attendance.

1.4 Health and Safety Plans

GEI projects must have a health and safety plan (HASP) before beginning site work. GEI HASP templates are located on the Health and Safety page on the GEI intranet. Specific requirements for HASPs are located in Section 7 of GEI's Health and Safety Manual. After the HASP has been completed, it must be sent to the Corporate Health and Safety Officer (CHSO) and the Regional Health and Safety Officer (RHSO) for review. Project employees must read the HASP and sign the signature page to document that they have read, understood, and will comply with the requirements of the HASP. The site-specific HASP must be kept on-site at all times.

1.5 Personal Protective Equipment

Project-specific personal protective equipment (PPE) will be identified in the HASP based on the hazards present during work tasks. Required PPE must be worn on the project site. More information regarding PPE is located in Section 6 of GEI's Health and Safety Manual.

1.6 Fire Protection and Prevention

The work site should be kept clear of flammable materials and debris. GEI field personnel should know where fire extinguishers are located, and be familiar in the use of the extinguisher. Information on the correct use of a fire extinguisher is included in GEI's general health and safety training. Call 911(or other number identified in the project HASP) in the event of a fire.

1.7 Accident/Incident Reporting

The following accident reporting procedures must be followed:

- Seek medical attention.
- Notify your supervisor.
- Notify CHSO and Human Resources (HR) within two hours of the accident/incident.
- Complete Accident Reporting Form (found on the Health and Safety page of the GEI Intranet or on the GEI App) within **24 hours** and send to the CHSO and Human Resources. Refer to Section 8 of the GEI Health and Safety Manual for more information.

1.8 Near Miss Reporting

GEI employees will complete a near-miss reporting form if a hazardous or unsafe condition or near miss is observed. The near-miss reporting form is located on the Health and Safety page of the GEI Intranet. Refer to Section 8 of the GEI Health and Safety Manual for more information.

1.9 Housekeeping

Work areas, passages, and stairs will be kept clear of debris. Debris will be removed from the project site at regular intervals.

1.10 Illumination

Project sites will be illuminated either with natural or artificial illumination, in compliance with OSHA regulations.

1.11 Sanitation

Hand-washing is an essential form of protection from chemical and biological exposures and illness. GEI employees should wash their hands after performing work tasks and regularly throughout the day. If soap and water are not available, hand sanitizers and/or wipes should be used.

1.12 Machinery, Tools, Material, and Equipment

Machinery, tools, material, and equipment will be kept in good working condition and will be inspected by a competent person. Unsafe equipment will be identified as unsafe by tagging or locking the controls to render them inoperable. Arrangements will be made to repair or dispose of damaged or unsafe equipment.

1.13 Vehicles

GEI's motor vehicles will be maintained in accordance with the GEI fleet maintenance program. Each GEI-owned vehicle will have a fire extinguisher and first aid kit. Additional fire extinguishers and first aid kits are kept in each GEI office for use in personal or rental vehicles.

1.14 Heavy Equipment

GEI employees will keep a line of sight between them and heavy equipment operators. If a GEI employee needs to communicate with heavy equipment operators, they will use hand signals or direct communication with the operator. GEI employees should not:

- Operate or climb on heavy equipment
- Approach heavy equipment while it is in operation.
- Use cellular telephones when working near operating equipment.

For more information regarding heavy equipment, refer to GEI's SOP HS-018 Heavy Equipment.

1.15 Limitations

Follow safety procedures as defined in the site-specific HASP. Appropriate PPE must be worn correctly to provide the intended level of protection.

1.16 Attachments

None

1.17 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer

GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

STANDARD OPERATING PROCEDURES

SOP No. HS-008a Non-Powered Hand Tools

1.1 Objective

This SOP is intended for use by employees working with non-powered hand tools. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the hazards associated with the non-powered hand tools that will be used. These hazards should be reviewed during the project safety briefing and documented on the Project Safety Briefing form, found on the Health and Safety page of the GEI intranet.

1.2 General

Misuse of hand tools accounts for the majority of accidents and injuries involving hand tools. Only use a tool for which it was designed for and use the proper tool for the task. Improper maintenance is another leading cause of injuries. Employees using hand tools may be exposed to a number of potentially serious hazards: falling objects, objects fall as a result of contact with tools, objects which are abrasive or splash, harmful dust, fumes mists, vapors, and gases, as well as contact with electrical power sources.

1.2.1 Condition of Tools

All hand tools, whether furnished by GEI or the employee, will be maintained in safe working condition. All hand tools must be inspected before use. Never use a tool if its handle has splinters, burrs, cracks, splits or if the head of the tool is loose. Never use impact tools such as hammers, chisels, punches or steel stakes having mushroomed heads. Tag worn, damaged or defective tools "Out of Service" and do not use them. If the tools cannot be repaired they will be disposed of. GEI does not issue or permit the use of unsafe hand tools.

1.2.2 Personal Protective Equipment

Employees using hand tools will be provided with the personal protective equipment (PPE) necessary to protect them from the hazard of the tool as well as the associated hazards with using the tool. (i.e. projectile debris, dust, etc.). <u>All employees will wear work gloves and safety glasses at a minimum.</u> In addition, face shields and hearing protection may be required. Most hand injures could be avoided with the proper use of PPE. PPE must be maintained in good condition, kept clean and properly stored when not in use. More information regarding PPE is located in Section 6 of GEI's Corporate Health and Safety Program.

1.2.3 General Safe Practices

Never wear sandals, open-toed or canvas shoes when working with tools. Avoid loose-fitting clothes which might become entangled in a tool. Always remove rings and other jewelry. Make sure your grip and footing are secure when using large tools. Never carry tools up ladders, use a tool belt, hoist or a rope. Use extra caution when using tools at heights – a falling tool could kill a co-worker. Always pass a tool to another person by the handle – never toss it to them. Select ergonomically designed tools for work tasks when movements are repetitive and forceful.

1.3 Non-Power Hand Tools

Non-powered hand tools include anything from axes to wrenches. Even though the tool is powered by human inertia, these injuries often involve sever disabilities.

1.3.1 Knives

Only use a knife with a sharpened blade. Always cut in the direction away from your body. Never use knives having broken or loose handles. Never use knives as screwdrivers, pry bars, or can openers. Never pick up knives by their blades. Always carry knives with their tips points toward the floor. Never carry knives, scissors, or other sharp tools in pockets. Never attempt to catch a falling knife. When not in use, knives should be stored in sheaths. Box cutters will be self-retracting.

1.3.2 Wrenches

Never use wrenches that are bent, cracked or badly chipped, or having loose or broken handles. Discard any wrench with spread or battered jaws, if the handle is bent, or if a wrench has broken or battered points. Never slip a pipe over a single head wrench handle for increased leverage. Never use a shim to make a wrench fit. Pull on a wrench using a slow, steady motion. Do not use push force on a wrench you'll be more likely to lose your balance if the wrench slips.

1.3.3 Screwdrivers

Never use a screwdriver if your hands are wet, oily, or greasy. Always match the size and type of screwdriver blade to fit the head of the screw. Do not hold the work piece against your body while using a screwdriver. Never put your fingers near the tip of a screwdriver when tightening a screw. Never use a screwdriver to make a starting hole for screws. Never use a screwdriver as a chisel, pry bar, or nail puller. When performing electrical work, always use an insulated screwdriver. Never use a screwdriver to test the charge of a battery.

1.3.4 Hammers

Never use a hammer if your hands are oily, greasy or wet. Always check behind you before swinging a hammer. Use a claw hammer for pulling nails. Never strike nails or other objects with the “cheek” of the hammer. Do not strike a hardened steel surface, such as a cold chisel, with a claw hammer. Never strike one hammer against another hammer. Never use a hammer as a wedge or a pry bar.

1.3.5 Pliers

Never use pliers which are cracked, broken, or sprung. Never use pliers as a wrench or a hammer. Do not attempt to force pliers by using a hammer on them. Never slip a pipe over the handles of pliers to increase leverage. When performing electrical work, always use insulated pliers. When using diagonal cutting pliers, shield loose pieces of cut material from flying into the air by using a cloth or your gloved hand.

1.3.6 Snips

Never use snips as a hammer, screwdriver, or pry bar. Always wear safety glasses or safety goggles when using snips to cut materials. Always wear work gloves when cutting materials with snips. Keep the blade aligned by tightening the nut and bolt of the snips. Never use straight cut snips to cut curves. Always use the locking clip on the snips when you have finished using them. Never leave or store snips in the open position.

1.3.7 Hand Saws

Always keep handsaws sharp and free of rust to prevent them from binding or jumping. Never carry a saw by the blade. Always hold the work piece firmly against a work table. Keep control of saws by releasing downward pressure at the end of the stroke. Never use an adjustable blade saw such as a hacksaw, coping saw, keyhole saw or bow saw, if the blade is not taut. Oil saw blades after each use. Never force the saw through the cut as this may cause the saw to buckle or fly out of the groove causing an injury.

1.3.8 Chisels

Only use sharpened chisels. Never use chisels having “mushroomed” striking heads. Whenever possible, hold a chisel by using a tool holder. Clamp small work pieces in a vise and chip towards the stationary jaw of the vise. Chip or cut away from yourself and be sure to keep both hands back in back of the cutting edge. Always wear safety glasses or a face shield.

1.3.9 Vise and Clamps

Never use a vise having worn or broken jaw inserts, or having cracks or fractures in the body of the vise. Position the work piece in the vise so the entire face of the jaw supports the work piece. When clamping a long work piece in a vise, support the far end of the work piece by using an adjustable pipe stand or saw horse. Never slip a pipe over the handle of a vise to gain extra leverage. Never use a C-clamp for hoisting materials. Never use a C-clamp as a permanent fastening device.

1.3.10 Jacks

A manufacture's rated capacity must be clearly marked on all jacks and all jacks must have a stop indicator. Never exceed the capacity of the stop indicator on the jack. Jacks should be lubricated and inspected regularly. When setting up a jack, ensure the base is centered on a firm, level surface. The jack head should also be placed against a level surface. Lift force should be applied evenly. Put a block under the base of the jack when the foundation is not firm. Place a block between the jack cap and load if the cap might slip. Immediately block the load after it is lifted.

1.4 Limitations

Follow safety procedures as defined in the site-specific HASP or in the manufacturer's specifications. Appropriate PPE must be worn correctly to provide the intended level of protection.

1.5 References

OSHA Standards for the Construction Industry, Subpart I
Risk Analytics, LLC Hand Tools Training, 2006

1.6 Attachments

None

1.7 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

STANDARD OPERATING PROCEDURES

SOP NO. HS-009 Hazardous Substances Management

1.1 Objective

This Standard Operating Procedure (SOP) is intended to outline the steps GEI employees will take to identify potential hazards associated with exposure to hazardous substances, the risks associated with these hazards, and the proper controls to use to minimize exposure. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the potential for encounters with biological hazards and the control methods to be implemented by GEI employees. These hazards should be reviewed in the project safety briefing and documented on the Project Safety Briefing form, found on the Health and Safety page of the GEI intranet.

1.2 Hazard Identification

An initial identification of hazards should be done based on a review of available documents including lists of chemicals used on site, analytical data from soil, surface water, groundwater, air, spill history, site history, equipment on site, maps, photos, and a preliminary survey.

1.3 Risk Identification

Once the presence and concentrations of specific hazardous substances and health hazards have been established, the risks associated with these substances will be identified. GEI employees and GEI subcontractors who will be working on the site will be informed of risks that have been identified.

Risks to consider include, but are not limited to:

- Potential exposures exceeding the permissible exposure limits and published exposure levels.
- Potential Immediately to Life and Health (IDLH) Concentrations.
- Potential Skin Absorption and Irritation Sources.
- Potential Eye Irritation Sources.
- Potential hazardous atmospheres, including oxygen deficiency and fire and explosion hazards.

1.4 Engineering Controls, Work Practices, and Personal Protective Equipment for Employee Protection

Engineering controls, work practices, and personnel protective equipment (PPE) for substances regulated in OSHA Subpart Z (Toxic and Hazardous Substances) will be implemented in accordance with this section to protect employees from exposure to hazardous substances and safety and health hazards.

1.4.1 Engineering Controls, Work Practices, and Personal Protective Equipment for Substances Regulated in Subparts G (Occupational Health and Environment Control) and Subpart Z (Toxic and Hazardous Substances)

Engineering controls and work practices will be instituted to reduce and maintain employee exposure at or below the permissible exposure limits for substances regulated by 29 CFR Part 1910.

Engineering controls that may be feasible include the use of pressurized cabs or control booths on equipment, and/or the use of remotely operated material handling equipment. Work practices may include removing non-essential employees from potential exposure during opening of drums, wetting down dusty operations, and positioning employees upwind of potential hazards.

If engineering controls and work practices are not feasible, or not required, a reasonable combination of engineering controls, work practices, and PPE will be used to reduce and maintain at or below the permissible exposure limits or dose limits for substances regulated by 29 CFR Part 1910, Subpart Z.

GEI will not implement a schedule of employee rotation as a means of compliance with permissible exposure limits or dose limits except when there is no other feasible way of complying with the airborne or dermal dose limits for ionizing radiation.

The provisions of 29 CFR, subpart G, Occupational Health and Environment control, will be followed.

1.4.2 Engineering Controls, Work Practices, and Personal Protective Equipment for Substances <u>Not</u> Regulated in Subparts G and Subparts Z

An appropriate combination of engineering controls, work practices, and personal protective equipment will be used to reduce and maintain employee exposure to or below published exposure levels for hazardous substances and health hazards not regulated by 29 CFR Part 1910, Subparts G and Subparts Z. GEI will use published literature and Safety Data Sheet (SDS) as a guide in making the determination of what level of protection is appropriate for hazardous substances and health hazards for which there is no permissible exposure limit or published exposure limit.

1.4.3 Decontamination Procedure

Decontamination procedure(s) will be developed, communicated to employees, and implemented before employees or equipment enter areas on site where potential for exposure to hazardous substances exists. Procedures will be developed to minimize employee contact with hazardous substances or with equipment that has contacted hazardous substances.

GEI employees leaving a contaminated area will be properly decontaminated; contaminated clothing and equipment leaving a contaminated area will be properly disposed of or decontaminated.

Decontamination procedures will be monitored by the site safety officer (SSO) to determine their effectiveness. When such procedures are found to be ineffective, the site safety officer will contact the CHSO and appropriate steps will be taken to correct deficiencies.

1.4.3.1 Location

Decontamination will be performed in areas that will minimize the exposure to employees, equipment, and the environment.

1.4.3.2 Equipment and Solvents

Equipment and solvents used for decontamination will be decontaminated or disposed of properly.

1.4.3.3 Personal Protective Clothing and Equipment

Protective clothing and equipment will be decontaminated, cleaned, laundered, maintained or replaced as needed to maintain their effectiveness.

Employees whose clothing comes in contact with hazardous substances will immediately remove that clothing and rinse the exposed area with water. The clothing will be disposed of or decontaminated before it is removed from the work zone.

1.4.3.4 Commercial Laundries or Cleaning Establishments

Commercial laundries or cleaning establishments that decontaminate protective clothing or equipment will be informed of the potentially harmful effects of exposures to hazardous substances.

1.4.3.5 Showers and Changing Rooms

Where the decontamination procedure indicates a need for regular showers and change rooms outside of a contaminated area, they will be provided and meet the requirements of

29 CFR 1910.141 (Sanitation). If temperature conditions prevent the effective use of water, then other effective means for cleansing will be provided and used.

1.5 Limitations

None

1.6 Attachments

None

1.7 References

OSHA 1910.120 Hazardous Waste Operations and Emergency Response
OSHA 1910 Subpart G Occupational Health and Environment Control
OSHA 1910 Subpart Z Toxic and Hazardous Substances
OSHA 1910.141 General Environmental Controls - Sanitation

1.8 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

STANDARD OPERATING PROCEDURES

SOP No. HS-010 Inclement Weather

1.1 Objective

Inclement weather can affect work activities and pose safety hazards to employees working in these conditions. The following guidelines will be followed when weather conditions become a safety concern.

1.2 General

This standard operating procedure (SOP) is intended for use by employees engaged in work with the potential to be affected by inclement weather. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the potential for encounters with biological hazards and the control methods to be implemented by GEI employees. These hazards should be reviewed in the project safety briefing and documented on the Project Safety Briefing form, found on the Health and Safety page of the GEI intranet.

Employees should be aware of local weather conditions and monitor advisories issued by the National Weather Service and other local reporting services. Depending on location and season, storms are capable of producing heavy rain, floods, extreme temperatures, high wind conditions, lighting, tornados, and/or snowfall.

1.2.1 Heavy Rain

If working or driving in a storm use extreme caution. When driving, turn your lights on when the rainfall becomes heavy. Employees should be aware of the following:

- Heavy rain decreases visibility, especially when driving.
- Surfaces and tools become slippery.
- If you are working in the rain and your clothes become wet there is a risk of hypothermia when exposed to winds, even in warm temperatures.
- If the storms are going to produce thunder and/or lightning, leave the work area immediately and move to a safe area.
- Use your best judgment to determine if the rainfall becomes too heavy to continue working safely.

1.2.2 Lightning

Lightning can strike as far as 10 miles from the area where it is raining. That's about the distance you can hear thunder. **If you can hear thunder, you are within striking distance. Seek safe shelter immediately.** This can be within a building or vehicle. Wait 30 minutes after the last clap of thunder or flash of lightning before going outside again.

1.2.3 Flooding

Flooding may occur as a result of heavy rain in a short period of time. Flooding can be particularly acute in canyon areas where dry creek beds can turn into raging rivers from rainfall in distant or higher elevation areas. Be aware of this and your surroundings and move to a safe place if you begin to see signs that flooding may occur. Do not attempt to drive through areas or streets that are flooded. Seek alternate routes. Be particularly cautious at night when flooded areas are difficult to see. Urban flooding can stop traffic and increase the potential for traffic accidents and becoming trapped in vehicles.

1.2.4 Extreme Temperatures

Work activities may take place in extreme heat or cold. Be prepared if these conditions are anticipated. Have the appropriate personal protective equipment (PPE) available, exercise proper fluid intake, and take breaks to prevent heat and cold stress. For more information about these conditions see the heat stress and cold stress programs found in GEI's Health and Safety Manual.

1.2.5 High Wind and Tornados

Tropical storms are described as storms with sustained winds ranging from 39 to 73 miles per hour (mph) and hurricanes produce sustained winds that exceed 74 mph. When winds approach 40 mph (gale force winds) twigs begin to break off of trees and vehicles will veer off of the road. When winds approach **40 mph** or the GEI employee feels unsafe based on the activities being performed, stop work and seek shelter as soon as possible. Blowing or falling debris and overhanging limbs/signs can be a significant hazard. If possible, avoid driving in these conditions; 70 percent of injuries during hurricanes are a result of vehicle accidents. Note that tall or elevated equipment will have manufacturer's safe operating wind speeds defined that could be less than 40 mph. The operator's manual should be consulted prior to operation of the equipment.

A tornado is a violent, dangerous, rotating column of air that is in contact with both the surface of the earth and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud. The Fujita Scale is used to rate the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure. Based on the Fujita Scale or F-Scale Numbers begin at F0: 40-72 mph and go to F6: 319-379 mph (F6 is generally theoretical). Nearly three-fourths of tornados are on the weak F0-F1 scale with just over two-thirds of deaths resulting from the violent F4-F5 tornados. If tornado wind speeds exceed the 40 mph, stop work and seek shelter immediately if a tornado is seen. If a tornado siren is sounded move immediately to safety indoors and then move to a windowless interior space, basement, stair well, or designated fall-out shelter. Windows should not be opened before an oncoming tornado. If there is no shelter available, seat belt yourself into your stationary vehicle or seek a depression or low spot on the land surface.

1.2.6 Snowfall and Ice Conditions

Working in the winter months will result in activities taking place during periods of snowfall or icy conditions. If you are working during or after snow has fallen, dress appropriately for the conditions. Snow and ice can cause working surfaces to become slippery. Clear snow and ice from work areas to prevent slip hazards. Use caution when performing snow or ice removal activities to prevent injuries. Driving in snowy and icy conditions is also hazardous. Reduce speed and use caution if you must drive in these conditions.

If the weather conditions deteriorate and you do not feel safe working in these conditions, stop work, move to a safe indoor location, and contact your Project Manager to let them know the weather, work conditions, and your location.

1.3 Limitations

Follow safety procedures as defined in the site-specific HASP. Appropriate PPE must be worn correctly to provide the intended level of protection. Protection extreme weather conditions can best be accomplished if the conditions are anticipated. Monitor local weather conditions prior to starting work.

1.4 References

Center for Disease Control and Prevention – Natural Disasters and Severe Weather
http://www.bt.cdc.gov/disasters/
National Lightning Safety Institute
NOAA, National Weather Service
Office of Climate, Water, and Weather Services

1.5 Attachment

None

1.6 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer

GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

STANDARD OPERATING PROCEDURES
SOP No. HS-012 Noise Exposures

1.1 Objective

Working in loud environments can cause hearing damage and loss if the proper protection is not in place. The following procedures describe methods to mitigate unhealthy noise levels and protect hearing.

1.2 General

This SOP is intended for use by employees engaged in work within loud environments. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the potential for work in loud environments and the control methods to be implemented by GEI employees. These hazards should be reviewed in the project safety briefing and documented on the Project Safety Briefing form, found on the Health and Safety page of the GEI intranet.

Prior to working on a project, an Activity Analysis or Job Hazard Analysis will be performed by the Project Manager or their designee to evaluate the potential hazards and identify steps to be taken to protect workers from hazards. If projects involve high levels of noise from such sources as heavy equipment, power tools, pumps, generators, or other noise source employees should take steps to remove the noise exposure. GEI has an established Hearing Conservation Program located in the GEI Health and Safety Manual.

Hearing protection is required if noise levels in a work area are known to be above 85 decibels (dB), which can be measured with a noise meter. When decibel levels are not known, hearing protection is required if you need to raise your voice to talk to someone standing within a normal speaking distance from you.

The first option for employee protection from hazardous noise levels is to remove the hazard by taking away the source of the noise or using engineering controls to reduce the level. If this cannot be accomplished, the next control measure to be used is to remove the employee from the source. This can be done by moving the work area to a quieter location or distancing the employee from the noise source. For example, GEI employees do not need to be standing next to an operating drill rig or other heavy equipment, by distancing themselves from heavy equipment or other noise sources the need for hearing protection can be eliminated. The final option for employee protection is personal protective equipment (PPE). Disposable ear plugs are made available to GEI employees and are to be used when required. Additional means of hearing protection will be provided, such as ear muffs, if the disposable ear plugs are not adequate.

Employees should be aware of surroundings such as moving equipment, traffic, and other site hazards when wearing hearing protection.

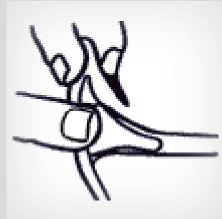
1.3 Proper Use of Hearing Protection

DISPOSABLE EAR PLUG FITTING INSTRUCTIONS

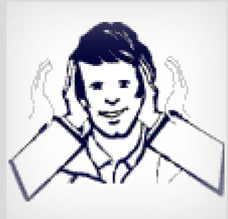
Before fitting any ear plugs, make sure your hands are clean.
Foam ear plugs are disposable and not intended for reuse.

Hold the ear plug between your thumb and forefinger. Roll and compress the entire ear plug to a small, crease-free cylinder. While still rolling, use your other hand to reach over your head and pull up and back on your outer ear. This straightens the ear canal, making way for a snug fit.

Insert the ear plug and hold for 20 to 30 seconds. This allows the ear plug to expand and fill your ear canal.



Test the fit. In a noisy environment, and with earplugs inserted, cup both hands over your ears and release. You should not notice a significant difference in the noise level. If the noise seems to lessen when your hands are cupped over your ears, your ear plugs are not fitted properly. Remove and refit following instructions.



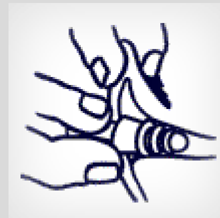
Always remove ear plugs slowly, twisting them to break the seal. If you remove them too quickly, you could damage your ear drum.

REUSABLE EAR PLUG FITTING INSTRUCTIONS

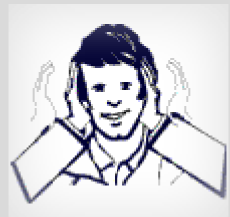
Before fitting any ear plugs, make sure your hands are clean. Reach around your head and pull up and back on your outer ear. This straightens out the ear canal, making way for a snug fit.

Reusable ear plugs should be inspected and cleaned often in soapy water. If they become hard, torn, or deformed they should be replaced.

Hold the stem end of the ear plug and insert it well inside your ear canal until you feel it sealing and the fit is comfortable.



Test the fit. In a noisy environment, and with ear plugs inserted, cup both hands over your ears and release. You should not notice a significant difference in the noise level. If the noise seems to lessen when your hands are cupped over your ears, your ear plugs are not fitted properly. Remove and refit following instructions.



Always remove ear plugs slowly, twisting them to break the seal. If you remove them too quickly, you could damage your ear drum.

1.4 Limitations

Follow safety procedures as defined in the site-specific HASP. Appropriate PPE must be worn correctly to provide the intended level of protection.

1.5 References

OHSA 29 CFR 1910.95 – Occupational Noise Exposure
OHSA 29 CFR 1926.101 – Hearing Protection
Texas American Safety Company (TASCO)

1.6 Attachment

None

1.7 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

STANDARD OPERATING PROCEDURE

SOP HS-014 Utility Mark-out

1.1 Objective

This standard operating procedure (SOP) provides guidance for utility mark-out procedures related to drilling, excavation, or other sub-surface or intrusive activities to avoid injury to GEI employees or property damage. This SOP is applicable when GEI is responsible for its operation or our subcontractor's operation for utility mark-out.

Clients or local agencies may have additional requirements or procedures for the marking of utilities. If local utility mark-out procedures differ from those described within this SOP, applicable state or municipal regulations should be followed.

1.2 General

- This SOP is intended for use by employees engaged in work with sub-surface or intrusive activities. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the potential for subsurface hazards and the control methods to be implemented by GEI employees. These hazards should be reviewed in the project safety briefing and documented on the Project Safety Briefing form, found on the Health and Safety page of the GEI intranet.
- The contractor or GEI employee visits the site and marks out each exploration area with white paint, flags, or stakes. Mark-outs will be performed wearing required PPE, including eye protection when using spray paint to perform the mark-out.
- Exploration locations should be marked out with sample identification number(s) and type of sample (e.g., boring, test-pit, or monitoring well).
- The contractor compiles information about the work areas on a request form specified by the state utility mark-out program and provides this information to the mark-out program call center with a phone call or electronic submittal. Work area location maps can be sent to the utility mark-out program to clarify locations.
- The mark-out program customer service representative will provide a mark-out ticket number and a list of utilities notified upon receipt of the request information. This information will be recorded on the GEI documentation form or in other project documents.

- If known, the contractor will also notify non-member utility operators (such as apartment complexes, commercial complexes, railroads with communication cables, etc.).
- Utility companies or their sub-contractors will only mark-out, or clear, utilities under their responsibility. Generally, this means that they will only mark-out utilities within the public right-of-way up to private property boundaries. Information needed to determine the location of utilities on private properties will be requested from the property owner. This may include available property drawings or as-built figures. If this information is not available, additional non-intrusive surveys of the property may be required by a private utility locator to find underground utilities by using techniques, including ground penetrating radar (GPR).
- American Public Works Association (APWA) Uniform Color Code For Marking Underground Utility Lines are:

  1. **White –** Proposed Excavation
  2. **Pink** – Temporary Survey Markings
  3. **Red** – Electric Power Lines, Cables, Conduit and Lighting Cables
  4. **Yellow –** Gas, Oil, Steam, Petroleum, and Gaseous Material
  5. **Orange** – Communications, Alarm, Signal Lines, Cables or Conduit
  6. **Blue** – Water
  7. **Purple** – Radioactive Materials
  8. **Green –** Sanitary and Storm Sewers and Drain Lines

- Before the intrusive work activities begin, the contractor will verify that each utility company has completed a utility location for the work area or the location has been cleared by a private locator and record this on the mark-out request information sheet.
- A visual survey of the project area will be done prior to the start of intrusive activities. This visual inspection will be done to identify signs, manholes, utility boxes, or other evidence of an underground utility is present and has been considered.
- The contractor can begin work on the scheduled work date and time if the utility operators have responded, taking care to find and preserve markings that have been made.
- Completed clearance documentation will be located on the excavation site during excavation activities and kept in project files.
- When excavating near a buried utility, observe the approximate location around that utility.

- If exposing a utility, proper support and protection must be provided so that the utility will not be damaged.
- If the excavation work requires significant spans of the utility to be exposed, it is the contractor's responsibility to support them (to prevent sagging or collapse) as needed. Contact the utility operator for support, guidance, or assistance.
- When the excavation is complete, provide proper backfill for utilities that have been exposed.

- Take care not to damage the conduit or protective coating of a utility. If the contractor damages this, leave the damaged utility exposed and immediately call the utility owner.
- If a gas line is contacted, the contractor must notify police, fire, and emergency personnel, and evacuate employees according to the site evacuation procedures. No attempt should be made to tamper with or correct the damaged utility.
- If the contractor/consultant needs to dig within the approximate location of a combustible, hazardous fluid, or gas line (natural gas, propane or gasoline), soft digging is required (hand digging, vacuum extraction) to a maximum depth of five feet. The approximate location is defined as 24 inches on either side of the designated center line of the utility if the diameter is not provided or 24 inches from each outside edge if the diameter is provided.

1.3 Limitations

- Follow safety procedures as defined in the site-specific HASP. Appropriate PPE must be worn correctly to provide the intended level of protection.
- Mark-out notification time usually does not include holidays. Make sure holidays are considered and mark-out time is scheduled accordingly. Under no circumstances are intrusive activities allowed to be performed prior to the required mark-out.
- Do not use white paint if precipitation is eminent. Consider using stakes if snow is predicted.

1.4 References

Reference the website for the "Call Before You Dig – 811" for the utility mark-out agency for the state you working in prior to site work. If you have issues locating the appropriate agency, contact the Health and Safety Committee for assistance.

1.5 Attachment

Attachment A – Standard Utility Color Codes
Attachment B – GEI Utility Clearance Documentation Form

1.6 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

COLOR CODE FOR UTILITY MARKING

(BASED ON 'THE AMERICAN PUBLIC WORKS ASSOCIATION' RECOMMENDATIONS AND THE ANSI STANDARD Z-53.1 FOR SAFETY COLORS)

UTILITY	COLOR
PROPOSED EXCAVATION	WHITE
ELECTRIC POWER LINES, CABLES, CONDUIT AND LIGHTING CABLES	RED
POTABLE WATER	BLUE
STEAM, CONDENSATE, GAS OR OIL COMPRESSED AIR	YELLOW
TELECOMMUNICATIONS, ALARM OR SIGNAL LINES, CABLES OR CONDUIT	ORANGE
TEMPORARY SURVEY MARKINGS	PINK
SEWER AND STORM DRAINS	GREEN
CHILLED WATER, RECLAIMED WATER, IRRIGATION AND SLURRY LINES	PURPLE
OTHER	LIGHT BLUE

1.0/4902e011.pdf (12/2004)

Utility Clearance Documentation

Client: ______________________________

Project: ______________________________

Site: ______________________________

Excavation/Drilling Location ID: ______________________________

Excavator/Driller: ______________________________

GEI PM: ______________________________

GEI Field Team Leader: ______________________________

Utility Drawings Reviewed: ______________________________

Provided By: ______________________________

Reviewed By: ______________________________

Utility Clearance Call Date: ______________________________

Utility Clearance Received back from (list utilities): ______________________________

Completed By (Company): ______________________ Date: ____________

GEI Staff Responsible for Oversight: ______________________________

Metal Detector Survey (yes/no): ______________________________

Drilling Location Cleared by: ______________________________

Contractor: ______________________ Date: ____________

GEI Staff Responsible for Oversight: ______________________________

Private Location Clearance Required (yes/no): ______________________________

Contractor: ______________________ Date: ____________

Methods used for utility location (i.e. GPR, electronic pipe location) ______________________________

GEI Staff Responsible for Oversight: ______________________________

Hand clearing Performed: ______________________ Date: ____________

Contractor: ______________________________

GEI Staff Responsible for Oversight: ______________________________

Notes: ______________________________

____

Based upon the best available information, appropriate utility clearance procedures were performed for the invasive work specified. If client ordered/site specific deviations from existing GEI utility clearance procedures exist, they are approved by the client signature below.

Client Signature (Optional): ____________________ Date: ____________________

GEI, Inc. Representative: ____________________ Date: ____________________

STANDARD OPERATING PROCEDURES

SOP No. HS-016 Traffic Hazard Management

1.1 Objective

The objective of this standard operating procedure (SOP) is to prevent or limit the potential for GEI personnel to encounter traffic hazards during field activities.

1.2 General

This SOP is intended for use by employees engaged in work with the potential for traffic hazards. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the potential for exposure to traffic hazards and the control methods to be implemented by GEI employees. These hazards should be reviewed in the project safety briefing and documented on the Project Safety Briefing form, found on the Health and Safety page of the GEI intranet.

1.3 Traffic Hazard Management

Traffic Hazard Management is the process of identifying and managing the potential risks associated with the movement of traffic through, around, or past a work area. This Traffic Hazard Management SOP is designed to assist employees in identifying and managing these hazards. Work areas should be as safe as possible. It is the responsibility of GEI employees to follow the Traffic Hazard Management plan and adhere to these safety standards. Safety is not negotiable.

Under no circumstances are GEI employees permitted to commence work in a situation that they feel puts their health and safety, or the health and safety of others, at risk.

Major risk factors for work site Traffic Hazard Management include:

- The speed of traffic past or through a work site.
- The clearance between moving traffic, workers, vehicles and equipment, and over-head power lines.
- Traffic volume and vehicle composition.
- Nature and conditions at the work site and approaches to the work site.
- Other factors such as the time of day, sight distance, weather, presence of pedestrians, or cyclists, and the type of work being carried out.

- Other hazards in proximity to the work site (e.g., power lines, open excavations) that may have conflicting measures needing to be considered when developing the plan.

1.4 Site Preparation

The following management measures will be considered whenever working in traffic areas. In addition, remain aware of the amount of traffic around the working area. The work space should be large enough for the job to be completed safely. Check permit, traffic control plans, and flagger/police detail requirements for the local jurisdiction. Perform routine checks of the work zone to make sure there are adequate levels of protection.

1.4.1 Warning Cones and Warning Signs

GEI employees will comply with the Department of Transportation's (DOT) Manual on Uniformed Traffic Control Devices (MUTCD) and/or state regulations for temporary traffic barriers (cones, barriers) and sign placement when required for working in traffic areas. Clearly define the work site by placing traffic barriers around the work space to indicate the space that is needed to safely perform the work. The traffic barrier will help make the work site more visible to other workers and moving vehicles. Place traffic barriers to give yourself adequate space to work, so equipment is not outside the space. OSHA suggests placing the first warning sign at a distance calculated to be 4 to 8 times (in feet) the speed limit (in MPH).

1.4.2 Adequate Light

Requirements for night conditions and work areas with poor visibility are similar to day requirements; however there are a number of additional things to consider, such as visibility of the work site to advancing traffic and sufficient lighting. OSHA requires lighting for workers on foot and equipment operators to be at least 5 foot-candles or greater.

Visibility of the work area can be increased by employing the following measures:

- Using parked vehicles hazard and flashing lights.
- Wearing reflective safety vest that is in good condition.
- Providing adequate lighting to illuminate the work area. This lighting should be positioned so that there is no glare to approaching drivers.
- Placing advance warning signs and cones with retro reflective stripes so that they are visible to road users.

1.4.3 Distance from the Nearest Traffic Lane

Work areas located along roadsides will have a minimum clearance as defined by DOT's MUTCD and/or state or local DOT regulations for cone and sign placement.

1.4.4 PPE

The proper personal protective equipment (PPE), as outlined in the project HASP, will be worn when appropriate. The color/type of safety vest will comply with site regulations.

1.5 Equipment Operation

Vehicles and heavy equipment operators should use a spotter when possible if it is necessary to drive in reverse to reduce risk of collision with oncoming traffic. If it is necessary to drive against the flow of traffic make sure this area is within the work zone and properly blocked off from oncoming traffic.

1.6 Pedestrian Safety

When working near pedestrian traffic, a safe walkway will be established. Refer to local regulations when establishing pedestrian walkways.

1.7 Limitations

Follow safety procedures as defined in the site-specific HASP, federal DOT, and local jurisdictions. Appropriate PPE must be worn correctly to provide the intended level of protection.

1.8 References

DOT's Manual on Uniformed Traffic Control Devices (2009 Edition)
https://www.osha.gov/SLTC/etools/hurricane/work-zone.html

1.9 Attachments

None

1.10 Contact

GEI Corporate Health and Safety Officer
GEI East-North Regional Health and Safety Officer
GEI East-South Regional Health and Safety Officer
GEI Mid-West Regional Health and Safety Officer

GEI Western Regional Health and Safety Officer

STANDARD OPERATING PROCEDURES

SOP No. HS-018 Working Around Heavy Equipment

1.1 Objective

The objective of this standard operating procedure (SOP) is to prevent or limit the physical hazards when working around heavy equipment for GEI personnel.

1.2 General

This SOP is intended for use by employees engaged in work with the potential for working near heavy equipment. The site-specific health and safety plan (HASP) should include a hazard assessment for the project for working near heavy equipment to be implemented by GEI employees. These hazards should be reviewed in the project safety briefing and documented on the Project Safety Briefing form, found on the Health and Safety page of the GEI intranet.

1.3 Heavy Equipment

Heavy equipment (excavators, backhoes, drill rigs, etc.), can present many physical hazards that can result in serious injury or death if the proper safety precautions are not followed. The following is a list of precautions to be aware of when working around heavy equipment:

- Wear appropriate personal protective equipment (PPE), including a reflective, high-visibility safety vest.
- Always keep your distance from moving vehicles.
- Do not assume the vehicle operator knows where you are or where you are going. Make sure to make eye contact and receive acknowledgement of your presence with the operator. Avoid working near heavy equipment, but if unavoidable, communicate your location with the heavy equipment operators. If using hand signals, discuss the signals with the equipment operator prior to starting work.
- Watch for moving equipment. Construction sites can have a lot of activity and vehicles may be moving closer than you may think.
- Do not rely on back-up or other alarms. They may not be working or you may not hear them with the noise of other activities taking place in the area.
- Stay out of the swing radius of cranes, excavators, or other equipment that swings or rotates.
- Do not walk beside a moving vehicle, the vehicle may turn, slip, or the load may shift causing the vehicle to go off course.

- Do not ride on the outside of a moving vehicle.
- Always stay out from under a suspended load on cranes or hoists, even if it means taking the long way around.
- Do not walk behind a piece of equipment that is backing up. The operator may not see you.
- If working next to heavy equipment is unavoidable, be aware of the hazards including pinch points and moving parts. Use a spotter to watch the work area for moving equipment.
- If necessary, ask the operator to stop equipment operation to perform your work tasks.
- Verify the location and operation of emergency shut-off devices on the equipment.
- Be aware of the fuels and chemicals associated with the equipment. Have a spill prevention and response plan in place that includes the appropriate containment materials (i.e., spill kit).
- Do not wear loose fitting clothing when working around moving equipment (i.e., drill rig augers).
- Do not operate heavy equipment.
- Do not use cellular telephones near operating equipment.

1.4 Limitations

Follow safety procedures as defined in the site-specific HASP. Appropriate PPE must be worn correctly to provide the intended level of protection.

1.5 References

OSHA 29 CFR 1926.600 – Subpart O; Motor Vehicles, Mechanized Equipment, and Marine Operations.
www.*toolboxtopics.com*/Construction
Caterpillar Safety – http://safety.cat.com/

1.6 Attachment

None

1.7 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

STANDARD OPERATING PROCEDURES

SOP No. HS-025 Manual Lifting

1.1 Objective

The purpose of the GEI Consultants, Inc. (GEI) Manual Lifting SOP is to identify and reduce potential work-related musculoskeletal disorder (WMSD) hazards. The SOP is intended to comply with state regulations and safe work practices developed by the Occupational Safety and Health Administration (OSHA). Modifications to meet these requirements will be made to this program as changing laws or regulations dictate.

1.2 General

The following Safe Lifting guidelines will be followed by GEI employees involved in manual lifting activities:

- Before manual lifting is performed, a hazard assessment must be completed. The assessment must consider size, bulk, and weight of the object(s), if mechanical lifting equipment is required, if two-man lift is required, whether vision is obscured while carrying and the walking surface and path where the object is to be carried.
- Get a co-worker to help if equipment or other item is too heavy to lift.
- If possible, use powered equipment instead of manually lifting heavy materials. Lifting equipment such as dollies, hand trucks, lift-assist devices, jacks, or carts can be provided for employees.
- Reduce lifts from shoulder height and from floor height by repositioning the shelf or bin.
- Make sure walkways are clear of tripping hazards before moving materials.
- Use your legs and keep your back in a natural position while lifting. Keep the load close to your torso.

- Test the load to be lifted to estimate its weight, size, and bulk and to determine the proper lifting method.

- Do not twist while carrying a load. Instead, shift your feet and take small steps in the direction you want to turn.
- Make sure there are appropriately marked and sufficiently safe clearances for aisles and at loading docks or passageways where mechanical-handling equipment is used.
- Properly stack loose or unboxed materials which might fall from a pile by blocking, interlocking, or limiting the height of the pile to prevent falling hazards.
- Bags, containers, bundles, etc. should be stored in tiers that are stacked, blocked, interlocked, and limited in height so that they are stable and secure to prevent sliding or collapse.
- Storage areas should be kept free from accumulation of materials that could lead to tripping, fire, or explosion.
- Work methods and stations should be designed to minimize the distance between the person and the object being handled.

Supervision must periodically evaluate work areas and employees' work techniques to assess the potential for and prevention of injuries. New operations should be evaluated to engineer out hazards before work processes are implemented.

1.3 Injury Reporting

Injuries experienced during manual lifting activities should receive prompt medical attention. If a GEI employee suffers an injury on the job, he/she is to report the injury to their immediate supervisor within 2 hours of the incident. The supervisor will immediately notify the CSHO and Director of Human Resources.

After verbal notification has been made, an Incident and Accident Report Form is to be completed by the employee and/or Project Manager and submitted to Human Resources and the CHSO within 24 hours of its occurrence. This form is available on the Health and Safety site on the GEI Intranet.

Upon notification from a Branch or Office Manager, Human Resources, and/or the receipt of the Incident and Accident Report Form, the CHSO and/or the RHSO will conduct an investigation and evaluation of the incident and the incident response. Information received will be analyzed for the hazards and risk factors associated with the incident. The CHSO will then recommend (as necessary) engineering controls, PPE, training or other appropriate measures to minimize the potential for future musculoskeletal injuries. The CHSO/RHSO will develop educational information based on lessons learned for distribution to GEI employees.

1.4 Training

Training will include general principles of ergonomics, correct maul lifting training to avoid musculoskeletal injuries, recognition of hazards and injuries, procedures for reporting hazardous conditions, and methods and procedures for early reporting of injuries.

1.5 Ergonomic Evaluation Process

1.5.1 Requesting an Evaluation

An evaluation can be requested by the employee if they have concerns about their workstation, tasks, or are experiencing discomfort while working. The employee can request an evaluation by directly contacting their supervisor, Branch Manager, RHSO, HR or the CHSO via email. The Branch Manager will be notified of the requested evaluation. The Coordinator will send the Worksheet to the employee, who will complete it and return it to the Coordinator. The Coordinator will review the Worksheet and suggest modifications to the employee. If these modifications do not resolve the issue, the Coordinator will then schedule an in-person evaluation with the employee. If an employee is experiencing discomfort at their workstation and a request for an evaluation has been made, the evaluation will occur as soon as possible to assist the employee. If the Coordinator is not available another Coordinator will be assigned the evaluation.

Coordinators will be trained to treat the information obtained during the evaluation as confidential. If there are concerns the employee does not wish to discuss with the Coordinator due to their personal nature, a representative from HR will be designated to assist with the evaluation.

1.5.2 Job Hazard Analysis

Once the evaluation has been scheduled, the Coordinator will meet with the employee at their workstation and conduct the interview and review their work area. The Ergonomic Evaluation Checklist will help guide the Coordinator through a series of questions to help evaluate the potential ergonomic safety concerns. The evaluation is designed to be a conversation between the employee and Coordinator to help develop an open dialog. During the evaluation the Coordinator will identify ergonomic risk factors and implement immediate corrective actions, if possible. In many cases, simple adjustments can be made to the work station using existing equipment. Ergonomic work practices including “ergo breaks” and stretching can also be recommended.

1.5.3 Corrective Actions

During the evaluation the Coordinator may suggest adjustments that can be made to the existing work station. The employee will be encouraged to adopt the suggestions but ultimately has the choice to accept and implement them. Once the evaluation has been completed, the Coordinator will review the evaluation and if there are concerns, they will evaluate them with the HSC. Once the HSC has discussed the evaluation and developed corrective actions, they will be documented on the Checklist. The corrective actions will be shared with the employee and the Branch Manager. Prior to equipment purchases, approval will be authorized by the local branch manager.

Broken equipment will be taken out of service, properly disposed of and replaced. If improper equipment is being used, the proper equipment will be obtained or purchased with approval. If the employee's workspace presents a hazardous condition (fire hazards, trip hazards, noise exposure, etc.) the hazard will be corrected, if possible, or the employee will be moved to a safe workspace. If the equipment being used is not an appropriate fit for the employee, a suggestion will be made in the evaluation report to obtain or purchase the equipment that fits the employee properly.

If a repetitive task is identified, options will be discussed with the Branch Manager, the HSC and/or other appropriate personnel to evaluate whether the task can be altered to facilitate a safer condition. Many times accelerated deadlines, apprehension, or lack of options cause an employee to believe they don't have a choice and will just push through to complete the task potentially causing an ergonomic injury. These types of situations need to be recognized and corrected. A proactive approach by both the Branch Manager and employee should be instituted to prevent or anticipate these situations so that the correct equipment, additional employees or better planning can be incorporated while still meeting the deadline.

The organization of the workspace is also an important ergonomic factor. Items should be placed so that frequently used equipment is within arm's reach and located on the correct side of the body for which that equipment is used to prevent unnecessary twisting or reaching. Having adequate space to complete tasks is necessary but may not be achieved if piles and unnecessary items occupy the space. The Coordinator can suggest how to take advantage of tools and organizational skills to free up space.

Other areas of concern may be outside factors that occur away from the office. If the employee conducts field work, the tasks should be completed with ergonomics in mind.

A separate evaluation of these tasks may be conducted to determine if a different process or equipment may be used to reduce any unnecessary pressure or fatigue to the employee's body. At times when employees have permission to work from home or use their GEI computers at home, in hotels while traveling, in an environment that is not ergonomically correct, employees will be encouraged to adopt the ergonomic recommendations they learn at work.

Employee's hobbies can also pose ergonomic risks. Hobbies that involve repetitive motions, prolonged postures, vibration, excessive force/overexertion and adverse environmental factors may cause ergonomic injuries that can be aggravated at work.

During the interview process, the Coordinator will try to identify these risks and discuss techniques to help alleviate discomfort and minimize additional injury. It will be up to the employee to modify anon-related work risks.

If an employee is experiencing discomfort, efforts will be made to alleviate the discomfort while at work. For example, if an employee has a physical injury that occurred outside of work that requires them to keep their leg elevated, the employee can work with their Coordinator to determine a solution. This may involve temporarily modifying their workstation or transferring to another workstation. Healthy work practices and generally good health are keys to staying comfortable at work too. Regular stretch breaks, good posture, vision check-ups, good sleep habits and maintaining a healthy weight are factors in creating a comfortable work environment. If a physical non-work related problem persists and impedes the employee from being effective at work, suggestions may be made to see a personal physician for further advice.

1.5.4 Reporting and Follow-up

Once the evaluation has been completed and the Coordinator's suggestions have been implemented, the Coordinator will document the findings on the Checklist and an evaluation report will be completed and submitted to the employee, the evaluated employee's Branch Manager, and the CHSO. Then a follow-up will be conducted by the Coordinator to evaluate whether the adjustments were successful. The timeline for follow-up will be based on the adjustments suggested and employed. If new equipment is installed, the Coordinator will follow-up after the equipment has been installed and the employee has had time to adjust to it. If an injury has been identified, the Coordinator will notify the Branch Manager and CHSO immediately following the evaluation. This will confirm on-going management of the injury.

During the follow-up evaluation the Coordinator will make visits to the employee's workstation and assess visually and through interviews determine how the changes have been received. Each of these follow-ups will be documented on the Checklist. If during the follow-up a re-adjustment or different equipment is needed, the reevaluation process will continue until the employee is comfortable.

1.6 Limitations

Follow safety procedures for manual lifting.

1.7 References

OSHA Technical Manual (OTM), Section VII: Chapter 1 - Back Disorders And Injuries

1.8 Attachments

None

1.9 Contact

GEI Corporate Health & Safety Officer
GEI East – North Regional Health & Safety Officer
GEI East – South Regional Health & Safety Officer
GEI Central Regional Health & Safety Officer
GEI West Regional Region Health & Safety Officer

Pesticides

Pesticide Registration Manual Helps Applicants

Find application forms, guidance and more

1 2

About Pesticides

Pesticides can be used to control a variety of pests, such as insects, weeds, rats and mice, bacteria and mold, and more. Find out more about pesticides:

- What are pesticides?
- How EPA evaluates pesticide risks
- Understanding pesticide risks Exit
- How EPA regulates pesticides
- Pesticides and public health
- Sales and usage report

Protecting Health and the Environment

EPA's focus in overseeing pesticides is to ensure that human health and the environment are protected. Find out how we do this for some key issues:

- Pesticide worker safety
- Endangered species
- Protecting pollinators
- Reducing pesticide drift
- Reporting pesticide incidents

Pest Control

Find information on controlling pests with both chemical and non-chemical methods. This integrated pest management approach helps protect health and the environment.

Pesticide Regulation

EPA regulates pesticides so they are safe when used according to the label directions. Learn about the regulation processes.

- Pesticide registration

- Bed bugs
- Pest control and pesticide safety for consumers
- Managing pests in schools
- Insect repellents
- Mosquito control
- Protecting pets from fleas and ticks
- Pesticide reevaluation
- PRIA fees
- Pesticide science and assessing pesticide risk
- Regulating biotechnology under TSCA and FIFRA
- Pesticide labels
- Pesticide tolerances

Partners

Our success depends on working with other regulators and getting input from people who have an interest in pesticide issues. Learn more.

- Advisory committees and regulatory partners
- Pesticide applicator certification in Indian country
- International activities
- Pesticide Environmental Stewardship Program
- Partnerships to educate pesticide workers

Pesticide Ingredients and Products

Find information about some of the pesticide ingredients we regulate.

- Ingredients used in pesticide products
- Minimum risk pesticides
- Soil fumigants
- Rodenticides
- Biopesticides
- Antimicrobials

For Kids

Children have a strong interest in environmental issues. We hope they have some fun learning with these pages.

- Endangered species coloring book
- Endangered species poster
- Join our Pest Patrol: A backyard activity book on integrated pest management
- Help! It's a Roach!

Tools

These pages can help you find the information you are looking for.

- A-Z index
- Pesticide chemical search
- Pesticide Product Label System
- Analytical methods for pesticides
- Pesticide contacts
- Visit the Office of Pesticide Programs
- Freedom of Information Act requests
- Public involvement opportunities

National Pesticide Information Center Exit

More Highlights

- New Use (First Food Use) Registered - Isaria fumosorosea strain FE 9901
- Decision to establish import tolerances in/on milk and meat commodities for Aminocyclopyrachlor
- Antimicrobial Data Requirements Training Videos, 40 CFR Part 158W
- Draft Guidance on Managing Pesticide Resistance

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STANDARD OPERATING PROCEDURE

SG-001 General Guidance on Soil Vapor Intrusion Evaluations

1. Objective

The goal of a soil vapor intrusion evaluation is to assess whether complete exposure pathways of soil vapor to indoor air exist. A complete exposure pathway exists if vapors from constituents are migrating through various pathways into residential or commercial buildings at concentrations that may result in an unacceptable human health risk. If a complete exposure pathway does not exist, then further assessment of soil vapor intrusion is not required.

Depending on the status of investigation performed at the site it may be appropriate to approach an evaluation of soil vapor intrusion at different tiers. If little work has been performed relative to the potential for contaminants to affect soil vapor near a structure, then a screening level assessment is an appropriate first step. However, if a plume is well delineated and the potential for groundwater impacts, or nearby source material, to affect soil vapor near a potential receptor structure is well understood, then it may be more appropriate to directly develop and implement a soil vapor and/or indoor air sampling plan. To accommodate the potential varied states of knowledge when a vapor intrusion evaluation is required, a flexible approach is needed that incorporates the following elements.

- SOP SG-002 Soil Vapor Sample Collection
- SOP SG-003 Sub-Slab Soil Vapor Collection
- Indoor Air Sampling
- SOP SG-004 Ambient Air Sample Collection

Soil vapor intrusion evaluations should be approached on a site-specific basis and depending on the site-specific setting and proximity to impacted groundwater or source material, it may be appropriate to proceed in a hierarchical fashion through each tier of evaluation or a variety of tiers may be combined and implemented simultaneously. The SOPs presented in this SOP address each of these sampling procedures.

2. Execution

2.1. Implementation Triggers

Soil vapor intrusion evaluations may be implemented at various times based on event triggers throughout the Site Characterization (SC), Remedial Investigation (RI), and site remedial action plan. The following event triggers would require the implementation of this soil vapor intrusion investigation.

- Identification of a potential complete exposure pathway
- Private property owner request for sampling

- State or Federal administrative order

2.2. Factors Affecting Soil Vapor Intrusion

Prior to conducting a soil vapor intrusion assessment at a private property, an analysis of the factors contributing to the migration of soil vapor to indoor air should be conducted. The completion of this analysis should take into account the two types of factors: environmental and building factors.

2.2.1. Environmental Factors

Environmental factors include site specific conditions in the subsurface and above the ground surface that may affect the rate and direction at which soil vapor may migrate.

The soil and groundwater conditions between the contamination and the residential/commercial building should be evaluated and recorded in any soil vapor intrusion investigation. If the SC/RI has been completed, then the data are available for this review. If the SC/RI has not been completed, then at a minimum the nature and extent of impacted soil and/or groundwater between the site and the residential/commercial building should be defined.

After compiling the necessary site-specific data, that information should be reviewed to determine groundwater conditions at the site. The potential for man-made or natural preferential pathways for vapor migration in the vadose zone and/or for groundwater migration in the saturated zone should also be determined at this time.

- The depth to groundwater below the residential or commercial building will be determined. For example, in cases where groundwater intersects the foundation there is no vadose zone to collect a sub-slab sample. In cases where the groundwater is close to the foundation, there is a risk of causing/exacerbating groundwater intrusion through the foundation during periods of high groundwater.

Additional Site Observations

- Direction of groundwater flow from the contaminant source to the residential or commercial building;
- The location, depth, extent, and concentration of potential constituents in unsaturated soil and groundwater on the property; and,
- Presence of an overlying water bearing zone that does not have impacts beneath the residential or commercial building. An un-impacted shallow water zone will significantly retard or completely prohibit the potential for deeper impacted groundwater to affect soil vapor.
- Potential “smear zones” (residual non-aqueous phase liquid (NAPL) present at depths over which the water table fluctuates) should also be identified as they may also affect the rate of soil vapor migration.
- Location, depth, extent of NAPL, if present.

Soils which are highly organic, wet, and/or of low permeability should be identified. If these soils are present beneath a structure and above impacted groundwater or soil, they may effectively shield the building from potential vapor intrusion. Conversely, dry and porous soils underlying a building may provide a less inhibited soil vapor intrusion pathway. The limits of backfill surrounding residential or commercial building should be also noted.

2.2.2. Building Factors

Building Factors include the physical characteristics, such as structure, floor layout, air flow, and physical conditions. These conditions will be documented during the evaluation. The New York State Department of Health (NYSDOH) Center for Environmental Health's Indoor Air Quality Questionnaire and Building Inventory form is presented in Attachment A. At a minimum, the following information should be recorded.

- Building foundation construction characteristics (basement, footers, crawl spaces, etc), including potential preferential vapor intrusion pathways such as foundations cracks and utility penetrations.
- Basement wall materials (hollow block, stone, or poured concrete, etc.)
- Presence of an attached garage.
- Recent renovations to the building such as new paint or new carpet.
- Mechanical heating/cooling equipment that may affect air flow.
- Use and storage of petroleum products such as home heating oil storage tanks, underground storage tanks (USTs), or kerosene heaters.
- Recent use of petroleum-based finish or other products containing volatile organic compounds (VOCs).
- Areas of pavement on the property should also be identified in the event sub slab vapor sampling is not feasible or appropriate due to a high groundwater table. Paved areas could serve as surrogate locations in lieu of sub slab soil vapor sampling if high water table conditions exist.

The construction materials and integrity of the floor of the structure closest to the potential point of entry for soil vapor (basement level or first floor for slab-on-grade constructions) should be identified. In addition to the foundation type and integrity, this survey should note any preferential pathways (utility lines/pipes, sumps, etc.) that may exist within the bottom-most level of the structure.

The operation and presence of heating systems, including fireplaces and clothes dryers, may create a pressure differential between the structure and the outside environment, causing an increase of migration of soil vapor into the building. The NYSDOH guidance document suggests limiting indoor air sampling to the heating season (with the exception of immediate inhalation hazard situations), which is roughly defined as November 15th to March 31st. However, sampling may be completed at any time during the year for any sampling completed in response to a request by a community member. In situations where non-heating season sampling has taken place, consideration should be given to re-sampling the property within the heating season. The operation of HVAC systems should be noted on the building inventory form (Attachment A).

During the initial building assessment and visit, and again when sub-slab soil vapor and/or indoor air sampling are performed, differential pressure measurements between indoor air, ambient air, and soil vapor should be collected and recorded to document the potential effect building conditions have on soil vapor migration.

2.2.3. Property Visit

A property visit will be conducted prior to sampling. During the site visit, technical representatives will complete site visit observations, inventories and occupant questionnaire forms (Appendix A). During the course of the interview, observations will be made to identify any potential areas or issues of concern or the presence of any odors, and if sampling appears necessary, identify potential sampling points and general building characteristics. The questionnaire is also used to identify potential sources and activities that may interfere with sampling results. The questionnaire will specifically address the activities of the occupant's (e.g., smoking, work place activities) that may contribute to indoor air concentrations of volatile chemicals.

The responses to the questionnaire will be evaluated and a determination will be made as to whether additional investigation is required.

2.2.4. Chemical Inventory

The chemical inventory complements the identification of the building factors affecting soil vapor intrusion. The chemical inventory will identify the occurrence and use of chemicals and products throughout the building. These products can be used to develop an indoor environmental profile. A separate inventory should be prepared for each room on the floor being tested as well as any other indoor areas physically connected to the areas being tested. Inventories will include product names, chemical ingredients, or both. If possible, photographs of the products should be taken of the location and condition of the inventoried products and the photographic records should be indexed with the inventory records. The products inventory can also be used to document odors and if possible portable vapor monitoring equipment measurements should be taken and recorded. A product inventory will be repeated prior to each round of testing at the building. If available, the volatile ingredients should be recorded for each product. If the ingredients are not listed on the label, record the manufacturer's name and address or phone number if available. The product inventory form is presented in Attachment A.

2.2.5. Water Table Conditions and Vapor Intrusion Assessment Approach

Sub-slab soil vapor sampling is intended to evaluate the potential for vapor intrusion. However, there are circumstances where collection of sub-slab soil vapor samples may not be feasible if the water table is near, at, or above the elevation of a buildings foundation slab. An evaluation of the water table elevation relative to the building slab should be made before attempting to install a sub-slab vapor sampling point.

If the water table is found to be sufficiently below the building slab and sub-slab vapor sampling can be performed, then the following Low Water Table Scenario should be followed.

2.2.5.1. Low Water Table Scenario

If the water table elevation is lower than the basement slab, then the following samples should be collected.

- Sub-slab soil vapor samples
- Indoor air samples from basement level
- Indoor air samples from main living space (First floor)
- Outdoor ambient air sample

If the water table is deemed to be at too high of an elevation to allow sub-slab vapor sampling, then alternate means of evaluating the potential for vapor intrusion must be employed. If a building has a groundwater sump, the sump should be evaluated to determine if there is water present in the sump and if that water is representative of groundwater or if the water is stagnant. If water in the sump represents groundwater, then a sample from the sump should be collected. The High Water Scenario below summarizes the methods to evaluate potential vapor intrusion if sub-slab vapor sampling cannot be conducted due to high groundwater conditions.

2.2.5.2. High Water Table Scenario

If the water table elevation is higher than the basement slab, then the following tasks should be performed.

- Determine if a sump pump is present and actively pumping water.
- If sump is actively pumping, collect a sample of groundwater from the sump.
- Collect an indoor air sample from basement level.
- Collect an indoor air sample from main living space (first floor).
- Identify exterior soil vapor sample location near foundation (outside of foundation backfill) and preferably beneath a surrogate vapor cap (e.g. paved driveway, patio).
- Collect soil vapor samples from exterior soil vapor location
- Collect an outdoor ambient air sample.

3. References

USEPA modified Method TO-15 and helium via ASTM D-1945.

Section 2.7.1 of the New York State Department of Health (NYSDOH) Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, dated October 2006.*

4. Attachments

Attachment A - NYSDOH Center for Environmental Health's Indoor Air Quality Questionnaire and Building Inventory Form

5. Contact

Chris Berotti

ATTACHMENT A

Off-Site Property Sampling Documentation Form

Property Location/Address: ______________________________

Property: ____________________________

Sampling Date: ____________________________

Property Location/Address: ______________________________
Property: _____________________________
Sampling Date: _____________________________

Preparer's Name: ________________________________ Date/Time Prepared: ______________

Preparer's Affiliation: ________________________________ Phone No.: __________________

Purpose of Investigation:____

1. OCCUPANT Interviewed: Yes ☐ No ☐

Last Name: _____________________________ First Name: ____________________________

Address: ____

County: _______________________

Home Phone: ___________________________ Office Phone: __________________________

Number of Occupants/persons at this location _______ Age of Occupants__________________

2. OWNER OR LANDLORD (Check if same as occupant __) Interviewed: Yes ☐ No ☐

Last Name: _____________________________ First Name: ____________________________

Address: ____

County: _______________________

Home Phone: ___________________________ Office Phone: __________________________

3. CONTACT NAME (Check if same as Occupant ____, Owner ____)

Last Name: _____________________________ First Name: ____________________________

Address: ____

County: _______________________

Home Phone: ___________________________ Office Phone: __________________________

4. PROPERTY LOCATION: ____

Relative to Site:

Direction _________ Direction to Nearest Cross Street: __________

Distance _________ Distance to Nearest Cross Street: __________

Surrounding Land Use:

North: _________________ East: _________________

South: _________________ West: _________________

Property Location/Address: ______________________________
Property: ____________________________
Sampling Date: ____________________________

5. PROPERTY BOUNDARIES

Delineate the boundaries of the property (on a separate project map, outline property location, private well location, septic/leachfield location, groundwater flow, compass direction, windrose.)

6. BUILDING CONSTRUCTION

Type of Building (Circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other: ________________

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Log Home	Other:_______________

If multiple units, how many? ________

If the property is commercial, type?

Business Type(s) ____________________________________

Does it include residences (i.e., multi-use)? Yes □ No □

If yes, how many? ______

Other characteristics:

Number of floors______ Building age______

Is the building insulated? Yes □ No □ How air tight? Tight / Average / Not Tight

Construction Material ___________________________________

7. BASEMENT AND CONSTRUCTION CHARACTERISTICS

Does the building have a basement and/or crawl space, or is it slab-on-grade construction?

____

Describe the construction of the basement/crawl space (Circle all that apply)

a. Above grade construction:	wood frame	concrete	stone	brick
b. Basement type:	full	crawlspace	slab	other ________

Property Location/Address: ______________________________
Property: ______________________________
Sampling Date: ______________________________

c. Basement floor:	concrete	dirt	stone	other ________
d. Basement floor surface:	uncovered	covered	covered with ____________	
e. Concrete floor:	unsealed	sealed	sealed with _____________	
	unpainted	painted	painted with ____________	
f. Foundation walls:	poured	block	stone	other ________
g. Foundation walls:	unsealed	sealed	sealed with _____________	
h. The basement is:	wet	damp	dry	moldy
i. The basement is:	finished	unfinished	partially finished	

Does your basement have a sump? Yes □ No □

Is, is there water in the sump? Yes □ No □

Describe sump conditions:____

____

Have you observed standing water in your basement? Yes □ No □

If so, what is the frequency of this observation? _____________During rain events? □

Have you observed sheen atop the standing water? Yes □ No □

Basement/Lowest level depth below grade: ________(feet)

Are there any cracks in the floor of your basement? Yes □ No □

Description: ____

____

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

Description: ____

____

What activities occur in the finished basement?

Description: ____

____

Approximately how many hours per day (or week) do you spend in your basement? __________

8. HEATING, VENTING AND AIR CONDITIONING

Type of heating system(s) used in building: (Circle all that apply – note primary)

Property Location/Address: ______________________________
Property: ____________________________
Sampling Date: ____________________________

Hot Air Circulation	Hot Water Baseboard	Steam Radiation
Electric Baseboard	Heat Pump	Wood Stove
Space Heaters	Radiant Floor	Outdoor wood boiler

Unvented Kerosene Heater   Other ______________________________

The primary type of fuel used is:

Fuel Oil	Natural Gas	Electric
Kerosene	Propane	Solar
Wood	Coal	Other? ____________________

Time of use of each type of heating? ____

Domestic hot water tank fueled by: ____

Boiler/furnace located in: Basement Outdoors Main Floor Other________________

Air conditioning: Central Air Window units Open Windows None

Are there air distribution ducts present? Yes □ No □

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

____

Type of insulation (e.g. blown, fiber, etc.)? ____

Does building have energy efficient windows (e.g. double paned) Yes □ No □

Was weather-stripping recently added/upgraded? Yes □ No □

Particleboard used in construction? Yes □ No □

9. OCCUPANCY

Property Location/Address: ______________________________
Property: ____________________________
Sampling Date: ____________________________

Level	General Use of Each Floor (e.g., family room, bedroom, laundry, workshop, storage)
Basement	____
1st Floor	____
2nd Floor	____
3rd Floor	____
4th Floor	____

10. BULK PETROLEUM STORAGE

Aboveground storage tank on the property Yes ☐ No ☐

If yes, how old is tank? ______________ Condition? _________________

Last inspected? ______________ Location: ___________________

Describe conduits to building (type, location, and entry portal condition): ________________

____

Underground storage tank on the property. Yes ☐ No ☐

If yes, how old is tank? ______________ Condition? _________________

Last inspected? ______________ Location: ___________________

Describe conduits to building (type, location, and entry portal condition): ________________

____

11. WATER AND SEWAGE

Water Supply:

Public Water Drilled Well Driven Well Dug Well Other _____________

Is there use of groundwater water for irrigation purposes? Yes ☐ No ☐

Sewage Disposal:

Public Sewer Septic Tank Leach Field Dry Well Other _____________

12. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Yes ☐ No ☐

If not, is there a separate garage or carport? Yes ☐ No ☐

b. Does the garage have a separate heating unit? Yes ☐ No ☐ NA ☐

Property Location/Address: ______________________________
Property: ______________________________
Sampling Date: ______________________________

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car)
Yes ☐ No ☐ NA ☐ Please specify__________________

Is gasoline stored in the garage? Yes ☐ No ☐

Quantity? ________________

d. Has the building ever had a fire? Yes ☐ No ☐

When?_________________

e. Is a kerosene or unvented gas space heater present? Yes ☐ No ☐

Where? ________________

f. Is there a workshop or hobby/craft area? Yes ☐ No ☐

Where & Type? ________________

g. Is there smoking in the building? Yes ☐ No ☐

How frequently? _______________

h. Have cleaning products been used recently? Yes ☐ No ☐

When & Type? ________________

i. Have cosmetic products been used recently? Yes ☐ No ☐

When & Type? ________________

j. Has painting/staining been done in the last 6 months? Yes ☐ No ☐

Where & When? _______________

Is house paint stored inside? Yes ☐ No ☐

Where? _______________

k. Is there new carpet, drapes or other textiles? Yes ☐ No ☐

Where & When? _______________

l. Have air fresheners been used recently? Yes ☐ No ☐

When & Type? ________________

m. Is there a kitchen exhaust fan? Yes ☐ No ☐

If yes, where vented?____________

n. Is there a bathroom exhaust fan? Yes ☐ No ☐

If yes, where vented?____________

o. Is there a clothes dryer? Yes ☐ No ☐

If yes, is it vented outside? Yes ☐ No ☐

p. Has there been a pesticide/chemical fertilizer application? Yes ☐ No ☐

Property Location/Address: ____________________________
Property: ___________________________
Sampling Date: ___________________________

When & Type?____

Conducted by Owner or Private Yard Service _________________________

Is yard waste/trash burned on-site? Yes ☐ No ☐

Do any of the building occupants use solvents at work? Yes ☐ No ☐

(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? Yes ☐ No ☐

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, Use dry-cleaning regularly (weekly) No

Use dry-cleaning infrequently (monthly or less) Unknown

Yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Yes ☐ No ☐

Date of Installation: ___________

Is the system active or passive? Active ☐ Passive ☐

Are there any recent/past improvements to building? Yes ☐ No ☐

Interior painting? ____

Any landscaping improvements that involved bringing fill on site? Yes ☐ No ☐

Other ____

Approximately when (how long ago) did these improvements occur? _____________

Does anyone living here engage in any of the following activities or hobbies?

a. Art projects (e.g. oil painting, ceramics, pottery, stained glass, metal sculpture)

Yes ☐ No ☐

Name: __________________________ Age: ________ Sex: ____________

Name: __________________________ Age: ________ Sex: ____________

Property Location/Address: ______________________________
Property: ______________________________
Sampling Date: ______________________________

b. Furniture refinishing Yes ☐ No ☐

Name: ____________________________ Age: _________ Sex: _____________

Name: ____________________________ Age: _________ Sex: _____________

c. Model building(e.g. planes,boats,cars) Yes ☐ No ☐

Name: ____________________________ Age: _________ Sex: _____________

Name: ____________________________ Age: _________ Sex: _____________

d. Gardening Yes ☐ No ☐

Name: ____________________________ Age: _________ Sex: _____________

Name: ____________________________ Age: _________ Sex: _____________

e. Automotive work Yes ☐ No ☐

Name: ____________________________ Age: _________ Sex: _____________

Name: ____________________________ Age: _________ Sex: _____________

f. Ammunition reloading Yes ☐ No ☐

Name: ____________________________ Age: _________ Sex: _____________

Name: ____________________________ Age: _________ Sex: _____________

Is there a wood burning stove? Yes ☐ No ☐

If so, how frequently is it used?

____

____

Is there a barbeque grill? Yes ☐ No ☐

If so, how frequently is it used? What is the type of fuel?

____

____

Has the building ever had fumigation? Yes ☐ No ☐

Property Location/Address: ____________________________
Property: ___________________________
Sampling Date: ___________________________

If so, when and how frequently? Type?

____

____

13. ODOR SUMMARY

Have the occupants observed any unusual odors? ___________________________________

____

____

____

____

History of odor observation – date of onset, duration, severity, etc.

____

____

____

____

____

____

____

14. PRODUCT INVENTORY

Record the specific products found in building that have the potential to affect indoor air quality on the attached product inventory form.

15. INDOOR SKETCH

Draw a plan view sketch (on grid paper) of the basement, first floor, and any other floor where sampling was conducted in the building as well as any outdoor sample locations. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Property Location/Address: ______________________________
Property: _____________________________
Sampling Date: _____________________________

Product Inventory
Off-Site Property Sampling Documentation
Soil Vapor Intrusion Investigation

Property Address:	**Performed by:**
Date of Inventory:	**Field Instrument Make & Model:**

Location	Product Description	Size (units)	Condition *	Chemical Ingredients	Field Instrument Reading (units)	Photo ** Y/N

Notes

* Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D)

** Photographs of the front and back of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

STANDARD OPERATING PROCEDURE

SG-003 Sub-slab Soil Vapor Collection

1. Objective

This procedure outlines the general steps to collect sub-slab soil vapor samples. The site-specific Sampling and Analysis Work Plan should be consulted for proposed sample locations, sample depths, and sampling duration.

2. Execution

Permanent and temporary sub-slab soil vapor probes will be installed using the procedures outlined below. All sub-slab soil vapor probes will be installed using a direct-push drill rig (e.g., Geoprobe® or similar), hand auger, or manually using a slide hammer.

2.1. Document Field Conditions

Document pertinent field conditions prior to installation of any probe locations.

- Record weather information (precipitation, temperature, barometric pressure, relative humidity, wind speed, and wind direction) at the beginning of the sampling event. Record substantial changes to these conditions that may occur during the course of sampling. The information may be measured with on-site equipment or obtained from a reliable source of local measurements (e.g., a local airport). Data should be obtained for the past 24 to 48 hours. Record the indoor conditions (temperature, heating/cooling system active, windows open/closed, etc.).
- Measure the differential pressure at the building. Measure the indoor and outdoor barometric pressure using a high resolution device. Where possible, measure the sub-slab barometric pressure at the sampling point.
- If sampling near a commercial or industrial building, uses of volatile chemicals during normal operations of the facility should be identified.
- Indoor floor plan sketches should be drawn that include the floor layout with sampling locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, heating, ventilating and air conditioning (HVAC) system air supply and return registers, compass orientation (North), footings that create separate foundation sections, and any other pertinent information should be completed;
- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sampling locations (if applicable), compass orientation (north), and paved areas.
- Any pertinent observations should be recorded, such as odors and readings from field instrumentation.

2.2. Sub-Slab Soil Vapor Point Installation Specifications

Each sub-slab soil vapor point will be constructed as follows:

- Drill an approximately 3/8-inch hole through the slab. If necessary, advance the drill bit 2-3 inches into the sub-slab material to create an open cavity.
- Using dedicated inert Teflon or stainless steel tubing of laboratory or food grade quality, insert the inlet of the tubing to the specified depth below the slab. For permanent installation, only stainless steel tubing and fittings will be used.
- For permanent point installations, the annular space surrounding the vapor probe tip will be filled with a porous backfill material (e.g., glass beads or coarse silica sand) to cover 1-inch of the above the tip of the probe.
- Seal the annular space between the hole and the tubing using an inert non-shrinking sealant such as melted 100% beeswax, permagum grout, putty, etc. For permanent installations, cement may be used.
- For permanent points, a protective casing will be set around the top of the point tubing and grouted in place minimize infiltration of water or ambient air, as well as to prevent accidental damage to he permanent point.
- The tubing top will be fitted with a Swagelok® and cap to prevent moisture and foreign material from infiltrating the tubing.

In cases where sub-slab sampling is impractical or infeasible, a surrogate location (attached garage, concrete patio, asphalt driveway, etc.) may be used if it is representative of sub-slab conditions. In surrogate locations, the vapor sampling point may be installed in accordance with SOP SG-002 Soil Vapor Collection.

2.3. Sub-Slab Soil Vapor Sample Collection

Sub-slab soil vapor samples will be collected as indicated in the site-specific Sampling and Analysis Work Plan and in accordance with state or Federal guidance documents. Specifically, sub-slab samples from the points will be collected as follows:

- Document pertinent field conditions prior to sampling as described above.
- A suction pump will be used to remove one to three implant volumes from the sub-slab soil vapor points prior to sampling. Include the volume of any additional tubing added to affix sampling equipment and the annular space between the probe and the native material if sand or glass beads were used.
- The purge rate shall not exceed 0.2 liters per minute.
- Samples will be collected in an individually laboratory certified clean 1-liter SUMMA® canister (or equivalent) using a certified flow controller calibrated for the anticipated sample duration (4 minutes). The regulator flow rate will not exceed 0.2 liters per minute.
- A helium tracer gas will be used to identify any potential migration or short circuiting of ambient air during sampling as described below.

- Remove the protective brass plug from the canister. Connect the pre-calibrated flow controller to the canister.
- Record the identification numbers for the canister and flow controller.
- Record the initial canister pressure on the vacuum gauge (check equipment-specific instructions for taking this measurement). A canister with a significantly different pressure than originally recorded by the testing laboratory should not be used for sampling. Record these numbers and values on the chain-of-custody form for each sample.
- Connect the tubing from the sub-slab soil vapor probe to the flow controller.
- Open the valve on the canister. Record the time that the valve was opened (beginning of sampling) and the canister pressure on the vacuum gauge.
- Photograph the canister and the area surrounding the canister.
- Monitor the vacuum pressure in the canister routinely during sampling.
- Stop sample collection when the canister still has a minimum amount of vacuum remaining. Check with the laboratory supplying the canister and flow controller for the ideal final vacuum pressure. Typically, the minimum vacuum is between 2 and 5 inches of mercury, but not zero. If there is no vacuum remaining, the sample will be rejected and collected again in a new canister.
- Record the final vacuum pressure and close the canister valve. Record the date and time that sample collection was stopped.
- Remove the flow controller from the canister and replace the protective brass plug.
- Attach labels/tags (sample name, time/date of sampling, etc.) to the canister as directed by the laboratory.
- Place the canister and other laboratory-supplied equipment in the packaging provided by the laboratory.
- Enter the information required for each sample on the chain-of-custody form, making sure to include the identification numbers for the canister and flow controller, and the initial and final canister pressures on the vacuum gauge.
- Samples will be analyzed for volatile organic compounds (VOCs) and naphthalene via modified USEPA modified Method TO-15 and helium via ASTM D-1945
- Include the required copies of the chain-of-custody form in the shipping packaging, as directed by the laboratory. Maintain a copy of the chain-of-custody for the project file.
- Deliver or ship the samples to the laboratory as soon as practical.
- All laboratory analytical data will be validated by a data validation professional in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, January 2005 and the USEPA Region II Standard Operating Procedure (SOP) for the Validation of Organic Data modified to accommodate the USEPA Method TO-15 and natural gas analysis by ASTM D-1945.

2.4. Tracer Gas Evaluation

The tracer gas evaluation provides a means to evaluate the integrity of the sub-slab soil vapor probe seal and assess the potential for introduction of indoor air into the sub-slab soil vapor sample. A tracer gas evaluation should be conducted on the each temporary sub-slab soil vapor probe to be sampled in a sampling event. A tracer gas evaluation should be conducted on the each permanent sub-slab soil vapor probe during the initial sampling event and a minimum of 10% of the sub-slab soil vapor probes during subsequent sampling events.

The following tracer gas evaluation procedure uses helium as a tracer gases which can be measured through laboratory analysis or by a portable detector.

- Retain the tracer gas around the sub-slab sample probe by filling an air-tight chamber (such as a plastic bucket) positioned over the sample location.
- Make sure the chamber is suitably sealed to the ground surface.
- Introduce the tracer gas into the chamber. The chamber will have tubing at the top of the chamber to introduce the tracer gas into the chamber and a valved fitting at the bottom to let the ambient air out while introducing tracer gas. Close the valve after the chamber has been enriched with tracer gas at concentrations >10%.
- The chamber will have a gas-tight fitting or sealable penetration to allow the sub-slab soil vapor sample probe tubing to pass through and exit the chamber.
- After the chamber has been filled with tracer gas, attach the sample probe tubing to a pump that will be pre-calibrated to extract sub-slab soil vapor at a rate of no more than 0.2 lpm. Purge the tubing using the pump. Calculate the volume of air in the tubing and purge one to three tubing volumes prior collecting an analytical sample or using a portable device to measuring the tracer gas concentration.
- Samples collected from vapor points during a tracer gas evaluation will be analyzed for VOCs and naphthalene via modified USEPA modified Method TO-15 and helium via ASTM D-1945.
- Alternately, a tracer gas detector may be used to verify the presence of the tracer gas in the chamber by affixing it to the valve fitting at the bottom of the chamber. The tracer gas detector may also be used to measure the tracer gas concentration in the pump exhaust during purging. If used, then record the tracer gas concentrations in the chamber and in the soil vapor sample.
- Based on the concentrations of the tracer gas detected during analysis or direct measurement, determine whether additional gas tracer evaluations are necessary:

If the evaluation on a probe indicates a high concentration of tracer gas in the sample (>10% of the concentration of the tracer gas in the chamber), then the surface seal is not sufficient and requires improvement via repair or replacement prior to commencement subsequent sample collection.

A non-detectable level of tracer gas is preferred; however, if the evaluation on a probe indicates a low potential for introduction of ambient air into the sample (<10% of the concentration of the tracer gas in the chamber), then proceed with the soil vapor sampling. While lower concentrations of tracer gas are acceptable, the impact of the detectable leak on sample results should be evaluated in the sampling report.

3. References

USEPA modified Method TO-15 and helium via ASTM D-1945.

Section 2.7.1 of the New York State Department of Health (NYSDOH) Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York, dated October 2006.

4. Contact

Chris Berotti

STANDARD OPERATING PROCEDURE

SG-004 Ambient Air Sample Collection

1. Objective

Describe procedures to collect ambient air samples. The site-specific Work Plan should be consulted for proposed sample locations and sampling duration.

2. Execution

2.1. Document Field Conditions

Document pertinent field conditions prior to sample collection:

- Record weather information, if available (such as precipitation, temperature, barometric pressure, relative humidity, wind speed, and wind direction) at the beginning of the sampling event. Record substantial changes to these conditions that may occur during the course of sampling. The information may be measured with on-site equipment or obtained from a reliable source of local measurements (e.g., a local airport). Data should be obtained for at least the past 12 hours.
- If sampling near a commercial or industrial building, uses of volatile chemicals during normal operations of the facility should be identified.
- Outdoor plot sketches should be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor air sampling locations (if applicable), and compass orientation (North).
- Any pertinent observations should be recorded, such as odors and readings from field instrumentation.

2.2. Sample Collection

- Samples should be collected in laboratory-certified clean SUMMA® canister (or equivalent) using a flow controller calibrated for the anticipated sample duration (1-hour, 8-hour, etc.). The regulator flow rate should not exceed 0.2 liters per minute.
- Place the canister at the sampling location. If the sample is collected from breathing height (e.g., 3 to 5 feet above ground), then mount the canister on a stable platform such that the sample inlet should be at the proper height.
- Remove the protective brass plug from canister. Connect the pre-calibrated flow controller to the canister.
- Record the identification numbers for the canister and flow controller.
- Record the initial canister pressure on the vacuum gauge (check equipment-specific instructions for taking this measurement). A canister with a significantly different pressure than originally recorded by the testing laboratory should not be used for sampling. Record these numbers and values on the chain-of custody form for each sample.

- Connect the tubing to the flow controller.
- Open the valve on the canister. Record the time that the valve was opened (beginning of sampling) and the canister pressure on the vacuum gauge.
- Photograph the canister and the area surrounding the canister.
- If possible, monitor the vacuum pressure in the canister routinely during sampling. During monitoring, note the vacuum pressure on the gauge.
- Stop sample collection after the scheduled duration of sample collection but make sure that the canister still has a minimum amount of vacuum remaining. Check with the laboratory supplying the canister and flow controller for the ideal final vacuum pressure. Typically, the minimum vacuum is between 2 and 5 inches of mercury, but not zero. If there is no vacuum remaining, call the laboratory and discuss the sample viability with them. Determine whether another sample will be taken after sharing the laboratory's opinion with your project manager.
- Record the final vacuum pressure and close the canister valves. Record the date and time that sample collection was stopped.
- Remove the flow controller from the canister and replace the protective brass plug.
- Attach labels/tags (sample name, time/date of sampling, etc.) to the canister as directed by the laboratory.
- Place the canister and other laboratory-supplied equipment in the packaging provided by the laboratory.
- Enter the information required for each sample on the chain-of-custody form, making sure to include the identification numbers for the canister and flow controller, and the initial and final canister pressures on the vacuum gauge.
- Include the required copies of the chain-of-custody form in the shipping packaging, as directed by the laboratory. Maintain a copy of the chain-of-custody for the project file.
- Deliver or ship the samples to the laboratory as soon as practical.

3. References

USEPA modified Method TO-15 and helium via ASTM D-1945

Section 2.7.1 of the New York State Department of Health (NYSDOH) Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, dated October 2006.*

4. Contacts

Chris Berotti
Bill Simons

STANDARD OPERATING PROCEDURE

SM-002 VOC Soil Sample Collection and Preservation Method

1. Objective

Describe methods to collect and preserve soil samples for analysis of Volatile Organic Compounds (VOCs) in accordance with the U.S. Environmental Protection Agency (EPA) Method 5035.

Some states have adopted soil sampling and preservation methods that vary from the procedures presented herein. Confirm that this method is appropriate for your project.

2. Execution

VOCs evaporate readily at normal temperatures and pressures. Care should be taken during sampling and preservation to limit the potential for VOCs to off-gas from the soil sample prior to being analyzed by the laboratory.

Soil samples should be obtained utilizing a small diameter core sampler such as a 10 milliliter (ml) plastic disposable syringe, an EnCore® sampler, an EasyDraw Syringe®. The EnCore® sampler is the only EPA-approved small diameter core sampler that can be used to collect the sample, store the sample, and transport the sample to the lab.

A separate soil sample must be collected and submitted to the laboratory for percent solids testing. At least approximately 20 grams of soil must be collected in a separate glass or plastic sampling container.

2.1. Collection and Preservation of Soil Samples

Three types of soil samples may be collected for VOCs analysis:

- High (typically >200 µg/kg) VOC concentration soil sample (Section 2.2 below)
- Low (typically 0.05-200 µg/kg) VOC concentration soil sample (Section 2.3 below)
- Synthetic Precipitation Leaching Procedure/Toxicity Characteristic Leaching Procedure (SPLP/TCLP) soil sample (Section 2.4 below)

2.2. Collection and Preservation of a Soil Sample with "High" Concentrations of VOCs (typically >200 µg/kg)

2.2.1. Option 1 – Methanol Preservation Method

Supplies include: an electronic field balance (in some cases), two VOC vials (per sample) with 10 ml methanol (the number of vials and amount of methanol might vary among labs), and a small diameter core sampler to collect an approximately 10 gram soil sample. Some labs, and EPA method 5035, specify a 5 gram soil sample. Check with the lab or project manager for the amount to collect.

Sampling Procedure:

- Weigh the VOC vials containing the methanol and record the weight. Some laboratories provide pre-weighed VOC vials.
- If you are weighing your samples, take a test sample with the sampler and weigh it to evaluate how close you are to the appropriate sample weight. If the laboratory VOC vial is pre-marked with a line, then you do not need to weigh the soil, just fill the VOC vial with soil until the methanol and soil mixture reaches the line.
- Collect the sample using the sampling device and extrude the sample into the preserved VOC vial. Be sure that the VOC vial and cap threads are free of soil, and then screw the cap tightly onto the VOC vial. Gently swirl the methanol in the VOC vial to coat the soil sample. Do not vigorously shake the vial.
- If necessary, weigh the VOC vial and record the weight. Some laboratories will weigh the vials at the lab, and it is not required in the field.
- Collect separate soil samples from the same area for percent solids and head space sampling.
- Samples must be frozen or analyzed within 14 days.

2.2.2. Option 2 – EnCore® Sampling Method

Supplies needed: One 5 or 10 ml EnCore® sampler.

Sampling Procedure:

- Label the EnCore® sampling container.
- Collect the soil sample quickly, wipe the sampler free of soil, and seal the sampler.
- Place sampler in a clean ziplock bag and place on ice in a cooler.
- Collect separate samples in separate containers for percent solids and head space sampling.
- Samples must be frozen, or preserved, or analyzed within 48 hours (requires coordination with the laboratory).

2.3. Collection and Preservation of a Soil Sample with “Low” Concentrations of VOCs (typically 0.5 to 200 µg/kg)

2.3.1. Option 1 – Water Preservation Method

Supplies required: an electronic field balance, two 40 ml VOC vials pre-weighed and containing 5 ml of water, a magnetic stirrer, and a sampling device.

Sampling Procedure:

- Use a small diameter core sampler to collect two soil samples (5 grams each) into pre-weighed 40 ml VOC vials with 5 ml of water and a magnetic stirrer. Wipe threads and cap and seal the VOC vial. Repeat for the second VOC vial.
- Weigh the VOC vials and record the weights.
- Collect separate samples in separate containers for percent solids and head space sampling.
- Samples must be frozen or analyzed within 14 days.

2.3.2. Option 2 – Collection into Unpreserved VOC Vials

Supplies required: electronic field balance, two 40 ml VOC vials pre-weighed, and a sampling device.

Sampling Procedure:

- Collect the sample using the sampling device and extrude the sample into the VOC vial. Be sure that the threads are free of soil, and cap and seal the VOC vial. Repeat for the second vial.
- Weigh the VOC vials and record the weights.
- Collect separate samples in separate containers for percent solids and head space sampling.
- Samples must be frozen or analyzed within 48 hours (requires coordination with the laboratory).

2.3.3. Option 3 – Collection in VOC Vials Preserved with Sodium Bisulfate

Supplies required: electronic field balance, two VOC vials pre-weighed with 5 ml of sodium bisulfate, a magnetic stir bar, and a sampling device.

Sampling Procedure:

- Collect the sample using the sampling device and extrude a 5 gram sample into the VOC vial containing the sodium bisulfate. Wipe threads and cap and seal the VOC vial. Repeat for the second VOC vial.
- Weigh the VOC vials and record the weights.

- Collect separate samples in separate containers for percent solids and head space sampling.
- Samples must be frozen or analyzed within 14 days.

2.3.4. Option 4 –EnCore® Sampling Method

Supplies required: two 5 gram EnCore® samplers.

Sampling Procedure:

- Label the EnCore® sampling container.
- Collect the soil sample quickly, wipe the sampler free of soil, and seal the sampler.
- Place sampler in a clean ziplock bag and place on ice in a cooler.
- Collect separate samples in separate containers for percent solids and head space sampling.
- Repeat previous steps with the second EnCore® device.
  Samples must be frozen, or preserved, or analyzed within 48 hours (requires coordination with the laboratory).

2.4. Collection of samples being analyzed for VOCs by the TCLP or SPLP method

Sampling methods for TCLP or SPLP are similar to the methods presented above. The appropriate method is determined by local regulations. If using an EnCore® sampler, a 25 gram sampler should be used.

3. General Guidance

- Each state and federal regulatory agency has unique soil preservation requirements. Always verify collection and preservation methods with governing bodies.
- Verify preservation techniques with laboratory prior to sample collection.

4. Contacts

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Mark Ensign

STANDARD OPERATING PROCEDURE

SM-004 Test Pit Excavation

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1. Objective

Describe methods for excavating test pits and documenting findings.

The test pit is used to characterize geologic strata, subsurface conditions and provide access for collection of representative soil samples from these strata.

2. Execution

- Before digging begins, proper permits and notifications must be obtained, in accordance with applicable rules or regulations.
- Make sure that utility clearance has been conducted. Contact the property owner to determine the location of underground utilities. Verify, with the contractor that local/regional utility clearance service has been contacted. Ask subcontractor to provide local/regional utility clearance service authorization number and record this in the field notebook. Show the contractor the approximate excavation area, and have the contractor confirm that the area is suitable for excavation. Clearance may require marking of subsurface explorations prior to contacting utility clearance service.
- Have contractors pressure wash or steam clean equipment before beginning field activities, if necessary.
- Observe the contractor excavating the designated area.
- If contamination is suspected, have the contractor place excavated material on plastic sheeting.
- During excavation, monitor ambient air for contaminants of concern identified in the site-specific Health and Safety Plan. Record readings in field notebook (see SOP FD-001 Field Notebook).
- Record in a field book or test pit log:
    - Test pit dimensions,
    - Soil classifications (see SOP SM-003 Soil Classification)
    - Visual and olfactory indications of contamination
    - Subsurface structures
    - Obstructions to excavation
    - Any other observations relevant to the project objectives
    - Take photographs of excavation and completed test pit walls, etc. (SOP FD-004 Photodocumentation).
- Record technical information on a PDA, test pit log form, or a field book.
- Label sample bottles (see SOP SC-002 Sample Handling).
- Screen soil samples for contaminants of concern and record results in the field notebook or test pit log.
- Collect soil samples from the test pit as designated in the work plan including sidewalls and bottom at designated depths, at strata changes, or based upon

field screening using remote sampling equipment (backhoe bucket, stainless steel remote sampler, etc.). Do not enter a test pit unless side slopes satisfy Occupational Safety and Health Administration (OSHA) regulations and other health and safety concerns have been addressed.

- Transfer soil samples to the appropriate glassware according to soil sampling SOPs (SOP SM-002 VOC Soil Collection and Preservation Method, etc.).
- Store samples on ice in a cooler (see SOP SC-002 Sample Handling and SOP FD-003 Chain-of-Custody).
- Backfill excavation as soon as possible with material as described in the field plan. Place the excavated material back in the excavation in approximately the same strata it came from.
- Segregate contaminated soil as necessary (see SOP SC-003 IDW). Properly identify segregated material and secure as described in the work plan.
- Measure dimensions of excavation and record in the field notebook or test pit log. If sampling locations are to be surveyed, mark the corners and provide surveyor with location ID.
- Sketch dimension and location of the test pit relative to a site reference point and record in the field notebook. Note the sample locations by number on a cross-section sketch and plan view sketch.

3. Limitations

- Never enter the excavation unless it is shored or the sidewalls are sloped in accordance with OSHA regulations and all proper personal protective safety precautions have been considered and implemented.
- Terminate excavation if the flow of groundwater into the excavation adversely affects the stability of the excavation (i.e., slumping). Make sure to note in the field notebook or test pit log the depth to ground water.
- Terminate excavation if drums, tanks, or other potential sources of contamination are observed. Record visible drum markings, labels, and any other pertinent information on the test pit log and in the field notebook. Photograph drums and materials. Consult with the project manager before filling the excavation.
- Do not leave an open test pit unattended.

4. References

Earth Manual (1968), United States Department of the Interior, Bureau of Reclamation, United States Government Printing Office, Washington, D.C., pp. 134-139.

OSHA Standards for Excavations, Department of Labor, Federal Register, 29 CFR Part 1926, Aug. 9, 1994.

5. Contacts

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