Consulting
Engineers and
Scientists

Supplemental Remedial Investigation Work Plan - Parcel 6

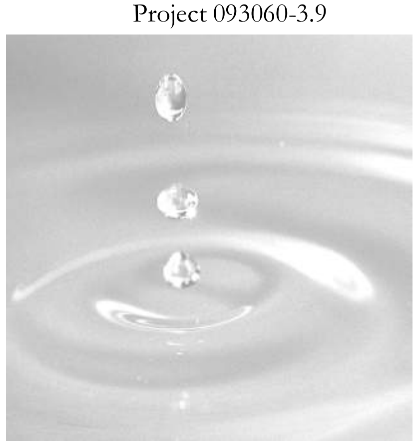
Portion of K - Williamsburg Works Site

Brooklyn, New York
Index # CO 2-20200901-300
Site ID: 224055

Prepared for:
The Brooklyn Union Gas Company d/b/a National Grid NY
2 Hanson Place
Brooklyn, New York 11217

Prepared by:
GEI Consultants, Inc., P.C.
455 Winding Brook Drive
Glastonbury, CT 06033
860-368-5300

February 2025
Project 093060-3.9



Melissa J. Felter, P.G., LEP
Project Manager

Matthew O'Neil, P.E.
Senior Engineer

Qualified Environmental Professional's Certification

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

Date: ____________________ ______________________________

Melissa J. Felter, P.G., LEP
GEI Consultants, Inc., P.C.

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MF/MO:bdp
\\geiconsultants.com\data\Data_Storage\Working\NATIONAL GRID\093060 - WILLIAMSBURG\01_ADMIN\SRIWP\Parcel 6\Draft to NYSDEC 20250221\Supplemental RIWP Parcel 6_2025-02-21.docx

Executive Summary

By way of an Order on Consent (Order) Index No. CO 2-20200910-300, The Brooklyn Union Gas Company d/b/a National Grid NY (National Grid), while preserving its rights to seek reimbursement from any responsible parties, has agreed to complete a supplemental delineation of the nature and extent of contamination at, and which might be emanating from the K - Williamsburg Works site, site #224055 in Brooklyn, Kings County, New York (the Site, Fig. 1). Pursuant to that Order, National Grid has further agreed to implement this Supplemental Remedial Investigation (SRI) Work Plan (SRIWP).

Remedial investigation (RI) activities were previously performed in accordance with a superseded Order on Consent and Administrative Settlement (AOC) Index No. A2-0552-0606 between New York State Department of Environmental Conservation (NYSDEC) and The Brooklyn Union Gas Company (BUG) d/b/a KeySpan Corporation and AOC Index No. CO 2-20200910-300 between NNYSDEC and BUG d/b/a National Grid NY, and they were conducted in accordance with the NYSDEC -approved Remedial Investigation Work Plans (RIWPs). A draft RI Report was submitted to the NYSDEC October 2023 (draft RI Report). For ease of discussion in the draft RI Report, the RI study area has been divided into six parcels identified as Parcels 1 through 6 as shown in the table below and in Fig. 2.

Parcel ID	Address	Current Owner	Block	Lot
Within Former Williamsburg Works MGP Footprint (*i.e.*, Within the Site)				
Parcel 1	35 Kent Avenue Brooklyn, NY	North 12th Associates, LLC	2288	1
Parcel 2	50 Kent Avenue (aka 41 North 11th Street), Brooklyn, NY	NYC Department of Parks and Recreation (NYCDPR)	2287	1
Parcel 3	20 North 12th Street Brooklyn, NY	NYCDPR	2287	16
Parcel 4	2 North 12th Street Brooklyn, NY	NYCDPR	2287	30
Outside Former Williamsburg Works MGP Footprint (*i.e.*, Outside the Site)				
Parcel 5	16 North 11th Street Brooklyn, NY	NYCDPR	2294	1
	33 North 10th Street Brooklyn, NY	NYCDPR	2294	5
Parcel 6	26 North 12th Street Brooklyn, NY	NYCDPR	2277	1
Source: NYCity Map https://experience.arcgis.com/experience/d826b115c87841d491c2b41fcb175305 accessed 4/16/2024				

On March 4 and 15, 2024, NYSDEC provided two letters commenting on the draft RI Report. On June 13, 2024, NYSDEC provided an additional letter commenting of the draft Supplemental RI Work Plan for Parcels 3 and 4 requesting additional wells on Parcel 6. The comments were discussed with NYSDEC, and it was determined that National Grid would address, in part, NYSDEC's comment on delineating groundwater by installing additional wells on Parcel 6 (the Investigation Area). This SRIWP has been prepared by GEI Consultants, Inc. (GEI), on behalf of National Grid, and in general accordance with the NYSDEC *DER-10 Technical Guidance for Site Characterization and Remedial Investigation,* dated May 2010.

The Site is adjacent to properties located at Parcels 5 and 6 and 25 Kent Avenue, where a large-scale oil refining and storage facility (Pratt Works) was operated by Standard Oil and its predecessors (now collectively ExxonMobil) from the 1860s until 1949, roughly contemporaneous with the operation of the Williamsburg Works. Both the Williamsburg Works and ExxonMobil operations, as well as onsite and adjacent operations by Bayside Fuel Oil Depot Co, Motiva Enterprises LLC., Buckeye Partners, L.P., Sunoco, Inc., and Chevron U.S.A. Inc. (ChevTex), included the storage and use of petroleum and petroleum products. Parcel 6 is currently vacant and comprises a portion of one of five blocks that have been or will be redeveloped by the New York City Department of Parks and Recreation (NYCDPR) as part of Bushwick Inlet Park (Friends of Bushwick Inlet Park, 2024).

In this SRIWP, the installation of three soil borings and nine monitoring wells to further evaluate the extent of impacts in subsurface soil and groundwater at the Investigation Area, is described. The conceptual site model (CSM) will be updated and presented in a draft SRI Report for Parcel 6, including tables and figures.

1. Introduction

By way of an Order on Consent (Order) Index No. CO 2-20200910-300, The Brooklyn Union Gas Company d/b/a National Grid NY (National Grid), while preserving its rights to seek reimbursement from any responsible parties, has agreed to complete delineation of the nature and extent of the contamination at, and which might be emanating from the K - Williamsburg Works site, site #224055 which is approximately 5.5 acres in area and consists of the following properties located in Brooklyn, Kings County, New York (the Site).

Tax Map/Lot No.	Address
Block 2287 Lot 1	50 Kent Avenue (aka 41 North 11th Street), Brooklyn, NY
Block 2287, Lot 16	20 North 12th Street, Brooklyn, NY
Block 2287, Lot 30	2 North 12th Street, Brooklyn, NY
Block 2288, Lot 1	35 Kent Avenue, Brooklyn, NY

The Site location is shown in Fig. 1. Pursuant to the Order, National Grid has further agreed to implement this Supplemental Remedial Investigation Work Plan (SRIWP).

A remedial investigation (RI) was performed, and a draft RI Report was submitted to NYSDEC in October 2023 (RI Report). The RI was conducted in accordance with a superseded Order on Consent and Administrative Settlement (AOC) Index No. A2-0552-0606 between New York State Department of Environmental Conservation (NYSDEC) and The Brooklyn Union Gas Company (BUG) d/b/a KeySpan Corporation and AOC Index No. CO 2-20200910-300 between NYSDEC and BUG d/b/a National Grid NY, and they were conducted in accordance with the NYSDEC -approved Remedial Investigation Work Plans (RIWPs). For ease of discussion, in the draft RI Report, the RI study area has been divided into six parcels, identified as Parcels 1 through 6, as shown in the table below and in Fig. 2.

Parcel ID	Address	Current Owner	Block	Lot
Within Former Williamsburg Works MGP Footprint (*i.e.*, Within the Site)				
Parcel 1	35 Kent Avenue Brooklyn, NY	North 12th Associates	2288	1
Parcel 2	50 Kent Avenue (aka 41 North 11th Street), Brooklyn, NY	NYC Department of Parks and Recreation (NYCDPR)	2287	1
Parcel 3	20 North 12th Street Brooklyn, NY	NYCDPR	2287	16
Parcel 4	2 North 12th Street Brooklyn, NY	NYCDPR	2287	30
Outside Former Williamsburg Works MGP Footprint (*i.e.*, Outside the Site)				
Parcel 5	16 North 11th Street Brooklyn, NY	NYCDPR	2294	1
	33 North 10th Street Brooklyn, NY	NYCDPR	2294	5
Parcel 6	26 North 12th Street Brooklyn, NY	NYCDPR	2277	1
Source: New York City Oasis Map http://www.oasisnyc.net/map.aspx accessed 10/25/2023				

The Site is adjacent to properties located at Parcels 5 and 6, and 25 Kent Avenue, where a large-scale oil refining and storage facility (Pratt Works) was operated by Standard Oil and its predecessors (now collectively ExxonMobil) from the 1860s until 1949, generally contemporaneous with the operation of the Williamsburg Works. Both the Williamsburg Works and ExxonMobil operations as well as on-site and adjacent operations by Bayside Fuel Oil Depot Co; Motiva Enterprises LLC.; Buckeye Partners, L.P.; Sunoco, Inc.; and Paragon Oil, Inc. and Texaco Inc., and Chevron U.S.A. Inc. (collectively ChevTex) included the storage and use of petroleum and petroleum products.

On March 4 and 21, 2024, NYSDEC provided two letters commenting on the draft RI Report. On June 13, 2024, NYSDEC provided an additional letter commenting of the draft Supplemental RI Work Plan for Parcels 3 and 4 requesting additional wells on Parcel 6. The comments were discussed with NYSDEC, and it was determined that National Grid would address NYSDEC's comment on delineating groundwater by installing additional wells at Parcel 6 (the Investigation Area). In this SRIWP, the installation of soil borings and monitoring wells is proposed to further evaluate the extent of impacts in subsurface soil and shallow, intermediate and deep groundwater at the Investigation Area. Plate 1 shows the Investigation Area, proposed investigations, and sample locations from prior investigations. Data generated during the implementation of this SRIWP investigation will be used to evaluate the extent of impacts and to prepare a Draft SRI Report for Parcel 6, including the conceptual site model (CSM), with respect to the Investigation Area.

Parcel 6, currently vacant, was most recently used as an oil terminal and was previously used for petroleum product manufacturing and as a refinery. Parcel 6 comprises a portion of one of five blocks that have been or will be redeveloped by the NYCDPR as part of Bushwick Inlet Park (Friends of Bushwick Inlet Park, 2024).

This SRIWP has been prepared by GEI Consultants, Inc. (GEI), on behalf of National Grid, and in general accordance with the NYSDEC *DER-10 Technical Guidance for Site Characterization and Remedial Investigation,* dated May 2010. The Investigation Area history and Site geology and hydrogeology is described in the 2023 Draft RI Report. The scope of work is described in Section 2. The Health and Safety Plan (HASP), Community Air -Monitoring Plan (CAMP), Field Sampling Plan (FSP), and Quality Assurance Project Plan (QAPP) have been updated from the 2008 RI Work Plan to incorporate new information and changes to policy and industry practice since 2008 (e.g., 2010 version of DER-10) and are provided as Appendices A through D, respectively. If data for Parcel 6 is available prior to completion of the implementation of this SRIWP, National Grid reserves the right to amend/add to this SRIWP to incorporate and or consider recent sampling data from Block 2277.

2. Scope of Work

The proposed activities will be conducted in accordance with the HASP (Appendix A), CAMP (Appendix B), QAPP (Appendix C), and FSP (Appendix D). The remainder of this SRIWP describes the proposed soil borings and monitoring wells as well as analytical samples.

2.1 Soil Borings

Three soil borings (WW-MW-208D through WW-MW-210D) are proposed for installation in the Investigation Area to facilitate installing three monitoring well clusters. The proposed well locations are shown on RI cross sections B and C and groundwater analytical summary figures (Appendix E) and in Plate 1. Analytical results of the recent groundwater sampling show the highest concentrations of potentially MGP-related impacts on the northern side of Parcels 3 and 4 in the intermediate zone of the WW-MW-204 well cluster. WW-MW-200I is located downgradient of WW-MW-204I. Concentrations of potentially MGP-related analytes in the sample collected at WW-MW-200I are not detected or are below New York State Ambient Water Quality Standards. We have proposed the WW-MW-209 well cluster is proposed down and side gradient of WW-MW-204. Well cluster WW-MW-208 is proposed further downgradient of WW-MW-209 in an area with no groundwater analytical data. Well cluster WW-MW-210 is proposed side and downgradient of Parcel 2. Actual drilling locations will be determined based upon the subsurface utility clearance activities, permanent aboveground structures, and property owner requirements.

The borings will be installed with a sonic drill rig in accordance with drilling methods and procedures in the FSP and SRIWP. The concrete surface will be removed, and each boring location will be hand -cleared for utilities to 5 feet bgs. Soil samples will be collected and logged continuously from each deep boring. It is anticipated that drilling will proceed to the clay layer present at approximately 60 feet bgs. After completing each borehole, the casing will be removed, and a monitoring well will be installed.

Table 1 contains sample descriptions, rationale, and analysis. Up to four soil samples per boring will be selected for chemical analysis, as follow.

- One sample will be collected from the screen interval of the shallow monitoring well.
- One sample will be collected from the screen interval of the intermediate monitoring well.
- One sample will be collected from the screen interval of the deep monitoring well.
- The final sample will be collected beneath impacts within the screened interval of the deep monitoring well, if any. Impacts include visual and olfactory impacts, as well as

elevated PID readings within the screened interval compared to soil at the completion depth of the boring.

Each sample will be analyzed for volatile organic compounds (VOCs) by the United States Environmental Protection Agency (EPA) Method 8260D, semi-volatile organic compounds (SVOCs) by EPA Method 8270E, target analyte list (TAL) metals plus tin by EPA Method 6000/7000 series, free cyanide by EPA Method 9014.

Drilling and sampling equipment will be decontaminated between each sample location as described in the FSP. Soil cuttings and decontamination fluids will be contained within properly labeled United States Department of Transportation (USDOT) 55--gallon drums and disposed of at a National Grid -approved disposal facility.

2.2 Monitoring Wells

The proposed soil borings (WW-MW-208D through WW-MW-210D) will be completed as permanent monitoring wells. Three monitoring wells, shallow, intermediate, and deep, will be installed at each location. The proposed well locations are shown in Plate 1. Table 1 provides sample description, rationale, and analysis. The wells will be installed using sonic methods in accordance with drilling methods and procedures in the FSP.

Each proposed deep monitoring well will be screened above the clay layer, which is expected to be encountered at 60 feet bgs. Each proposed shallow well will be installed spanning the water table. Each proposed intermediate monitoring well will be screened at the midpoint between the shallow and deep wells. The proposed shallow, intermediate and deep wells will be spaced approximately 5-feet apart. Each monitoring well will be constructed with an approximate 10-foot length of 2-inch inner diameter (ID), 0.010-inch-slotted, PVC monitoring well screen and finished with 2-inch ID poly vinyl chloride (PVC) riser pipe to the surface and a 2-foot sump. The annular space between the well screen and borehole wall will be backfilled with chemically inert sand to promote efficient groundwater flow to the well and to minimize the passage of any fine -grained formational material into the well. A bentonite clay seal will be placed above the sand pack. The remaining annular space will be filled to grade with cement/bentonite grout. Each monitoring well will be fitted with a lockable cap and finished with a flush -mounted curb box secured with cement.

Each newly installed monitoring well will be developed by alternatively surging and pumping until the turbidity is less than 50 nephelometric turbidity units (NTUs) or until a maximum of 10 well volumes of water has been removed. A field turbidity meter will be used to monitor the NTU levels. Well development will be completed in general accordance with the FSP.

Each of the newly installed monitoring wells will be sampled after a minimum of 2 weeks following completion of well development. Prior to sampling, two synoptic rounds of groundwater level measurements will be recorded for the existing and newly installed monitoring wells; the groundwater will be gauged at both the low and high tidal levels.

Each newly installed monitoring well will be purged and sampled using low flow groundwater sampling procedures and in accordance with the FSP unless NAPL is observed in the monitoring well. Each groundwater sample will be analyzed for VOCs by EPA Method 8260D, SVOCs by EPA Method 8270E, TAL metals and tin by EPA Method 6000/7000 series, and total cyanide by EPA Method 9014. If NAPL is observed in a monitoring well at the time of sampling, NAPL thickness will be documented in sampling logs and a sample of the NAPL will be collected and analyzed for VOCs by EPA Method 8260D and SVOCs by EPA Method 8270E, . NAPL will then be removed. A groundwater sample will not be collected due to the presence of NAPL in groundwater. All analytical results for VOCs and SVOCs will include Tentatively Identified Compounds (TICs). The QAPP details the QA/QC samples that will be collected.

Purge water generated during the installation and sampling of monitoring wells will be collected in 55--gallon USDOT drums and will be disposed at a National Grid -approved disposal facility.

2.3 Survey

Monitoring wells will be surveyed by a New York State Licensed Land Surveyor to A-2 standards of accuracy with an approximate horizontal precision of ±0.02 feet. The elevation of each sample location will be determined to ±0.01 foot and will be tied into the Site benchmark. All locations and elevations will be referenced to the New York State Plane Eastern Zone North American Datum 1983 and North American Vertical Datum 1988.

2.4 Data Validation and Management

Soil and groundwater samples will be analyzed by a NYSDOH environmental laboratory approval program accredited laboratory. Analytical results will be provided in a New York State Category B data deliverable format. The data will be validated in accordance with New York State Analytical Service Protocols, and a data usability summary report will be prepared documenting the adequacy of the analytical data obtained from the laboratory and discussing any quality control non-compliance issues or limitations on the use of the data.

3. SRI Report Preparation

3.1 Supplemental Remedial Investigation Report

The information collected as part of this SRIWP will be used to update the CSM and will be presented in a Draft SRI Report, including tables and figures, for Parcel 6. This report will be separate from the comprehensive RI Report per prior agreement with NYSDEC. The CSM and SRI report developed using data collected as part of this SRIWP will build upon data already collected at the Site including the 2023 RI Report, 50 Kent Avenue PDI, and other data collected previously on the Site.

4. Schedule

Field activities can commence 2 to 4 weeks following NYSDEC and NYSDOH approval of this SRIWP, pending access and contractor availability. The field work is projected to last approximately 5 weeks (approximately 12 workdays for drilling activities and groundwater sampling at least 2 weeks following development). Investigation derived waste will be removed from the Site after groundwater sampling activities and characterization. This is estimated to be within 2 weeks of groundwater sampling. The draft SRI report will be submitted to NYSDEC for review within 16 weeks following the completion of field activities.

References

Brooklyn Union Gas (BUG) Drawings, 1908 through 1946. Drawing 1D36, dated November 9, 1908, Drawing OA8, dated February 5, 1909, Drawing 1G122, dated June 23, 1909, and retraced October 5, 1939 and July 16, 1946, Drawing 1G102, dated June 23, 1909, and Drawing 2G130, dated July 27, 1921.

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City of New York (1938). *Board of Estimate*. Resolution. February 3.

Colton, J. H., (1849). Map of the City of Brooklyn.

Dripps, M., (1855). Map of the Cities of New York, Brooklyn & Jersey City.

Friends of Bushwick Inlet Park (2024). *BIP Parcel Map*, https://bushwickinletpark.org/parcel-map/, accessed May 1.

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

NYSDEC (2006). *New York State Code of Rules and Regulations*, 6NYCRR Title 6, Chapter 100, Part 700-705.

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Ratzer, Bernard, *Plan of the City of New York in North America: Surveyed in the Years of 1766 and 1767*, 1776.

Sanborn Fire Insurance Maps. Site Parcels 1-6, 1868, 1887, 1905, 1916, 1941, 1951, 1965, 1978, 1979, 1980, 1981, 1982, 1983, 1986, 1987, 1988, 1989, 1991, 1993, 1995, and 1996.

United States Coast Survey (1844). *Map of New-York Bay And Harbor And The Environs.*

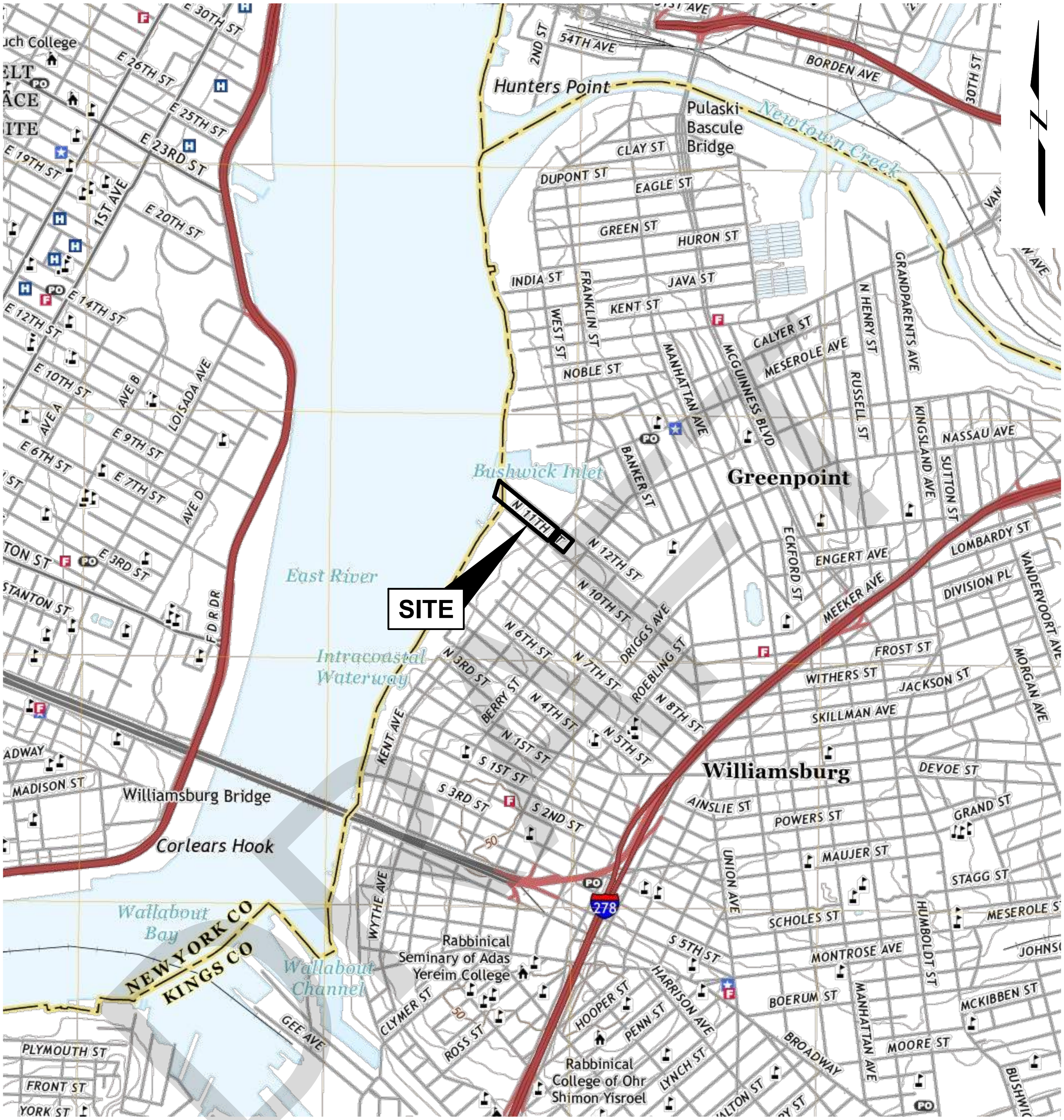
Table

Table 1. Sample Location Rationale
Supplemental Remedial Investigation Work Plan - Parcel 6
Portion of K Williamsburg Works Site
Brooklyn, New York

Proposed Sample Identification Number	Location	Rationale	Number of Samples		Target Boring Depth	Soil Sample Target Depths	VOCs (EPA 8260D)[2]	SVOCs (EPA 8270E)[2]	TAL Metals and Tin (6000/7000)	Cyanide (EPA 9014)[1]
			Soil	GW						
Soil Borings and Monitoring Wells										
WW-MW-208D	Parcel 6	Evaluate soil quality within Parcel 6. Evaluate groundwater flow and quality within Parcel 6.	Up to 4	3	Top of clay expected at 60 feet	1. Shallow monitoring well screen interval. 2. Intermediate monitoring well screen interval. 3. Deep monitoring well screen interval. 4. Beneath impacts within the deep monitoring well screen interval, if any.	X	X	X	X
WW-MW-209D	Parcel 6	Evaluate soil quality within Parcel 6. Evaluate groundwater flow and quality within Parcel 6.	Up to 4	3	Top of clay expected at 60 feet	1. Shallow monitoring well screen interval. 2. Intermediate monitoring well screen interval. 3. Deep monitoring well screen interval. 4. Beneath impacts within the deep monitoring well screen interval, if any.	X	X	X	X
WW-MW-210D	Parcel 6	Evaluate soil quality within Parcel 6. Evaluate groundwater flow and quality within Parcel 6.	Up to 4	3	Top of clay expected at 60 feet	1. Shallow monitoring well screen interval. 2. Intermediate monitoring well screen interval. 3. Deep monitoring well screen interval. 4. Beneath impacts within the deep monitoring well screen interval, if any.	X	X	X	X

Notes:
Chemical analysis test methods specified are from U.S. EPA SW-846 test methods
EPA - Environmental Protection Agency
SVOC - semivolatile organic compounds
TAL - target analyte list
VOC - volatile organic compounds
1 - Soils will be analyzed by Free Cyanide, water will be analyzed by Total Cyanide
2 - VOC and SVOC analyses for groundwater will include Tentatively Identified Compounds (TICs)

Figures



0 2000 4000

SCALE, FEET

SOURCE:

USGS TOPOGRAPHIC QUADRANGLE, 7.5 MINUTE SERIES: BROOKLYN, NY 2019
NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88)
10-FOOT CONTOUR INTERVAL

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Supplemental Remedial Investigation Work Plan Williamsburg Works Former MGP Site Borough of Brooklyn, New York	GEI Consultants	SITE LOCATION MAP
nationalgrid	Project 093060	February 2025 Fig. 1

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LEGEND:

APPROXIMATE SITE BOUNDARY

APPROXIMATE BOUNDARY OF FORMER MGP PROPERTY

SOURCES:

1. AERIAL PHOTOGRAPH OBTAINED FROM NEARMAP ©2024 IMAGERY DATE: 06/18/2024.
2. SANBORN FIRE INSURANCE MAPS (1887 - 1996).
3. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM *HTTP://WWW.OASISNYC.NET* ACCESSED JANUARY 2008.
4. NEW YORK CITY DEPARTMENT OF CITY PLANNING, MAP PLUTO PARCELS.

0 150 300

SCALE, FEET

DRAFT

Supplemental Remedial Investigation Work Plan Williamsburg Works Former MGP Site Borough of Brooklyn, New York	GEI Consultants	REMEDIAL INVESTIGATION PARCEL IDENTIFICATION MAP
nationalgrid	Project 093060	February 2025 Fig. 2

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Plate

LEGEND:

- APPROXIMATE CURRENT PROPERTY BOUNDARY
- APPROXIMATE BOUNDARY OF FORMER MGP PROPERTY
- HISTORIC MGP STRUCTURES

PROPOSED 2024 SUPPLEMENTAL REMEDIAL INVESTIGATION - PARCEL 6 SAMPLE LOCATIONS

- PROPOSED MONITORING WELL

PREVIOUS REMEDIAL INVESTIGATION SAMPLES

- SOIL BORING AND MONITORING WELL
- ABANDONED MONITORING WELL
- SOIL BORING WITH TEMPORARY GROUNDWATER POINT
- SOIL BORING
- INDOOR AIR
- OUTDOOR AIR
- SOIL VAPOR POINT
- SURFACE SOIL
- SEDIMENT CORE
- TEST PIT

OTHER INVESTIGATION SAMPLES

- MONITORING WELL
- ABANDONED MONITORING WELL
- RECOVERY WELL
- ABANDONED RECOVERY WELL
- SOIL BORING
- SEDIMENT CORE
- TEST PIT

SOURCES:

1. AERIAL PHOTOGRAPH NEARMAP ©2024 IMAGERY DATE: 06/18/2024.
2. SANBORN FIRE INSURANCE MAPS (1887 THROUGH 1996).
3. HISTORIC MAP OF BROOKLYN UNION GAS, DATED JULY 27, 1921.
4. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM *HTTP://WWW.OASISNYC.NET* ACCESSED JANUARY 2008.
5. SURVEY OF WILLIAMSBURG WORKS BOUNDARIES, EXISTING CONDITIONS, AND SAMPLE LOCATIONS CONDUCTED BY GEI CONSULTANTS, INC. SURVEYED BY NEW YORK STATE-LICENSED LAND SURVEYOR No. 050146.
6. *SITE INVESTIGATION REPORT BAYSIDE FUEL OIL COMPANY,* PREPARED BY: METCALF AND EDDY OF NEW YORK, INC. NOVEMBER 2006.
7. *SITE INVESTIGATION REPORT PROPERTY WEST OF KENT AVENUE BETWEEN AND INCLUDING NORTH 10TH AND NORTH 12TH STREETS,* PREPARED BY: METCALF AND EDDY OF NEW YORK, INC., NOVEMBER 2006.
8. *SITE INVESTIGATION REPORT 9TH STREET EQUITIES, LLC,* PREPARED BY: METCALF AND EDDY OF NEW YORK, INC., AUGUST 2006.
9. *SITE INVESTIGATION REPORT MOTIVA ENTERPRISES, LLC / BUSHWICK CREEK INLET,* PREPARED BY: METCALF AND EDDY OF NEW YORK, INC., NOVEMBER 2006.
10. URS CORPORATION IRM DESIGN INVESTIGATION BORING LOGS AND LOCATION MAP PROVIDED TO GEI CONSULTANTS, INC. VIA EMAIL ON FEBRUARY 12, 2013.
11. URS CORPORATION, NAPL RECOVERY WELLS, CONSTRUCTION COMPLETION REPORT, NOVEMBER 2014.
12. 2022 RI SOIL BORINGS, SOIL VAPOR SAMPLES, TEST PITS AND MONITORING WELLS SURVEYED BY MJ ENGINEERING AND LAND SURVEYING, P.C., HORIZONTAL DATUM: NAD83/2011, NYSPCS LONG ISLAND ZONE (3104), VERTICAL DATUM: NAVD88, GEOID18, SURVEY DATE: 10/25/2022.
13. *SITE INVESTIGATION REPORT, FORMER BAYSIDE FUEL OIL DEPOT, 26 NORTH 12TH/ STREET,* PREPARED BY ROUX ENVIRONMENTAL ENGINEERING FOR EXXONMOBIL OIL CORPORATION, FEBRUARY 24, 2021.

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SCALE: 1" = 80'

Supplemental Remedial Investigation Work Plan Williamsburg Works Former MGP Site Borough of Brooklyn, New York	GEI Consultants	SAMPLE LOCATIONS
nationalgrid	Project 093060	February 2025 Plate 1

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Appendix A

Health and Safety Plan

GEI Safety
EVERYONE LIVE SAFE EVERYDAY

GEI Consultants

Consulting Engineers and Scientists

Health and Safety Plan

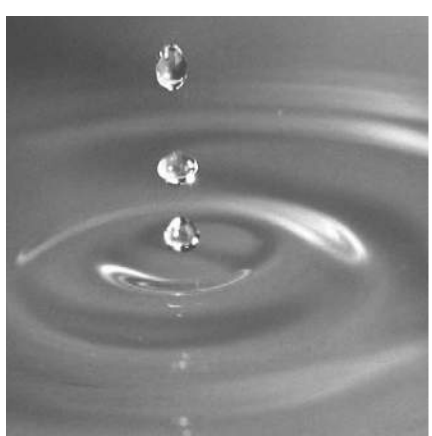
Williamsburg Works Former MGP Site
Brooklyn, New York

National Grid
2 Hanson Place
Brooklyn, NY 11217

Prepared by:
455 Winding Brook Drive
Glastonbury, CT 06033
860 368 5300

July 2024

Project No. 093060 3.4



Melissa J Felter
Melissa J. Felter
Project Manager, LEP, P.G.

Lesley Gastwirth
Lesley Gastwirth, ASP
Regional Safety Manager

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Appendices

MF/AS:bdp
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1. Emergency Contact Information

Table 1. Emergency Contact Information

Site Information	
Project Name:	Williamsburg Works Former MGP Site
Project Address:	35 and 50 Kent Avenue and 2 and 20 N. 12th Street, Brooklyn, NY
Project Number:	093060
Important Phone Numbers	
Local Police:	911
Fire Department:	911
Ambulance:	911
Hospital and Occupational Clinic Information *(See Attached Map and Directions in Appendix A)*	
Local Hospital: Woodhull Medical and Mental Health Center 760 Broadway Brooklyn, NY 11206 **Urgent Care/Occupational Health Clinic: Contact Medcor Triage** 73 01 Grand Avenue Maspeth, NY 11378	(718) 250 8075 Call Medcor Triage 1 800 775 5866 (718) 457 5900
Contacts	
Project Manager: Melissa Felter	(860) 368 5328 office (860) 608 9717 cell
Safety Director: Steve Hawkins	(860) 368 5348 office (860) 916 4167 cell
Regional Safety Manager: Lesley Gastwirth	(404) 592 0127 office (404) 667 7444 cell
Site Safety Manager: Alina Salaiz	(860) 368 5385 office (978) 413 4332 cell
Medcor Triage	1 800 775 5866
Client Contact: Donald Campbell (Project Manager) Bill Ryan (SIR Regional Safety Lead)	(347) 436 9916 office (347) 452 5973 cell (516) 545 2586 office (516) 790 1660 cell
Other Information	
Contractor Requesting/Performing Utility Clearance: ADT	Utility Clearance Ticket Number: TBD

2. GEI Safety Practices to Live By

Safety is what we do and how we do it every day. These Everyday Practices to Live Safe are simple yet concise reminders to our employees, clients, contractors, visitors of the steps that must be taken to avoid injury, illness, and incident so everyone can live safe every day. To maintain a safe work environment, GEI has established an organizational structure and a Corporate Health and Safety Program along with these safety practices.

Stop work if it is unsafe to continue, after any incident, injury, or near miss.

Prepare before starting work. Complete safety training and project related safety requirements, such as preparation and review Health and Safety Plans (HASPs) as required by project or job related duties.

Assess and control safety hazards/risks before starting any tasks and when previously unidentified safety hazards are observed.

Be attentive and aware of your environment. Constant focus and awareness will avoid complacency.

Properly use and maintain GEI approved and required PPE in all appropriate circumstances.

Do not work or drive impaired, including under the influence of alcohol/drugs or while fatigued.

Follow all safety practices when operating a vehicle. Always wear your seatbelt while in any vehicle. Do not drive distracted, including using hand held cell phones, when operating any vehicle.

Use tools, equipment, and safety devices in accordance with manufacturers recommendations and GEI expectations. Never modify or override safety devices.

When activities involve chemicals or hazardous substances, follow GEI's hazard communication requirements, including labeling, reviewing Safety Data Sheets (SDS), and keeping proper protections in place.

Be aware of and keep clear of equipment moving in all work areas, at all times.

Follow GEI's incident reporting procedure in the event of safety incidents, including injuries, illness, near misses, or observation of unsafe behaviors.

3. Site Background

This HASP establishes policies and procedures to protect GEI Consultants, Inc. (GEI) personnel from the potential hazards posed by the activities at the Williamsburg Works Former Manufactured Gas Plant (MGP) Site, 35 and 50 Kent Avenue and 2 and 20 N. 12th Street, Brooklyn, New York (Fig. 1). Reading, understanding, and compliance with the contents of the HASP is required for on site GEI personnel and will be reviewed by GEI subcontractors. Subcontractors will prepare their own site specific HASP but may use this HASP as a guide. This HASP identifies measures to minimize accidents and injuries which may result from site conditions or activities. A copy of this HASP will be maintained on site for the duration of the work.

Employees should review National Grid's Safety Procedure, Contractor Safety Requirements for reference (Appendix F). This document represents policies and safety related work methods unique to National Grid and they may be more stringent than the Occupational Safety and Health Administration (OSHA) regulations. Contractors must follow these requirements as well as their own rules or regulations that meet or exceed OSHA and other regulatory requirements.

3.1 Site Description

The Williamsburg Works Former MGP site is located in an industrial and commercial section of the Williamsburg neighborhood of Brooklyn, New York. The Site is also located in the 94th Precinct. The Site is bordered by North 12th Street to the northwest, industrial and commercial properties to the southeast, North 11th Street to the southwest, and the East River to the northeast.

The Site consists of four properties. The Parcel IDs, addresses, and tax map information for these properties are presented in the table below.

Parcel ID	Address	Block	Lot
Parcel 1	35 Kent Avenue Brooklyn, NY	2288	1
Parcel 2	21 North 12th Street (50 Kent Avenue) Brooklyn, NY	2287	1
Parcel 3	20 North 12th Street Brooklyn, NY	2287	16
Parcel 4	2 North 11th Street Brooklyn, NY	2287	30

The site history of the Williamsburg Works Former MGP and surrounding area was developed through the review of available Sanborn Fire Insurance (Sanborn) maps and other historic documents.

3.1.1 MGP History

The former Williamsburg Works MGP Site operated in a highly industrialized area that included dozens of historic, industrial, and manufacturing uses; large petroleum storage sites; and reported spills, all of which constitute sources of soil and groundwater contamination surrounding the Site. Historic property uses in the site vicinity included petroleum refining, fuel storage, a railroad terminal, iron works, varnishing works, chemical works, a brass foundry, laundry and dry cleaning supply facilities, and other manufacturing facilities. Facilities that used or generated petroleum and tar like substances include the former Pratt Works Refinery and former iron foundries. A more detailed Site history can be found in the Remedial Investigation Report (GEI, 2015) and the Construction Completion Report for 50 Kent Avenue (AECOM, 2018).

The Williamsburg Gas Light Company was incorporated in 1850 (Murphy, 1995) and was the first known operator of the Williamsburg Works MGP. The Williamsburg Works MGP was first shown on the 1887 Sanborn map. At that time, the gas production facilities consisted of coal carbonization facilities including a retort house, an engine room, a meter house, and a condenser house.

Gas storage and purification facilities included three gas holders, a governor house, a purifying house, two tar tanks, scrubbers and lime houses on the 1887 Sanborn map. Two of the gasholders were identified as relief holders built in 1863 and 1868 with two lifts each and had 315,000 and 306,000 cubic foot capacities in a 2009 New York State Archives document. The third gasholder, built in 1884, was constructed with three lifts, and had a 460,000 cubic foot capacity. All three holders were constructed with subsurface brick tanks and concrete foundations. The three holders are identified as Relief Holder, Holder No. 1, and Holder No. 2, respectively, on the 1921 Brooklyn Union Gas Company (BUG) drawing (2 G 130). In 1888, an additional holder with a capacity of 1,100,000 cubic feet and three lifts was built. The holder was constructed with subsurface brick and a concrete foundation (New York State Archives, 2009). It was identified as Holder No. 3 on the 1921 BUG drawing.

In the 1880s, H. H. Rogers, a Standard Oil trustee and vice president, and William A. Rockefeller, Jr., the president of the Standard Oil Company of New York, were on the board of the Williamsburg Gas Light Company, and by at least September 1893 the Williamsburg Works was operating a Loomis carbureted water gas process. In April, The Williamsburg Gas Light Company stopped buying naphtha from Standard Oil at above market prices. [1] In 1895, through the influence of H. H. Rogers and William A. Rockefeller, Jr., the Williamsburg Gas Light Company and several other Brooklyn gas manufacturing companies merged to form BUG. In 1896, H. H. Rogers and William A. Rockefeller, Jr. became board members of BUG (Murphy, 1995).

The 1905 Sanborn map indicated the former MGP was renamed the BUG Williamsburg Branch. According to the 1905 Sanborn map, the gas production facilities remained relatively unchanged, since construction, with the exception of the addition of iron tanks and a pump house. One circular gas tank, a generator house, a condenser house, exhauster houses, and purifying houses were added.

A 1912 map showing existing substructures prepared by the City of New York shows multiple 4 and 6 inch oil pipes along N. 12th Street and crossing into both Parcel 4 and the Pratt Works Refinery to the north of the MGP. On the 1912 map, the pipes are shown in two groups, one identified as '3 6" Oil Pipes' and the other identified variously as '9 4" Oil Pipes' and '11 4" Oil Pipes.' A 1908 BUG drawing shows an excavation plan for a pump house, settling tank, and oil separator to be built, and the generator house shown on the 1905 Sanborn is identified as the Old Loomis House. In the 1908 BUG drawing, two oil conduits are shown crossing the Site, within the area of Parcel 4. One of the conduits is identified as the "Pratt Oil Conduit" is shown to contain three pipes. The other conduit is labeled simply "Oil Conduit."

By 1916, the Sanborn map indicates the former Williamsburg Works MGP continued water gas production as evidenced by the addition of generators and conversion of the retort house to a generator house. A pump house and oil separator, similar to those shown in the 1908 BUG drawing, as well as two additional oil tanks and a tar slop tank are shown. An additional tank was added; the tank is identified as a gasometer on the Sanborn map and as a gas oil tank in a later 1921 BUG drawing.

The Williamsburg Works MGP ceased operation and the MGP structures were dismantled prior to 1941, as evidenced by the vacant lots shown in the 1941 Sanborn map. Subsequent to dismantlement, the former Williamsburg Works MGP property was subdivided and redeveloped for commercial, industrial and manufacturing uses.

3.1.2 Post MGP History

Subsequent to dismantlement, the former Williamsburg Works MGP property was subdivided and redeveloped for commercial, industrial, and manufacturing uses. A brief history of the post MGP use was developed from available BUG and Sanborn maps and is

[1] Progressive Age. Volume XI. 1893. p. 324.

presented below by Site specific Parcel IDs and tax lot. All of these properties are currently not owned by National Grid.

BUG drawing 1G122 dated June 23, 1909, and retraced October 5, 1939, includes handwritten notes indicating Block 2287 (Parcels 2 through 4) was leased by the United States Navy beginning on July 1, 1945, with permission to stay until June 30, 1946 or six months after the end of the war. The same lease was noted for Block 2288 (Parcel 1), with a cancelation of the lease in June of 1946. Title searches for former MGP Parcels 1 through 4 did not indicate purchase of property by the United States Government between 1945 and 1946. The use and activity at the Site, if any, by the United States Navy is unknown. The Parcels were then under contract of sale in May 1946 with the condition that a railroad connection could be extended to the property. The connection was unable to be made and the contract was canceled as noted in the 1946 BUG drawing, which is included in Appendix A.

A July 1946 BUG drawing, 1G122, retraced July 16, 1946, which includes subsequent hand notes, indicates that modern day Block 2287 Lot 1 (Parcel 2) was sold on January 30,1946, and that modern day Block 2287 Lots Lot 16 and 30 (Parcels 3 and 4 respectively) were under contract for expected closing sale by February 1947. Block 2288 Lot 1 (Parcel 1) was sold on May 27, but the year is not legible.

- **Parcel 1 [Block 2288 Lot 1]:** The larger parcel within Parcel 1, still owned by BUG, was sold to Jerome Zirinsky in 1948. According to Sanborn maps, the property was developed as a beverage warehouse and garage in 1951 and had a gasoline storage tank. Subsequent Sanborn maps, 1965, 1978, and 1979 indicated the property use as a garage. Mr. Zirinsky was involved in property ownership until 1979 when the property was sold to NYC Industrial Development Agency. Colonial Mirror and Glass Corp. purchased the property on May 7, 1996. Colonial Mirror and Glass Corp. formerly operated a garage at the property. January 7, 2002, Colonial Mirror and Glass Corp. sold the property to George and Abe Weiner, aka, Abraham individually and as trustees of the Colonial trust. In August of 2013 Amazon opened a photography studio at the property.
- **Parcel 2 [Block 2287 Lot 1]:** BUG sold the property to Kent Industrial Corp. on July 22, 1946. A warehouse/industrial building was constructed by 1951 and was occupied by the Ferro Co. Corp. for sheet metal product manufacturing. By 1965, the building was occupied by Commercial Corrugated Container Corp. On June 2, 1971, the property was owned by American Sandfill and Marine Corp. By 1978, the property was occupied by a New York City Department of Sanitation garage, which occupied the property until February 2009 when the building was demolished. The Parcel is currently a vacant, fenced lot used by the New York City Department of Parks and Recreation as a parking lot and an outdoor concert space during the summer.

- **Parcel 3 [Block 2287 Lot 16]:** The property was sold by the BUG to Havemeyer and Elder Inc. on January 31, 1947. Again, the property was purchased possibly to extend the Brooklyn Eastern District Terminal operations. Paragon Oil Co. Inc. purchased the property from the Brooklyn Eastern District Terminal on August 14, 1958. The 1965 Sanborn depicts two railroad spurs, a repair shop, office, scale, and scrap metal storage on the property. By 1978, the property and buildings were vacant except for the office. Texaco Inc. sold the property to Bridge Lumber Co. Inc. on May 24, 1982, which then sold the property to the New York City Industrial Development Agency on October 5, 1982. In 1983, the buildings were demolished, and the property was used for parking. In March 26, 1987 the property was repurchased by the Bridge Lumber Co. Inc. which sold it to the R.A.R Realty Corp. on the same day. The current warehouse building was constructed in 1985 and used for lumber storage from 1988 until 1995 according to Sanborn maps. An underground storage tank, used as an oil/water separator for rainwater runoff from delivery trucks by the lumber company, was identified beneath the floor of the building in a 1998 Phase I ESA conducted by EEA. CitiStorage used the building for document storage until January 2015 when a fire destroyed the building. This parcel is currently vacant.
- **Parcel 4 [Block 2287 Lot 30]:** According to the title search, the property was sold from the BUG to Havemeyer and Elder Inc. on January 31, 1947. Havemeyer & Elder purchased multiple properties along the East River to expand their railroad terminal, the Brooklyn Eastern District Terminal. The 1965 Sanborn figure depicted three railroad spurs extending into the property from the west. Brooklyn Eastern District Terminal sold the property to Paragon Oil Company Inc. on August 14, 1958. The Sanborn maps depict oil truck parking operations occurred from approximately 1978 until 1982. Texaco Inc. sold the property to The Bridge Lumber Company Inc. on May 24, 1982. The current warehouse building was constructed in 1985 and used for lumber storage from 1988 until 1995 according to Sanborn maps. CitiStorage used the building for document storage until January 2015 when a fire destroyed the building. This parcel is currently vacant.

3.1.3 Current Site Conditions

The current site conditions of each property are summarized below.

Parcel ID	Address	Current Owner	Block	Lot	Land Use Description
1	35 Kent Avenue Brooklyn, NY 11211	North 12th Associates	2288	1	Industrial factory building is used by Amazon as a photography studio.
2	21 North 12th Street (50 Kent Avenue) Brooklyn, NY 11211	Parks and Recreation	2287	1	Grassed fenced lot used by the New York City Department of Parks and Recreation as a pop-up park.
3	20 North 12th Street Brooklyn, NY 11211	10th Street, LLC.	2287	16	Vacant following the burning of former warehouse building.
4	2 North 11th Street Brooklyn, NY 11211	10th Street, LLC.	2287	30	Vacant following the burning of former warehouse building.

3.1.4 Investigation and Remedial History

On behalf of National Grid, GEI conducted a Remedial Investigation for the Williamsburg Works MGP site from June 2009 through December 2012. At their request, an interim data deliverable was submitted to NYSDEC in August 2010, and in September 2010 NYSDEC responded with a letter requesting that an excavation/stabilization based IRM be performed at "the 50 Kent Ave. parcel (bounded by Citi Storage [Block 2278, Lot 16], N. 12th St., Kent Ave., and N. 11th St.)."

On August 2, 2011, NYSDEC approved, with modification, a GEI prepared IRM Design Work Plan dated July 2011 and subsequently revised in August 2011. The IRM Design Work Plan was implemented by URS (URS has since become part of AECOM) between January 2012 and June 2015. URS submitted an IRM 100% Design Report (Design Report) to NYSDEC in June 2015. The Design Report was approved by NYSDEC on August 17, 2015. The IRM was conducted from December 2015 through June 2017.

During design of the IRM, GEI continued to implement RI field work. A RI Report, prepared by GEI, was submitted to NYSDEC on January 31, 2015.

On August 25, 2021, NYSDEC approved a RI work plan addendum for Parcels 3 and 4. Field work was implemented in 2022. At the request of NYSDEC, a RI work plan addendum for NAPL gauging and recovery was submitted to NYSDEC on December 7, 2022. NAPL gauging and recovery commenced in February 2023 and is ongoing. The revised RI report was submitted to NYSDEC on October 31, 2023.

3.2 Scope of Field Work

National Grid USA retained GEI to conduct a Remedial Investigation. Activities that GEI will be performing during the RI are listed below:

- Site Mobilization
- Soil Boring and Monitoring Well Installation Observation
- Groundwater Sampling
- Non Aqueous Phase Liquid (NAPL) Gauging and Recovery
- Site Survey

Table 2. GEI Employee Site Tasks and Descriptions

Task Number	Task Titles	Task Descriptions
1.	Site Mobilization	Mobilize equipment and contractors to Site, mark out sample locations, observe utility clearance activities.
2.	Soil Boring and Monitoring Well Installation Observation	Observe contractor installing soil borings and monitoring wells and collect soil samples.
3.	Groundwater Sampling	Collect low flow groundwater samples.
4.	NAPL Gauging and Recovery	Gauge wells for NAPL and remove NAPL if necessary.
5.	Site Survey	Observe contractor surveying sample locations.

4. Potential Hazards

The potential hazards associated with site conditions and activity hazards related to GEI on site activities have been identified in this section. Detailed information for these hazards and their control methods are discussed further in the Table 3 and the job hazard analysis (JHAs) included in Appendix B.

4.1 General Site Hazards

General hazards and control measures that are applicable to all site activities have been identified in Table 3.

Table 3. General Site Hazards

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, and Nitrile gloves (as needed). • Dispose of gloves after use and wash hands. • Avoid contact with pooled liquids and limit contact with contaminated soils/groundwater. • See SOP HS 009
Cold Stress Hypothermia, Frostbite	• Take breaks in heated shelters when working in extremely cold temperatures. • Drink warm liquids to reduce the susceptibility to cold stress. • Wear protective clothing (recommended three layers: an outside layer to break the wind, a middle layer to provide insulation, and an inner layer of cotton of synthetic weave to allow ventilation). • Wear a hat and insulated boots. • Keep a change of dry clothing available in case clothes become wet. • Do heavy work during the warmer parts of the day and take breaks from the cold. • If possible, shield work areas from drafts of wind and use insulating material on equipment handles when temperatures are below 30°F • Watch for symptoms of cold stress and initiate first aid procedures (Section 4.3.2).

General Hazards **These Hazards Apply to All Site Activities**	**Control Measure**
Cell Phone Use On Project Site	• Look and listen for potential hazards while using a cell phone for work related activities. • Limit your cell phone use for personal calls or other activities to non-working hours in areas free of hazards. • Do not use your cell phone when safety hazards are present. • Do not use headphones or ear buds while performing work related activities. Headphone or ear bud use can prevent you from hearing hazards around you. • Noise canceling headphones or earbuds are not to be used in place of hearing protection. • Never use a cell phone while operating any equipment or vehicle. • Consider using the "do not disturb" or "silent" functions to allow you to focus on your task.
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 during times when dust causes hazardous driving conditions. • Wear protective gear – dust masks, safety glasses • Use engineering methods to suppress dust if possible.
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

General Hazards **These Hazards Apply to All Site Activities**	**Control Measure**
Heavy Equipment Working Near 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 or 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 SOP HS 018
Inclement Weather	• Listen to local forecasts for warnings about specific weather hazards such as tornados, thunderstorms, 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
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 SSM prior to commencing work. • Field personnel should perform a self-check at the end of the day for ticks. • See SOP HS 001

General Hazards **These Hazards Apply to All Site Activities**	**Control Measure**
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.
Repetitive Motion Injury Standing, Squatting, and Bending Over	• Take regular breaks and do not work in unusual positions for long periods of time. • Walk and stretch between tasks. • See SOP HS 025
Sun Exposure	• Liberally apply sunscreen, with a minimum broad spectrum sun protection factor (SPF) of 30. • Wear safety glasses that offer protection from ultraviolet A and B (UVA/UVB) rays. • Bring shade to the site to reduce exposure. • When possible, wear long sleeved shirts and long pants. • Clothes made from tightly woven fabric and darker colors offer the best protection. Some clothing is certified as offering UV protection. • Wear a hat that has a brim all the way around that shades your face, ears, and the back of your neck. A tightly woven fabric, such as canvas, works best to protect your skin from UV rays. • Sunscreen wears off. Put it on again if you stay out in the sun for more than 2 hours. • Check the sunscreen's expiration date. Sunscreen without an expiration date has a shelf life of no more than 3 years.
Unsecured or High Crime Areas	• Be aware of your surroundings. • Use the buddy system. Do not remain on site alone. Accompany or be accompanied by others to vehicles. • Request police detail when appropriate. • Let the SSM know when you begin work in these areas and when you leave. • Call in regularly. • 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.

General Hazards These Hazards Apply to All Site Activities	**Control Measure**
Utilities Shock, Electrocution, Fire, Explosion	• A thorough underground utility survey must be conducted prior to intrusive activities. Coordination with utility locating services, property owner(s) or utility companies must be conducted. • Utilities are to be considered live or active until documented otherwise. • For overhead utilities within 50 feet, determine with the utility company the appropriate distance. Minimum distance for clearance is based on voltage of the line. • If exposing a utility, proper support and protection must be provided so that the utility will not be damaged. • 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. • See SOP HS 014
Vehicular Traffic Struck by injury, crushing	• Increase visibility of the work area to others by using cones, flags, barricades, proper lighting and caution tape to define work area. • Use a "spotter" to locate oncoming vehicles. • Use vehicle to block work area. • Engage police detail for all work conducted in appropriate areas. • Wear high visibility, reflective vest at all times. • Maintain minimum DOT defined distances to other traffic lanes. • See SOP HS 016.

4.1.1 Hazard Controls

On site safety equipment to control the hazards listed above will include:

Site Specific Safety Equipment *(check all that apply)*		
☒ Drinking water/electrolyte fluids	☒ Hand cleaner/sanitizer	☒ Tick removal kit
☒ Eye wash bottles	☒ Insect repellent	☒ Other: Tyvek clothing
☒ Fire extinguisher	☒ Phone charger	☐ Other:
☒ First aid kit	☐ Poison ivy/oak cleanser	☐ Other:
☐ Flashlight/head lamp	☒ Sunscreen	

GEI will ensure subcontractors are aware of pedestrian traffic safety for cyclers. GEI employees will ensure subcontractors are aware when a pedestrian is crossing the entrance and exit points to the Site on a bike.

Personal protective equipment (PPE) is discussed in further detail in Section 5.

4.1.2 Personal Safety

Field activities have the potential to take employees into areas which may pose a risk to personal safety. The following websites have been researched to identify potential crime activity in the area of the project:

- https://communitycrimemap.com/: No crimes identified in the past 30 days of preparing this HASP (July 2024) within a 3-mile radius of the Site.
- www.cityrating.com/crimestatistics.asp: New York crime statistics report an overall downward trend in crime based on data from 20 years with violent crime decreasing and property crime decreasing. With one exception to murder and manslaughter in 2019 but has decreased since then. Based on this trend, the crime rate in New York for 2024 is expected to be lower than in 2019.

The city violent crime rate for New York in 2019 was higher than the national violent crime rate average by 50.42% and the city property crime rate in New York was lower than the national property crime rate average by 30.82%.

In 2019 the city violent crime rate in New York was higher than the violent crime rate in New York by 59.14% and the city property crime rate in New York was lower than the property crime rate in New York by 6.28%.

Brooklyn, New York is not listed on the Crime Mapping website; however, the New York City Police Department has a Crime Map showing crime statistics for the year to date. Prior to July 7, 2024, 577 incidents were listed in the 94th Precinct. This is a decrease of 9.13% from 2023.

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 Site Safety Manager (SSM) and Safety Team (Safety Director and Regional Safety Managers – SafetyTeam@geiconsultants.com)mailto:Health%26safetyteam@geiconsultants.com of any incidents once you are out of potential danger.

In the event of an emergency, prompt communications with local emergency responders are essential. At least one charged and functioning cell phone to enable emergency communications will be on site. Confirmation of cellular phone operation will be confirmed at the start of each working day.

4.1.3 Communicable Diseases

Communicable diseases are illnesses caused by viruses or bacteria that people spread to one another through contact with contaminated surfaces, bodily fluids, blood products, insect bites, or through the air. Examples of communicable diseases include influenza, coronavirus 2019, hepatitis B, salmonella, measles, and blood borne illnesses. Most common forms of spread include food, insect bites, droplets, or skin contact. Infections may range in severity from asymptomatic (without symptoms) to severe and fatal. Transmission of these biologic agents can occur in a variety of ways including airborne (inhalation), direct physical contact with an infectious person, consuming contaminated foods or beverages, contact with contaminated body fluids, contact with contaminated inanimate objects, or being bitten by an infected insect or tick. Below are ways to prevent the infection or spread of communicable diseases:

1. **Distancing:** Maintain a distance of at least 6 feet (2 meters) from others. Minimize the number of employees in one location to the extent possible. If tasks need to be performed close to others (within 6 feet) and that cannot be avoided, wear appropriate PPE including a face mask (surgical or cloth), gloves, and eye protection.
2. **Wash Hands Often:** Frequent hand washing with soap and warm water for 20 seconds. If soap and water are not readily available, use hand sanitizer (containing 60% alcohol) until soap and water can be used.
3. **Clean and Disinfect Commonly Used Surfaces:** Wipe down surfaces with disinfectant on a routine basis. This includes field equipment and other items that may have previously been used by others. This is especially important while working in construction trailers. When using company and personal vehicles, wipe surfaces including the steering wheel, gear shifter, controls, and door handles before and after use.
4. **Use Good Hygiene Practices:** These include washing hands frequently, avoid touching your eyes, nose, and mouth, and cover coughs and sneezes.
5. **Get Vaccinated:** Vaccines can prevent many infectious diseases. There are also vaccines that are recommended or required for travel to certain parts of the world.
6. **Avoid Touching Wild Animals:** Be cautious around wild animals as they can spread infectious diseases.
7. Stay home when you are sick.

4.2 Job Hazard Analysis

The site-specific tasks, potential hazards, and control measures established to reduce the risk of injury or illness are identified in step by step JHAs included in Appendix B. Prior to the start of work, project team members will determine what tasks are covered in the scope of work (Table 2) and then develop a JHA for each of these tasks and have them reviewed by the Project Manager (PM) or their designee and approved by a member of the Safety Team. Indicated in each JHA are the specific PPE, training, equipment, health and safety SOPs and programs that apply to each task. Additional information on hazard controls can be found in GEI's SOPs and programs that apply to this project which are indicated in Appendix E.

4.2.1 Handling Drums and Containers

Regulations for handling drums and containers are specified by 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.

4.2.2 Electrical Hazards

4.2.2.1 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.

4.2.2.2 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.
- 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 to them otherwise restricted to avoid chance of accidental contact. 811 must be called at least 3 days prior to work starting and valid 811 tickets will be maintained on site.

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.

4.2.2.3 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.

4.2.3 Precautions for Working in Confined Spaces

Work in confined spaces will be performed in accordance with 29 CFR 1910.146 and the GEI Permit Required Confined Space Entry program. Confined space work will not be performed without first notifying and receiving approval from a member of the Safety Team. The PM will work with the Safety Director to address confined space hazards as applicable prior to the start of the project. The PM will contact local emergency responders to plan for potential rescue. This correspondence will be documented on the Confined Space Permit and communicated to the project team. A confined space entry number will be obtained from the Safety Director or the RSM before entering space.

A JHA will be developed that includes the site-specific tasks and hazard controls in will be reviewed by the PM and included in Appendix B. A link to GEI's Confined Space program is available in Appendix E which directs you to the Safety Resources page of GEI Connections. Excavations and Trenches (Including Drilling)

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.
- Atmospheres are to be tested with a properly calibrated Combustion Gas Indicator (CGI) or Gas Measurement Instrument (GMI) in accordance with National Grid excavation procedures as required.

Employees will refer to GEI's Excavation Safety SOP for further information.

4.2.4 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.

4.2.5 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.

4.2.6 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.

4.2.7 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, do not twist.

4.2.8 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.

4.2.9 Cuts and Lacerations

The core sampling program may require employees or the contractor 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.

4.3 Heat and Cold Stress

4.3.1 Heat Stress

Employees may be exposed to the hazards associated with heat stress when ambient temperatures exceed 80ºF. To prevent heat related illness, PMs should plan for proper hydration (drinking plenty of water), acclimatization (getting used to weather conditions), and schedules that alternate work with rest. Employees should also be trained to recognize the symptoms of heat related illnesses and know how to administer first aid for heat related illnesses and activate emergency medical services quickly when needed. Water and shade will be available to all project employees and located as close as practicable to the work areas when temperatures exceed 80°F.

CDC Heat Planning Tool

For the most recent details and tools for heat stress, use your smart phone to access the Centers for Disease Control for the latest information. Additional details can be found in GEI's Heat Stress Program located on the Safety Resources page of GEI Connections.

Prior to each workday, the forecasted temperature and humidity for the worksite will be reviewed and will be compared against the National Weather Service Heat Index to evaluate the risk level for heat illness. When the temperature equals or exceeds 95°F, or during a heat wave, high heat procedures will be used which include additional preventive measures including pre shift meetings to encourage employees to drink plenty of water, working in the buddy system or regular communication so observations can be made for heat related illness, and to remind employees of their right to take a cool down rest when necessary.

4.3.2 Cold Stress

Employees may be exposed to the hazards associated with cold stress when working in cold, wet, and/or windy conditions. Potential hazards in cold environments include frostbite, trench foot or immersion foot, hypothermia, as well as slippery surfaces, brittle equipment, and poor judgment.

CDC Cold Stress Info

For the most recent details and tools for cold stress, use your smart phone to access the Centers for Disease Control for the latest information. Additional details can be found in GEI's Cold Stress Program located on the Safety Resources page of GEI Connections.

4.4 Confined Spaces

Work in confined spaces will be performed in accordance with 29 CFR 1910.146 and the GEI Permit Required Confined Space Entry program. Confined space work will not be performed without first notifying and receiving approval from a member of the Safety Team. The PM will work with the Safety Director to address confined space hazards as applicable prior to the start of the project. The PM will contact local emergency responders to plan for potential rescue. This correspondence will be documented on the Confined Space Permit and communicated to the project team. A confined space entry number will be obtained from the Safety Director or the RSM before entering space.

A JHA will be developed that includes the site-specific tasks and hazard controls in will be reviewed by the PM and included in Appendix B. A link to GEI's Confined Space program is available in Appendix E which directs you to the Safety Resources page of GEI Connections.

4.5 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 SSM, the Safety Director 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.

4.6 Constituents of Concern

The characteristics of constituents of concern (COC) at the site are discussed below for safety information purposes. A COC is any substance classified or defined as hazardous, extremely hazardous, toxic, or dangerous. The COC included in this HASP will be the primary constituents that have been detected on site or are anticipated to be detected. These COC will be used to determine the action levels and PPE necessary for site personnel. Adherence to the safety and health guidelines in this HASP should reduce the potential for exposure to the COC discussed below.

4.6.1 Site Specific COC

4.6.1.1 Asbestos Containing Materials

The Site potentially contains asbestos containing materials (ACM) in the forms of demolition debris within or without holders, ACM pipe insulation, and asbestos cement pipe. Chronic exposure to asbestos may cause asbestosis and mesothelioma. The primary route of exposure for asbestos is inhalation during the disturbance and/or removal of asbestos from the pipe insulation and cement pipes.

Asbestos is strictly regulated under OSHA 29 CFR 1910.1001/1926.1101. Employees that may be potentially exposed to ACM must participate in a medical surveillance program, have specific training in the hazards and controls of exposure to asbestos, and wear respirators with high efficiency particulate air (HEPA) filters. Work must be conducted in demarcated regulated areas to minimize the amount of people within the exposure area. Employers must conduct air sampling and provide signs and labels regarding the presence of asbestos.

4.6.1.2 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 dense non aqueous phase liquid (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 (CNS) 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.

4.6.1.3 Coal Tar and Coal Tar Products

Coal tar products, which are semi volatile organic compounds (SVOCs) 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, pyrene.

Coal tar products and other SVOCs are present at the Site within impacted soil and groundwater and as a DNAPL by product of gas production within soils, former MGP structures, and abandoned pipelines.

Coal tar products 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. Coal tar is considered to be very toxic, if ingested. High levels of exposure to coal tar, 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.

4.6.1.4 Cyanide

Cyanide compounds are common by products of manufactured gas production. Hydrogen cyanide is toxic because it is a chemical asphyxiate. It replaces the oxygen in the blood and thereby suffocates the cells. Ferro cyanides are not considered toxic because the hydrogen cyanide ion is bound too tightly to the iron and cannot therefore replace the oxygen. It takes a great amount of heat and/or acid to release cyanide gas from the ferro cyanide molecule; therefore, hydrogen cyanide is not a concern at this Site. However, it is National Grid's policy to monitor for hydrogen cyanide during earth disturbing activities at sites where MGP related contaminants have been found.

4.6.1.5 Heavy Metals

Exposure to high concentrations of arsenic can cause dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, and hyper pigmentation of skin. Chronic exposure to arsenic has resulted in lung cancer in humans.

Exposure to high concentrations of aluminum can cause irritation of the eyes, skin, and the respiratory system.

Exposure to high concentrations of antimony can cause irritation of eyes, skin, nose, throat, and mouth; coughing; dizziness; headache; nausea, vomiting, diarrhea; stomach cramps; insomnia; anorexia; and could be unable to smell properly. Chronic exposure to antimony can produce respiratory effects that include antimony pneumoconiosis (inflammation of the lungs due to irritation caused by the inhalation of dust), alterations in pulmonary function, chronic bronchitis, chronic emphysema, inactive tuberculosis, pleural adhesions, irritation; cardiovascular effects (increased blood pressure, altered EKG readings and heart muscle damage) and gastrointestinal disorders in humans.

Exposure to high concentrations of beryllium can result in "beryllium sensitization," which is an allergic response to beryllium. Symptoms of the disease include cough, shortness of breath, fatigue, fevers, skin rash, and night sweats. In the later stages, lung tissue becomes scarred. In severe cases, the right side of the heart may be strained due to increased pressure in the pulmonary artery from lung damage.

Exposure to high concentrations of cadmium can cause acute symptoms such as pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness and pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; loss of the sense of smell), mild anemia; and is considered a potential occupational carcinogen.

Exposure to chromium can cause acute symptoms such as irritation of the eyes, nose and throat as well as wheezing and coughing. Chronic effects include nosebleeds, nasal congestion, dermatitis, and loss of sight.

Exposure to high concentrations of copper through inhalation can cause irritation of the eyes, nose, pharynx, nasal septum. Ingestion may cause a metallic taste. Skin irritation may result from direct contact with skin. Damage to the liver and kidneys may occur.

No adverse health effects are associated with environmental exposure to iron. Target organs for iron via ingestion of iron (most often in supplement form) are the liver, cardiovascular system, and kidneys. Exposure to high concentrations of iron through ingestion can cause salivation nausea, vomiting, diarrhea, and abdominal pain.

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.

Exposure to high concentrations of manganese can cause manganism, metal fume fever, flu like fever, and kidney damage.

Exposure to high concentrations of nickel may cause sensitization dermatitis, allergic asthma, and pneumonitis. Exposure to mercury can cause dizziness, salivation nausea, vomiting, diarrhea, constipation, emotional disturbance, and kidney injury. Chronic exposure to mercury can cause CNS damage.

Exposure to high concentrations of selenium can cause mucous membrane irritation, coughing, sneezing, shortness of breath, chills, headaches, hypotension, and CNS depression. Chronic exposure to selenium could cause bronchial irritation, gastrointestinal distress, excessive fatigue, and skin discoloration.

Exposure to high concentrations of thallium can cause nausea, diarrhea, abdominal pain, vomiting; tremor; chest pain, pulmonary edema; convulsions, psychosis; liver, kidney damage; and alopecia.

Vanadium may cause greenish black discoloration of the tongue and is a possibly carcinogenic to humans. Long term or repeated exposure to vanadium may have effects on the respiratory tract, resulting in chronic rhinitis and chronic bronchitis.

Exposure to high concentrations of zinc through ingestion can cause abdominal pain, nausea, vomiting, and diarrhea. Chronic exposure can lead to low blood pressure, jaundice, and seizures.

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.

4.6.1.6 Hydrogen Sulfide

Hydrogen sulfide is another common by product of manufactured gas production. Exposure to lower concentrations can result in eye irritation, a sore throat and cough, shortness of breath, and fluid in the lungs. These symptoms usually go away in a few weeks. Long-term, low-level exposure may result in fatigue, loss of appetite, headaches, irritability, poor memory, and dizziness. Breathing very high levels (> 800 parts per million [ppm]) of hydrogen sulfide can cause death within just a few breaths. The primary route of exposure is through inhalation and, therefore, respiratory protection is the primary control against exposure to hydrogen sulfide.

4.6.1.7 Pesticides

Pesticide exposures, in general, affect the CNS, liver, kidneys, and skin. At high concentrations, pesticides can cause headache, dizziness, nausea, vomiting, malaise (vague feeling of discomfort), sweating, limb jerks, convulsions, and coma. The pesticides detected at the site are at environmental concentrations and are not expected to be at concentrations that exposure symptoms would occur.

4.6.1.8 Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs), are a group of chemicals consisting of numerous carbon atoms joined together to form multiple rings. PAHs include 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 methylnaphthalene, naphthalene, phenanthrene, phenols, and pyrene. Most are formed from the incomplete combustion of plant or animal matter, or carbon fuels, such as coal or petroleum. These compounds are at environmental concentrations and are not expected to be at concentrations that exposure symptoms would occur. PAHs 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. High levels of exposure to PAHs, 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.

4.6.1.9 Polychlorinated Biphenyls (PCBs)

PCBs have previously been encountered during MGP site investigations at other sites. PCBs have historically been used from a number of sources including, but not limited to; electrical systems, hydraulic oils, lubricants, cutting oils, printer's ink, and asphalt. Exposure to PCBs can occur through unbroken skin without immediate pain or irritation. PCBs detected at the site are at environmental concentrations and are not expected to be at concentrations that exposure symptoms would occur. Acute effects of exposure to high concentrations of PCB can include eye, skin, nose, and throat irritation. Chronic effects of PCB exposure can include skin swelling and redness, gastro intestinal disturbances, and neurological effects such as headache, dizziness, nervousness, and numbness of extremities. PCBs are suspected human carcinogens that can cause liver cancer. PCBs can accumulate in fatty tissues and result in health effects after the initial exposure has occurred. The primary route of exposure for PCBs is inhalation, dermal contact, and ingestion. Analysis of soils from the Site did not indicate elevated PCB concentrations.

4.6.1.10 SVOCs

SVOCs are present at the Site within impacted soil and groundwater and as a dense DNAPL by product of gas production within soils, former MGP structures, and abandoned pipelines.

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.

4.6.1.11 Volatile Organic Compounds (VOCs)

VOCs, such as benzene, toluene, ethyl benzene, and xylene (BTEX) are present as soil and groundwater contaminants, and in some cases chemical components in NAPL such as oil or tar within soils and abandoned pipelines. 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 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 exposure to VOCs.

4.6.1.12 Coal Ash

Coal ash, also referred to as coal combustion residuals or CCRs, is produced primarily from the burning of coal in coal fired power plants. Coal ash includes a number of by products produced from burning coal. Coal ash contains contaminants like mercury, cadmium and arsenic. Ash is a solid, grey/black or brown/tan, odorless powder which may contain solidified masses. It is not combustible or explosive. Airborne dust may cause immediate or delayed irritation or inflammation to the eyes, nose, throat, or lungs depending on the degree of exposure. Ash may contain trace amounts of ammonia or ammonia bisulfate. Contact with water or moisture can cause the ammonia to be released from the ash into the air. Inhalation of ammonia can cause coughing and irritation or burns to the nose throat and lungs. These effects depend on the concentration of ammonia inhaled. Inhalation may occur when the soil is disturbed causing respirable and nuisance dust particles to become airborne. For dust generated during site activities which exceed site specific limits, engineering controls such as water application will be used to control dust concentrations.

4.6.1.13 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.

4.6.1.14 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.

Table 4. Primary Constituents of Concern Data

\	Exposure Limit(s)	Route of Exposure	Primary Hazard/ Symptoms of Exposure
Aluminum	TWA 15 mg/m^3 (total) TWA 5 mg/m^3 (resp)	Inhalation, skin and/or eye contact	Irritation eyes, skin, respiratory system
Antimony	TWA 0.5 mg/m^3	Inhalation, ingestion, skin contact, eyes	Irritation eyes, skin, nose, throat, mouth; cough; dizziness; headache; nausea, vomiting, diarrhea; stomach cramps; insomnia; anorexia; unable to smell properly
Arsenic	0.01 mg/m^3 A.L. 0.005mg/m^3	Inhalation, skin absorption, ingestion, skin contact	Ulceration of nasal septum, dermatitis, GI disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, potential carcinogen
Asbestos	0.1 f/cc over 8 hr. period or 1.0 f/cc over 30 min.	Inhalation, ingestion, skin contact	Asbestosis (chronic exposure); mesothelioma, breathing difficulty, interstitial fibrosis' restricted pulmonary function, finger clubbing; irritate eyes, potential carcinogen
Barium	TWA 15 mg/m^3 (total) TWA 5 mg/m^3 (resp)	Inhalation, skin and/or eye contact	Irritation eyes, nose, upper respiratory system; benign pneumoconiosis (baritosis)
Benzene	1 ppm TWA 5 ppm STEL	Inhalation, skin absorption, ingestion skin contact	Irritation of eyes, skin, nose, respiratory system, giddiness, headache, nausea; staggering gait, fatigue, anorexia, weakness, dermatitis, bone marrow depression, potential carcinogen
Beryllium	TWA 0.002 mg/m^3 C 0.005 mg/m^3 (30 minutes), with a maximum peak of 0.025 mg/m^3	Inhalation, skin and/or eye contact	Berylliosis (chronic exposure): anorexia, weight loss, lassitude (weakness, exhaustion), chest pain, cough, clubbing of fingers, cyanosis, pulmonary insufficiency; irritation eyes; dermatitis; [potential occupational carcinogen]
Cadmium	TWA 0.005 mg/m^3	Inhalation, ingestion	Pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [potential occupational carcinogen]
Carbon Disulfate	30 ppm C	Inhalation, ingestion, skin absorption, skin contact, eye contact	Dizziness, headache, poor sleep, lassitude, anxiety

\	Exposure Limit(s)	Route of Exposure	Primary Hazard/ Symptoms of Exposure
Carbon Monoxide	50 ppm	Inhalation, skin and/or eye contact (liquid)	Headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S T segment of electrocardiogram, angina, syncope
Carbon Tetrachloride	Ca ST 2 ppm (12.6 mg/m^3) [60 minute]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; CNS depression; nausea, vomiting; liver, kidney injury; drowsiness, dizziness, incoordination; [potential occupational carcinogen]
Chromium (Chromic Acid and Chromates)	0.1 mg/m^3	Inhalation, ingestion, skin contact	Irritates respiratory system, nasal, septum perforation, liver and kidney damage, leukocytosis (increased blood leucocytes), leukopenia (reduced blood leucocytes), moncytosis (increased monocytes), Eosinophilia, eye injury, conjunctivitis, skin ulcer, sensitivity dermatitis, potential carcinogen
Copper (as a fumes)	TWA 1 mg/m^3	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis; In Animals: lung, liver, kidney damage; anemia
Cresol	TWA 5 ppm (22 mg/m^3) [skin]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; CNS effects: confusion, depression, respiratory failure; dyspnea (breathing difficulty), irregular rapid respiration, weak pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage
Ethylbenzene	100 ppm	Inhalation, ingestion, skin contact	Eye, skin, mucous membrane irritation; headache; dermatitis, narcosis; coma
Hydrogen cyanide	10 ppm (11 mg/m^3) [skin]	Inhalation, ingestion, absorption, skin/eye contact	Asphyxia; weakness, headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes
Hydrogen sulfide (H2S)	20 ppm C 50 ppm [10 min. Maximum peak]	Inhalation, skin/eye contact	Irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, fatigue, irritability, insomnia; gastrointestinal disturbance; liquid: frostbite
Iron	Iron oxide dust and fume: 10 mg/m^3	Inhalation, ingestion, eye contact	Respiratory tract irritation, coughing, shortness of breath, overdose of iron may cause vomiting, abdominal pain, bloody diarrhea, vomiting blood, lethargy, and shock; acidity in the blood, bluish skin discoloration, fever, liver damage, and possibly death; eye and cornea irritation and discoloration

\	Exposure Limit(s)	Route of Exposure	Primary Hazard/ Symptoms of Exposure
Lead	0.05 mg/m^3 A.L. 0.03 mg/m^3	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
Manganese	C 5 mg/m^3	Inhalation, ingestion	Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu like fever; low back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage
Mercury	0.10 mg/m3	Inhalation, ingestion, skin contact, skin absorption	Irritates eyes and skin, chest pain, cough, difficulty breathing, bronchitis, pneumonitis, tremor, insomnia, irritability, indecision, headache, fatigue, weakness, stomatitis, salivation, Gastrointestinal disturbance, weight loss, proteinuria
Naphthalene	10 ppm (50 mg/m^3) TWA	inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage
Nickel	TWA 1 mg/m^3 [*Note: The PEL does not apply to Nickel carbonyl.]	Inhalation, ingestion, skin and/or eye contact	Sensitization dermatitis, allergic asthma, pneumonitis; [potential occupational carcinogen]
PCBs	0.5 mg/m^3 (Skin)	Inhalation, skin absorption, ingestion, skin contact	Irritate eyes; chloracne; liver damage
Phenol	5 ppm (19 mg/m^3) [skin]	Inhalation, skin, absorption, ingestion, skin contact	Irritates eyes, nose, throat, anorexia, weight loss, weakness, muscle ache, pain, dark urine, cyanosis, liver and kidney damage, skin burns, dermatitis, tremors, convulsions, twitching,
Portland Cement	TWA 50 mppcf	Inhalation, ingestion, Skin and/or Eye Contact	Irritation eyes, skin, nose; cough, expectoration; exertional dyspnea (breathing difficulty), wheezing, chronic bronchitis; dermatitis
Selenium	0.2 mg/m^3	Inhalation, ingestion, skin contact	Irritant to eyes, skin, nose and throat, visual disturbance, headache, chills, fever, breathing difficulty, bronchitis, metallic taste, garlic breath, GI disturbance, dermatitis, eye, and skin burns,
Thallium	OSHA PEL: TWA 0.1 mg/m^3 [skin]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Nausea, diarrhea, abdominal pain, vomiting; ptosis, strabismus; peri neuritis, tremor; retrosternal (occurring behind the sternum) tightness, chest pain, pulmonary edema; convulsions, chorea, psychosis; liver, kidney damage; alopecia; paresthesia legs

\	Exposure Limit(s)	Route of Exposure	Primary Hazard/ Symptoms of Exposure
Toluene	200 ppm	Inhalation, skin absorption, ingestion, skin contact	Eye, nose irritation; fatigue, weakness, confusion, euphoria, dizziness, headache; dilated pupils, tearing of eyes; nervousness, muscle fatigue, insomnia, tingling in limbs; dermatitis
1,2,4 Trimethyl b enzene	None	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat, respiratory system; bronchitis; hypochromic anemia; headache, drowsiness, lassitude (weakness, exhaustion), dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonitis (aspiration liquid)
1,3,5 – Trimethylbenzen e	NA	inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat, respiratory system; bronchitis; hypochromic anemia; headache, drowsiness, lassitude (weakness, exhaustion), dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonitis (aspiration liquid)
Vanadium	C 0.5 mg	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, throat; green tongue, metallic taste, eczema; cough; fine rales, wheezing, bronchitis, dyspnea (breathing difficulty)
Xylene	100 ppm	Inhalation, skin absorption, ingestion, skin contact	Eye, skin, nose, throat irritation; dizziness, excitement, drowsiness; incoordination, staggering gait; corneal damage; appetite loss, nausea, vomiting, abdominal pain; dermatitis
Zinc	TWA 15 mg/m^3 (total dust) TWA 5 mg/m3 (resp dust)	Inhalation	Metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough; lassitude (weakness, exhaustion); metallic taste; headache; blurred vision; low back pain; vomiting; malaise (vague feeling of discomfort); chest tightness; dyspnea (breathing difficulty), rales, decreased pulmonary function

Notes:
A.L. Action Level
C ceiling limit, not to be exceeded
Ca – carcinogen
f/cc fibers per cubic centimeter
mg/m^3 micrograms per cubic meter
mppcf millions of particulates per cubic foot of air
ppm parts per million
STEL Short term exposure limit (15 minutes)
TWA Time weighted average (8 hours)

4.6.2 Chemicals Brought on Site

Potential hazards associated with chemicals brought on site (e.g., decontamination chemicals, sample preservatives, fuels, calibration fluids) for the work will be mitigated through training, administrative controls (e.g., proper labeling and storage), and proper use of PPE. SDSs for all chemicals brought on site shall be maintained by the SSM and are included in Appendix C.

5. Personal Protective Equipment

The PPE required to be worn on the project site is listed in the table below. Additional PPE required for the tasks to be performed is listed on the JHAs in Appendix B.

Site Required PPE *(check all that apply)*		
☒ Hard Hat	☐ Respirator	☒ Tyvek clothing/boots
☒ Safety Glasses	☐ Flame Resistant Clothing	☐ Other:
☒ Safety Boots	☐ Personal Flotation Device	☐ Other:
☐ Long Sleeve Shirt	☐ Snake Chaps	☐ Other:
☒ High Visibility Safety Vest	☐ EH Rated Boots	☐ Other:

If site conditions suggest the existence of a situation more hazardous than anticipated, the site personnel will evacuate the area to a safe distance. The hazard, the level of precautions, and the PPE will then be reevaluated with the assistance and approval of the Safety Director and the PM. If conditions indicating the need for Level A or Level B PPE are encountered, personnel will leave the site and notify the PM or a member of the Safety Team. GEI's PPE Program can be found on the Safety Resources page of GEI Connections.

5.1 Respiratory PPE

GEI personnel who have the potential to don a respirator must have a valid fit test certification and medical clearance. 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.

Upgrades to respiratory protection may be required based on the designated Action Levels found in Section 9.

6. Responsibilities and Lines of Authority

6.1 GEI Personnel Responsibilities

The implementation of health and safety at this project location will be the shared responsibility of the Safety Director, Regional Safety Director, PM, the SSM, and each GEI personnel implementing the proposed scope of work.

6.1.1 GEI Safety Director

The Safety Director is responsible for the overall management of GEI's safety programs, policies, and procedures. Modifications to this HASP which may result in the reduction in the identification, evaluation, and control of safety and health hazards cannot be undertaken by the project team without the approval of the Safety Director.

6.1.2 GEI Project Manager

The PM is responsible for confirming that the requirements of this HASP are implemented. The PM's specific responsibilities include:

- Conducting and documenting the Project Safety Briefing.
- Verifying that the GEI staff and subcontractors selected to work on this program are sufficiently trained for site activities and have reviewed this HASP.
- Maintaining regular communications with the SSM and, if necessary, the Safety Director.

6.1.3 GEI Regional Safety Manager

The RSM is responsible for supporting the safety needs and requirements specified in this HASP. The RSM's specific responsibilities include:

- Reviewing and approving the HASP and applicable JHAs.
- Working with the PM and SSM to meet client safety requirements.
- Providing approval for fall protection plans and confined space entries (permit numbers), as applicable.
- Providing safety support regarding safety programs and procedures as applicable to the project.

6.1.4 GEI Site Safety Manager

The SSM is responsible for implementing and enforcing the safety requirements specified in this HASP and will be on site during activities covered in the HASP. The SSM's specific responsibilities include:

- Enforcing the requirements of this HASP and notify the PM of noncompliance.
- Conduct daily Safety Tailgate meetings for site related work.
- Maintaining a high level of health and safety consciousness among employees implementing the proposed activities.
- Procuring the air monitoring instrumentation, PPE, and safety equipment needed for GEI project employees and verifying that each is in good working order.
- Verifying that GEI subcontractors are utilizing the correct PPE and safety equipment.

6.1.5 All GEI Field Personnel

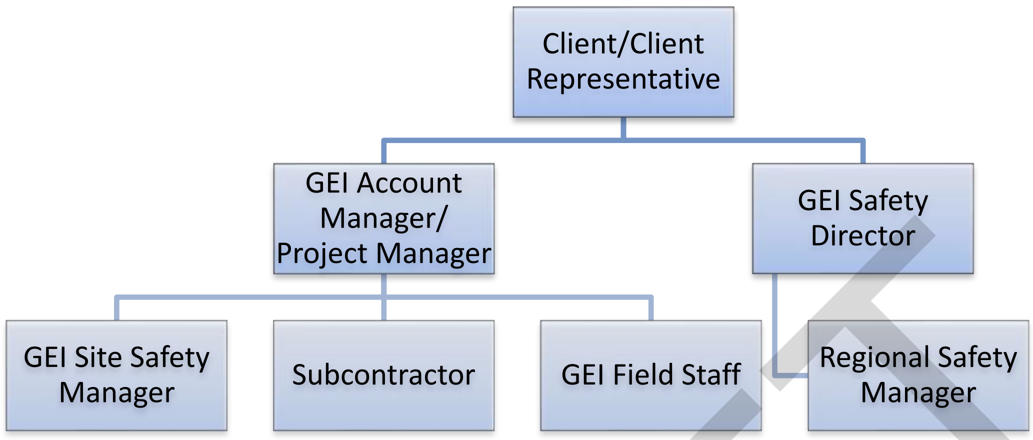
All GEI field personnel (including the PM and SSM) covered by this HASP are responsible for following the health and safety procedures in this HASP and for performing their work in a safe and responsible manner. The specific responsibilities that apply to all field personnel include:

- Reading and signing the HASP prior to the start of on site work.
- Bringing forth any questions or concerns regarding the content of the HASP to the PM or the SSM.
- Attending and actively participating in the required Project Safety Briefing prior to beginning on site work and any subsequent safety meetings.
- Complying with the requirements of this HASP and the requests of the SSM.
- Stopping work in the event that an immediate danger situation is perceived.
- Reporting accidents, injuries, and illnesses, regardless of their severity by following GEI's incident reporting procedures.

6.2 Lines of Authority

GEI will have responsibility for safety of its employees during the work performed at the site. GEI's SSM will have a cell phone available to contact the appropriate local authorities, in the event of an emergency. GEI's SSM will be available for communication with the GEI PM and with National Grid's representative.

Project Lines of Authority



6.2.1 Stop Work Authority

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 Safety Director and the Project Manager to discuss the stop work conditions and potential control methods that can be implemented.

6.3 Subcontractors

GEI has subcontracted the following firms to assist in performing work on this project:

Subcontractor Information	
Aquifer Drilling & Testing 75 E 2nd St Mineola, NY 11501	
Contact Name: Joe McGill	Cell: (631) 889 2927
Scope of Work: Preclearing, test pit excavation, drilling, well construction, well development.	

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 Safety Prequalification 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. The PM will obtain applicable safety certifications and training records from the subcontractor's site supervisor prior to the initiation of work.

7. Training Requirements

Prior to commencement of field activities, the PM or their designee 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. This training will be documented on the applicable JHAs (Appendix B). Personnel that have not received project specific training will not be allowed on site.

Applicable Site Specific Training Requirements *(check all that apply)*		
☒ HAZWOPER (8Hr Refresher)	☐ Railroad	☐ Other:
☒ HAZWOPER (Site Supervisor)	☐ Transportation Worker Identification Credential (TWIC)	☐ Other:
☒ First Aid/CPR	☐ MSHA (Mine Safety and Health Administration)	☐ Other:

7.1 On Site Safety Briefings

GEI personnel will be given health and safety briefings daily (or as frequently as needed) by the SSM or their designee to plan for conducting work activities safely. The briefing will include GEI subcontractors and others as appropriate. The briefings can include information on:

- Applicable JHAs.
- Changes in work practices.
- Changes in environmental conditions.
- Anticipated weather.
- Evacuation/emergency procedures.
- Air monitoring results.
- Safety inspection results.
- Pedestrian Cycling Awareness.

Documentation of these briefings will be recorded in the GEI field book or the Tailgate Safety Briefing Form (Appendix D). For long term projects, the Tailgate Safety Briefing Form is preferred.

8. Medical Surveillance Program

GEI maintains a medical surveillance program under the supervision of the Safety Director that includes a plan designed specifically for field personnel engaged in work at sites where hazardous materials may be present. Field personnel undergo an initial physical examination, including a detailed medical and occupational history before they are able to engage in work at hazardous waste sites. Upon successful completion of the examination, personnel are provided a medical clearance from an occupational health physician stating their fitness to perform the specified work activities. Employees who are part of this program will schedule and attend annual exams 12 months from the date of their previous exam.

If a GEI employee or other project worker shows symptoms of exposure to a hazardous substance and wishes to be seen by a doctor, GEI will consult with their third party medical administrator and provide access to the nearest area hospital or medical facility.

GEI subcontractor personnel that will enter any hazardous waste sites 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). A copy of their medical clearance will be submitted to the GEI PM or SSM prior to the start of field activities.

9. Atmospheric Monitoring

Air Monitoring Required?	
☒ Yes	☐ No*

Air monitoring will be performed to identify and quantify airborne levels of hazardous substances and atmospheric hazards to determine the appropriate level of worker protection needed on site. Work on this project requiring air monitoring includes:

Air Monitoring Tasks *(check all that apply)*		
☒ Excavation	☐ Confined Space Entry	☐ Other:
☒ Soil Sampling	☐ Indoor Drilling	☐ Other:
☐ GW Monitoring Well Headspace	☒ Product Sampling	☐ Other:

The following air monitoring equipment will be on site:

Air Monitoring Equipment *(check all that apply)*	
☒ PID with 10.6 eV lamp or equivalent	☒ Particulate Meter (PM 10 capable)
☐ Drager Chip Measurement System (CMS) with appropriate gas detection chips	☒ Multi gas meter: lower explosive limit (LEL) / oxygen (O_2) / hydrogen sulfide (H_2S) / hydrogen cyanide (HCN) or carbon monoxide (CO) meter
☐ Sensodyne Gas Detection Pump with appropriate gas detector tubes	☐ Other:

GEI will conduct and document on site work zone monitoring and will inform GEI employees of the results. ***If Action Levels are exceeded, immediately implement site action(s) according to Action Table below and notify the PM***.

9.1 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.

9.2 Action Levels

The tables below provide 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).

9.2.1 VOC Monitoring and Control

Air monitoring reduces the risk of overexposure by indicating when action levels have been exceeded and when PPE must be upgraded or changed. Based on the VOCs listed in Table 4, determine which constituent has the lowest PEL. This data is used to determine the action levels needed including respiratory protection at the project site. GEI's action level is half of the PEL listed in Table 4.

Exposure to organic COC can be evaluated and/or controlled by:

- Monitoring worker breathing zone atmospheric concentrations for organic COC in the breathing zone with a PID or a 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.

Air Monitoring Instrument	Action Level (above background)	Site Action
Action Levels for the following parameters are 15 minute time weighted averages (TWA), not a single exceedance.		
PID (Monitoring for VOCs)	0.0 – 50 ppm	No respiratory protection is required if VOCs are not present. (If benzene or naphthalene are constituents of interest at this site, follow the action levels below for benzene and/or naphthalene.)
	> 50 ppm	Stop work, withdrawal from work area, institute engineering controls, if levels persist, upgrade to Level C. Notify PM and Safety Team.
PID (Monitoring for benzene)	0.0 1.0 ppm	No respiratory protection is required if benzene is not present. Use detector tube for benzene to verify if concentration of 1.0 ppm or greater is benzene.
	1.0 – 50 ppm	If benzene is present (confirmation via detector tube), stop work and contact your PM. If work continues and benzene is present, or no detector tubes are used to determine presence, upgrade to Level C. No respiratory protection is required if benzene is not present.
	> 50 ppm	Stop work, withdraw from work area, notify PM and Safety Team.

Air Monitoring Instrument	Action Level (above background)	Site Action
PID (Monitoring for naphthalene)	0.0 5 ppm	No respiratory protection is required if naphthalene is not present. Use Sensodyne detector tube for naphthalene to verify if concentration of 5 ppm or greater is naphthalene.
	5 – 50 ppm	If naphthalene is present (confirmation via detector tube), stop work and contact your PM. If work continues and naphthalene is present or no detector tubes are used to determine presence, upgrade to Level C. No respiratory protection is required if naphthalene is not present.
	> 50 ppm	Stop work, withdraw from work area, notify PM and Safety Team.

9.2.2 Dust Monitoring and Control

Some COC hazards may become hazardous when they are associated with dust/particles and become airborne. For worker safety, dust levels must be managed to eliminate this hazard. Dust generated during activities can cause irritation to the respiratory system and eyes. Contaminants can also be carried in airborne dust causing potential exposure to workers through skin contact and inhalation. Constituent concentrations on site are expected to be low therefore the exposure hazard through inhalation should be minimal; however, contaminant contact through skin and clothing can introduce additional exposures.

For dust generated during site activities which exceed site specific limits, engineering controls such as water application will be used to control dust concentrations. However, if excessive dust concentrations cannot to be handled through engineering controls, then respirators will be required to be worn.

Air Monitoring Instrument	Action Level (above background)	Site Action
Action Levels for the following parameters are 15 minute time weighted averages (TWA), not a single exceedance.		
Particulate Meter	150 μg/m^3	Implement work practices to reduce/minimize airborne dust generation, e.g., spray/misting of soil with water. Don respirator with particulate filters if action levels remain in exceedance.

10. Site Control

10.1 Site Zones

Site zones are intended to control the potential spread of contamination and to assure that only authorized individuals are permitted into potentially hazardous areas. This project is being conducted under the requirements of 29 CFR 1910.120, and any personnel working in an area where the potential for exposure to site contaminants exists, will only be allowed access after proper training and medical documentation.

10.2 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 help in the event of an emergency. Some projects may not support the need for the buddy system to be implemented. If this is the case, the PM is required to conduct regular check ins with the employee on site.

10.3 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. Public restrooms are available in Bushwick Inlet Park, near the intersection of Kent Avenue and N. 9th Street.

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. 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. All GEI employees must comply with

GEI's Controlled Substance Use & Alcohol Misuse Policy found on the Safety Resources page of GEI Connections. Employees may be subject to random drug and/or alcohol testing if required by a client at a project 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:

- For incidents involving life threatening situations or serious injury that require emergency response personnel (Police, Fire, EMS), call 9 1 1 from a safe area.
- Stop work activity to address any injury, illness, property damage, spill or other emergency.
- Call Medcor Triage at 1 800 775 5866 to speak with a medical professional following any injury or illness.
- Notify the PM of the incident or injury.
- The PM will immediately inform the Safety Director, GEI National Grid Client Manager, and the Project Specific National Grid Representative of any accident, incident, injury or near miss.
- Complete an incident report using the GEI Incident Report Form located on the GEI Safety Smartphone App, GEI Connections intranet page, or in the project HASP.
- Resume work activity if all steps above have been completed and it is safe to do so.
- A DRAFT Incident Report Form including root cause/corrective actions will be completed by a member of the Safety Team and submitted to the Project Specific National Grid Representative within 4 hours.
- A FINAL Incident Report will be submitted within 24 hours via e mail to the Project Specific National Grid PM, National Grid Regional Safety Lead, and/or the person to whom the verbal notification was initially provided.

All work will be suspended until contact is made with the Project Specific PM so that National Grid can assess if continued work suspension or if a stand down is necessary. If the National Grid PM cannot be reached, contact the National Grid SIR Regional Safety Lead as noted on the following table.

Name	Region	Phone Numbers	E Mail
William Ryan	Downstate NY	W (516) 545 2586 C (516) 790 1660	William.Ryan@nationalgrid.com
Brian Stearns	Upstate NY	W (315) 428 5731 C (315) 461 7892	Brian.Stearns@nationalgrid.com
Elizabeth Greene	MA/RI	W (781) 907 3656 C (781) 248 6469	Elizabeth.Greene@nationalgrid.com

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 Resources page of GEI Connections. 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. A representative with knowledge of the incident should be available to provide incident information until the investigation is completed by National Grid.

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.

11.2 Flow Chart for Accident Reporting

Employee — Stop work [redacted]

Employee — [redacted]

Employee — [redacted]

PM — [redacted]

Safety Director — [redacted]

Employee — [redacted]

PM with assist from Safety Director or Regional Safety Manager — [redacted]

PM with assist from Safety Director or Regional Safety Manager — [redacted]

Regional Safety Manager — [redacted]

Regional Safety Manager — [redacted]

Safety Director — [redacted]

12. Decontamination Procedures

Site decontamination procedures are designed to achieve an orderly, controlled removal or neutralization of contaminants that may come in contact with personnel or equipment. These procedures minimize contact with contaminants and protect against the transfer of contaminants to clean areas. They also extend the useful life of PPE by reducing the amount of time that contaminants contact and can permeate PPE surfaces. This project is being conducted under the requirements of 29 CFR 1910.120(k), and any personnel or equipment that are exposed to site contaminants will follow applicable decontamination procedures.

12.1 Personnel and PPE Decontamination

A decontamination station where employees can drop equipment and remove PPE will be set up to minimize the potential for hazardous skin or inhalation exposure and to avoid cross contamination and chemical incompatibilities. It will be equipped with basins for water and detergent, and trash bag(s), or cans for containing disposable PPE and discarded materials. Once personnel have decontaminated at this station and taken off their PPE, they will wash themselves wherever they have potentially been exposed to any contaminants (e.g., hands, face, etc.)

The following specific decontamination procedure will be used as necessary by GEI personnel or subcontractor personnel wearing PPE from Level D through Level C.

- **Step 1:** Equipment drop (respirator, tools, monitoring equipment, etc.). Decontaminate as appropriate (per GEI's field representative's instructions).
- **Step 2:** Boot wash/rinse (wash with non-foaming detergent, rinse with freshwater spray). Remove boots. If inner and outer gloves are worn, wash outer gloves, remove and save for later use, or remove and discard outer gloves and place in trash bag/can provided in the decontamination area.
- **Step 3:** Hard hat removal; wash if visibly contaminated (use same wash as in Step 2).
- **Step 4:** If Tyvek® (or equivalent) suit was worn and is visibly contaminated, remove and place in trash bag/can provided in the decontamination area or decontaminate (wash) and store for reuse. Contaminated washable coveralls should be removed and bagged for washing.
- **Step 5:** Respirator and/or eye protection removal (as applicable). Wash (per Step 2) to remove visible contamination.
- **Step 6:** Remove outer gloves.
- **Step 7:** Wash potentially exposed skin (use water and soap at indoor sink).

- **Step 8:** Disinfect respirator per manufacturer's recommendations.

Decontamination wastewater and used cleaning fluids will be collected and disposed of in accordance with applicable state and federal regulations.

Contaminated PPE (gloves, suits, etc.) will be decontaminated and stored for reuse or placed in plastic bags (or other appropriate containers) and disposed of in an approved facility. Decontamination wastewater and used cleaning fluids will be collected and disposed of in accordance with applicable state and federal regulations.

12.2 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.

12.3 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. Emergency Response

13.1 Evacuation

Prior to the start of work, emergency procedures must be identified and communicated to workers on site. This includes evacuation routes, safe areas, and/or muster points. Also communicate how employees will be notified that an emergency or evacuation of the site is occurring (audio alarms, visible (light) alarms, radios, sirens, etc.) Upon discovering an emergency situation, personnel will notify the SSM, who will initiate an appropriate response. Once the scene is safe, use the incident report procedures to report the evacuation to the PM and Safety Team.

13.2 Fire

In the event of a fire personnel will evacuate the area to the muster point located on Fig. 1. GEI's SSM will contact the local fire department with jurisdiction and report the fire. The SSM will account for GEI personnel and subcontractor personnel and report their status to the PM. Incident reporting procedures will be followed once the scene is safe.

13.3 Spills or Material Release

If a hazardous waste spill or material release occurs, if safe, the SSM 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.
- Estimates of area under influence of release.

If the spill or release is determined to be within the on site emergency response capabilities, the SSM 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 fire department will be contacted. The SSM will notify the PM and follow the incident reporting procedures.

13.4 Medical Support

In case of minor injuries, on site care will be administered with the site first aid kit. A GEI employee certified by the American Red Cross or other American Health & Safety Institute (ASHI) will be on site at all times. 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 of the emergency and follow incident reporting procedures.

In the event of an emergency, prompt communications with local emergency responders are essential. At least one charged and functioning cell phone to enable emergency communications will be on site. Confirmation of cellular phone operation will be confirmed at the start of each working day.

Table 1 of this HASP contains detailed emergency information, including directions to the nearest hospital, and a list of emergency services and their telephone numbers. In addition, Appendix A includes a map to the local hospital/emergency room and Fig. 1 indicates the evacuation route (including muster point).

13.5 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 40 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 SSM. Notification of evacuation will be made to the PM. The SSM 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 lightning.

13.6 Hazard Communication Plan

GEI personnel have received hazard communication (HAZCOM) training as part of their annual safety training and new employee safety orientation training. Hazardous materials brought on site will be properly labeled, stored, and handled. SDSs for each chemical will be included in this HASP in Appendix C. GEI's HAZCOM program can be found on the Safety Resources page of GEI Connections (Appendix E).

14. Health and Safety Plan Sign Off

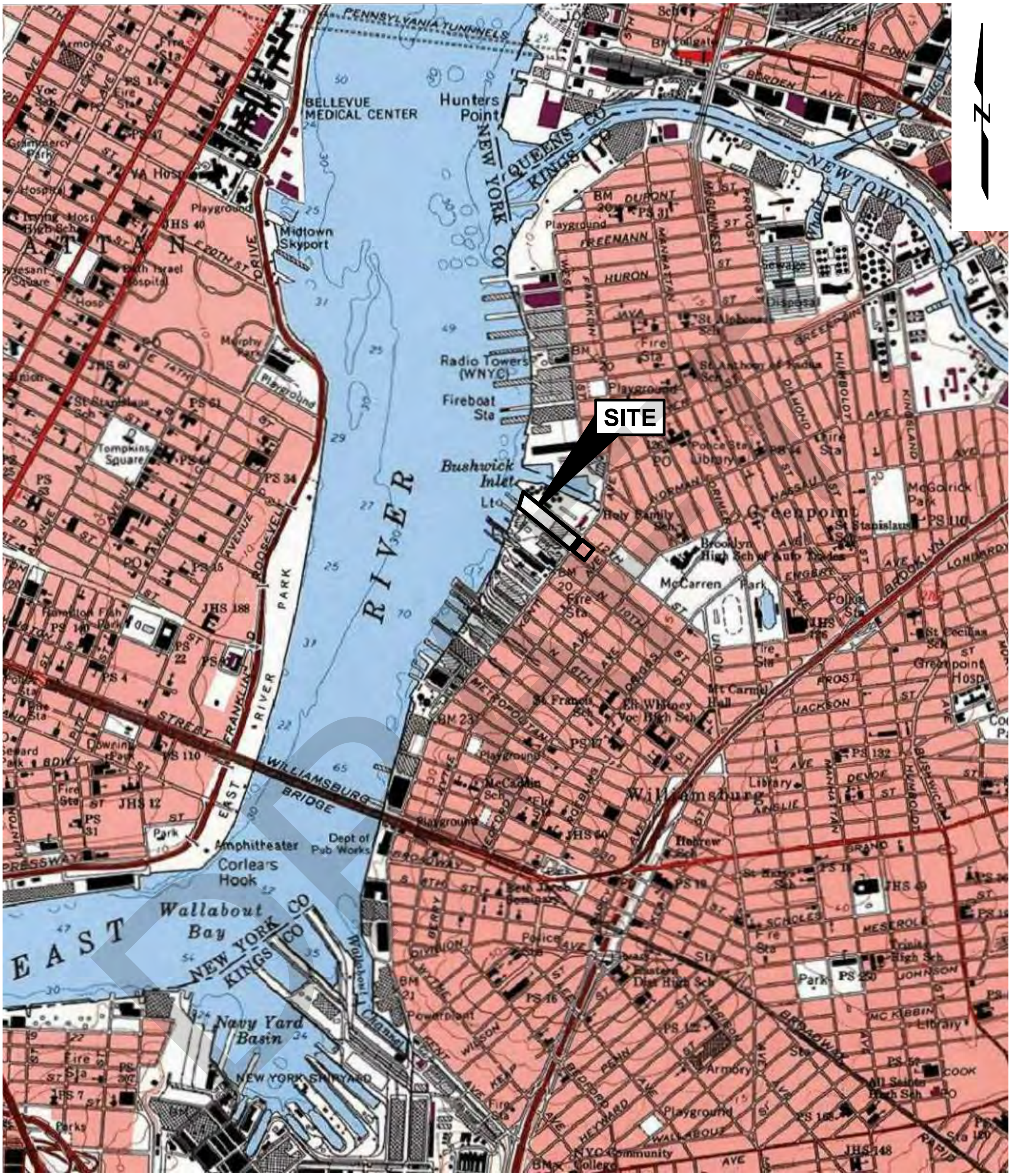
GEI personnel conducting site activities will be familiar with the information in this HASP. After reviewing this plan, please sign the copy in the project files, and bring a copy of the plan with you to the site. By signing this site specific HASP, you are agreeing that you have read, understand, and will adhere to the provisions described in this plan while working on the site below.

Site Name: Williamsburg Works MGP Site

GEI Project No: 093060

Print Name	Signature
Project Manager: Melissa Felter	Melissa J Felter

Figure



SOURCE:
Map created with TOPO! ® ©2001 National Geographic (www.nationalgeographic.com/topo)

Williamsburg Works Former MGP Site
Borough of Brooklyn, New York

nationalgrid

GEI Consultants

SITE LOCATION MAP

Project 093060 | June 2022 | Fig. 1

\\Gtb-pzcc-1\ I:\Project\National Grid\Williamsburg\00_CAD\Figures\RIWPA_L1630\093060_RIWPA_SLM.dwg - 6/30/2021

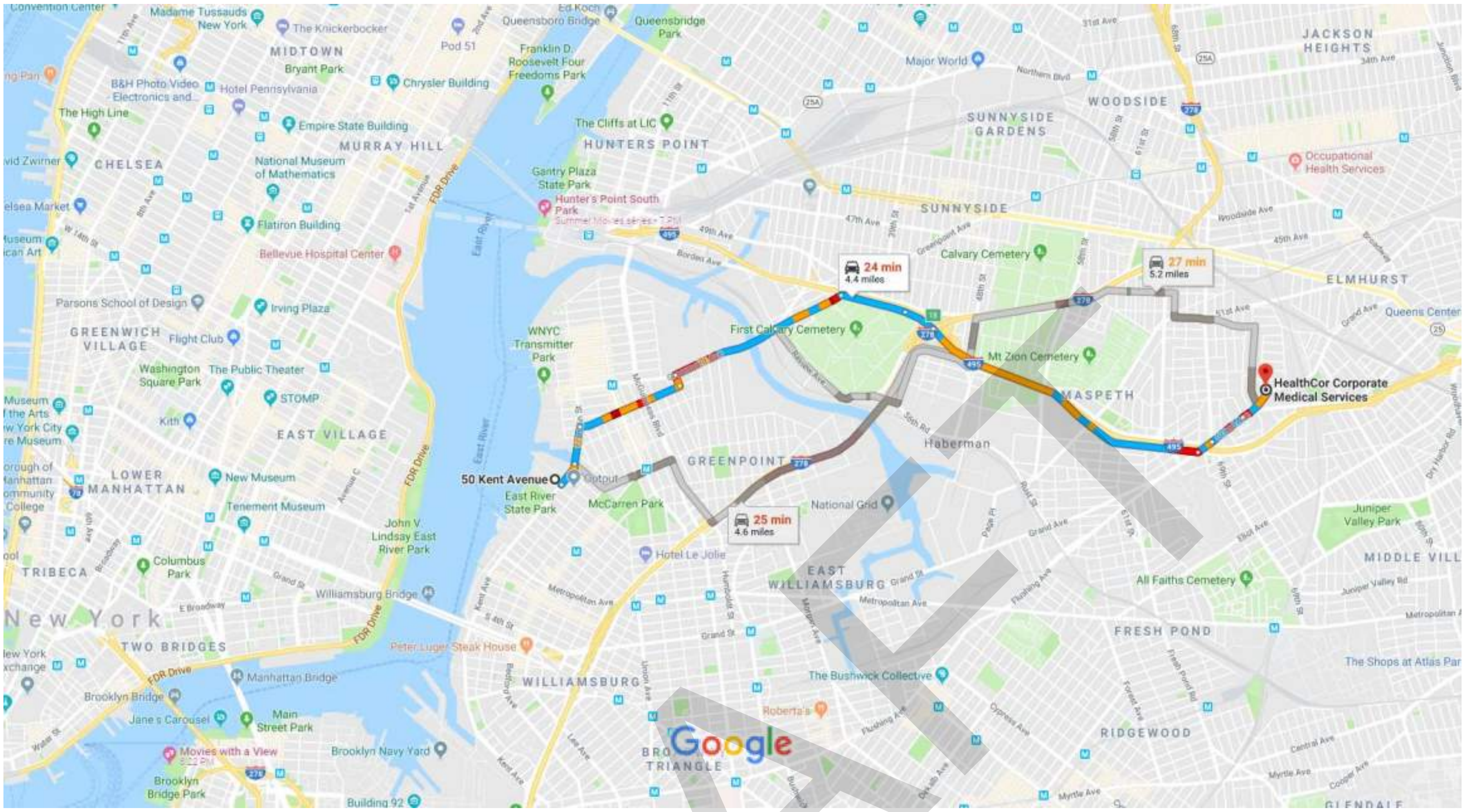
Appendix A

Map to Hospital

(Included if cell phone service is not reliable at or around project site)

Scan this QR code or click the link for access to Google Maps.

Google Maps **50 Kent Avenue, Brooklyn, NY to HealthCor Corporate Medical Services** Drive 4.4 miles, 24 min



Map data ©2018 Google 2000 ft

50 Kent Ave

Brooklyn, NY 11249

Take Franklin St to Calyer St

2 min (0.3 mi)

1. Head northeast on Kent Ave toward N 12th St

0.1 mi

2. Continue onto Franklin St

0.2 mi

Follow Calyer St to Greenpoint Ave

4 min (0.6 mi)

3. Turn right onto Calyer St

0.6 mi

4. Turn left onto Moultrie St

322 ft

Continue on Greenpoint Ave. Take Exit 18 and Borden Ave to Grand Ave in Queens

14 min (3.5 mi)

5. Turn right onto Greenpoint Ave

0.6 mi

6. Slight right to stay on Greenpoint Ave

0.4 mi

7. Turn right onto the Interstate 495 E ramp to Long Island Expressway/Eastern Long Island

0.3 mi

8. Use the 2nd from the left lane to follow signs for I-278 E/La Guardia/Airport/Bronx/I-495 Alt/Maurice Ave

0.2 mi

9. Keep left at the fork to continue on Exit 18, follow signs for Maurice Ave and merge onto Borden Ave
   Pass by McDonald's (on the right in 1.0 mi)

1.5 mi

10. Turn left onto Grand Ave

463 ft

11. Continue straight to stay on Grand Ave
    Pass by Iavarone Bros. (on the right)

0.2 mi

12. Continue straight to stay on Grand Ave
    Destination will be on the left

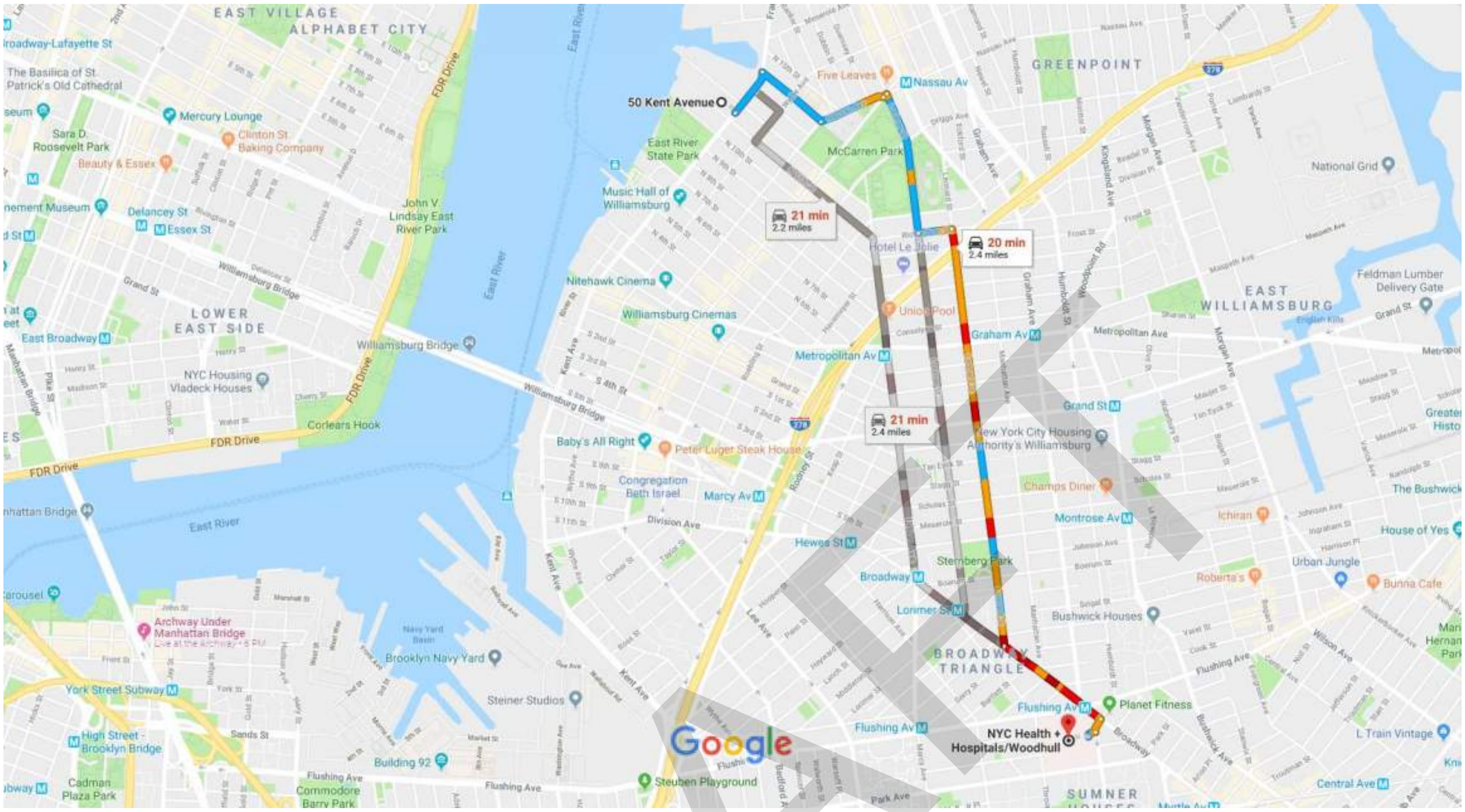
0.2 mi

HealthCor Corporate Medical Services

73-01 Grand Ave, Maspeth, NY 11378

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Google Maps **50 Kent Avenue, Brooklyn, NY to NYC Health + Hospitals/Woodhull** Drive 2.4 miles, 20 min



Map data ©2018 Google 1000 ft

50 Kent Ave

Brooklyn, NY 11249

1. Head northeast on Kent Ave toward N 12th St

   32 s (0.1 mi)

Take Lorimer St and Leonard St to Broadway

13 min (1.9 mi)

2. Turn right onto N 14th St

   0.2 mi

3. N 14th St turns left and becomes Nassau Ave

   0.2 mi

4. Turn left onto Bedford Ave

   59 ft

5. Turn right onto Lorimer St

   0.4 mi

6. Turn left onto Richardson St

   459 ft

7. Turn right at the 1st cross street onto Leonard St

   1.1 mi

Drive

3 min (0.3 mi)

8. Turn left onto Broadway

   Pass by McDonald's (on the right)

   0.3 mi

9. Turn right onto Marcus Garvey Blvd/Sumner Ave

   197 ft

10. Turn right

    Destination will be on the right

    27 s (135 ft)

NYC Health + Hospitals/Woodhull

760 Broadway, Brooklyn, NY 11206

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Appendix B

Job Hazard Analyses

Job Hazard Analysis

<table>
<tr><td>Task</td><td colspan="3">Drilling Oversight</td></tr>
<tr><td>Revision Date</td><td>6/27/22</td><td>Client Name</td><td>National Grid</td></tr>
<tr><td>Project Name</td><td>Williamsburg MGP Site</td><td>Project Number</td><td>093060</td></tr>
<tr><td>Tools/Equipment Used</td><td colspan="3">Hand tools, camera</td></tr>
<tr><td>Task Specific Training</td><td colspan="3">GEI Annual Safety Training (Field or HAZWOPER), First Aid/CPR</td></tr>
<tr><td>Minimum PPE Required</td><td colspan="3">☒ Hard Hat ☒Safety Glasses ☒Safety-Toed Boots ☒ Reflective Vest ☒Hearing Protection ☐ Personal Flotation Device (PFD)
☐ Face Shield ☐ Chaps ☐ Tyvek clothing/boots ☐ Flame Resistant Clothing
☒ Gloves Nitrile ☐Respirator
☐Other</td></tr>
</table>

JHA Prepared By:	**Date:**	**Approved by:**	**Date:**

Task Steps	Potential Hazards	[GEI SOP or Program]	Hazard Controls[1]
1. Mobilize on site	Slips/trips/falls, stuck by, crushing hazards	Hazard Identification HS-026	• Wear PPE that properly fits, is in good condition, and is 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. • Wear shoes with traction. • Avoid traversing steep areas in slippery conditions. • Do not carry heavy objects to work areas, on steeply sloped areas, or where steep areas must be traversed to reach work areas.

[1] Use the hierarchy of controls to determine applicable hazard controls for the task in order of most effective to least effective: Elimination (physically remove the hazard), Substitution (replace the hazard), Engineering Controls (Isolate the team from the hazard), Administrative Controls (change the way people work), PPE (personal protective equipment).

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
2. Utility survey	Shock, Explosion, Fire	Utility Markout HS-014	• Ensure that all utilities have been properly marked prior to beginning work. • If a utility strike occurs, call the appropriate authorities immediately. Clear the area and do not delay.
3. Observe contractor activities	Struck by/crushing hazards	Working Around Heavy Equipment HS-018	• Identify yourself and your work location to heavy equipment operators, so they may incorporate you into their operations. • Coordinate hand signals with operators. • Confirm equipment inspection has been completed. • Stay Alert! Pay attention to equipment backup alarms and swing radii. • Position yourself in a safe location. • Confirm adequate clearance from overhead utilities. • 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.
4. Waste characterization	Contaminant contact	Hazardous Substance Management HS-009	• 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.
5. Demobilize from site	Personal/material security, slips/trips/falls	Hazard Identification HS-026	• Confirm all materials are secured/labeled, including drums and any equipment left on site. • Confirm that any open trenches/pits are properly marked or barricaded. • Clean all equipment/tools prior to leaving. • Secure any gates/locks. • Notify project manager (or designee) you are leaving the site.

Job Hazard Analysis

Task	**Driving – Site Mobilization**		
Revision Date	6/27/22	**Client Name**	National Grid
Project Name	Williamsburg MGP Site	**Project Number**	093060
Tools/Equipment Used	None		
Task Specific Training	GEI Annual Safety Training (Field or HAZWOPER), First Aid/CPR		
Minimum PPE Required	☐ Hard Hat ☐Safety Glasses ☐Safety-Toed Boots ☐ Reflective Vest ☐Hearing Protection ☐ Personal Flotation Device (PFD) ☐ Face Shield ☐ Chaps ☐ Tyvek clothing/boots ☐ Flame Resistant Clothing ☐ Gloves Nitrile ☐Respirator ☐Other		

JHA Prepared By: Melissa Felter	**Date: 6/27/22**	**Approved by:**	**Date:**

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
1. Inspect Vehicle	Slips/trips/falls	Hazard Identification HS-026, Driver Safety HS-004	• Walk around vehicle to inspect for any vehicle safety issues or hazards that could be within the travel path. • Adjust mirrors and seats prior to driving. • Becoming familiar with dashboard, center console, and steering controls. • Locate the turn signals, windshield wipers, lights, emergency flashers, and the heating, air conditioning, and defrost controls. • Use a spotter if needed when backing up.
2. Driving	Struck by/crushing hazards	Driver Safety SOP HS-004	• Employees must wear their safety belt while in a moving vehicle. • Employees will follow safe driving behaviors, which include limiting distractions such as manipulating radios or other equipment that may cause a distraction. Employees will not exceed the posted speed limit and will maintain a safe distance between other vehicles. • Use defensive driving techniques. • Avoid driving during hazardous weather conditions. • Driving distance and time after a 12-hour shift will not exceed 30 miles or 30 minutes (whichever is greater). • Vehicle accidents will be reported in accordance with GEI's

[1] Use the hierarchy of controls to determine applicable hazard controls for the task in order of most effective to least effective: Elimination (physically remove the hazard), Substitution (replace the hazard), Engineering Controls (Isolate the team from the hazard), Administrative Controls (change the way people work), PPE (personal protective equipment).

			accident reporting procedures.
3. Parking Vehicle	Struck by, crushing hazards, security	Driver Safety SOP HS-004	• Be aware of surrounding conditions. Park in designated areas or a safe area away from heavy equipment. • Position the vehicle in a manner which reduces or eliminates the need to operate the vehicle in reverse. Choose an easy-exit parking space, like pull-through or where no one else is parked. • Don't crowd neighboring vehicles; be sure to park your vehicle in the middle of your space. • Secure equipment and supplies in the trunk or where they cannot be seen. Or take items with you if they cannot be hidden. • If at night, park in well lit areas.
4. Site Entry	Slips/trips/falls, struck by, crushing	Working Around Heavy Equipment HS-018, Hazard Identification HS-026	• Don appropriate PPE prior to walking on site. • Identify yourself and your work location to heavy equipment operators, so they may incorporate you into their operations. • Stay Alert! Pay attention to equipment backup alarms and swing radii. • Avoid distractions like using cell phones while traversing the site.
5. Backing Up Vehicle	Struck by, crushing	Driver Safety HS-004	• Before entering your vehicle do a walk-around. Check for fences, poles, drop-offs, buildings, etc. • Know your clearances. While performing your walk-around also check for obstructions, low hanging eaves and tree limbs, wires, and any other potential clearance-related obstacles. • Use a spotter. Do not allow the spotter to be positioned directly behind your vehicle or walk backwards behind you while giving instructions. They should be off to the driver's side where you can see them in your side mirror.

Job Hazard Analysis

Task	Groundwater Monitoring Well Gauging		
Revision Date	6/27/22	Client Name	National Grid
Project Name	Williamsburg MGP Site	Project Number	093060
Tools/Equipment Used	Hand tools, water interface meter		
Task Specific Training	GEI Annual Safety Training (Field or HAZWOPER), First Aid/CPR		
Minimum PPE Required	☐ Hard Hat ☒Safety Glasses ☒Safety-Toed Boots ☒ Reflective Vest ☐Hearing Protection ☐ Personal Flotation Device (PFD) ☐ Face Shield ☐ Chaps ☐ Tyvek clothing/boots ☐ Flame Resistant Clothing ☒ Gloves Nitrile/Cut resistant ☐Respirator ☐Other		

JHA Prepared By: Melissa Felter	Date: 6/27/22	Approved by:	Date:

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
1. Carry Equipment and Set-up	Heavy lifting, Cuts/Scrapes, Slips/Trips/Falls, Pinch points	Non-Powered Hand Tools HS-008a Manual Lifting HS-025 Ergonomic Program	• User proper lifting techniques. • Keep trafficked areas free from slip/trip/fall hazards. • 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 • Take breaks when carrying items frequently and/or for long distances • Do not overreach when picking up or placing items. • Use the buddy system when necessary
2. Open Monitoring Well	Cuts/Scrapes, Insect Bites	Non-Powered Hand Tools HS-008a Manual Lifting HS-025 Ergonomic Program	• Keep trafficked areas free from slip/trip/fall hazards. • Wear the proper type of glove to protect hands against sharp edges and skin/soft tissue injuries • Use proper tools to open monitoring wells • Open casings slowly in case insects inhabit the area. • If insect nest is inside casing, open protective casing and see if insects will leave the nest. Once free of insects, proceed with work. If not, contact project manager if problem persists. • If severely allergic to insects, have appropriate epinephrine on hand.

[1] Use the hierarchy of controls to determine applicable hazard controls for the task in order of most effective to least effective: Elimination (physically remove the hazard), Substitution (replace the hazard), Engineering Controls (Isolate the team from the hazard), Administrative Controls (change the way people work), PPE (personal protective equipment).

			• Remain calm and still if a single stinging insect is flying around. (Swatting at an insect may cause it to sting.) • If you are attacked by several stinging insects at once, run to get away from them. (Bees release a chemical when they sting, which may attract other bees.) • Follow incident reporting procedures if first aid is needed.
3. Deploy Interface Meter	Awkward position, contaminant exposure	Hazard Identification HS– 026 Ergonomic Program	• Wear Nitrile/neoprene gloves and dispose of gloves after use and wash hands. • Take regular breaks and do not work in unusual positions for long periods of time. • Keep control of the reel when deploying the probe. Avoid letting the probe drop quickly into the well. • Reel the probe up slowly to avoid splashes from contaminated groundwater or sediment. • Keep trafficked areas free from slip/trip/fall hazards.
4. Equipment Decontamination	Contaminant Contact, Cuts or Abrasions, Slips/Trips/Falls	Hazard Identification HS–026 Ergonomic Program	• Wear nitrile gloves and glasses to provide eye protection from splashing. • Wash hands immediately after use. • Take regular breaks and do not work in unusual positions for long periods of time. • Keep trafficked areas free from slip/trip/fall hazards.
5. Equipment De-Mob	Heavy lifting, Cuts/Scrapes, Slips/Trips/Falls, Pinch points	Non-Powered Hand Tools HS-008a Manual Lifting HS-025 Ergonomic Program	• User proper lifting techniques. • Keep trafficked areas free from slip/trip/fall hazards. • 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 • Take breaks when carrying items frequently and/or for long distances • Do not overreach when picking up or placing items. • Use the buddy system when necessary

Job Hazard Analysis

Task	Groundwater Sampling – (Low Flow)		
Revision Date	6/27/22	Client Name	National Grid
Project Name	Williamsburg MGP Site	Project Number	093060
Tools/Equipment Used	Hand tools, interface meter, pump, water quality meter		
Task Specific Training	GEI Annual Safety Training (Field or HAZWOPER), First Aid/CPR		
Minimum PPE Required	☐ Hard Hat ☒Safety Glasses ☒Safety-Toed Boots ☒ Reflective Vest ☐Hearing Protection ☐ Personal Flotation Device (PFD) ☐ Face Shield ☐ Chaps ☐ Tyvek clothing/boots ☐ Flame Resistant Clothing ☒ Gloves Nitrile/Cut resistant ☐Respirator ☐Other		

JHA Prepared By:	Date:	Approved by:	Date:

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
1. Carry Equipment and Set-up	Heavy lifting, Cuts/Scrapes, Slips/Trips/Falls, Pinch points	Non-Powered Hand Tools HS-008a Manual Lifting HS-025 Ergonomic Program	• User proper lifting techniques. • Keep trafficked areas free from slip/trip/fall hazards. • 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 • Take breaks when carrying items frequently and/or for long distances • Do not overreach when picking up or placing items. • Use the buddy system when necessary
2. Cut Tubing/String	Cuts/Scrapes, pinch points	Non-Powered Hand Tools HS-008a	• 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.

[1] Use the hierarchy of controls to determine applicable hazard controls for the task in order of most effective to least effective: Elimination (physically remove the hazard), Substitution (replace the hazard), Engineering Controls (Isolate the team from the hazard), Administrative Controls (change the way people work), PPE (personal protective equipment).

3. Collect GW Reading/Samples	Awkward position, contaminant exposure	Hazard Identification HS– 026 Benzene Awareness Program Ergonomic Program	• Wear Nitrile/neoprene gloves and 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.
4. Drum Purge Water	Contaminant Contact, Cuts or Abrasions Heavy Lifting , Slips/Trips/Falls	Container Management HS–003 Manual Lifting HS–025 Ergonomic Program	• Wear proper PPE during sampling including nitrile gloves and safety glasses and face shield as appropriate. • Use proper dollies or drum moving tools. • Use applicable tools to open/close drum lids. • Do not handle drums with bulging sides. • Dispose of gloves after use and wash hands. • Wear work gloves over nitrile gloves. • Use proper lifting techniques. • Ask fellow worker for help. • Keep trafficked areas free from slip/trip/fall hazards.
5. Equipment Decontamination	Contaminant Contact, Cuts or Abrasions, Slips/Trips/Falls	Hazard Identification HS–026 Benzene Awareness Program Ergonomic Program	• Wear nitrile gloves and glasses to provide eye protection from splashing. • Wash hands immediately after use. • Take regular breaks and do not work in unusual positions for long periods of time. • Keep trafficked areas free from slip/trip/fall hazards.
6. Equipment De-Mob	Heavy lifting, Cuts/Scrapes, Slips/Trips/Falls, Pinch points	Non-Powered Hand Tools HS-008a Manual Lifting HS-025 Ergonomic Program	• User proper lifting techniques. • Keep trafficked areas free from slip/trip/fall hazards. • 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 • Take breaks when carrying items frequently and/or for long distances • Do not overreach when picking up or placing items. • Use the buddy system when necessary

Job Hazard Analysis

Task	**Site Surveying**		
Revision Date	6/27/22	**Client Name**	National Grid
Project Name	Williamsburg MGP Site	**Project Number**	093060
Tools/Equipment Used	None		
Task Specific Training	Annual Safety Training (Field or Hazwoper), First Aid/CPR		
Minimum PPE Required	☐ Hard Hat ☐Safety Glasses ☒Safety-Toed Boots ☒ Reflective Vest ☐Hearing Protection ☐ Personal Flotation Device (PFD) ☐ Face Shield ☐ Chaps ☐ Tyvek clothing/boots ☐ Flame Resistant Clothing ☐ Gloves Enter Type(s) - e.g., Nitrile, Cut Resistant, Latex ☐Respirator Enter Type/Cartridges - (e.g., Half-face, P-100) ☐Other		

JHA Prepared By: Melissa Felter	**Date: 6/27/22**	**Approved by:**	**Date:**

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
1.Clothing Treatment - Permethrin	Chemical Exposure	Biological Hazards HS-001 (Permethrin Guidance)	• Read application instructions thoroughly and apply according to the directions. Do not over-treat products. • Permethrin treatments are for meant only for fabrics, do not apply directly to the skin. • Apply product to clothing and gear outdoors in a well-ventilated area protected from wind. • Hang treated clothing outdoors and allow for them to dry completely before wearing. • Do not spray directly on clothing that you are wearing. • Do not wear clothing or use gear that is not completely dry. • Wash treated clothing separate from other garments. • Retreat clothing and gear after six washings or six weeks of exposure to sun and air.

[1] Use the hierarchy of controls to determine applicable hazard controls for the task in order of most effective to least effective: Elimination (physically remove the hazard), Substitution (replace the hazard), Engineering Controls (Isolate the team from the hazard), Administrative Controls (change the way people work), PPE (personal protective equipment).

Job Hazard Analysis
Task Name: Site Surveying
Project: Williamsburg MGP Site
Date: 6/27/22

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
2.Carrying Equipment/Site Setup	Heavy lifting, strains/sprains, slip/trips/falls, pinch points	Non-Powered Hand Tools HAS-008a, Manual Lifting HS-025, GEI Ergonomic Program	• Use proper lifting techniques • Check route for clearance of trip hazards • Wear appropriate footwear and gloves to protect hands against sharp edges and soft tissue injuries • Be aware of hard to grip and hold items that may force your hand or wrist into awkward, stressful positions • Take breaks when carrying items frequently and/or for long distances • Do not overreach when picking up or placing items • Use the buddy system when necessary
3. Site Walk/Survey	Slip/trips/falls, repetition, heat stress, cold stress, biological hazards	Biological Hazards HS-001, Inclement Weather HS-010, Manual Lifting HS-025, Hazard Identification HS-026, GEI Cold Stress Program, GEI Heat Stress Program, GEI Ergonomic Program	• Wear steel-toed boots and high visibility reflective vest when traversing work areas • Avoid walking on uneven, steeply sloped or debris ridden ground surfaces • Discuss action plan prior to severe weather • Apply insect repellent and poisonous plant barrier cream prior to the start of any field work and as needed throughout the workday • Use the buddy system and have a check in plan with project team and/or project manager • Bring adequate hydration for the workday (water, fluids with electrolytes) • Apply sunscreen regularly or wear a hat and long sleeve to reduce sun exposure • Plan an area to take breaks with natural shade or provided by pop up structure • Bring backpack to carry your fluids, snacks, first aid kits, etc. for larger project sites
4.Demobilize from Site	Personal/material security, slips/trips/falls	Hazard Identification HS-026	• Confirm all materials are secured/labeled, including drums and any equipment left on site. • Confirm that any open trenches/pits are properly marked or barricaded. • Clean all equipment/tools prior to leaving. • Secure any gates/locks. • Notify project manager (or designee) you are leaving the site.

Job Hazard Analysis

Task	**Soil Sampling – Drill Rig**		
Revision Date	6/27/22	**Client Name**	National Grid
Project Name	Williamsburg MGP Site	**Project Number**	093060
Tools/Equipment Used	Hand tools, CAMP equipment, PID, camera		
Task Specific Training	GEI Annual Safety Training (Field or HAZWOPER), First Aid/CPR		
Minimum PPE Required	☒ Hard Hat ☒Safety Glasses ☒Safety-Toed Boots ☒ Reflective Vest ☒Hearing Protection ☐ Personal Flotation Device (PFD) ☐ Face Shield ☐ Chaps ☐ Tyvek clothing/boots ☐ Flame Resistant Clothing ☒ Gloves: Nitrile ☐Respirator: ☐Other:		

JHA Prepared By:	**Date:**	**Approved by:**	**Date:**

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
1. Mobilize On Site/Equipment Setup	Slips/trips/falls, stuck by, crushing hazards	Hazard Identification HS-026	• Wear PPE that properly fits, is in good condition, and is 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. • Wear shoes with traction. • Avoid traversing steep areas in slippery conditions. • Do not carry heavy objects to work areas, on steeply sloped areas, or where steep areas must be traversed to reach work areas.

[1] Use the hierarchy of controls to determine applicable hazard controls for the task in order of most effective to least effective: Elimination (physically remove the hazard), Substitution (replace the hazard), Engineering Controls (Isolate the team from the hazard), Administrative Controls (change the way people work), PPE (personal protective equipment).

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
2. Utility survey	Shock, Explosion, Fire	Utility Markout HS-014	• Ensure that all utilities have been properly marked prior to beginning work. • If a utility strike occurs, call the appropriate authorities immediately. Clear the area and do not delay.
3. Observe contractor activities	Struck by/crushing hazards	Working Around Heavy Equipment HS-018	• Identify yourself and your work location to heavy equipment operators, so they may incorporate you into their operations. • Coordinate hand signals with operators. • Confirm equipment inspection has been completed. • Stay Alert! Pay attention to equipment backup alarms and swing radii. • Position yourself in a safe location. • Confirm adequate clearance from overhead utilities. • 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.
4. Cutting cores	Cuts and lacerations	Hazardous Substance Management HS-009/ Non Powered Hand Tools HS-008a	• Use care when cutting cores. Use mechanical shears, electric knife or self-retracting safety blade when handling cores. • Eliminate hazard by having the drillers open the cores for you. • 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.

Job Hazard Analysis
Task: Soil Sampling – Drill Rig
Project: Williamsburg MGP Site
Date: 6/27/22

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
5. Sample Soil	Contaminant Exposure, Cuts/Scrapes, Repetition, Slips/Trips/Falls	Hazard Identification HS-026/Container Management HS-003	• 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.
6. Drum Soil Cuttings	Contaminant Contact, Cuts or Abrasions Heavy Lifting , Slips/Trips/Falls	Container Management HS–003 Manual Lifting HS–025 Ergonomic Program	• Wear proper PPE during sampling including nitrile gloves and safety glasses and face shield as appropriate. • Use proper dollies or drum moving tools. • Use applicable tools to open/close drum lids. • Do not handle drums with bulging sides. • Dispose of gloves after use and wash hands. • Wear work gloves over nitrile gloves. • Use proper lifting techniques. • Ask fellow worker for help. • Keep trafficked areas free from slip/trip/fall hazards.
7. Equipment Decontamination	Contaminant Contact, Cuts or Abrasions, Slips/Trips/Falls	Hazard Identification HS–026 Benzene Awareness Program Ergonomic Program	• Wear nitrile gloves and glasses to provide eye protection from splashing. • Wash hands immediately after use. • Take regular breaks and do not work in unusual positions for long periods of time. • Keep trafficked areas free from slip/trip/fall hazards.
8. Demobilize from site	Personal/material security, slips/trips/falls	Hazard Identification HS-026	• Confirm all materials are secured/labeled, including drums and any equipment left on site. • Confirm that any open trenches/pits are properly marked or barricaded. • Clean all equipment/tools prior to leaving. • Secure any gates/locks. • Notify project manager (or designee) you are leaving the site.

Job Hazard Analysis

Task	**NAPL Gauging and Recovery**		
Revision Date	October 5, 2022	**Client Name**	National Grid
Project Name	Williamsburg Works MGP Site	**Project Number**	093060
Tools/Equipment Used	Pump, generator, compressor, interface probe, tubing cutter, bailer, string, scissors		
Task Specific Training	GEI Annual Safety Training (HAZWOPER), First Aid/CPR		
Minimum PPE Required	☐ Hard Hat ☒Safety Glasses ☒Safety-Toed Boots ☒ Reflective Vest ☒Hearing Protection ☐ Personal Flotation Device (PFD) ☒ Face Shield ☐ Chaps ☒ Tyvek clothing/boots ☐ Flame Resistant Clothing ☒ Gloves Nitrile/Cut resistant ☐Respirator ☐Other		

JHA Prepared By: Melissa Felter	**Date: 10/5/2022**	**Approved by: Lesley Gastwirth**	**Date: 10/6/2022**

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
1. Carry Equipment and Set-up	Heavy lifting, Cuts/Scrapes, Slips/Trips/Falls, Pinch points	Non-Powered Hand Tools HS-008a Manual Lifting HS-025 Ergonomic Program	• User proper lifting techniques. • Keep trafficked areas free from slip/trip/fall hazards. • 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 • Take breaks when carrying items frequently and/or for long distances • Do not overreach when picking up or placing items. • Use the buddy system when necessary
2. Cut Tubing/String	Cuts/Scrapes, pinch points	Non-Powered Hand Tools HS-008a	• 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.

[1] Use the hierarchy of controls to determine applicable hazard controls for the task in order of most effective to least effective: Elimination (physically remove the hazard), Substitution (replace the hazard), Engineering Controls (Isolate the team from the hazard), Administrative Controls (change the way people work), PPE (personal protective equipment).

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
			• 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.
3. Set up pump, generator and compressor, if needed.	Heavy Lifting, Slips/Trips/Falls	Manual Lifting HS–025 Ergonomic Program	• Check air compressor hoses before use. • Position the generator downwind of the work area. • Keep trafficked areas free from slip/trip/fall hazards.
4. Fuel generator	Heavy Lifting, Slips/Trips/Falls	Manual Lifting HS–025 Ergonomic Program	• Turn off the generator and allow to cool at least 15-minutes before refueling. • Gasoline used to refill the generator will be stored in an OSHA-approved portable fuel container (safety can).
5. Secure string to bailer and lower bailer down well to collect NAPL	Contaminant Contact, Awkward position, Slips/Trips/Falls, Heavy lifting	Benzene Awareness Program Ergonomic Program	• Wear proper PPE during sampling including nitrile gloves, Tyvek or Tyvek apron with sleeves, and safety glasses and face shield as appropriate. • Keep trafficked areas free from slip/trip/fall hazards. • Be aware of hard to grip and hold items that may force your hand or wrist into awkward, stressful positions • Take breaks when carrying items frequently and/or for long distances • Do not overreach when picking up or placing items. • Use the buddy system when necessary
6. Drum Purged NAPL	Contaminant Contact, Cuts or Abrasions Heavy Lifting , Slips/Trips/Falls	Container Management HS–003 Manual Lifting HS–025 Ergonomic Program Benzene Awareness Program	• Wear proper PPE during sampling including nitrile gloves, Tyvek or Tyvek apron with sleeves , and safety glasses and face shield as appropriate. • Use proper dollies or drum moving tools. • Use applicable tools to open/close drum lids. • Do not handle drums with bulging sides. • Dispose of gloves after use and wash hands. • Wear work gloves over nitrile gloves. • Use proper lifting techniques. • Ask fellow worker for help. • Keep trafficked areas free from slip/trip/fall hazards.
7. Equipment Decontamination	Contaminant Contact, Cuts or Abrasions, Slips/Trips/Falls	Hazard Identification HS–026 Benzene Awareness Program Ergonomic Program	• Wear nitrile gloves and glasses to provide eye protection from splashing. • Wash hands immediately after use. • Take regular breaks and do not work in unusual positions for long

Task Steps	Potential Hazards	GEI SOP or Program	Hazard Controls[1]
			periods of time. • Keep trafficked areas free from slip/trip/fall hazards.
8. Equipment De-Mob	Heavy lifting, Cuts/Scrapes, Slips/Trips/Falls, Pinch points	Non-Powered Hand Tools HS-008a Manual Lifting HS-025 Ergonomic Program	• User proper lifting techniques. • Keep trafficked areas free from slip/trip/fall hazards. • 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 • Take breaks when carrying items frequently and/or for long distances • Do not overreach when picking up or placing items. • Use the buddy system when necessary

Appendix C

Safety Data Sheets

NFPA 704 (Section 16)

MATERIAL SAFETY DATA SHEET

Benzene **MSDS No. 0166**

1. CHEMICAL PRODUCT and COMPANY INFORMATION (rev. Jan-99)

HOVENSA L.L.C.
1 Estate Hope
Christiansted, VI 00820-5652

EMERGENCY TELEPHONE NUMBER (24 hrs): **CHEMTREC (800) 424-9300**
COMPANY CONTACT (business hours): **Safety Department (340) 692-3000**

SYNONYMS: Benzol; Coal Naphtha; coal tar naphtha; Cyclohexatriene; Phenyl hydride
See Section 16 for Abbreviations and Acronyms.

2. COMPOSITION and INFORMATION ON INGREDIENTS (rev. Apr-98)

INGREDIENT NAME	EXPOSURE LIMITS		CONCENTRATION PERCENT BY WEIGHT
Benzene CAS NUMBER: 71-43-2	OSHA PEL-TWA/STEL: ACGIH TLV-TWA: US Coast Guard:	1 / 5 ppm 0.5 / 2.5 ppm, A1, skin same as OSHA	100

3. HAZARDS IDENTIFICATION (rev. Apr-98; Tox-98)

EMERGENCY OVERVIEW
DANGER!
FLAMMABLE - BLOOD TOXIN AND CARCINOGEN - ABSORBED THROUGH THE SKIN - CENTRAL NERVOUS SYSTEM - HARMFUL OR FATAL IF SWALLOWED - ASPIRATION HAZARD

High fire hazard. Keep away from heat, spark, open flame, and other ignition sources.

If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs). Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects.

Long-term exposure may cause blood disease, including anemia and leukemia.

EYES
Moderate to severe irritant. Contact with liquid or vapor may cause irritation.

SKIN
Moderate to severe irritant. May cause skin irritation with prolonged or repeated contact. Practically non-toxic if absorbed following acute (single) exposure. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

INGESTION
The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION
Excessive exposure may cause irritation to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

Effects to the blood (including decreased platelet and white blood cell counts), cardiovascular system, nervous system, retina, lungs, gastrointestinal system, spleen, and kidneys have been reported from large, acute (short) and repeated or prolonged exposures.

CHRONIC EFFECTS and CARCINOGENICITY
Benzene is a regulated human carcinogen. Benzene has the potential to cause bone marrow depression, aplastic anemia (low red blood cell count) and other blood diseases, including leukemia, after repeated and prolonged exposure. Benzene can cause liver and kidney toxicity.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE
Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash). Pre-existing chronic respiratory disease, liver or kidney dysfunction, or blood, cardiovascular and central nervous system disorders may be aggravated by exposure.

4. FIRST AID MEASURES (rev. Apr-98)

EYES
In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN
Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION
DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION
Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

NOTE TO PHYSICIAN
OSHA and US Coast Guard require that a person exposed to benzene in an emergency have a urine sample taken at the end of the shift and have a urine phenol test performed within 72 hours. For results equal to or greater than 75 ml/L of urine, employees must have a complete blood count every month for three months after the emergency exposure. See OSHA 29 CFR 1910.1028 or USCG 49 CFR 193.

5. FIRE FIGHTING MEASURES (rev. Jan-99)

FLAMMABLE PROPERTIES:

FLASH POINT:	12 ^{o}F (-11^{o}C)
AUTOIGNITION TEMPERATURE:	928 ^{o}F (498 ^{o}C)
OSHA/NFPA FLAMMABILITY CLASS:	1B (flammable liquid)
LOWER EXPLOSIVE LIMIT (%):	1.3%
UPPER EXPLOSIVE LIMIT (%):	7.9%

FIRE AND EXPLOSION HAZARDS
Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA
SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

FIRE FIGHTING INSTRUCTIONS
Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES (rev. Apr-98)

ACTIVATE FACILITY SPILL CONTINGENCY or EMERGENCY PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE (rev. Apr-98)

HANDLING PRECAUTIONS
Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents.

STORAGE PRECAUTIONS
Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK/HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION (rev. Apr-98)

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

EYE/FACE PROTECTION

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION

Gloves constructed of Viton are recommended for heavy exposure; Viton, nitrile, PVC, or neoprene for intermittent exposure. Chemical protective clothing such as DuPont Barricade ® or equivalent recommended based on degree of exposure.

Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, ANSI Z88.2-1992, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection and limitations.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES (rev. Mar-95)

APPEARANCE

A clear, water-like liquid

ODOR

A sweet, aromatic odor.

ODOR THRESHOLD

4.7 ppm

BASIC PHYSICAL PROPERTIES

BOILING RANGE:	176 °F (80 °C)
VAPOR PRESSURE:	74.6 mm Hg @ 68 °F (20 °C)
VAPOR DENSITY (air = 1):	2.8
SPECIFIC GRAVITY (H_2O = 1):	0.87
EVAPORATION RATE:	High
PERCENT VOLATILES:	100 %
SOLUBILITY (H_2O):	Insoluble to slightly soluble

10. STABILITY and REACTIVITY (rev. Mar-95)

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID and INCOMPATIBLE MATERIALS

Material is stable under normal conditions. Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

11. TOXICOLOGICAL PROPERTIES (rev. Apr-98; Tox-98)

ACUTE TOXICITY

Acute Dermal LD50 (rabbits): > 9.4 ml/kg
Acute Oral LD50 (mouse): 4.7 g/kg
Acute inhalation LC50: 10,000 ppm (rat; 7 hours)
Eye irritation (rabbit): mild to moderate
Primary dermal irritation (rabbits): mild to moderate

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenicity: OSHA: YES IARC: (1) NTP: YES ACGIH: (A1)

Numerous epidemiological (human) and animal studies have reported an increased incidence or a causal relationship between leukemia and benzene exposure.

Mutagenicity: positive

12. ECOLOGICAL INFORMATION (rev. Apr-98)

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

13. DISPOSAL CONSIDERATIONS (rev. Apr-98)

Consult federal, state and local waste regulations to determine appropriate disposal options.

14. TRANSPORTATION INFORMATION (rev. Apr-98)

DOT PROPER SHIPPING NAME:	Benzene
DOT HAZARD CLASS and PACKING GROUP:	3, PG II
DOT IDENTIFICATION NUMBER:	UN 1114
DOT SHIPPING LABEL:	FLAMMABLE LIQUID

15. REGULATORY INFORMATION (rev. Apr-98)

U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other federal, state, or local regulations; consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

Benzene is a CERCLA Section 103 "hazardous substance" subject to CERCLA and SARA Section 304 reporting requirements.

Reportable Quantity: 10 pounds

SARA SECTION 311/312 - HAZARD CLASSES

ACUTE HEALTH	CHRONIC HEALTH	FIRE	SUDDEN RELEASE OF PRESSURE	REACTIVE
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION WT. PERCENT
Benzene (71-43-2)	100

CANADIAN REGULATORY INFORMATION (WHMIS)

Class B, Division 2 (Flammable Liquid)
Class D, Division 2A (Very toxic by other means) and Class D, Division 2B (Toxic by other means)

16. OTHER INFORMATION (rev. Apr-98)

NFPA® HAZARD RATING	HEALTH:	2	Moderate
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
HMIS® HAZARD RATING	HEALTH:	3 *	Serious
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
			* Chronic

SUPERSEDES MSDS DATED: 04/23/98

ABBREVIATIONS:

AP = Approximately	< = Less than	> = Greater than
N/A = Not Applicable	N/D = Not Determined	ppm = parts per million

ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute (212) 642-4900
API	American Petroleum Institute (202) 682-8000
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
DOT	U.S. Department of Transportation [General Info: (800) 467-4922]
EPA	U.S. Environmental Protection Agency
HMIS	Hazardous Materials Information System
IARC	International Agency For Research On Cancer
MSHA	Mine Safety and Health Administration
NFPA	National Fire Protection Association (617) 770-3000
NIOSH	National Institute of Occupational Safety and Health
NOIC	Notice of Intended Change (proposed change to ACGIH TLV)
NTP	National Toxicology Program
OPA	Oil Pollution Act of 1990
OSHA	U.S. Occupational Safety & Health Administration
PEL	Permissible Exposure Limit (OSHA)
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit (NIOSH)
SARA	Superfund Amendments and Reauthorization Act of 1986 Title III
SCBA	Self-Contained Breathing Apparatus
SPCC	Spill Prevention, Control, and Countermeasures
STEL	Short-Term Exposure Limit (generally 15 minutes)
TLV	Threshold Limit Value (ACGIH)
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average (8 hr.)
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

Material Safety Data Sheet

HYDROGEN SULFIDE

August 31, 1995

PHILLIPS 66 COMPANY
A Division of Phillips Petroleum Company
Bartlesville, Oklahoma 74004

PHONE NUMBERS
Emergency: (918) 661-8118
General MSDS Information: (918) 661-8327
For Additional MSDSs: (918) 661-5952

A. Product Identification

Synonyms: Sulfuretted Hydrogen; Hepatic Gas; Hydrosulfuric Acid
Chemical Name: Hydrogen Sulfide
Chemical Family: Inorganic Acid
Chemical Formula: H2S
CAS Reg. No.: 7783-06-4
Product No.: Not Established

Product and/or Components Entered on EPA's TSCA Inventory: YES

This product is in U.S. commerce, and is listed in the Toxic Substances Control Act (TSCA) Inventory of Chemicals; hence, it may be subject to applicable TSCA provisions and restrictions.

B. Hazardous Components

Ingredients	CAS Number	% By Wt.	OSHA PEL	ACGIH TLV
Hydrogen Sulfide	7783-06-4	100	10 ppm	10 ppm@

@ Short term exposure limit is 15 ppm.

C. Personal Protection Information

Ventilation: Use adequate ventilation to control exposure below recommended levels.

Respiratory Protection: For concentrations exceeding the recommended exposure level, use NIOSH/MSHA approved air purifying respirator. If conditions immediately dangerous to life or health (IDLH) exist, use NIOSH/MSHA approved self-contained breathing apparatus (SCBA) equipment.

Eye Protection: For splash protection use chemical goggles and face shield.

Skin Protection: Gloves and coveralls of rubber or neoprene construction if liquid contact could occur. Avoid unnecessary skin contamination with material.

NOTE: Personal protection information shown in Section C is based upon general information as to normal uses and conditions. Where special or unusual uses or conditions exist, it is suggested that the expert assistance of an industrial hygienist or other qualified professional be sought.

D. Handling and Storage Precautions

Proper personal protective equipment must be used when handling this chemical.

Do not get liquefied gas into eyes, on skin, or on clothing. May cause freeze burns upon direct contact. Do not breathe vapor, mist, fume or dust. May be harmful. Launder contaminated clothing before reuse. Use only with adequate ventilation. Wash thoroughly after handling.

Keep away from heat, sparks, and flames. Secure container to prevent damage. Store in a well-ventilated area. Store in tightly closed container. Bond and ground during transfer. Do not puncture or incinerate container.

Handle cylinders with care. Protect cylinders from physical damage. Containers should not be subjected to temperatures above 125F. Do not heat cylinders by any means to increase the product discharge rate. Use a check valve or trap in the discharge line to prevent backflows into the cylinders. All electrical equipment should be non-sparking or explosion proof. Test atmosphere periodically for H2S. Do not rely on sense of smell for H2S release. Use product in a closed system.

E. Reactivity Data

Stability: Stable
Conditions to Avoid: Heat, flame, or other sources of ignition.
Incompatibility (Materials to Avoid): Concentrated nitric acid, sulfuric acid, and other strong oxidizers. Vapors will combust spontaneously when mixed with chlorine, nitrogen trifluoride, or oxygen trifluoride vapors. Distinct hydrogen sulfide odor can be masked by high concentrations of vapors or gas of other chemicals.

Hazardous Polymerization: Will Not Occur
Conditions to Avoid: Not Applicable
Hazardous Decomposition Products: Sulfur Oxides formed when burned.

F. Health Hazard Data

Recommended Exposure Limits:

See Section B.

Acute Effects of Overexposure:

Eye: May be irritating to eyes at levels near the permissible exposure limit. Liquid may cause freeze burns.

Skin: Gas not expected to be irritating to skin. Liquid may cause freeze burns, irritation, reddening or swelling.

Inhalation: Toxic by inhalation. Release of liquefied product may create atmospheres which can rapidly exceed lethal levels. Acute low level exposure that exceeds the permissible exposure limit will result in irritation of the nose and throat, headache, dizziness, nausea, and nervousness.

Ingestion: Liquid may cause freeze burns and death.

Subchronic and Chronic Effects of Overexposure:

Humans breathing up to 8 ppm of hydrogen sulfide over a two month period experienced nausea, headache, shortness of breath, sleep disturbance, eye and throat irritation.

Other Health Effects:

The odor of hydrogen sulfide may not be recognized after prolonged inhalation due to paralysis of the sense of smell. Effects from inhaling the fumes may lead to chronic bronchitis, respiratory irritation, increased loss of pulmonary function, and tearing of the eyes.

Health Hazard Categories:

	Animal	Human		Animal	Human
Known Carcinogen	___	___	Toxic	_X_	_X_
Suspect Carcinogen	___	___	Corrosive	___	___
Mutagen	___	___	Irritant	___	___
Teratogen	___	___	Target Organ Toxin	_X_	_X_
Allergic Sensitizer	___	___	Specify - Skin & Eye Hazard - Freeze burns;		
Highly Toxic	___	___	Lung Hazard-Irritant; Nerve Toxin		

First Aid and Emergency Procedures:

NOTE: For freeze burns, immediately flush effected area with tap water for at least fifteen minutes, seek immediate medical attention.

Eye: Flush eyes with running water for at least fifteen minutes. If irritation or adverse symptoms develop, seek medical attention.

Skin: Wash skin with soap and water for at least fifteen minutes. If irritation or adverse symptoms develop, seek medical attention.

Inhalation: Immediately remove from exposure. If breathing is difficult, give oxygen. If breathing ceases, administer artificial respiration followed by oxygen. Seek immediate medical attention.

Ingestion: If illness or adverse symptoms develop, seek medical attention.

Prompt medical attention is mandatory in all cases of overexposure to hydrogen sulfide. Rescue personnel should be equipped with NIOSH/MSHA approved self-contained breathing apparatus (SCBA). Rescue personnel should recognize the hazards of overexposure due to olfactory fatigue. The use of rescue equipment which might contain ignition sources or cause static discharges should be avoided.

Nitrite treatment as medical therapy has been used in persons overexposed to hydrogen sulfide, but the benefits of this treatment are still considered by some to be of questionable usefulness.

Therapy can only be undertaken by qualified emergency medical personnel.

Treatment should be initiated with inhalation of amyl nitrite for fifteen to thirty seconds of each minute until 10 ml of a 3% solution of sodium nitrite can be injected intravenously at a rate of 2.5 to 5 ml per minute. Sodium nitrite injections may be repeated if necessary.

G. Physical Data

Appearance: Colorless Gas or Liquefied Gas
Odor: Repulsive (rotten egg) Odor
Boiling Point: -75F (-60C)
Vapor Pressure: 394.0 psia @ 100F (37.8C)
Vapor Density (Air = 1): 1.176 @ 60F (15.6C)(Calculated)
Solubility in Water: Slight
Specific Gravity (H2O = 1): 0.79 @ 60F (15.6C) Saturation Pressure
Percent Volatile by Volume: 100
Evaporation Rate (Ethyl Ether = 1): >1
Viscosity: Not Applicable

H. Fire and Explosion Data

Flash Point (Method Used): Flammable Gas
Flammable Limits (% by Volume in Air): LEL - 4
UEL - 44

Fire Extinguishing Media: Dry chemical, foam or carbon dioxide (CO2)

Special Fire Fighting Procedures: Shut off source, if possible. Water for or spray may be used to cool exposed containers and equipment. Use NIOSH/MSHA approved self-contained breathing apparatus. Wear protective equipment and/or garments described in Section C.

Fire and Explosion Hazards: Sulfur oxides formed when burned. Vapors are heavier than air and may travel to an ignition source and flashback. Autoignition temperature is 500F (260C).

I. Spill, Leak and Disposal Procedures

Precautions Required if Material is Released or Spilled:
Evacuate area of all unnecessary personnel. Wear protective equipment and/or garments described in Section C if exposure conditions warrant. Shut off source. Ventilate confined area.

Waste Disposal (Insure Conformity with all Applicable Disposal Regulations):
Incinerate or place in permitted waste management facility.

J. DOT Transportation

Shipping Name: Hydrogen sulfide, liquefied
Hazard Class: 2.3 (Poisonous gas)
ID Number: UN 1053

Packing Group: Not applicable
Marking: Hydrogen Sulfide, liquefied, UN1053, RQ* Inhalation hazard
Label: Poison gas and Flammable gas
Placard: Poisonous gas/1053
Hazardous Substance/RQ: Hydrogen sulfide/100#
Shipping Description: Hydrogen sulfide, liquefied, 2.3 (Poisonous gas), UN 1053, RQ*, Poison - Inhalation Hazard Zone B
Packaging References: 49 CFR 173.304, 173.314, 173.315

* Enter the letters "RQ" as shown only if the hazardous substance is present in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) shown for the hazardous substance.

K. RCRA Classification - Unadulterated Product as a Waste

Ignitable (D001); Hydrogen Sulfide (U135)

Prior to disposal, consult your environmental contact to determine if the TCLP (Toxicity Characteristic Leaching Procedure, EPA Test Method 1311) is required. Reference 40 CFR Part 261.

L. Protection Required for Work on Contaminated Equipment

Contact immediate supervisor for specific instructions before work is initiated. Wear protective equipment and/or garments described in Section C if exposure conditions warrant. If repair of user's equipment is required, purge equipment with an inert gas prior to repairing.

M. Hazard Classification

_X_ This product meets the following hazard definition(s) as defined by the Occupational Safety and Health Hazard Communication Standard (29 CFR Section 1910.1200):

___ Combustible Liquid	___ Flammable Aerosol	___ Oxidizer
_X_ Compressed Gas	___ Explosive	___ Pyrophoric
_X_ Flammable Gas	_X_ Health Hazard (Section F)	___ Unstable
___ Flammable Liquid	___ Organic Peroxide	___ Water Reactive
___ Flammable Solid		

___ Based on information presently available, this product does not meet any of the hazard definitions of 29 CFR Section 1910.1200.

N. Additional Comments

As of the preparation date, this product did not contain a chemical or chemicals subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

NFPA 704 Hazard Codes - - - - - - - - Signals

	Least - 0
Health : 3	Slight - 1
Flammability: 4	Moderate - 2

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Reactivity  : 0                    High - 3
Special Haz.: -                    Extreme - 4
```

Material Safety Data Sheet
Phenol Liquid

Section 1 - Chemical Product and Company Identification

MSDS Name: Phenol Liquid
Catalog Numbers: A88I-500, A931I-1, A931I-200, A931I-4, A931I-500, S801181, S801181MF
Synonyms: Phenylic acid
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
108-95-2	Phenol	89	203-632-7
7732-18-5	Water	11	231-791-2

Hazard Symbols: T
Risk Phrases: 34 24/25

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: colorless liquid. Flash Point: 175 deg F. **Danger!** Corrosive. **Combustible liquid and vapor.** Toxic. Harmful if swallowed, inhaled, or absorbed through the skin. May cause severe respiratory and digestive tract irritation with possible burns. Causes severe eye and skin burns. May cause liver and kidney damage. May cause reproductive and fetal effects. Eye contact may result in permanent eye damage. May cause central nervous system effects.
Target Organs: Kidneys, central nervous system, liver.

Potential Health Effects

Eye: Contact with liquid or vapor causes severe burns and possible irreversible eye damage.
Skin: Causes severe skin irritation. Harmful if absorbed through the skin. Direct skin contact results in white, wrinkled discoloration, followed by severe burns. Phenol solutions may be absorbed through the skin ra pidly to cause systemic poisoning and possible death.
Ingestion: Symptoms may include: headache, excitement, fatigue, nausea, vomiting, stupor, and coma. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure. Causes digestive tract burns with immediate pain, swelling of the throat, convulsions, and possible coma.
Inhalation: Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma. May be fatal if exposed to high concentrations. May also cause pallor, loss of appetite, nausea, vomiting, diarrhea, weakness, darkened urine, headache, sweating, convulsions, cyanosis (bluish skin due to deficient oxygenation of the blood), unconsciousness, fatigue, pulmonary edema & coma.
Chronic: Chronic inhalation and ingestion may cause effects similar to those of acute inhalation and ingestion. May cause liver and kidney damage. May cause fetal effects. Repeated skin contact may cause dermatitis with dark pigmentation of the skin.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately.
Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes

while removing contaminated clothing and shoes. Discard contaminated clothing in a manner which limits further exposure. SPEEDY ACTION IS CRITICAL! Destroy contaminated shoes.
Ingestion: Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.
Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: Vapors may form an explosive mixture with air. Use water spray to keep fire-exposed containers cool. Wear appropriate protective clothing to prevent contact with skin and eyes. Wear a self-contained breathing apparatus (SCBA) to prevent contact with thermal decomposition products.
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam.
Flash Point: 175e deg F (79.44 deg C)
Autoignition Temperature: 1319 deg F (715.00 deg C)
Explosion Limits, Lower:1.8
Upper: 8.6
NFPA Rating: (estimated) Health: 4; Flammability: 2; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Use water spray to disperse the gas/vapor. Remove all sources of ignition. Provide ventilation.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Do not get in eyes, on skin, or on clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Do not ingest or inhale. Use only in a chemical fume hood. Wash clothing before reuse. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames.
Storage: Keep away from heat and flame. Keep away from sources of ignition. Keep from contact with oxidizing materials. Store in a cool, dry, well-ventilated area away from incompatible substances.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Phenol	5 ppm TWA; skin - potential for cutaneous absorption	5 ppm TWA; 19 mg/m3 TWA 250 ppm IDLH	5 ppm TWA; 19 mg/m3 TWA
Water	none listed	none listed	none listed

OSHA Vacated PELs: Phenol: 5 ppm TWA; 19 mg/m3 TWA Water: No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear neoprene gloves, apron, and/or clothing. Selection of specific glove materials should be based on your conditions of use in your application in consultation with your Safety Officer and manufacturer's glove recommendations.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: colorless

Odor: sweetish odor
pH: 6 aqueous solution.
Vapor Pressure: .35 mm Hg @25C
Vapor Density: 3.2
Evaporation Rate:<0.01 (butyl acetate=1)
Viscosity: 1.51 cp@80C
Boiling Point: 360 deg F
Freezing/Melting Point:109 deg F
Decomposition Temperature: Not available.
Solubility: 6.75% in water
Specific Gravity/Density:1.0576
Molecular Formula:H6H6O
Molecular Weight:28.0834

Section 10 - Stability and Reactivity

Chemical Stability: Stable.
Conditions to Avoid: Temperatures above recommended temperatures.
Incompatibilities with Other Materials: Incompatible with strong oxidizing agents, alkalies, nitric acid, calcium hypochlorite, and halogens, Mixture with nitrobenzene and aluminum chloride may violently explode. Coagulates colodion and proteins. Hot liquid phenol will attack aluminum, magnesium, lead, and zinc metals. Mixtures with nitrobenzene and aluminum chloride may violently explode.
Hazardous Decomposition Products: Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 108-95-2: SJ3325000
CAS# 7732-18-5: ZC0110000
LD50/LC50:
CAS# 108-95-2:
Draize test, rabbit, eye: 5 mg Severe;
Draize test, rabbit, skin: 500 mg/24H Severe;
Draize test, rabbit, skin: 100 mg Mild;
Inhalation, mouse: LC50 = 177 mg/m3;
Inhalation, rat: LC50 = 316 mg/m3;
Oral, mouse: LD50 = 270 mg/kg;
Oral, rat: LD50 = 317 mg/kg;
Skin, rabbit: LD50 = 630 mg/kg;
Skin, rat: LD50 = 669 mg/kg;
CAS# 7732-18-5:
Oral, rat: LD50 = >90 mL/kg;
Carcinogenicity:
CAS# 108-95-2:
ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: IARC Group 3 - not classifiable CAS# 7732-18-5: Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology: The IARC has determined that there is inadequate evidence fo r carcinogenicity of phenol in humans and experiment aal animals.
Teratogenicity: No information available.
Reproductive Effects: No information available.
Neurotoxicity: No information available.
Mutagenicity: No information available.
Other Studies: Rabbit skin irritation: severe. Rabbit eye irritation: sever e.

Section 12 - Ecological Information

Ecotoxicity: Daphnia: EC50=4.0mg/l; 96hour; ia: EC50=12.0mg/l; 48 hour; No data
Environmental: Will not be expected to significantly bioconcentrate in aquatic organisms.
Physical: In water, phenol will not be expected to significantly hydrolyze.
Other: 96-hour LC50=11 mg/l in Gammarus fasciatus. 48-hour LC=11.2 mg/l in Leuciscus idus.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: CAS# 108-95-2: waste number U188.

Section 14 - Transport Information

	US DOT	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	PHENOL SOLUTIONS				PHENOL SOLUTION
Hazard Class:	6.1				6.1(9.2)
UN Number:	UN2821				UN2821
Packing Group:	II				II

Section 15 - Regulatory Information

US FEDERAL
TSCA
CAS# 108-95-2 is listed on the TSCA inventory.
CAS# 7732-18-5 is listed on the TSCA inventory.
Health & Safety Reporting List
CAS# 108-95-2: Effective Date: 6/1/87; Sunset Date: 6/1/97
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
CERCLA Hazardous Substances and corresponding RQs
CAS# 108-95-2: 1000 lb final RQ; 454 kg final RQ
SARA Section 302 Extremely Hazardous Substances
CAS# 108-95-2: 500 lb TPQ (lower threshold); 10,000 lb TPQ (upper thre shold)
SARA Codes
CAS # 108-95-2: acute, chronic, flammable.
Section 313
This material contains Phenol (CAS# 108-95-2, 89%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.
Clean Air Act:
CAS# 108-95-2 is listed as a hazardous air pollutant (HAP). This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
CAS# 108-95-2 is listed as a Hazardous Substance under the CWA. CAS# 108-95-2 is listed as a Priority Pollutant under the Clean Water Act. CAS# 108-95-2 is listed as a Toxic Pollutant under the Clean Water Act.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
CAS# 108-95-2 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.
CAS# 7732-18-5 is not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level: None of the chemicals in this product are listed.
European/International Regulations
European Labeling in Accordance with EC Directives
Hazard Symbols:
T
Risk Phrases:
R 34 Causes burns.
R 24/25 Toxic in contact with skin and if swallowed.
Safety Phrases:

S 28 After contact with skin, wash immediately with...
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

WGK (Water Danger/Protection)
CAS# 108-95-2: 2
CAS# 7732-18-5: No information available.

Canada - DSL/NDSL
CAS# 108-95-2 is listed on Canada's DSL List.
CAS# 7732-18-5 is listed on Canada's DSL List.

Canada - WHMIS
This product has a WHMIS classification of B3, D1A, E.

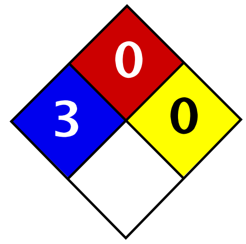
Canadian Ingredient Disclosure List
CAS# 108-95-2 is listed on the Canadian Ingredient Disclosure List.

Exposure Limits
CAS# 108-95-2: OEL-ARAB Republic of Egypt:TWA 5 ppm (19 mg/m3);Skin OEL-AUSTRALIA:TWA 5 ppm (19 mg/m3);Skin OEL-BELGIUM:TWA 5 ppm (19 mg /m3);Skin OEL-CZECHOSLOVAKIA:TWA 20 mg/m3;STEL 40 mg/m3 OEL-DENMARK: TWA 5 ppm (19 mg/m3);Skin OEL-FINLAND:TWA 5 ppm (19 mg/m3);STEL 10 pp m (38 mg/m3);Skin OEL-FRANCE:TWA 5 ppm (19 mg/m3);Skin OEL-GERMANY:T WA 5 ppm (19 mg/m3);Skin OEL-HUNGARY:TWA 4 mg/m3;STEL 8 mg/m3;Skin O EL-JAPAN:TWA 5 ppm (19 mg/m3);Skin OEL-THE NETHERLANDS:TWA 5 ppm (19 mg/m3);Skin OEL-THE PHILIPPINES:TWA 5 ppm (10 mg/m3);Skin OEL-POLAND :TWA 10 ppm OEL-RUSSIA:TWA 5 ppm;STEL 0.3 mg/m3;Skin OEL-SWEDEN:TWA 1 ppm (4 mg/m3);STEL 2 ppm (8 mg/m3);Skin OEL-SWITZERLAND:TWA 5 ppm (19 mg/m3);STEL 10 ppm (38 mg/m3);Skin OEL-THAILAND:TWA 5 ppm (19 mg/m 3) OEL-TURKEY:TWA 5 ppm (19 mg/m3);Skin OEL-UNITED KINGDOM:TWA 5 ppm (19 mg/m3);STEL 10 ppm;Skin OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TL V

Section 16 - Additional Information

MSDS Creation Date: 6/01/1999
Revision #5 Date: 10/08/2003

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.



Health	3
Fire	1
Reactivity	0
Personal Protection	J

Material Safety Data Sheet
Sodium Cyanide MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sodium Cyanide

Catalog Codes: SLS2314, SLS3736

CAS#: 143-33-9

RTECS: VZ7525000

TSCA: TSCA 8(b) inventory: Sodium Cyanide

CI#: Not available.

Synonym:

Chemical Name: Sodium Cyanide

Chemical Formula: NaCN

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium Cyanide	143-33-9	100

Toxicological Data on Ingredients: Sodium Cyanide: ORAL (LD50): Acute: 6.44 mg/kg [Rat]. DERMAL (LD50): Acute: 10.4 mg/kg [Rabbit].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (permeator). Corrosive to eyes and skin. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Inhalation of dust will produce irritation to gastro-intestinal or respiratory tract, characterized by burning, sneezing and coughing. Severe over-exposure can produce lung damage, choking, unconsciousness or death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.

The substance may be toxic to skin, eyes, central nervous system (CNS).
Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: Not available.

Flash Points: Not available.

Flammable Limits: Not available.

Products of Combustion: Some metallic oxides.

Fire Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of acids, of moisture.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder.

LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards:
Dangerous on contact with acids, acid fumes, water or stream. It will produce toxic and flammable vapors of CN-H and sodium oxide.
Contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas.
When heated to decomposition it emits toxic fumes hydgrogen cyanide and oxides of nitrogen

Special Remarks on Explosion Hazards: Fusion mixtures of metal cyanides with metal chlorates, perchlorated or nitrates causes a violent explosion

Section 6: Accidental Release Measures

Small Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container.

Large Spill:
Corrosive solid. Poisonous solid.
Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids, moisture.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 24°C (75.2°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor and dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
STEL: 5 (mg/m3) from ACGIH (TLV) [United States] SKIN
CEIL: 4.7 from NIOSH
CEIL: 5 (mg/m3) from NIOSHConsult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Granular solid. Flakes solid.)

Odor:
Faint almond-like odor.
Odorless when perfectly dry. Emits odor of hydrogen cyanide when damp.

Taste: Not available.

Molecular Weight: 49.01 g/mole

Color: White.

pH (1% soln/water): Not available.

Boiling Point: 1496°C (2724.8°F)

Melting Point: 563°C (1045.4°F)

Critical Temperature: Not available.

Specific Gravity: 1.595 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Vapor Density of Hydrogen Cyanide gas: 0.941

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:
Soluble in cold water.
Slightly soluble in Ethanol

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, moisture, incompatibles.

Incompatibility with various substances: Reactive with oxidizing agents, acids, moisture.

Corrosivity:
Corrosive in presence of aluminum.
Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Violent reaction with fluorine gas, magnesium, nitrates, nitric acid.
Dangerous on contact with acids, acid fumes, water or stream. It wil produce toxic and flammable vapors of CN-H and sodium oxide.
Cyanide may react with CO2 in ordinary air to form toxic hydrogen cyanide gas.
Strong oxidizers such as acids, acid salts, chlorates, and nitrates.
Contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas.

Special Remarks on Corrosivity: Corrosive to aluminum

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
Acute oral toxicity (LD50): 6.44 mg/kg [Rat].
Acute dermal toxicity (LD50): 10.4 mg/kg [Rabbit].

Chronic Effects on Humans: May cause damage to the following organs: skin, eyes, central nervous system (CNS).

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (irritant), of ingestion, of inhalation.
Hazardous in case of skin contact (permeator).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: May cause adverse reproductive effects (maternal and paternal fertility) based on animal data.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health effects:
Skin: May cause itching and irritation. May be fatal if absorbed through injured skin with symtpoms similar to those noted for inhalation and ingestion.
Eyes: May cause eye irritation and eye damage.
Inhalation: May cause respiratory tract irritation. May be fatal if inhaled. The substance inhibits cellular respiration causing metabolic asphyxiation. May cause headache, weakness, dizziness, labored breathing, nausea, vomiting. May be followed by cardiovascular effects, unconciousness, convulsions, coma, and death
Ingestion: May be fatal if swallowed. May cause gastrointestinal tract irritation with nausea, vomiting. May affect behavior and nervous systems(seizures, convulsions, change in motor activity, headache, dizziness, confusion, weakness stupor, aniexity, agitation, tremors), cardiovascular system, respiration (hyperventilation, pulmonary edema, breathing difficulty, respiratory failure), cardiovascular system (palpitations, rapid heart beat, hypertension, hypotension). Massive doses by produce sudden loss of conciousness and prompt death from respiratory arrest.
Smaller but still lethal doses
on the breath or vomitus.
Chronic Potential Health Effects:
Central Nervous system effects (headaches, vertigo, insomnia, memory loss, tremors, fatigue), fatigue, metabolic effects (poor appetite), cardiovascular effects (chest discomfort, palpitations), nerve damage to the eyes, or dermatitis, respiratory tract irritation, eye irritation, or death can occur.
may prolong the illness for 1 or more hours. A bitter almond odor may be noted

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 6.1: Poisonous material.

Identification: : Sodium cyanide UNNA: 1689 PG: I

Special Provisions for Transport: Marine Pollutant

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut carcinogen reporting list.: Sodium Cyanide
Illinois chemical safety act: Sodium Cyanide
New York release reporting list: Sodium Cyanide
Rhode Island RTK hazardous substances: Sodium Cyanide
Pennsylvania RTK: Sodium Cyanide
Minnesota: Sodium Cyanide
Massachusetts RTK: Sodium Cyanide
Massachusetts spill list: Sodium Cyanide
New Jersey: Sodium Cyanide
New Jersey spill list: Sodium Cyanide
Louisiana RTK reporting list: Sodium Cyanide
Louisiana spill reporting: Sodium Cyanide
California Director's List of Hazardous Substances: Sodium Cyanide
TSCA 8(b) inventory: Sodium Cyanide
TSCA 4(a) final test rules: Sodium Cyanide
TSCA 8(a) PAIR: Sodium Cyanide
TSCA 8(d) H and S data reporting: Sodium Cyanide
TSCA 12(b) one time export: Sodium Cyanide
SARA 302/304/311/312 extremely hazardous substances: Sodium Cyanide
CERCLA: Hazardous substances.: Sodium Cyanide: 10 lbs. (4.536 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-6: Reactive and very flammable material.
CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC).
CLASS E: Corrosive solid.

DSCL (EEC):
R27/28- Very toxic in contact with skin and if swallowed.
R41- Risk of serious damage to eyes.
S1/2- Keep locked up and out of the reach of children.
S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S28- After contact with skin, wash immediately

with plenty of water
S36/37- Wear suitable protective clothing and gloves.
S39- Wear eye/face protection.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S46- If swallowed, seek medical advice immediately and show this container or label.

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 1

Reactivity: 0

Personal Protection: j

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Synthetic apron.
Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/11/2005 01:58 PM

Last Updated: 11/06/2008 12:00 PM

SPI Supplies Division
Structure Probe, Inc.
P.O. Box 656 West Chester, PA 19381-0656 USA
Phone: 1-(610)-436-5400 Fax: 1-(610)-436-5755
E-mail: spi3spi@2spi.com
WWW: http://www.2spi.com
Manufacturer's CAGE: 1P573

Material Safety Data Sheet

SPI #02701-AB, 02701A-AB Chrysotile "B" and SPI#02740-AB, 02740A-AB Chrysolile "B" Asbestos Standards

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Section 1: Identification

Date Effective........... May 30, 2007
(most recent revision)

Chemical family..... Hydrous silicates of magnesia

Emergencies
Contacting CHEMTREC:

24 Hour Emergency Use Only #'s......
Worldwide phone: 1-(703)-527-3887
Worldwide FAX: 1-(703)-741-6090
Toll-free phone: 1-(800)-424-9300 USA only

Product or Trade Name.... Chrysotile asbestos fiber

Emergency Overview:
Chrysotile asbestos is a known human carcinogen.

Section 2: Composition

Name	CAS #	EC#	Approximate Weight %
Chrysotile	12001-29-5	650-013-006	>99.99%

Confirmed carcinogen by ACGIH, IARC, OSHA AND NTP.

Section 3: Hazard Identification

Potential Health Effects:

Acute: Overexposure to breathing asbestos may cause asbestosis, pulmonary fibrosis, mesothelioma, other lung disorders or cancer. Handling of materials and smoking or eating prior to washing could be hazardous. Medical examination and x-rays are required to determine signs & symptoms of exposure.

Routes of exposure: Inhalation, Skin contact, Ingestion

Medical Conditions Aggravated by Exposure:

Pulmonary disease

Occupational Exposure Limits:

TLV: 0.1 fiber/cc (as TWA)
A1 (ACGIH 1998. For fibers longer than 5Âµm with an aspect ratio equal to or greater than 3:1 as determined at 400-450X magnification by the membrane filter method).

Incompatibilies:
Strong oxidizers, strong acids, and bases

Route of entry: Inhalation, Skin contact, Ingestion
Target organs: Lungs

Symptoms:
There are not acute signs or symptoms associated with asbestos. Diseases associated with over exposure are chronic, generally taking from 10 to 40 years to become apparent.

Section 4: First Aid Measures

Eyes: In case of contact, immediately flush eyes with copious amounts of flowing water for at least 15 minutes, retracting eye lids often. Get medical attention immediately. Contact lenses should not be worn when working with this product.

Skin: Wash skin thoroughly with mild soap and water. Flush with copious amounts of water for 15 minutes.

Inhalation: Move the exposed person to fresh air at once. Support breathing. If symptoms persist contact physician.

Ingestion: Get medical aid immediately.

Section 5: Fire Fighting Measures

Flammability classification: Not classified.
Heat resistant up to 500°C; is completely decomposed at a temperature of 1000°C.

Flash Point/Method: Not known

Auto-Ignition Temperature: Not determined

Flammable Limits: Lower: Not applicable
Upper: Not applicable

Extinguishing Media: Water, Foam, Dry Chemical

Unusual Fire Hazards: Toxic gases and asbestos particulate may be Released in a fire.

Firefighting procedures/instructions:
Use NIOSH approved self-contained breathing apparatus and full protective equipment.
Properties that could increase fire or explosion hazard:
Combustibility of this material results from paraffin lubrication.

Section 6: Accidental Release Measures

Use HEPA vacuum wet methods when feasible. Use appropriate personal protection for clean-up personnel.

Section 7: Handling and Storage

Storage and handling:
Store in well-sealed container in cool, dry area.

Section 8: Exposure Controls and Personal Protection

ANSI approved eye wash and deluge shower should be available in the work area.

Personal Protective Equipment (PPE):

Eye/Face Protection: ANSI 87.1 approved chemical safety glasses with side shield.

Protective gloves: Rubber gloves
Protective clothing: Wear protective clothing to prevent skin contact. Do NOT take working clothes home.

Respiratory Protection:
Wear NIOSH approved respirator in accordance with 29CFR1910.1001.

Other: Wash prior to eating, drinking, or smoking. Avoid ingestion or breathing of dust.

Section 9: Physical and Chemical Properties

Appearance: white or gray fibrous solid
Color: white or gray
pH: Not applicable
Odor: None
Vapor Pressure: Not applicable
Vapor Density (Air=1): Not available
Boiling Point/Range: Not available
Melting Point/Range: Decomposes above 500°C
Specific Gravity: 2.2 to 2.6 g/cc
Solubility in water: None
Softening Point: Not determined
Molecular Formula: $Mg_3Si_2H_4O_6/Mg_3(Si_2O_5)(OH)4$
Molecular Weight: 277
%Volatile by Volume: Not determined
Evaporation Rate (n-butyl acetate = 1): Not available
Viscosity: Not available

Section 10: Stability and Reactivity

Chemical Stability: The product is stable under normal use conditions.

Conditions to Avoid:
Prevent dispersion of dust. Avoid all contact. Avoid airborne concentrations at or above OSHA PEL.

Incompatibility (materials to avoid):
Strong oxidizers, strong acids, and bases.

Hazardous Products of Decomposition:
None known

Reactions with Air and Water:
Avoid airborne concentrations at or above OSHA PEL.

Section 11: Toxicological Information

RTECS# CI3478500

Section 12: Ecological Information

None available

Section 13: Disposal Considerations

Bury waste is solid landfill as required in 29CFR1910.1001. Comply with applicable OSHA, Federal, State and Local regulations.

Section 14: Transport Information

Proper Shipping Name: White asbestos (chrysotile)

DOT Hazard Class: 9

UN/NA ID: UN2590

Packing Group: III

Labels: 9

Marine Pollutant: No information

DOT Status: Not Regulated

Section 15: Regulatory Information

United States:

TSCA
This product is listed under the TSCA Inventory.

CERCLA:
This product has an RQ of 1 pound under CERCLA.

SARA:
Section 313
This product is listed under SARA Section 313.

California Prop. 65:
Asbestos a known carcinogen under California Prop. 65.

US Statements:
Confirmed carcinogen. Target organs: Lung

European/International Regulations:
European Labeling in Accordance with EC Directives

Hazard Symbols: T Toxic
Risk Phrases:
R23 Toxic by Inhalation
R45 May cause cancer
R48 Danger of serious damage to health by prolonged exposure
R49 May cause cancer by inhalation

Safety Phrases:
S53 Avoid exposure â€“ obtain special instructions before use
S45 In case of accident, or if you feel unwell, seek medical advice immediately (show the label where possible.)

Canada

This product has a WHMIS classification of D2B.

DSL/NDSL
This product is listed on the DSL List and is not listed on the NDSL List.

Section 16: Other Information

If this product should be used in ways that are outside of the intended applications in scanning electron microscope laboratories, and if it is going to be formulated into some other system, so that it becomes just another component of that other system, read the MSDS sheets for the other components before blending as the resulting mixture may have the hazards of all of its parts.

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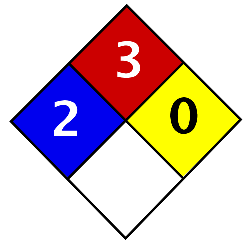

Health	2
Fire	3
Reactivity	0
Personal Protection	H

Material Safety Data Sheet
Ethylbenzene MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ethylbenzene

Catalog Codes: SLE2044

CAS#: 100-41-4

RTECS: DA0700000

TSCA: TSCA 8(b) inventory: Ethylbenzene

CI#: Not available.

Synonym: Ethyl Benzene; Ethylbenzol; Phenylethane

Chemical Name: Ethylbenzene

Chemical Formula: C8H10

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Ethylbenzene	100-41-4	100

Toxicological Data on Ingredients: Ethylbenzene: ORAL (LD50): Acute: 3500 mg/kg [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant, permeator).

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (irritant, sensitizer).
CARCINOGENIC EFFECTS: Classified 2B (Possible for human.) by IARC.
MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to central nervous system (CNS).
Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention.

Skin Contact: Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 432°C (809.6°F)

Flash Points:
CLOSED CUP: 15°C (59°F). (Tagliabue.) OPEN CUP: 26.667°C (80°F) (Cleveland) (CHRIS, 2001)
CLOSED CUP: 12.8 C (55 F) (Bingham et al, 2001; NIOSH, 2001)
CLOSED CUP: 21 C (70 F) (NFPA)

Flammable Limits: LOWER: 0.8% - 1.6%UPPER: 6.7% - 7%

Products of Combustion: These products are carbon oxides (CO, CO_2).

Fire Hazards in Presence of Various Substances: Highly flammable in presence of open flames and sparks, of heat.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.
Slightly explosive in presence of heat.

Fire Fighting Media and Instructions:
Flammable liquid, soluble or dispersed in water.
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards:
Vapor may travel considerable distance to source of ignition and flash back. Vapors may form explosive mixtures with air. When heated to decomposition it emits acrid smoke and irritating fumes.

Special Remarks on Explosion Hazards: Vapors may form explosive mixtures in air.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
Flammable liquid.
Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Avoid contact with eyes. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Sensitive to light. Store in light-resistant containers.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 100 STEL: 125 (ppm) from OSHA (PEL) [United States]
TWA: 435 STEL: 545 from OSHA (PEL) [United States]
TWA: 435 STEL: 545 (mg/m3) from NIOSH [United States]
TWA: 100 STEL: 125 (ppm) from NIOSH [United States]
TWA: 100 STEL: 125 (ppm) from ACGIH (TLV) [United States]
TWA: 100 STEL: 125 (ppm) [United Kingdom (UK)]
TWA: 100 STEL: 125 (ppm) [Belgium]
TWA: 100 STEL: 125 (ppm) [Finland]
TWA: 50 (ppm) [Norway]
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Sweetish. Gasoline-like. Aromatic.

Taste: Not available.

Molecular Weight: 106.16 g/mole

Color: Colorless.

pH (1% soln/water): Not available.

Boiling Point: 136°C (276.8°F)

Melting Point: -94.9 (-138.8°F)

Critical Temperature: 617.15°C (1142.9°F)

Specific Gravity: 0.867 (Water = 1)

Vapor Pressure: 0.9 kPa (@ 20°C)

Vapor Density: 3.66 (Air = 1)

Volatility: 100% (v/v).

Odor Threshold: 140 ppm

Water/Oil Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 3.1

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

Solubility:
Easily soluble in diethyl ether.
Very slightly soluble in cold water or practically insoluble in water.
Soluble in all proportions in Ethyl alcohol.
Soluble in Carbon tetrachloride, Benzene.
Insoluble in Ammonia.
Slightly soluble in Chloroform.
Solubility in Water: 169 mg/l @ 25 deg. C.; 0.014 g/100 ml @ 15 deg. C.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, ingnition sources (flames, sparks, static), incompatible materials, light

Incompatibility with various substances: Reactive with oxidizing agents.

Corrosivity: Not considered to be corrosive for metals and glass.

Special Remarks on Reactivity:
Can react vigorously with oxidizing materials.
Sensitive to light.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Inhalation.

Toxicity to Animals: Acute oral toxicity (LD50): 3500 mg/kg [Rat].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified 2B (Possible for human.) by IARC.
MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast.
May cause damage to the following organs: central nervous system (CNS).

Other Toxic Effects on Humans:
Hazardous in case of ingestion, of inhalation.
Slightly hazardous in case of skin contact (irritant, permeator).

Special Remarks on Toxicity to Animals:
Lethal Dose/Conc 50% Kill:
LD50 [Rabbit] - Route: Skin; Dose: 17800 ul/kg
Lowest Published Lethal Dose/Conc:
LDL[Rat] - Route: Inhalation (vapor); Dose: 4000 ppm/4 H

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects and birth defects (teratogenic) based on animal test data.
May cause cancer based on animals data. IARC evidence for carcinogenicity in animals is sufficient. IARC evidence of carcinogenicity in humans inadequate.
May affect genetic material (mutagenic).

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: Can cause mild skin irritation. It can be absorbed through intact skin.
Eyes: Contact with vapor or liquid can cause severe eye irritation depending on concentration. It may also cause conjunctivitis. At a vapor exposure level of 85 - 200 ppm , it is mildly and transiently irritating to the eyes; 1000 ppm causes further irritation and tearing; 2000 ppm results in immediate and severe irritation and tearing; 5,000 ppm is intolerable (ACGIH, 1991; Clayton and Clayton, 1994). Standard draize test for eye irritation using 500 mg resulted in severe irritation (RTECS)
Inhalation: Exposure to high concentrations can cause nasal, mucous membrane and respiratory tract irritation and can also result in chest constriction and, trouble breathing, respiratory failure, and even death. It can also affect behavior/Central Nervous System. The effective dose for CNS depression in experimental animals was 10,000 ppm (ACGIH, 1991). Symptoms of CNS depression include headache, nausea, weakness, dizziness, vertigo, irritability, fatigue, lightheadedness, sleepiness, tremor, loss of coordination, judgement and conciousness, coma, and death. It can also cause pulmonary edema. Inhalation of 85 ppm can produce fatigue, insomnia, headache, and mild irritation of the respiratory tract (Haley & Berndt, 1987).
Ingestion: Do not drink, pipet or siphon by mouth. May cause gastroinestinal/digestive tract irritation with Abdominal pain, nausea, vomiting. Ethylbenzene is a pulmonary aspiration hazard. Pulmonary aspiration of even small amounts of the liquid may cause fatal pneumonitis. It may also affect behavior/central nervous system with

Section 12: Ecological Information

Ecotoxicity:
Ecotoxicity in water (LC50): 14 mg/l 96 hours [Fish (Trout)] (static). 12.1 mg/l 96 hours [Fish (Fathead Minnow)] (flow-through)]. 150 mg/l 96 hours [Fish (Blue Gill/Sunfish)] (static). 275 mg/l 96 hours [Fish (Sheepshead Minnow)]. 42.3 mg/l 96 hours [Fish (Fathead Minnow)](soft water). 87.6mg/l 96 hours [Shrimp].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Ethylbenzene UNNA: 1175 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Ethylbenzene
Illinois toxic substances disclosure to employee act: Ethylbenzene
Illinois chemical safety act: Ethylbenzene
New York release reporting list: Ethylbenzene
Rhode Island RTK hazardous substances: Ethylbenzene
Pennsylvania RTK: Ethylbenzene
Minnesota: Ethylbenzene
Massachusetts RTK: Ethylbenzene
Massachusetts spill list: Ethylbenzene
New Jersey: Ethylbenzene
New Jersey spill list: Ethylbenzene
Louisiana spill reporting: Ethylbenzene
California Director's List of Hazardous Substances: Ethylbenzene
TSCA 8(b) inventory: Ethylbenzene
TSCA 4(a) proposed test rules: Ethylbenzene
TSCA 8(d) H and S data reporting: Ethylbenzene: Effective Date: 6/19/87; Sunset Date: 6/19/97
SARA 313 toxic chemical notification and release reporting: Ethylbenzene

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F).
CLASS D-2A: Material causing other toxic effects (VERY TOXIC).
CLASSE D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):
R11- Highly flammable.
R20- Harmful by inhalation.
S16- Keep away from sources of ignition - No smoking.
S24/25- Avoid contact with skin and eyes.
S29- Do not empty into drains.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: h

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Splash goggles.

Section 16: Other Information

References:
-Manufacturer's Material Safety Data Sheet.
-Fire Protection Guide to Hazardous Materials, 13th ed., Nationial Fire Protection Association (NFPA)
-Registry of Toxic Effects of Chemical Substances (RTECS)
-Chemical Hazard Response Information System (CHRIS)
-Hazardous Substance Data Bank (HSDB)
-New Jersey Hazardous Substance Fact Sheet
-Ariel Global View
-Reprotext System

Other Special Considerations: Not available.

Created: 10/09/2005 05:28 PM

Last Updated: 11/06/2008 12:00 PM

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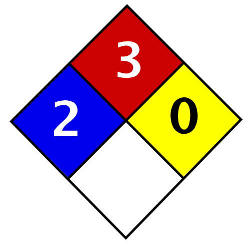

Health	2
Fire	3
Reactivity	0
Personal Protection	J

Material Safety Data Sheet
m-Xylene MSDS

Section 1: Chemical Product and Company Identification

Product Name: m-Xylene

Catalog Codes: SLX1066

CAS#: 108-38-3

RTECS: ZE2275000

TSCA: TSCA 8(b) inventory: m-Xylene

CI#: Not applicable.

Synonym: m-Methyltoluene

Chemical Name: 1,3-Dimethylbenzene

Chemical Formula: $C_6H_4(CH_3)_2$

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
{m-}Xylene	108-38-3	100

Toxicological Data on Ingredients: m-Xylene: ORAL (LD50): Acute: 5000 mg/kg [Rat.]. DERMAL (LD50): Acute: 14100 mg/kg [Rabbit.].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant), of eye contact (irritant). Slightly hazardous in case of skin contact (permeator), of ingestion, of inhalation. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant).
Slightly hazardous in case of skin contact (permeator), of ingestion, of inhalation.
CARCINOGENIC EFFECTS: Not available.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance is toxic to blood, kidneys, the nervous system, liver.
Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact: Check for and remove any contact lenses. Do not use an eye ointment. Seek medical attention.

Skin Contact:
After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

Serious Inhalation: Not available.

Ingestion:
Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 527°C (980.6°F)

Flash Points: CLOSED CUP: 25°C (77°F). OPEN CUP: 28.9°C (84°F) (Cleveland).

Flammable Limits: LOWER: 1.1% UPPER: 7%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances: Highly flammable in presence of open flames and sparks, of heat.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
Flammable liquid, insoluble in water.
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray or fog. Cool containing vessels with water jet in order to prevent pressure build-up, autoignition or explosion.

Special Remarks on Fire Hazards:
Explosive in the form of vapor when exposed to heat or flame. Vapor may travel considerable distance to source of ignition and flash back. When heated to decomposition it emits acrid smoke and irritating fumes.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
Flammable liquid, insoluble in water.

Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapour/spray. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes Keep away from incompatibles such as oxidizing agents.

Storage:
Flammable materials should be stored in a separate safety storage cabinet or room. Keep away from heat. Keep away from sources of ignition. Keep container tightly closed. Keep in a cool, well-ventilated place. Ground all equipment containing material. A refrigerated room would be preferable for materials with a flash point lower than 37.8°C (100°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection: Splash goggles. Lab coat. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Boots. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 100 STEL: 150 (ppm) from ACGIH (TLV)
TWA: 434 STEL: 651 (mg/m3) from ACGIHConsult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Liquid.)

Odor: Not available.

Taste: Not available.

Molecular Weight: 106.17 g/mole

Color: Colorless.

pH (1% soln/water): Not applicable.

Boiling Point: 139.3°C (282.7°F)

Melting Point: -47.87°C (-54.2°F)

Critical Temperature: Not available.

Specific Gravity: 0.86 (Water = 1)

Vapor Pressure: 6 mm of Hg (@ 20°C)

Vapor Density: 3.7 (Air = 1)

Volatility: Not available.

Odor Threshold: 0.62 ppm

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, methanol, diethyl ether.

Solubility:
Easily soluble in methanol, diethyl ether.
Insoluble in cold water, hot water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Reactive with oxidizing agents.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Eye contact.

Toxicity to Animals:
Acute oral toxicity (LD50): 5000 mg/kg [Rat.].
Acute dermal toxicity (LD50): 14100 mg/kg [Rabbit.].

Chronic Effects on Humans: The substance is toxic to blood, kidneys, the nervous system, liver.

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (irritant).
Slightly hazardous in case of skin contact (permeator), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
0347 Animal: embryotoxic, foetotoxic, passes through the placental barrier.
0900 Detected in maternal milk in human.
Narcotic effect; may cause nervous system disturbances.

Special Remarks on other Toxic Effects on Humans: Material is irritating to mucous membranes and upper respiratory tract.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: Class 3: Flammable liquid.

Identification: : Xylene : UN1307 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Pennsylvania RTK: m-Xylene
Massachusetts RTK: m-Xylene
TSCA 8(b) inventory: m-Xylene
SARA 313 toxic chemical notification and release reporting: m-Xylene
CERCLA: Hazardous substances.: m-Xylene

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F).
CLASS D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):
R10- Flammable.
R38- Irritating to skin.
R41- Risk of serious damage to eyes.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: j

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Wear appropriate respirator when ventilation is inadequate.
Splash goggles.

Section 16: Other Information

References:

-Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987.
-Material safety data sheet emitted by: la Commission de la SantÃ© et de la SÃ©curitÃ© du Travail du QuÃ©bec.
-SAX, N.I. Dangerous Properties of Indutrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984.
-The Sigma-Aldrich Library of Chemical Safety Data, Edition II.
-Guide de la loi et du rÃ¨glement sur le transport des marchandises dangeureuses au canada. Centre de conformitÃ© internatinal LtÃ©e. 1986.

Other Special Considerations: Not available.

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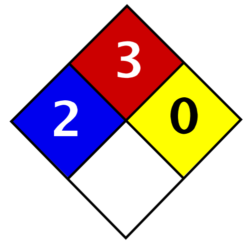

Health	2
Fire	3
Reactivity	0
Personal Protection	H

Material Safety Data Sheet
Toluene MSDS

Section 1: Chemical Product and Company Identification

Product Name: Toluene

Catalog Codes: SLT2857, SLT3277

CAS#: 108-88-3

RTECS: XS5250000

TSCA: TSCA 8(b) inventory: Toluene

CI#: Not available.

Synonym: Toluol, Tolu-Sol; Methylbenzene; Methacide; Phenylmethane; Methylbenzol

Chemical Name: Toluene

Chemical Formula: C6-H5-CH3 or C7-H8

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Toluene	108-88-3	100

Toxicological Data on Ingredients: Toluene: ORAL (LD50): Acute: 636 mg/kg [Rat]. DERMAL (LD50): Acute: 14100 mg/kg [Rabbit]. VAPOR (LC50): Acute: 49000 mg/m 4 hours [Rat]. 440 ppm 24 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for human.) by IARC.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to blood, kidneys, the nervous system, liver, brain, central nervous system (CNS).
Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 480°C (896°F)

Flash Points: CLOSED CUP: 4.4444°C (40°F). (Setaflash) OPEN CUP: 16°C (60.8°F).

Flammable Limits: LOWER: 1.1% UPPER: 7.1%

Products of Combustion: These products are carbon oxides (CO, CO_2).

Fire Hazards in Presence of Various Substances:
Flammable in presence of open flames and sparks, of heat.
Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
Flammable liquid, insoluble in water.
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray or fog.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards:
Toluene forms explosive reaction with 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione; dinitrogen tetraoxide;

concentrated nitric acid, sulfuric acid + nitric acid; N_2O_4; $AgClO_4$; BrF_3; Uranium hexafluoride; sulfur dichloride. Also forms an explosive mixture with tetranitromethane.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
Toxic flammable liquid, insoluble or very slightly soluble in water.
Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 200 STEL: 500 CEIL: 300 (ppm) from OSHA (PEL) [United States]
TWA: 50 (ppm) from ACGIH (TLV) [United States] SKIN
TWA: 100 STEL: 150 from NIOSH [United States]
TWA: 375 STEL: 560 (mg/m^3) from NIOSH [United States]
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Sweet, pungent, Benzene-like.

Taste: Not available.

Molecular Weight: 92.14 g/mole

Color: Colorless.

pH (1% soln/water): Not applicable.

Boiling Point: 110.6°C (231.1°F)

Melting Point: -95°C (-139°F)

Critical Temperature: 318.6°C (605.5°F)

Specific Gravity: 0.8636 (Water = 1)

Vapor Pressure: 3.8 kPa (@ 25°C)

Vapor Density: 3.1 (Air = 1)

Volatility: Not available.

Odor Threshold: 1.6 ppm

Water/Oil Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 2.7

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether, acetone.

Solubility:
Soluble in diethyl ether, acetone.
Practically insoluble in cold water.
Soluble in ethanol, benzene, chloroform, glacial acetic acid, carbon disulfide.
Solubility in water: 0.561 g/l @ 25 deg. C.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, ignition sources (flames, sparks, static), incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Incompatible with strong oxidizers, silver perchlorate, sodium difluoride, Tetranitromethane, Uranium Hexafluoride.
Frozen Bromine Trifluoride reacts violently with Toluene at -80 deg. C.
Reacts chemically with nitrogen oxides, or halogens to form nitrotoluene, nitrobenzene, and nitrophenol and halogenated products, respectively.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE.
Acute oral toxicity (LD50): 636 mg/kg [Rat].
Acute dermal toxicity (LD50): 14100 mg/kg [Rabbit].
Acute toxicity of the vapor (LC50): 440 24 hours [Mouse].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for human.) by IARC.
May cause damage to the following organs: blood, kidneys, the nervous system, liver, brain, central nervous system (CNS).

Other Toxic Effects on Humans:
Hazardous in case of skin contact (irritant), of ingestion, of inhalation.
Slightly hazardous in case of skin contact (permeator).

Special Remarks on Toxicity to Animals:
Lowest Published Lethal Dose:
LDL [Human] - Route: Oral; Dose: 50 mg/kg
LCL [Rabbit] - Route: Inhalation; Dose: 55000 ppm/40min

Special Remarks on Chronic Effects on Humans:
Detected in maternal milk in human. Passes through the placental barrier in human. Embryotoxic and/or foetotoxic in animal. May cause adverse reproductive effects and birth defects (teratogenic). May affect genetic material (mutagenic)

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: Causes mild to moderate skin irritation. It can be absorbed to some extent through the skin.
Eyes: Cauess mild to moderate eye irritation with a burning sensation. Splash contact with eyes also causes conjunctivitis, blepharospasm, corneal edema, corneal abraisons. This usually resolves in 2 days.
Inhalation: Inhalation of vapor may cause respiratory tract irritation causing coughing and wheezing, and nasal discharge. Inhalation of high concentrations may affect behavior and cause central nervous system effects characterized by nausea, headache, dizziness, tremors, restlessness, lightheadedness, exhilaration, memory loss, insomnia, impaired reaction time, drowsiness, ataxia, hallucinations, somnolence, muscle contraction or spasticity, unconsciousness and coma. Inhalation of high concentration of vapor may also affect the cardiovascular system (rapid heart beat, heart palpitations, increased or decreased blood pressure, dysrhythmia,), respiration (acute pulmonary edema, respiratory depression, apnea, asphyxia), cause vision disturbances and dilated pupils, and cause loss of appetite.
Ingestion: Aspiration hazard. Aspiration of Toluene into the lungs may cause chemical pneumonitis. May cause irritation of the digestive tract with nausea, vomiting, pain. May have effects similar to that of acute inhalation.
Chronic Potential Health Effects:
Inhalation and Ingestion: Prolonged or repeated exposure via inhalation may cause central nervous system and cardiovascular symptoms similar to that of acute inhalation and ingestion as well liver damage/failure, kidney damage/failure (with hematuria, proteinuria, oliguria, renal tubular acidosis), brain damage, weight loss, blood (pigmented or nucleated red blood cells, changes in white blood cell count), bone marrow changes, electrolyte imbalances (Hypokalemia, Hypophostatemia), severe, muscle weakness and Rhabdomyolysis.
Skin: Repeated or prolonged skin contact may cause defatting dermatitis.

Section 12: Ecological Information

Ecotoxicity:
Ecotoxicity in water (LC50): 313 mg/l 48 hours [Daphnia (daphnia)]. 17 mg/l 24 hours [Fish (Blue Gill)]. 13 mg/l 96 hours [Fish (Blue Gill)]. 56 mg/l 24 hours [Fish (Fathead minnow)]. 34 mg/l 96 hours [Fish (Fathead minnow)]. 56.8 ppm any hours [Fish (Goldfish)].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may

arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Toluene UNNA: 1294 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Toluene
California prop. 65 (no significant risk level): Toluene: 7 mg/day (value)
California prop. 65 (acceptable daily intake level): Toluene: 7 mg/day (value)
California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: Toluene
Connecticut hazardous material survey.: Toluene
Illinois toxic substances disclosure to employee act: Toluene
Illinois chemical safety act: Toluene
New York release reporting list: Toluene
Rhode Island RTK hazardous substances: Toluene
Pennsylvania RTK: Toluene
Florida: Toluene
Minnesota: Toluene
Michigan critical material: Toluene
Massachusetts RTK: Toluene
Massachusetts spill list: Toluene
New Jersey: Toluene
New Jersey spill list: Toluene
Louisiana spill reporting: Toluene
California Director's List of Hazardous Substances.: Toluene
TSCA 8(b) inventory: Toluene
TSCA 8(d) H and S data reporting: Toluene: Effective date: 10/04/82; Sunset Date: 10/0/92
SARA 313 toxic chemical notification and release reporting: Toluene
CERCLA: Hazardous substances.: Toluene: 1000 lbs. (453.6 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F).
CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R11- Highly flammable.
R20- Harmful by inhalation.
S16- Keep away from sources of ignition - No smoking.
S25- Avoid contact with eyes.
S29- Do not empty into drains.
S33- Take precautionary measures against static discharges.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: h

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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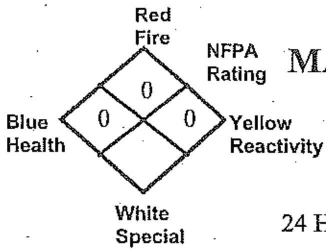
Alconox ®



MATERIAL SAFETY DATA SHEET

Alconox, Inc.
30 Glenn Street
White Plains, NY 10603

24 Hour Emergency Number – Chem-Tel (800) 255-3924

I. IDENTIFICATION

Product Name (as appears on label)	ALCONOX
CAS Registry Number:	Not Applicable
Effective Date:	January 1, 2001
Chemical Family:	Anionic Powdered Detergent
Manufacturer Catalog Numbers for sizes	1104, 1125, 1150, 1101, 1103 and 1112

II. HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

There are no hazardous ingredients in ALCONOX as defined by the OSHA Standard and Hazardous Substance List 29 CFR 1910 Subpart Z.

III. PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point (F):	Not Applicable
Vapor Pressure (mm Hg):	Not Applicable
Vapor Density (AIR=1):	Not Applicable
Specific Gravity (Water=1):	Not Applicable
Melting Point:	Not Applicable
Evaporation Rate (Butyl Acetate=1):	Not Applicable
Solubility in Water:	Appreciable-Soluble to 10% at ambient conditions
Appearance:	White powder interspersed with cream colored flakes.
pH:	9.5 (1%)

IV. FIRE AND EXPLOSION DATA

Flash Point (Method Used):	None
Flammable Limits:	LEL: No Data UEL: No Data
Extinguishing Media:	Water, dry chemical, CO_2, foam
Special Fire fighting Procedures:	Self-contained positive pressure breathing apparatus and protective clothing should be worn when fighting fires involving chemicals.
Unusual Fire and Explosion Hazards:	None

V. REACTIVITY DATA

Stability:	Stable
Hazardous Polymerization:	Will not occur
Incompatibility (Materials to Avoid):	None
Hazardous Decomposition or Byproducts:	May release CO_2 on burning

VI. HEALTH HAZARD DATA

Route(s) of Entry:	Inhalation? Yes Skin? No Ingestion? Yes
Health Hazards (Acute and Chronic):	Inhalation of powder may prove locally irritating to mucous membranes. Ingestion may cause discomfort and/or diarrhea. Eye contact may prove irritating.
Carcinogenicity:	NTP? No IARC Monographs? No OSHA Regulated? No
Signs and Symptoms of Exposure:	Exposure may irritate mucous membranes. May cause sneezing.
Medical Conditions Generally Aggravated by Exposure:	Not established. Unnecessary exposure to this product or any industrial chemical should be avoided. Respiratory conditions may be aggravated by powder.
Emergency and First Aid Procedures:	Eyes: Immediately flush eyes with water for at least 15 minutes. Call a physician. Skin: Flush with plenty of water. Ingestion: Drink large quantities of water or milk. Do not induce vomiting. If vomiting occurs administer fluids. See a physician for discomfort.

VII. PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be Taken if Material is Released or Spilled:	Material foams profusely. Recover as much as possible and flush remainder to sewer. Material is biodegradable.
Waste Disposal Method:	Small quantities may be disposed of in sewer. Large quantities should be disposed of in accordance with local ordinances for detergent products.
Precautions to be Taken in Storing and Handling:	Material should be stored in a dry area to prevent caking.
Other Precautions:	No special requirements other than the good industrial hygiene and safety practices employed with any industrial chemical.

VIII. CONTROL MEASURES

Respiratory Protection (Specify Type):	Dust mask - Recommended
Ventilation:	Local Exhaust-Normal Special-Not Required Mechanical-Not Required Other-Not Required
Protective Gloves:	Impervious gloves are useful but not required.
Eye Protection:	Goggles are recommended when handling solutions.
Other Protective Clothing or Equipment:	None
Work/Hygienic Practices:	No special practices required

THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH BUT NO WARRANTY IS EXPRESSED OR IMPLIED.

**** MATERIAL SAFETY DATA SHEET ****

Methanol
14280

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Methanol
Catalog Numbers:
, S75959, S75965, S75965A, S75965HPLC, S75965SPEC, A408-1, A408-4, A408SK-4 A411-20, A411-4, A412-1, A412-20, A412-200, A412-200LC, A412-4, A412-4LC, A412-500, A412-500LC, A412CU1300, A412FB115, A412FB19, A412FB200, A412FB50, A412J500, A412P-4, A412P-4LC, A412POP19, A412POP200, A412POP50, A412POPB19, A412POPB200, A412POPB50, A412RB115, A412RB19, A412RB200, A412RB50, A412RS115, A412RS200, A412RS28, A412RS50, A412SK-4, A412SS-115, A412SS-19, A412SS-200, A413-20, A413-200, A413-4, A413-500, A433F-1GAL, A433P-4, A433P1GAL, A433S-20, A433S-200, A433S-4, A434-20, A450-4, A452-1, A452-4, A452-4LC, A452J1, A452NB219, A452POP19, A452POP200, A452POP28, A452POP50, A452POPN19, A452RS-115, A452RS-19, A452RS-200, A452RS-28, A452RS-50, A452SK-1, A452SK-4, A452SS-115, A452SS-19, A452SS-200, A452SS-50, A453-1, A453-1LC, A453-500, A453J1, A454-1, A454-1LC, A454-4, A454-4LC, A454POP19, A454POP200, A454POP50, A454RS-115, A454RS-19, A454RS-200, A454RS-28, A454RS-50, A454SS-19, A454SS-28, A454SS-50, A455-1, A455POP19, A455POP200, A455POP50, A455SS19, A455SS200, A455SS50, A457-4, A935-4, A935FB200, A935POPB200, A935RB200, A936-1, A936-4, A947-4, A947-4LC, A947POP19, A947POP200, A947POP50, A947RS-115, A947RS-200, A947RS-28, A947SS-115, A947SS-19, A947SS-200, A947SS-28, A947SS-50, BP1105-1, BP1105-4, BP1105POP19, BP1105POP20, BP1105POP50, BP1105RS19, BP1105SS19, BP1105SS28, BP1105SS50, BP2618100, HC400 1GAL, NC9633361, NC9766429, NC9780216, NC9905242, NC9941388, NC9942270, NC9964975, NC9979250, SC95-1, SW2-1, TIA9474, TIA947P200L .

Synonyms:
Carbinol; Methyl alcohol; Methyl hydroxide; Monohydroxymethane; Wood alcohol; Wood naptha; Wood spirits; Columbian spirits; Methanol.

Company Identification: Fisher Scientific
1 Reagent Lane
Fairlawn, NJ 07410

For information, call: 301-796-7100
Emergency Number: 301-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
67-56-1	Methanol	>99.0	200-659-6

Hazard Symbols: T F
Risk Phrases: 11 23/24/25 39/23/24/25

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: clear, colorless liquid. Flash Point: 11 deg C.
Danger! Flammable liquid and vapor. Causes respiratory tract irritation. May cause central nervous system depression. Poison! Cannot be made non-poisonous. Causes eye and skin irritation. May be fatal or cause blindness if swallowed. Harmful if swallowed, inhaled, or absorbed through the skin. Vapor harmful.
Target Organs: Eyes, nervous system, optic nerve.

Potential Health Effects

Eye:
Methanol is a mild to moderate eye irritant. Inhalation, ingestion or skin absorption of methanol can cause significant disturbances in vision, including blindness.

Skin:
Causes moderate skin irritation. Harmful if absorbed through the skin. Prolonged and/or repeated contact may cause defatting of the skin and dermatitis. Methanol can be absorbed through the skin, producing systemic effects that include visual disturbances.

Ingestion:
Harmful if swallowed. May be fatal or cause blindness if swallowed. Aspiration hazard. May cause systemic toxicity with acidosis. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure.

Inhalation:
Methanol is toxic and can very readily form extremely high vapor concentrations at room temperature. Inhalation is the most common route of occupational exposure. At first, methanol causes CNS depression with nausea, headache, vomiting, dizziness and incoordination. A time period with no obvious symptoms follows (typically 8-24 hrs). This latent period is followed by metabolic acidosis and severe visual effects which may include reduced reactivity and/or increased sensitivity to light, blurred, double

and/or snowy vision, and blindness. Depending on the severity of exposure and the promptness of treatment, survivors may recover completely or may have permanent blindness, vision disturbances and/or nervous system effects.

Chronic:
Prolonged or repeated skin contact may cause dermatitis. Chronic exposure may cause effects similar to those of acute exposure. Methanol is only very slowly eliminated from the body. Because of this slow elimination, methanol should be regarded as a cumulative poison. Though a single exposure may cause no effect, daily exposures may result in the accumulation of a harmful amount. Methanol has produced fetotoxicity in rats and teratogenicity in mice exposed by inhalation to high concentrations that did not produce significant maternal toxicity.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical aid.

Skin:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.

Ingestion:
Potential for aspiration if swallowed. Get medical aid immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:
Effects may be delayed.

Antidote:
Ethanol may inhibit methanol metabolism.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
Containers can build up pressure if exposed to heat and/or fire. As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Water may be ineffective. Material is lighter than water and a fire may be spread by the use of water. Flammable liquid and vapor. Vapors are heavier than air and may travel to a source of ignition and flash back. Vapors can spread along the ground and collect in low or confined areas.

Extinguishing Media:
For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Water may be ineffective. For large fires, use water spray, fog or alcohol-resistant foam. Do NOT use straight streams of water.

Autoignition Temperature:464 deg C (867.20 deg F)
Flash Point: 11 deg C (51.80 deg F)
Explosion Limits, lower:6.0 vol %
Explosion Limits, upper:36.00 vol %
NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:
Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Use water spray to disperse the gas/vapor. Remove all sources of ignition. Provide ventilation. A vapor suppressing foam may be used to reduce vapors. Water spray may reduce vapor but may not prevent ignition in closed spaces.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:
Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Ground and bond containers when transferring material. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Do not ingest or inhale. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Use only with adequate ventilation. Keep away from heat, sparks and flame. Avoid use in confined spaces. Avoid breathing vapor or mist.

Storage:
Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a cool, dry, well-ventilated area away from incompatible substances. Flammables-area. Keep containers tightly closed.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Use explosion-proof ventilation equipment. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Methanol	200 ppm; 250 ppm STEL; skin - potential for cutaneous absorption	200 ppm TWA; 260 mg/m3 TWA 6000 ppm IDLH	200 ppm TWA; 260 mg/m3 TWA

OSHA Vacated PELs:
Methanol:
200 ppm TWA; 260 mg/m3 TWA

Personal Protective Equipment

Eyes:
Wear chemical goggles.
Skin:
Wear appropriate protective gloves to prevent skin exposure.
Clothing:
Wear appropriate protective clothing to prevent skin exposure.
Respirators:
A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Liquid
Color:	clear, colorless
Odor:	alcohol-like - weak odor
pH:	Not available.
Vapor Pressure:	127 mm Hg @ 25 deg C
Vapor Density:	1.11 (Air=1)
Evaporation Rate:	5.2 (Ether=1)
Viscosity:	0.55 cP 20 deg C
Boiling Point:	64.7 deg C @ 760 mm Hg
Freezing/Melting Point:	-98 deg C
Decomposition Temperature:	Not available.
Solubility in water:	miscible
Specific Gravity/Density:	.7910 g/cm3 @ 20&C
Molecular Formula:	CH4O
Molecular Weight:	32.04

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
High temperatures, ignition sources, confined spaces.
Incompatibilities with Other Materials:
Strong oxidizing agents, strong acids, powdered aluminum, powdered magnesium.
Hazardous Decomposition Products:
Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide, formaldehyde.
Hazardous Polymerization: Will not occur.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 67-56-1: PC1400000
LD50/LC50:
CAS# 67-56-1: Draize test, rabbit, eye: 40 mg Moderate; Draize test, rabbit, eye: 100 mg/24H Moderate; Draize test, rabbit, skin: 20 mg/24H Moderate; Inhalation, rabbit: LC50 = 81000 mg/m3/14H; Inhalation, rat: LC50 = 64000 ppm/4H; Oral, mouse: LD50 = 7300 mg/kg; Oral, rabbit: LD50 = 14200 mg/kg; Oral, rat: LD50 = 5600 mg/kg; Skin, rabbit: LD50 = 15800 mg/kg.
Human LDLo Oral: 143 mg/kg.
Inhalation: 300 ppm caused visual field changes & headache.
LDLo Skin: 393 mg/kg.
experimental animals than humans, because most animal species metabolize methanol differently. Non-primate species do not ordinarily show symptoms of metabolic acidosis or the visual effects

which have been observed in primates and humans.
Carcinogenicity:
Methanol -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
No data available.
Teratogenicity:
There is no human information available. Methanol is considered to be a potential developmental hazard based on animal data. In animal experiments, methanol has caused fetotoxic or teratogenic effects without maternal toxicity.
Reproductive Effects:
See actual entry in RTECS for complete information.
Neurotoxicity:
ACGIH cites neuropathy, vision and CNS under TLV basis.
Mutagenicity:
See actual entry in RTECS for complete information.
Other Studies:
No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Fish: Fathead Minnow: 29.4 g/L; 96 Hr; LC50 (unspecified)Fish: Goldfish: 250 ppm; 11 Hr; resulted in deathFish: Rainbow trout: 8000 mg/L; 48 Hr; LC50 (unspecified)Fish: Rainbow trout: LC50 = 13-68 mg/L; 96 Hr.; 12 degrees CFish: Fathead Minnow: LC50 = 29400 mg/L; 96 Hr.; 25 degrees C, pH 7.63Fish: Rainbow trout: LC50 = 8000 mg/L; 48 Hr.; UnspecifiedBacteria: Phytobacterium phosphoreum: EC50 = 51,000-320,000 mg/L; 30 minutes; Microtox test

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste.
US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: CAS# 67-56-1: waste number U154 (Ignitable waste).

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
Shipping Name: METHANOL
Hazard Class: 3
UN Number: UN1230
Packing Group: II
Canadian TDG
Shipping Name: METHANOL
Hazard Class: 3.61
UN Number: UN1230
Other Information: FLASHPOINT 11 C

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL
TSCA
CAS# 67-56-1 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
CERCLA Hazardous Substances and corresponding RQs
CAS# 67-56-1: 5000 lb final RQ; 2270 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 67-56-1: acute, flammable.
Section 313
This material contains Methanol (CAS# 67-56-1, 99 0%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 372.
Clean Air Act:
CAS# 67-56-1 is listed as a hazardous air pollutant (HAP).
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.

STATE
Methanol can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.
California No Significant Risk Level:
None of the chemicals in this product are listed.

European/International Regulations
European Labeling in Accordance with EC Directives
Hazard Symbols: T F
Risk Phrases:
R 11 Highly flammable.
R 23/24/25 Toxic by inhalation, in contact with skin and if swallowed.
R 39/23/24/25 Toxic : danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
Safety Phrases:
S 7 Keep container tightly closed.
S 16 Keep away from sources of ignition - No smoking.
S 36/37 Wear suitable protective clothing and gloves.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

WGK (Water Danger/Protection)
CAS# 67-56-1: 1

United Kingdom Occupational Exposure Limits
CAS# 67-56-1: OES-United Kingdom, TWA 200 ppm TWA; 266 mg/m3 TWA
CAS# 67-56-1: OES-United Kingdom, STEL 250 ppm STEL; 333 mg/m3 STEL

United Kingdom Maximum Exposure Limits

Canada
CAS# 67-56-1 is listed on Canada's DSL List.
This product has a WHMIS classification of B2, D1B, D2B.
CAS# 67-56-1 is listed on Canada's Ingredient Disclosure List.

Exposure Limits
CAS# 67-56-1: OEL-ARAB Republic of Egypt:TWA 200 ppm (260 mg/m3);Skin

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 7/21/1999 Revision #11 Date: 10/21/2002

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if the company has been advised of the possibility of such damages.

**** MATERIAL SAFETY DATA SHEET ****

Nitric Acid
16550

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Nitric Acid
Catalog Numbers:
, S71972, S71972MF, S75623-2, S75623-3, S76523, A198C-212, A198C4X-212, A200-212, A200-500, A200-612GAL, A200C-212, A200C4X-212, A200C4X2001, A200C4X2122, A200C4X212L, A200J500, A200S-212, A200S-500, A200S4X-212, A200S4X212L, A200SI-212, A467-1, A467-2, A467-250, A467-500, A483-212, A509-212, A509-500, A509SK-212, S719721, S719721MF, S71972SC
Synonyms:
Azotic Acid; Engravers Nitrate; Hydrogen Nitrate.
Company Identification: Fisher Scientific
1 Reagent Lane
Fairlawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
7697-37-2	Nitric acid	69-71	231-714-2
7732-18-5	Water	29-31	231-791-2

Hazard Symbols: O C
Risk Phrases: 35 8

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: clear to yellow liquid.
Danger! Strong oxidizer. Contact with other material may cause a fire. Corrosive. Causes eye and skin burns. Causes digestive and respiratory tract burns. Check internal container upon receipt. Bottles should be vented periodically to relieve pressure.
Target Organs: Eyes, skin, mucous membranes.

Potential Health Effects
Eye:
Causes severe eye burns. May cause irreversible eye injury. May cause chemical conjunctivitis and corneal damage.
Skin:
Causes skin burns. May cause deep, penetrating ulcers of the skin. May cause skin rash (in milder cases), and cold and clammy skin with cyanosis or pale color.
Ingestion:
May cause severe and permanent damage to the digestive tract. Causes gastrointestinal tract burns. May cause perforation of the digestive tract. May cause systemic effects.
Inhalation:
Effects may be delayed. Causes chemical burns to the respiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis and pulmonary edema. Aspiration may lead to pulmonary edema. May cause systemic effects. May cause acute pulmonary edema, asphyxia, chemical pneumonitis, and upper airway obstruction caused by edema.
Chronic:
Repeated inhalation may cause chronic bronchitis. Repeated exposure may cause erosion of teeth. Effects may be delayed.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
Get medical aid immediately. Do NOT allow victim to rub or keep eyes closed. Extensive irrigation with water is required (at least 30 minutes).
Skin:
Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Destroy contaminated shoes.
Ingestion:
Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.
Inhalation:
Get medical aid immediately. Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Do NOT use mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration

using oxygen and a suitable mechanical device such as a bag and a mask.
Notes to Physician:
Treat symptomatically and supportively.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Strong oxidizer. Contact with combustible materials may cause a fire. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Substance is noncombustible. Use water with caution and in flooding amounts.
Extinguishing Media:
Substance is noncombustible; use agent most appropriate to extinguish surrounding fire. Contact professional fire-fighters immediately.
Autoignition Temperature:Not available.
Flash Point: Not available.
Explosion Limits, lower:Not available.
Explosion Limits, upper:Not available.
NFPA Rating: (estimated) Health: 4; Flammability: 0; Instability: 0; Specia

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:
Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Neutralize spill with sodium bicarbonate. Provide ventilation. A vapor suppressing foam may be used to reduce vapors.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:
Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use only in a well-ventilated area. Do not breathe dust, vapor, mist, or gas. Keep container tightly closed. Avoid contact with clothing and other combustible materials. Do not get on skin or in eyes. Avoid ingestion and inhalation. Discard contaminated shoes.
Storage:
Keep away from heat, sparks, and flame. Do not store near combustible materials. Keep container closed when not in use. Store in a cool, dry, well-ventilated area away from incompatible substances. Bottles should be vented periodically in order to overcome pressure buildup.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Nitric acid	2 ppm; 4 ppm STEL	2 ppm TWA; 5 mg/m3 TWA 25 ppm IDLH	2 ppm TWA; 5 mg/m3 TWA
Water	none listed	none listed	none listed

OSHA Vacated PELs:
Nitric acid:
2 ppm TWA; 5 mg/m3 TWA
Water:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin:
Wear appropriate gloves to prevent skin exposure.
Clothing:
Wear a chemical apron. Wear appropriate clothing to prevent skin exposure.

Respirators:
Wear a NIOSH/MSHA or European Standard EN 149 approved full-facepiece airline respirator in the positive pressure mode with emergency escape provisions.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Liquid
Color:	clear to yellow
Odor:	strong odor - acrid odor
pH:	1.0
Vapor Pressure:	6.8 mm Hg
Vapor Density:	Not available.
Evaporation Rate:	Not available.
Viscosity:	Not available.
Boiling Point:	186.8 deg F
Freezing/Melting Point:	-43.6 deg F
Decomposition Temperature:	Not available.
Solubility in water:	Soluble in water.
Specific Gravity/Density:	1.50
Molecular Formula:	HNO3
Molecular Weight:	63.0119

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable. Decomposes when in contact with air, light, or organic matter.
Conditions to Avoid:
High temperatures, incompatible materials, ignition sources, moisture, combustible materials, reducing agents.
Incompatibilities with Other Materials:
Reducing agents, combustible materials, strong bases, alcohols, aldehydes, cyanides, metals, Incompatible with many substances..
Hazardous Decomposition Products:
Nitrogen oxides.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 7697-37-2: QU5775000 QU5900000
CAS# 7732-18-5: ZC0110000
LD50/LC50:
CAS# 7697-37-2: Inhalation, rat: LC50 = 260 mg/m3/30M; Inhalation, rat: LC50 = 130 mg/m3/4H; Inhalation, rat: LC50 = 67 ppm(NO2)/4H.
CAS# 7732-18-5: Oral, rat: LD50 = >90 mL/kg.
Carcinogenicity:
Nitric acid -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Water -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
No information found.
Teratogenicity:
No information found.
Reproductive Effects:
No information found.
Neurotoxicity:
No information found.
Mutagenicity:
No information found.
Other Studies:
See actual entry in RTECS for complete information.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Other
No information available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste.
US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
Shipping Name: NITRIC ACID
Hazard Class: 8
UN Number: UN2031
Packing Group: II

Canadian TDG
Shipping Name: NITRIC ACID
Hazard Class: 8(9.2)
UN Number: UN2031

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL
TSCA
CAS# 7697-37-2 is listed on the TSCA inventory.
CAS# 7732-18-5 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
CERCLA Hazardous Substances and corresponding RQs
CAS# 7697-37-2: 1000 lb final RQ; 454 kg final RQ
SARA Section 302 Extremely Hazardous Substances
CAS# 7697-37-2: 1,000 lb TPQ
SARA Codes
CAS # 7697-37-2: acute, chronic, flammable.
Section 313
This material contains Nitric acid (CAS# 7697-37-2, 69 71%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 372.
Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
CAS# 7697-37-2 is listed as a Hazardous Substance under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
Nitric acid can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.
Water is not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level:
None of the chemicals in this product are listed.
European/International Regulations
European Labeling in Accordance with EC Directives
Hazard Symbols: O C
Risk Phrases:
R 35 Causes severe burns.
R 8 Contact with combustible material may cause fire.
Safety Phrases:
S23B Do not breathe fumes.
S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 36 Wear suitable protective clothing.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
WGK (Water Danger/Protection)
CAS# 7697-37-2: 1
CAS# 7732-18-5: No information available.
United Kingdom Occupational Exposure Limits
CAS# 7697-37-2: OES-United Kingdom, TWA 2 ppm TWA; 5.2 mg/m3 TWA
CAS# 7697-37-2: OES-United Kingdom, STEL 4 ppm STEL; 10 mg/m3 STEL
CAS# 7697-37-2: OES-United Kingdom, STEL 4 ppm STEL; 10 mg/m3 STEL

United Kingdom Maximum Exposure Limits

Canada
CAS# 7697-37-2 is listed on Canada's DSL List.
CAS# 7732-18-5 is listed on Canada's DSL List.
This product has a WHMIS classification of C, D1A, E.
CAS# 7697-37-2 is listed on Canada's Ingredient Disclosure List.
CAS# 7732-18-5 is not listed on Canada's Ingredient Disclosure List.
Exposure Limits
CAS# 7697-37-2: OEL-ARAB Republic of Egypt:TWA 2 ppm (5 mg/m3)
OEL-AUSTRALIA:TWA 2 ppm (5 mg/m3);STEL 4 ppm (10 mg/m3)
OEL-BELGIUM:TWA 2 ppm (5.2 mg/m3);STEL 4 ppm (10 mg/m3)
OEL-CZECHOSLOVAKIA:TWA 2.5 mg/m3;STEL 5 mg/m3
OEL-DENMARK:TWA 2 ppm (5 mg/m3)
OEL-FINLAND:TWA 2 ppm (5 mg/m3);STEL 5 ppm (13 mg/m3);Skin
OEL-FRANCE:TWA 2 ppm (5 mg/m3);STEL 4 ppm (10 mg/m3)
OEL-GERMANY:TWA 10 ppm (25 mg/m3)

OEL-HUNGARY:STEL 5 mg/m3
OEL-JAPAN:TWA 2 ppm (5.2 mg/m3)
OEL-THE PHILIPPINES:TWA 2 ppm (5 mg/m3)
OEL-POLAND:TWA 10 mg/m3
OEL-RUSSIA:TWA 2 ppm;STEL 2 mg/m3;Skin
OEL-SWEDEN:TWA 2 ppm (5 mg/m3);STEL 5 ppm (13 mg/m3)
OEL-SWITZERLAND:TWA 2 ppm (5 mg/m3);STEL 4 ppm (1 mg/m3)
OEL-THAILAND:TWA 2 ppm (5 mg/m3)
OEL-TURKEY:TWA 2 ppm (5 mg/m3)
OEL-UNITED KINGDOM:TWA 2 ppm (5 mg/m3);STEL 4 ppm (10 mg/m3)
OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV
OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 9/30/1998 Revision #10 Date: 4/01/2003

MATERIAL SAFETY DATA SHEET: CRYSTAL SIMPLE GREEN®

I. PRODUCT & COMPANY INFORMATION

PRODUCT NAME: **CRYSTAL SIMPLE GREEN®**
OTHER NAMES: **CRYSTAL SIMPLE GREEN® - SPECIALIZED CLEANER / DEGREASER**
SIMPLE GREEN SAFETY TOWELS (fluid only)

COMPANY NAME: **SUNSHINE MAKERS, INC.**
15922 Pacific Coast Highway
Huntington Harbour, CA 92649 USA
Telephone: 800-228-0709 • 562-795-6000
Fax: 562-592-3034
Website: www.simplegreen.com

Version No. 4006
Issue Date: January 2002

For 24-hour emergency, call Chem-Tel, Inc.: 800-255-3924

USE OF PRODUCT: A specialized cleaner and degreaser for use in the industrial and institutional workplace..

II. INGREDIENT INFORMATION

The only ingredient of Crystal Simple Green® with established exposure limits is undiluted 2-butoxyethanol (<6%) (Butyl Cellosolve; CAS No. 111-76-2): the OSHA PEL and ACGIH TLV is 25 ppm (skin). Note, however, that Butyl Cellosolve is only one of the raw material ingredients that undergo processing and dilution during the manufacture of Crystal Simple Green®. Upon completion of the manufacturing process, Crystal Simple Green® does not possess the occupational health risks associated with exposure to undiluted Butyl Cellosolve. Verification of this is contained in the independent test results detailed under "Toxicological Information" on Page 3 of this MSDS.

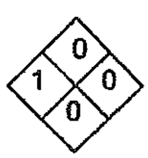
The Butyl Cellosolve in Crystal Simple Green® is part of a chemical category (glycol ethers) regulated by the Emergency Planning and Community Right-to-Know Act (SARA, Title III, section 313); therefore, a reporting requirement exists. Based upon chemical analysis, Crystal Simple Green® contains no known EPA priority pollutants, heavy metals, or chemicals listed under RCRA, CERCLA, or CWA. Analysis by TCLP (Toxicity Characteristic Leaching Procedure) according to RCRA revealed no toxic organic or inorganic constituents.

All components of Crystal Simple Green® are listed on the TSCA Chemical Substance Inventory.

III. HAZARDS IDENTIFICATION

UN Number: Not required
Dangerous Goods Class: Nonhazardous

Hazard Rating (NFPA/HMIS)
Health = 1* Reactivity = 0
Fire = 0 Special = 0



Rating Scale
0 = minimal 1 = slight
2 = moderate 3 = serious
4 = severe

*Mild eye irritant, non-mutagenic and non-carcinogenic. **None of the ingredients in Crystal Simple Green® are regulated or listed as potential cancer agents by Federal OSHA, NTP, or IARC.**

IV. FIRST AID MEASURES

SYMPTOMS OF OVEREXPOSURE AND FIRST AID TREATMENT

Eye contact: Reddening may develop. Immediately rinse the eye with large quantities of cool water; continue 10-15 minutes or until the material has been removed; be sure to remove contact lenses, if present, and to lift upper and lower lids during rinsing. Get medical attention if irritation persists.

Skin contact: Minimal effects, if any; rinse skin with water, rinse shoes and launder clothing before reuse. Reversible reddening may occur in some dermal-sensitive users; thoroughly rinse area and get medical attention if reaction persists.

Swallowing: Essentially non-toxic. Give several glasses of water to dilute; do not induce vomiting. If stomach upset occurs, consult physician.

Inhalation: Non-toxic. Exposures to concentrate-mist may cause mild irritation of nasal passages or throat; remove to fresh air. Get medical attention if irritation persists.

V. FIRE FIGHTING MEASURES

Crystal Simple Green® is stable, not flammable, and will not burn.

Flash Point/Auto-Ignition:	Not flammable.
Flammability Limits:	Not flammable.
Extinguishing Media:	Not flammable/nonexplosive. No special procedures required.
Special Fire Fighting Procedures:	None required.

VI. ACCIDENTAL RELEASE MEASURES

Recover usable material by convenient method; residual may be removed by wipe or wet mop. If necessary, unrecoverable material may be washed to drain with large quantities of water.

VII. HANDLING, STORAGE & TRANSPORT INFORMATION

No special precautions are required. **This product is non-hazardous for storage and transport according to the U.S. Department of Transportation Regulations.** Crystal Simple Green® requires no special labeling or placarding to meet U.S. Department of Transportation requirements.

UN Number:	Not required
Dangerous Goods Class:	Nonhazardous

VIII. EXPOSURE CONTROLS

Exposure Limits: The Crystal Simple Green® formulation presents no health hazards to the user when used according to label directions for its intended purposes. Mild skin and eye irritation is possible (please see Eye contact and Skin contact in Section IV.).

Ventilation: No special ventilation is required during use. Large-scale uses indoors should provide an increased rate of air exchange.

Human Health Effects or Risks from Exposure: Adverse effects on human health are not expected from Crystal Simple Green®, based upon twenty years of use of Simple Green without reported adverse health incidence in diverse population groups, including extensive use by inmates of U.S. Federal prisons in cleaning operations.

Crystal Simple Green® is a mild eye irritant; mucous membranes may become irritated by concentrate-mist.

Crystal Simple Green® is not likely to irritate the skin in the majority of users. Repeated daily application to the skin without rinsing, or continuous contact of Crystal Simple Green® on the skin may lead to temporary, but reversible, irritation.

Medical Conditions Aggravated by Exposure: No aggravation of existing medical conditions is expected; dermal-sensitive users may react to dermal contact by Crystal Simple Green®.

IX. PERSONAL PROTECTION

Precautionary Measures: No special requirements under normal use conditions.
Eye Protection: Caution, including reasonable eye protection, should always be used to avoid eye contact where splashing may occur.
Skin Protection: No special precautions required; rinse completely from skin after contact.
Respiratory Protection: No special precautions required except during large-scale spray applications where spray mist levels are high.
Work and Hygienic Practices: Wash or rinse hands before touching eyes or contact lenses. Follow standard hygienic practices for handling cleaning agents.

X. PHYSICAL AND CHEMICAL PROPERTIES

Appearance/odor::	Clear liquid	Vapor Pressure:	18 mm Hg @ 20 °C; 23.5 mm Hg @ 26 °C
Specific Gravity:	1.020	Vapor Density:	1.3 (air = 1)
pH of concentrate:	9.35	Density:	8.5 lbs./gallon
Evaporation:	>1 (butyl acetate = 1)		
Boiling Point:	100.6 °C (212 °F)		
Freezing Point:	-9 °C (16 °F) If product freezes, it will reconstitute without loss of efficacy when brought back to room temperature and agitated.		

VOC Composite Partial Pressure: 0 mm Hg @ 20 °C
Volatile Organic Compounds (VOCs): 0 g/L per ASTM Method D-2369. Per California AQMD's VOC test method, product must be diluted at least 2 parts of water to 1 part Crystal Simple Green® in order to meet SCAQMD Rule 1171 & Rule 1122 and BAAQMD Regulation 8-16 VOC requirements for solvent cleaning operations.
Water Solubility: Completely soluble in water.
Detection: Crystal Simple Green® has a characteristic odor that is not indicative of any hazardous situation.

XI. STABILITY AND REACTIVITY INFORMATION

Nonreactive. Crystal Simple Green® is stable, even under fire conditions, and will not react with water or oxidizers. Hazardous polymerization will not occur.

XII. TOXICOLOGICAL INFORMATION

The information and conclusions cited in this section are based on data and testing of Simple Green®. The data are directly applicable to Crystal Simple Green® because, except for the fragrance and dyes which have been removed, it contains the same ingredients as Simple Green®.

Nonhuman Toxicity
Acute Mortality Studies:
Oral LD_{50} (rat): >5.0 g/kg body weight // Dermal LD_{50} (rabbit): >2.0 g/kg body weight
Dermal Irritation: Only mild, but reversible, irritation was found in a standard 72-hr test on rabbits. A value of 0.2 (non-irritating) was found on a scale of 8.

Eye Irritation: With or without rinsing with water, the irritation scores in rabbits at 24 hours did not exceed 15 (mild irritant)
on a scale of 110.

Subchronic dermal effects: No adverse effects, except reversible dermal irritation, were found in rabbits exposed to Simple Green® (up to 2.0 g/kg/day for 13 weeks) applied to the skin of 25 males and 25 females. Only female body weight gain was affected. Detailed microscopic examination of all major tissues showed no adverse changes.

Fertility Assessment by Continuous Breeding: The Simple Green® formulation had no adverse effect on fertility and reproduction in CD-1 mice with continuous administration for 18 weeks, and had no adverse effect on the reproductive performance of their offspring.

XIII. BIODEGRADABILITY AND ENVIRONMENTAL TOXICITY INFORMATION

Biodegradability:
Like Simple Green®, Crystal Simple Green® is readily decomposed by naturally occurring microorganisms. The biological oxygen demand (BOD), as a percentage of the chemical oxygen demand (COD), after 4, 7, and 11 days was 56%, 60%, and 70%, respectively. Per OECD Closed Bottle Test, Crystal Simple Green® meets OECD and EPA recommendations for ready biodegradability.

In a standard biodegradation test with soils from three different countries, Butyl Cellosolve reached 50% degradation in 6 to 23 days, depending upon soil type, and exceeded the rate of degradation for glucose, which was used as a control for comparison.

Environmental Toxicity Information:
Crystal Simple Green® is considered practically non-toxic per EPA's aquatic toxicity scale.

XIV. DISPOSAL CONSIDERATIONS

Crystal Simple Green® is fully water soluble and biodegradable and will not harm sewage-treatment microorganisms if disposal by sewer or drain is necessary. Dispose of in accordance with all applicable local, state, and federal laws.

XV. OTHER INFORMATION

Containers:	Crystal Simple Green® residues can be completely removed by rinsing with water; the container may be recycled or applied to other uses.
Contact Point:	Sunshine Makers, Inc., Research and Development Division: 562-795-6000.

***** NOTICE *****

All information appearing herein is based upon data obtained by the manufacturer and recognized technical sources. Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of this information, Sunshine Makers, Inc. or its distributors extends no warranties, makes no representations and assumes no responsibility as to the suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Appendix D

Forms

GEI Consultants

[redacted]

Accident/Incident Report Form

SECTION A — ACCIDENT/INCIDENT DETAILS

EMPLOYEE INFORMATION:	OTHER INJURED (IF APPLICABLE):
Name: ____________	**Name:** ____________
Home Address: ____________ Street Address / City / State / Zip Code	**Home Address:** ____________ Street Address / City / State / Zip Code
Contact Information: ( ) ______ Primary ( ) ______ Secondary	**Contact Information:** ( ) ______ Primary ( ) ______ Secondary
Date of Birth: ____________	**Date of Birth:** ____________
Date of Hire: ____________	**Date of Hire:** ____________
Branch: ____________	**Branch:** ____________
Supervisor: ____________	**Supervisor:** ____________

Date and Time Accident/Incident	Date and Time Reported	LOCATION OF INCIDENT/ACCIDENT
______ /______ /______ Month Day Year ______ A.M. ______ P.M.	______ /______ /______ Month Day Year ______ A.M. ______ P.M.	**Project Name:** ____________ **Client and Location:** ____________ **or** ____________ **Office Location:** ____________

INCIDENT TYPE: (Check All That Applies)	WITNESS INFORMATION
□ **Personal Injury/Illness** □ **Vehicle Accident** □ **Property Damage** □ **Environmental Spill** □ **Other**	**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)**

[redacted]

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**

GEI Consultants

Daily Safety Briefing Log and Site Visitor Sign-In

Project Number:	**Project Name:**
[1]**Date:**	**Time:**
Briefing Conducted by:	**Signature:**

This sign-in log documents the tailgate briefing conducted in accordance with the site specific HASP. Personnel who perform work operations on site are required to attend each briefing and to acknowledge receipt of each briefing, daily.

TOPICS COVERED (check all those covered):

- ☐ General PPE Usage
- ☐ Hearing Conservation
- ☐ Respiratory Protection
- ☐ Personal Hygiene
- ☐ Exposure Guidelines
- ☐ Decon Procedures
- ☐ Confined Space
- ☐ Slips, Trips, Falls
- ☐ Heat Stress
- ☐ Cold Stresses
- ☐ Site Control
- ☐ Work Zones
- ☐ Lockout/Tagout
- ☐ Excavation Safety
- ☐ Confined Space
- ☐ Traffic Safety
- ☐ Changes to the HASP
- ☐ Initial Review of Hazard Evaluation
- ☐ Emergency Procedures (include route to hospital)
- ☐ Other (Specify):
- ☐ Other (Specify):

Daily Safety Topic Description:

Personnel Sign-in List

Printed Name	Signature	Company Name	Time-In	Time-Out

[1] This form is applicable for *only* 1 day of site activity.

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 INVESTIGATION

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:______

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

Appendix E

GEI's Health and Safety SOPs and Programs

Applicable GEI H&S SOPs *(check all that apply)*		
☒ Biological Hazards – 001	☒ Inclement Weather – 010	☐ Aerial Lift – 020
✔ Bloodborne Pathogens – 002	☐ Ladders 011	☐ Mobile Equipment – 021
☒ Container Management – 003	☒ Noise Exposure 012	☐ Aquatic Ecological Survey & Electrofishing 022
☒ Driver Safety 004	☐ Nuclear Density Gauge Operation 013	☐ Scaffolding 023
☐ Electrical Safety 005a	☒ Utility Markout 014	☐ Wilderness Safety 024
☐ Lockout Tagout 005b	☐ Respirator Fit Test Procedure 015	☒ Manual Lifting – 025
☒ Excavation Trenching 006	☒ Traffic Hazards 016	✔ Hazard Identification 026
☒ Non Powered Hand Tools 008a	☐ Water Safety – 017	☐ Confined Space Entry for Sanitary Sewers – 027
☐ Powered Hand Tools – 008b	☒ Working Around Heavy Equipment – 018	☐ Safe Trailer Use – 028
☒ Hazardous Substances Management 009	☐ Rail Safety 019	

Scan this QR code with your smartphone to access all GEI H&S SOPs

Applicable GEI H&S Programs *(check all that apply)*		
☐ Asbestos Program	☒ DOT Driver Safety	☐ Hydrogen Sulfide
☐ Arsenic Safety	✔ Ergonomic	☐ Injury and Illness Prevention (California Only)
☒ Benzene Awareness	☐ Fall Protection	☐ Respiratory Protection Program
☐ Cadmium Awareness	✔ Hazard Communication	☐ Hydrogen Sulfide
☒ Cold Stress	☒ Hearing Conservation	✔ Fire Prevention
☐ Confined Space Entry	☒ Heat Illness Prevention	☐ Lead Compliance
☒ Crystalline Silica	☐ Hexavalent Chromium	

Scan this QR code with your smartphone to access all GEI Programs

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.

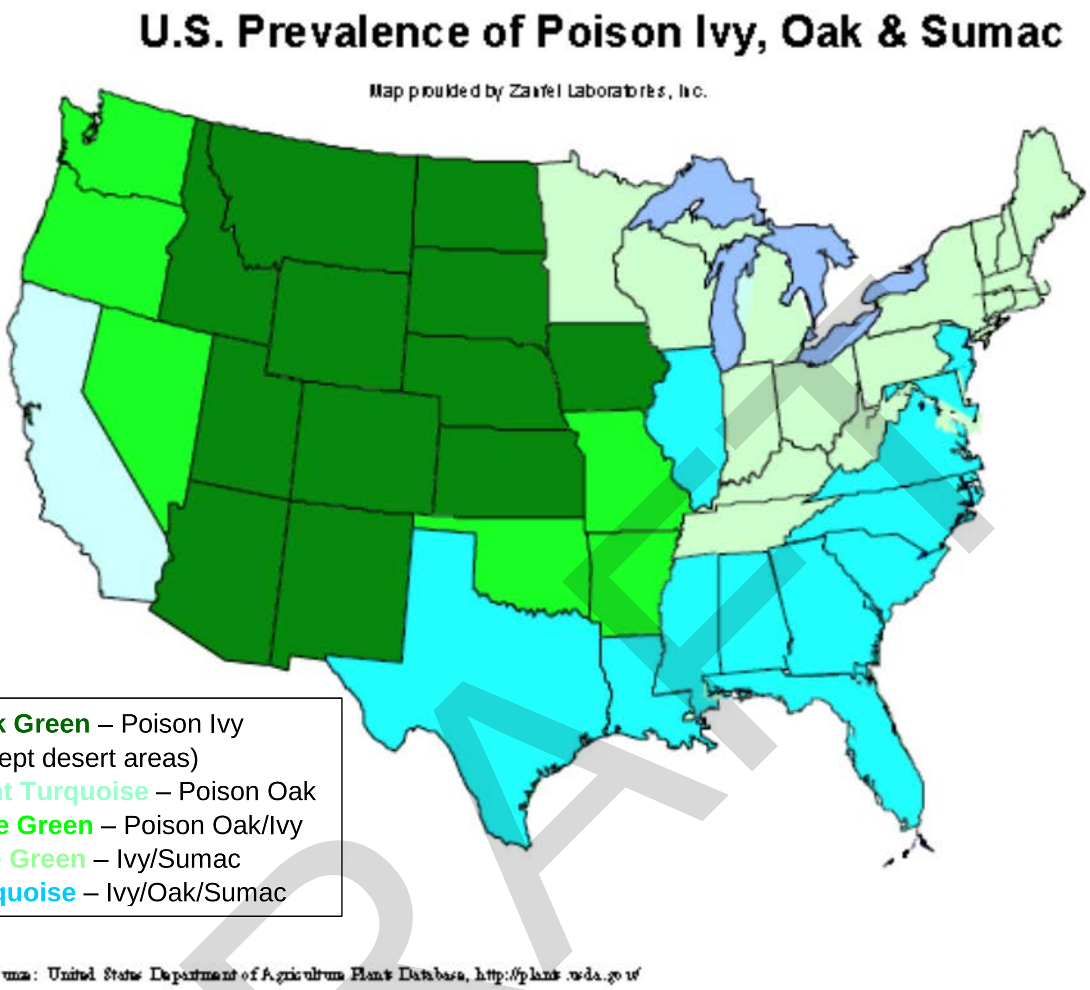
Poison oak can be present as a sparingly branched shrub. Poison oak can grow anywhere in the United States with the exception of Hawaii, Alaska, and some southwest areas that have desert climates. Poison oak is similar to poison ivy in that it has the same leaflet configuration; however, the leaves have slightly deeper notches.

Keep in mind that for each of these plants,

Poison Oak

Poison Ivy

Poison Sumac



Dark Green – Poison Ivy (except desert areas)
Light Turquoise – Poison Oak
Lime Green – Poison Oak/Ivy
Pale Green – Ivy/Sumac
Turquoise – Ivy/Oak/Sumac

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

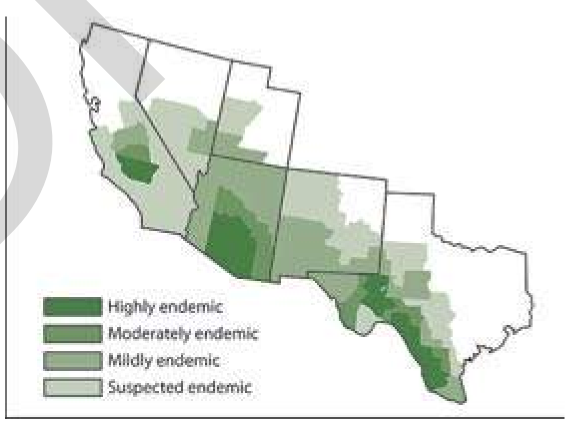
Some project work may be conducted at sites that serve or have served as a combined sewer overflow (CSO) and consequently may have received untreated sanitary sewage from numerous sources. Decomposed sewage can potentially be encountered within sites and their sediments. Sediments could contain soil 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
Merced
Madera
Fresno
Tulare
Kings
San Luis Obispo
Kern
Cases per 100,000 population
0.0
20.0—74.9
Potentially unreliable rate: relative standard error 23 percent or more
0.1—19.9
75.0—304.0
Center for Infectious Diseases - Division of Communicable Disease Control
Infectious Diseases Branch - Surveillance and Statistics Section


Highly endemic
Moderately endemic
Mildly endemic
Suspected endemic

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 PROCEDURES

SOP No. HS-002 Infectious Materials and Bloodborne Pathogens Exposure Control Plan

1.1 Objective

GEI personnel may come in contact with potentially infectious agents when performing first aid or cardiopulmonary resuscitation (CPR). Employees may also come into contact with these materials when working at certain contaminated sites (i.e., urban sites, discarded contaminated needles or sewer outfall exposures). This standard operating procedure (SOP) has been developed to minimize the potential for exposure to employees who may contact, directly or indirectly, infectious agents.

1.2 General

This SOP is intended for use by employees engaged in work with the potential for contact with infection materials and bloodborne pathogens. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the potential for encounters with infectious materials or bloodborne pathogens 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.

- Universal Precautions (i.e., treat all potentially infectious materials as if it were infected) will be used by GEI employees.

1.3 Exposure Control Plan

1.3.1 Standard Procedures

Sampling of potentially infectious materials will be performed in a manner that minimizes the potential for creating splashes, droplets, or aerosols. Mechanical pipetting devices will be used for manipulating sanitary sewer effluent. Mouth pipetting is prohibited.

The use of glassware or equipment with sharp or pointed edges will be kept at a minimum to reduce the potential of injury that would create a direct route of entry into the body for infectious materials.

Minor cuts, scratches, or other breaks in the skin barrier will be covered prior to the handling of infectious materials. Employees experiencing exudative lesions or weeping dermatitis will refrain from direct contact with infectious materials.

Eating, drinking, smoking, or application of cosmetics is not permitted in areas where potentially infectious materials are handled or sampled.

Employees will wash and disinfect their hands, face, or other potentially contaminated skin surfaces upon completing the handling of infectious or potentially infectious agents or after rendering first aid.

1.3.2 Personal Protective Equipment

Personal Protective Equipment (PPE) will be worn to reduce the potential of exposures to splashes or aerosols. At a minimum, this equipment will include safety glasses and appropriate gloves, but may also require the use of face, respiratory, foot, and full-body protection. Refer to the site-specific Health and Safety Plan for specific PPE requirements.

Gloves used in the handling or sampling of infectious materials will be appropriately disposed of and not reused.

1.3.3 Medical Monitoring

Medical monitoring is required for an employee when a potential workplace exposure has occurred. The employee must notify the Corporate Health and Safety Officer (CHSO) and Human Resources regarding the potential exposure as soon as possible. For infectious agents in which a medically accepted vaccination has been developed (e.g., hepatitis B virus [HBV]) potentially exposed employees will be given the option to receive an inoculation at no cost. Employees who have been exposed will be given the option to receive a confidential medical evaluation at no cost. Required records for exposed employees will be kept confidential.

1.3.4 Training

Employees with a reasonable risk for exposure must attend Bloodborne Pathogen training covering the following topics:

- An explanation of the Occupational Health and Safety Administration (OSHA) bloodborne pathogen standard.
- A general explanation of bloodborne diseases.
- An explanation of the modes of transmission of bloodborne diseases.
- An explanation of the GEI's Bloodborne Pathogen SOP and exposure control plan.
- Appropriate methods for recognizing tasks that involve potential exposure.
- An explanation of the use and limitations of methods to prevent exposure.
- Proper types, use, handling, decontamination, and disposal of PPE.
- The availability of HBV vaccines and the procedures for obtaining a vaccination.
- Appropriate actions to take during an emergency involving bloodborne pathogens.

- Post-exposure procedures.
- An explanation of required signs and labels.

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 Reference

OSHA 29 CFR 1910.1030 - Bloodborne Pathogens.

1.6 Attachments

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-003 Container Management

1.1 Objective

This standard operating procedure (SOP) has been developed to minimize the potential for injuries to GEI employees performing container and drum handling and sampling, through proper use of engineering and administrative controls, personal protective equipment (PPE), and education.

1.2 General

This SOP is intended for use by employees engaged in work with the management of containers that may contain hazardous substances or contaminated media. The site-specific health and safety plan (HASP) should include a hazard assessment and 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.

Hazardous substances and contaminated media will be handled, transported, labeled, and disposed of in accordance with this paragraph. Drums and containers will meet the appropriate United States Department of Transportation (DOT), Occupational Safety and Health Administration (OSHA), and Environmental Protection Agency (EPA) regulations for the wastes that they contain.

Site operations will be organized to minimize the amount of drum or container movement. Prior to movement of drums or containers, employees exposed to the transfer operation will be notified of the potential hazards associated with the contents of the drums or containers. Unlabeled drums and containers will be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled.

DOT specified salvage drums or containers and suitable quantities of proper absorbent will be kept available and used in areas where spills, leaks, or ruptures may occur. Where spills may occur, a spill containment program, which may be part of the HASP, will be implemented to contain and isolate the entire volume of the hazardous substance being transferred.

1.3 Opening Drums and Containers

The following procedures will be followed in areas where drums or containers are being opened:

- Employees not actually involved in opening drums or containers will be kept a safe distance from the drums or containers being opened.

- If employees must work near or adjacent to drums or containers being opened, a suitable shield that does not interfere with the work operation will be placed between the employee and the drums or containers being opened to protect the employee in case of accidental release.

- GEI employees will not handle or attempt to open bulging containers. Employees will not stand upon or work from drums or containers. GEI will contract with a hazardous waste company to handle, manage, and dispose of a bulging drum.

1.4 Material Handling Equipment

Material handling equipment, such as drum dollies, used to transfer drums and containers will be selected, positioned, and operated to minimize sources of ignition.

1.5 Radioactive Wastes

GEI does not routinely handle or manage radioactive waste. If required to do so for a project, procedures will be approved by the Corporate Health and Safety Officer (CHSO) and Regional Health and Safety Officer (RHSO).

1.6 Shock-Sensitive Wastes

GEI employees will not handle shock-sensitive waste. Shock-sensitive waste or chemicals may explode with friction, movement or heat. Some chemicals are shock-sensitive by nature-, others become shock-sensitive through drying, decomposition, or slow reactions with oxygen, nitrogen, or the container. Some chemicals that are, or can, become shock-sensitive will have that hazard noted in the safety data sheet (SDS).

- Drums and containers containing packaged laboratory wastes will be considered to contain shock-sensitive or explosive materials until they have been characterized. *Caution: Shipping of shock-sensitive wastes may be prohibited under U.S. Department of Transportation regulations. Shippers will refer to 49 CFR 173.21 and 173.50*.

1.7 Laboratory Waste Packs

GEI employees will not handle or open laboratory waste packs.

1.8 Sampling of Drum and Container Contents

Sampling of containers and drums will be done in accordance with a site-specific sampling plan that will be developed in conjunction with a site-specific HASP.

1.9 Staging Areas

Drums and containers will be identified and classified prior to packaging for shipment. Drum or container staging areas will be kept to a minimum number as approved by the client to safely identify and classify materials and prepare them for transport. Staging areas will be provided with adequate access and egress routes. Bulking of hazardous wastes will be permitted only after a thorough characterization of the materials has been completed and approved by the Client. GEI employees will not sign manifests unless a written authorization agreement is in place with the Client.

1.10 Tank and Vault Procedures

GEI employees do not routinely sample vaults and tanks. Entry procedures will be coordinated and approved by the CHSO and RHSO.

1.11 Limitations

Follow safety procedures as defined in the site-specific HASP. Appropriate PPE must be worn correctly to provide the intended level of protection.

1.12 References

OSHA 1910.120 Hazardous Waste Operations and Emergency Response (j) Handling of Drums and Containers.

1.13 Attachments

None

1.14 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

SOP No. HS-006 Excavations and Trenches

1.1 Objective

GEI employees may be involved with projects that include some type of excavation and trenching as part of the work activities. The following guidelines will be followed when excavations or trenches are present on GEI projects.

1.2 General

This standard operating procedure (SOP) is intended for use by employees engaged in work on project sites that include trenching and/or excavation operations. The site-specific health and safety plan (HASP) should include a hazard assessment for the project that identifies the potential for trenching and excavation 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.

Hazards associated with excavations and trenches can include collapse, falls, falling objects, hazardous atmospheres, and incidents involving mobile equipment.

GEI employees will not enter trenches or excavations that do not comply with OSHA 29 CFR 1926.650. If a project requires GEI employees to enter a trench or excavation, the trench or excavation should meet the following requirements:

- The excavation must be inspected daily by a competent person to identify potential hazards associated with the excavation. GEI generally does not act as the competent person.
- A protective system should be in place for trenches or excavations greater than 5- feet in depth.
- Employees will be protected from vehicular traffic by the use of barricades, cones and tape or other physical barriers.
- The protective system should be designed based on soil type, depth of excavation, water level, loads adjacent to the excavation, changes in weather conditions, or other operations in the area. Protective systems can include sloping or benching of the sidewalls, shoring the sidewalls using an approved support system, or shielding workers with a trench box or other similar type of support.
- If the excavation is greater than 20-feet in depth, the protection system requires a design by a registered professional engineer or based on tabulated data prepared and/or approved by a registered professional engineer.

- Excavations and trenches greater than four feet in depth require a safe access and egress including ladders, steps, or ramps. These points of access and egress are to be no greater than 25 feet of lateral travel in any direction.

- Where oxygen deficiency (atmospheres containing less than 20.7 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than four feet in depth.

When GEI is subcontracting the excavation activities:

- Care should be taken not to create new hazards like narrow walkways along edges of an excavation.
- Heavy equipment should not be parked or working at the edge of the excavation.
- Spoils should not be stockpiled within 2 feet of the trench edges.
- Confirm with subcontractor that underground utilities have been located before any excavation or trenching activities begin (refer to SOP HS-014 Utility Mark-out).
- When required guardrails will be installed for crossings and walkways to provide fall protection.
- Confirm with the subcontractor that the excavation or trench has been tested for hazardous atmospheres before entering.
- Confirm with the subcontractor that the excavation or trench has been inspected by a competent person before each work shift and after any type of precipitation. Water should be directed away from the excavation or trench whenever possible. If hazards are identified during this inspection, verify that the hazards are controlled prior to entering the trench or excavation.
- GEI employees will not work under raised or suspended loads.

In circumstances where GEI employees are working on sites where a contractual agreement with the excavation contractor does not exist and we cannot confirm the above stated conditions, entry into trenches or excavations should not be conducted.

1.3 Soil Classifications

The soil classification system means a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability.

1) Stable rock means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

2. Type A means cohesive soils with an unconfined, compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

a) The soil is fissured; or
b) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or
c) The soil has been previously disturbed; or
d) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or
e) The material is subject to other factors that would require it to be classified as a less stable material.

3) Type B means:

a) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or
b) Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.
c) Previously disturbed soils except those which would otherwise be classed as Type C soil.
d) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
e) Dry rock that is not stable; or
f) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

4) Type C means:

a) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or
b) Granular soils including gravel, sand, and loamy sand; or
c) Submerged soil or soil from which water is freely seeping; or
d) Submerged rock that is not stable, or
e) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

Where soils are configured in layers, i.e., where a layered geologic structure exists, the soil must be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer, i.e., where a Type C soil rests on top of stable rock.

1.4 GEI Requirements for the Excavation/Trenches Competent Person

Although GEI does not normally act as the competent person for excavations and trenches this person should have and be able to demonstrate the following:

- Training, experience, and knowledge of:
  - soil analysis;
  - use of protective systems; and
  - requirements of 29 CFR Part 1926 Subpart P.
- Ability to detect:
  - conditions that could result in cave-ins;
  - failures in protective systems;
  - hazardous atmospheres; and
  - other hazards including those associated with confined spaces.
- Authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.

1.5 Test Equipment And Methods For Evaluating Soil Type

Many kinds of equipment and methods are used to determine the type of soil prevailing in an area, as described below.

A. Pocket Penetrometer. Penetrometers are direct-reading, spring-operated instruments used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading. The instrument is calibrated in either tons per square foot (tsf) or kilograms per square centimeter (kPa). However, Penetrometers have error rates in the range of ± 20-40%.

   1. Shearvane (Torvane). To determine the unconfined compressive strength of the soil with a shearvane, the blades of the vane are pressed into a level section of undisturbed soil, and the torsional knob is slowly turned until soil failure occurs. The direct instrument reading must be multiplied by 2 to provide results in tons per square foot (tsf) or kilograms per square centimeter (kPa).

2. Thumb Penetration Test. The thumb penetration procedure involves an attempt to press the thumb firmly into the soil in question. If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A. If the thumb penetrates no further than the length of the thumb nail, it is probably Type B soil, and if the thumb penetrates the full length of the thumb, it is Type C soil. The thumb test is subjective and is therefore the least accurate of the three methods.
3. Dry Strength Test. Dry soil that crumbles freely or with moderate pressure into individual grains is granular. Dry soil that falls into clumps that subsequently break into smaller clumps (and the smaller clumps can be broken only with difficulty) is probably clay in combination with gravel, sand, or silt. If the soil breaks into clumps that do not break into smaller clumps (and the soil can be broken only with difficulty), the soil is considered unfissured unless there is visual indication of fissuring.

B. Plasticity or Wet Thread Test. This test is conducted by molding a moist sample of the soil into a ball and attempting to roll it into a thin thread approximately 1/8 inch (3 mm) in diameter (thick) by 2 inches (50 mm) in length. The soil sample is held by one end. If the sample does not break or tear, the soil is considered cohesive.

C. Visual Test. A visual test is a qualitative evaluation of conditions around the site. In a visual test, the entire excavation site is observed, including the soil adjacent to the site and the soil being excavated. If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular. The evaluator also checks for any signs of vibration.

During a visual test, the evaluator should check for crack-line openings along the failure zone that would indicate tension cracks, look for existing utilities that indicate that the soil has previously been disturbed, and observe the open side of the excavation for indications of layered geologic structuring.

The evaluator should also look for signs of bulging, boiling, or sluffing, as well as for signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for "quick" conditions. In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone, and the evaluator should check for surcharging and the spoil distance from the edge of the excavation.

1.6 Shoring Types

Shoring is the provision of a support system for trench faces used to prevent movement of soil, underground utilities, roadways, and foundations. Shoring or shielding is used when the location or depth of the cut makes sloping back to the maximum allowable slope impractical. Shoring systems consist of posts, wales, struts, and sheeting. There are two basic types of shoring, timber and aluminum hydraulic.

Hydraulic shoring can be a prefabricated strut and/or wale system manufactured of aluminum or steel. Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install or remove hydraulic shoring. Other advantages of most hydraulic systems are that they:

- Are light enough to be installed by one worker;
- Are gauge-regulated to ensure even distribution of pressure along the trench line;
- Can have their trench faces "preloaded" to use the soil's natural cohesion to prevent movement; and
- Can be adapted easily to various trench depths and widths.

All shoring should be installed from the top down and removed from the bottom up. Hydraulic shoring should be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts.

Pneumatic Shoring works in a manner similar to hydraulic shoring. The primary difference is that pneumatic shoring uses air pressure in place of hydraulic pressure. A disadvantage to the use of pneumatic shoring is that an air compressor must be on site.

- Screw jack systems differ from hydraulic and pneumatic systems in that the struts of a screw jack system must be adjusted manually. This creates a hazard because the worker is required to be in the trench in order to adjust the strut. In addition, uniform "preloading" cannot be achieved with screw jacks, and their weight creates handling difficulties.
- Single-Cylinder Hydraulic Shores. Shores of this type are generally used in a water system, as an assist to timber shoring systems, and in shallow trenches where face stability is required.
- Underpinning. This process involves stabilizing adjacent structures, foundations, and other intrusions that may have an impact on the excavation. As the term indicates, underpinning is a procedure in which the foundation is physically reinforced. Underpinning should be conducted only under the direction and with the approval of a registered professional engineer.

1.7 Shielding Types

Trench Boxes are different from shoring because, instead of shoring up or otherwise supporting the trench face, they are intended primarily to protect workers from cave-ins and similar incidents. The excavated area between the outside of the trench box and the face of the trench should be as small as possible. The space between the trench boxes and the excavation side are backfilled to prevent lateral movement of the box. Shields may not be subjected to loads exceeding those which the system was designed to withstand.

Trench boxes are generally used in open areas, but they also may be used in combination with sloping and benching. The box should extend at least 18 in (0.45 m) above the surrounding area if there is sloping toward excavation. This can be accomplished by providing a benched area adjacent to the box.

Earth excavation to a depth of 2 ft (0.61 m) below the shield is permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench and there are no indications while the trench is open of possible loss of soil from behind or below the bottom of the support system. Conditions of this type require observation on the effects of bulging, heaving, and boiling as well as surcharging, vibration, adjacent structures, etc., on excavating below the bottom of a shield. Careful visual inspection of the conditions mentioned above is the primary and most prudent approach to hazard identification and control.

1.8 Sloping And Benching

Maximum allowable slopes for excavations less than 20 ft (6.09 m) based on soil type and angle to the horizontal are as follows:

Soil type	height / Depth ratio	Slope angle
Stable Rock	Vertical	90°
Type A	¾:1	53°
Type B	1:1	45°
Type C	1½:1	34°
Type A (short-term)	½:1	63°
(For a maximum excavation depth of 12 ft)		

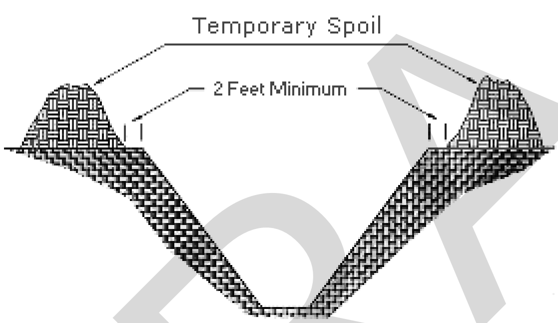
There are two basic types of benching, simple and multiple. The type of soil determines the horizontal to vertical ratio of the benched side.

As a general rule, the bottom vertical height of the trench must not exceed 4 ft (1.2 m) for the first bench. Subsequent benches may be up to a maximum of 5 ft (1.5 m) vertical in Type A soil and 4 ft (1.2 m) in Type B soil to a total trench depth of 20 ft (6.0 m). All subsequent benches must be below the maximum allowable slope for that soil type. For Type B soil the trench excavation is permitted in cohesive soil only.

1.9 Spoil

Temporary spoil must be placed no closer than 2 ft (0.61 m) from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. This distance should not be measured from the crown of the spoil deposit. This distance requirement ensures that loose rock or soil from the temporary spoil will not fall on employees in the trench.

Spoil should be placed so that it channels rainwater and other run-off water away from the excavation. Spoil should be placed so that it cannot accidentally run, slide, or fall back into the excavation.



Permanent spoil should be placed at some distance from the excavation. Permanent spoil is often created where underpasses are built or utilities are buried. The improper placement of permanent spoil, i.e. insufficient distance from the working excavation, can cause an excavation to be out of compliance with the horizontal-to-vertical ratio requirement for a particular excavation. This can usually be determined through visual observation. Permanent spoil can change undisturbed soil to disturbed soil and dramatically alter slope requirements.

1.10 Limitations

Follow safety procedures as defined in the site-specific HASP. Appropriate PPE must be worn correctly to provide the intended level of protection.

Do not enter a trench or excavation without consulting with the project manager, Corporate Health and Safety Officer (CHSO), or Regional Health and Safety Officer (RHSO).

Some states, including Massachusetts, require a trench permit prior to trenching or excavation activities. Verification of local requirements will be evaluated in the planning stage.

1.11 References

OSHA 29 CFR 1926.650 – Subpart P; *Excavations.*
OSHA Construction eTool - http://www.osha.gov/SLTC/etools/construction/index.html
OSHA Technical Manual (OTM), Section V: Chapter 2 - Excavations: Hazard Recognition In Trenching And Shoring

1.12 Attachments

None

1.13 Contact

GEI Corporate Health & Safety Officer
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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

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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 Not 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

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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. <u>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.</u> 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.

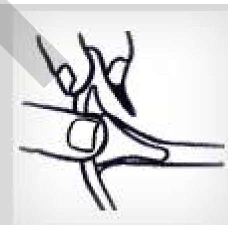
1.3 Proper Use of Hearing Protection

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.

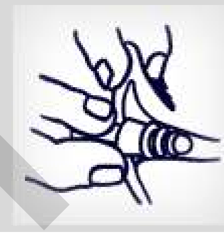
Always remove ear plugs slowly, twisting them to break the seal. If you remove them too quickly, you could damage your ear drum.

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

Appendix F

National Grid, Contractor Safety Requirements

FOREWORD

National Grid's vision is to be a world-class safety organization with zero injuries every day. This includes working to help ensure the safety of our employees, contractors and the community. National Grid is committed to delivering operational excellence, including excellent levels of safety internally and in cooperation with the external contractors we rely on.

The Executive Safety Committee provides review and input for Safety Policies and Procedures through the Safety Policies and Procedures Subcommittee.

The Safety department is the owner of this procedure and is responsible for maintaining and implementing this procedure, soliciting comments from stakeholders and revising as necessary.

This document, "Contractor Safety Requirements", represents the current contractor safety requirements that are unique to operations and various functional groups at National Grid. This document does not specifically reference actions that are required by OSHA, other laws, rules, or regulations. These are requirements that should be understood by the contractor and contractor compliance with all applicable federal, state and local laws, rules, and regulations is expected by National Grid as a contractual condition.

Questions regarding this procedure should be referred to the National Grid Safety Department.

This document will be updated as necessary to communicate all aspects of National Grid's contractor safety to bidders, current contractors and to reflect changes in National Grid's Safety Policies and Procedures.

Date of Review/Revision:

Revision	Date	Description
1	8/5/2004	Initial
2	3/2/2005	Additions
3	1/30/2007	Additions
4	8/1/2008	Additions
5	8/1/2010	Additions
6	2/1/2011	Audit recommendations included

Date of Review/Revision Continued:

Revision	**Date**	**Description**
7	9/11/2013	Additions included OH; technical changes; Compliance Monitoring; Ethics; Job Briefs
8	11/2/2015	Additions include Audit & IA recommendations; ISN alignment; technical changes, 1910. 269 updates
9	8/17/2016	Format update and technical changes
10	3/29/2017	Additions to sections 2.2.6 and 6.5
11	2/26/2018	Process Safety, PM&CC Electric and PM&CC Vegetation Additions
12	3/12/2019	Contaminated Site Work Additions
13	10/24/2019	Job brief, Hi-Vis clothing, ladder use, and air gap revisions
14	1/13/2020	Hi-Vis clothing and ladder use revisions; Fatigue Risk Addition in HASPs
15	3/10/2021	EH rated work boot and Dielectric (DI) footwear definitions and requirements; OSHA 1910.136(a) reference; requirement not to wear loose clothing; Hi-Vis vest or garment requirements
16	3/24/2021	One HASP form; HASP revisions; self-assessments; qualifications; and notice of subcontractors

17	6/14/2021	Loose garments/items for heavy equipment operators revision; addition of heavy equipment definition
18	5/4/2022	Removed requirements to upload contractor orientation/pre-construction meeting documents to ISN; Removed requirement to upload forestry training qualifications to ISN; Clarified that medium/high risk contractors acknowledge N1402 requirements by signing the N1402 acknowledgment form in ISN; Added additional examples to the medium/high risk exposure category; Revised the pre-construction meeting/contractor orientation requirement from “may” to “shall”; Changed Corporate Safety team references to Safety Policies & Programs

1.0 CONTRACTOR SAFETY AT NATIONAL GRID

1.1 Definitions

Adverse Public Impact
Incident that disrupts service to the public or results in adverse public reaction.

Bulk Commodity Transportation
Activities involved in the movement of bulk commodities via truck, rail, plane or water vessel onsite and offsite on behalf of National Grid that if released could have safety and / or environmental consequences. Examples include but are not limited to: gasoline, oil, boiler chemicals, LNG, Nitrogen.

Compliance Assessments (CAs)
An act of observing and engaging in discussion with employees at a job site or work area locations. Compliance Assessments are documented using the Compliance Assessment checklist for each segment of operation and are not considered anonymous. Compliance Assessments are utilized to comply with internal policy and external regulatory requirements.

Contracted Services
Contracted Services refers to any activity that is conducted by an organization or individual under the terms of a purchase order or through other financial arrangements (Procurement Card or credit card) between a National Grid representative and a contractor. Contracted services may include all types of construction and maintenance services, tree trimming, building maintenance and demolition, electrical structure dismantling, site restoration, engineering design, recycling and waste disposal, drilling, rigging, electrical, and utility pole/structure maintenance.

Contractor
An independent person or company that undertakes a contract to provide materials or labor to perform a service or do a job and are responsible for the safety of his/her employees and subcontractors.

Contractor Orientation
Contractor orientation is intended to serve as a resource in order to provide the contractor with the tools necessary to educate their employees and subcontractors. The session is not intended to train the contractor management, their employees or subcontractors. The extent and content of the orientation session shall be commensurate with the scope and type of the contractor's activities.

Dielectric (DI) Footwear
This term describes either boots or overshoes that are labeled in accordance with ASTM F1117, marked clearly and permanently with the name of the manufacturer or supplier, the size and AC voltage rating. The footwear shall meet dielectric strength testing prescribed in ASTM F1116. Dielectric footwear shall have a minimum rating of 15kV.

Effective Safety Discussion (ESD)
A discussion with an individual or group about their safety programs, issues or concerns (safety plans, tools, equipment, procedures, etc.). They are safety discussions amongst employees that share similar work environments…office to office, field to field.

EH Rated Work Boot
ASTM F2413 EH rated work boots are the minimum foot protection standard. This boot protects against impact, compression, and low voltage exposure.

Health & Safety Plan (HASP)
Contractors who perform high or medium risk-ranked services shall submit a project-specific HASP prior to the start of the project. In this plan, the contractor shall identify all significant tasks, their anticipated hazards and mitigation steps.

Hazardous Conditions
A condition that can and is rectified immediately by the person who identified the hazard.

Heavy Equipment
Maintenance and construction equipment including excavators, compact (mini) excavators, backhoe loaders, towable compact backhoes, front end loaders, skid-steer loaders, compact loaders, digger derricks, boom trucks, cranes and bulldozers.

Incident
An unplanned event that has a human component and results in or could potentially result in harm to people, damage to property and/or adverse public impact.

Incident Management System (IMS)
National Grid's online incident management tool that allows the company to report safety, environmental and asset-related incidents, perform incident analysis, generate safety reports and monitor the organization's safety performance.

ISNetworld, Inc. (ISN or ISN System)
Third party contractor that is a global resource for connecting Hiring Clients with safe and reliable contractors and is a contractor information management system currently contracted with National Grid.

Job Brief
A planned interactive discussion that covers, but is not limited to, potential hazards associated with the job including situational awareness (assets or other items which may impact the job at hand), work procedures involved, special precautions, and personal protective equipment requirements. The discussion should include all contractor employees, sub-contractors and team members working on a job that occurs just prior to a job, task or project. A new job brief shall be conducted for each of the following events: prior to a change in planned work specific to the job site, changes in weather conditions, extended breaks (i.e. lunch breaks) or when a new worker or company joins the crew. When possible and reasonably practical, a National Grid Representative should be present at contractor job briefings. Truck drivers for daily, non-hazardous material deliveries such as stone, gravel, concrete material or porta john cleaning are exempt from completing a job brief unless there are potential hazards associated to the driver or delivery. A National Grid representative shall talk to the driver to determine if a job brief is needed.

Major Hazard Asset (MHA)
A class of assets at National Grid, including Compressed Natural Gas (CNG), Gas Transmission (≥ 125 psig), Power Generation sites, Liquefied Natural Gas (LNG) plants, and LNG Trucking, in which any condition, or set of conditions, presents potential for a major accident to occur. Also referred to as process safety assets.

Major Accident
An event involving the release of potentially dangerous materials, the sudden and uncontrolled release of large amounts of energy (such as fires and explosions), or both. These can have catastrophic effects and can result in multiple injuries and fatalities, as well as substantial reputational, economic, property, and environmental damage

Operator Qualification (OQ)
As defined in the Code of Federal Regulations, Transportation, 49 Subpart 192.801 through 192.809 and/or DOT pipeline qualified for gas contractors doing work at National Grid. Additional state requirements pursuant to the state the contractor is working may be required.

Process Safety Management
Method of focusing and mitigating concerns of major hazards impacting safety, environmental damage and business losses. It is an organized effort to identify and analyze the significance of hazardous situations associated with a process or activity to aid management in making critical safety decisions

Project Representative
National Grid Owner's Representative or designee who is assigned to certain contracted projects and communicates regularly with the contractor during the course of the contracted service. This person also ensures the work is being performed in accordance with the contract, including the safety requirements.

Purchase Order (P.O.)
An agreement/contract between National Grid and a contractor to provide services and/or materials. The P.O. is set up by Procurement. The term "Contract" and "P.O." are similar and may be used interchangeably. A "Blanket P.O." is set up for contractors whose work is on-going. A "one-time P.O." is set up for project work.

Qualified Electrical Worker
Those who are knowledgeable in the construction and operation of the electric power generation, transmission and/or distribution equipment involved, along with the associated hazards.

Qualified Gas Worker
Any contractor who performs covered tasks in accordance with National Grid's Operator Qualification Program and the Northeast Gas Association are required to be knowledgeable and meet all regulatory standards.

Risk Assessment
A risk assessment is the process of identifying hazards and calculating or ranking the associated risks according to: the likelihood of occurrence, the severity of the harm from the hazard, and the amount of time of exposure to the hazard.

Safety Observer
A person who is responsible for alerting the work team to any potential unsafe conditions or lack of compliance with approved work practices, procedures or guidelines.

Transportation Advisor
Third party agency specializing in federal and company mandated drug and alcohol testing programs.

1.2 Introduction

Safety performance is a prime consideration in the selection of contractors. National Grid will stipulate safety performance requirements and responsibilities in our contracts, purchase orders (POs) and will hold the contractor accountable for meeting the contractual requirements.

National Grid's goal is to establish a long-term working relationship with contractors who share the same safety values and demonstrate those values through their work performance.

Contractor safety at National Grid involves three broad areas:

1. **The Contractor Procurement (Selection) Process**
   Contractor safety begins with the selection of contractors who have demonstrated a strong safety record. National Grid will complete a review during the procurement process that involves determining a contractors' risk and the scope(s) of work involved. National Grid currently uses ISNetworld, Inc. as a third (3rd) party assessment process for assisting with contractor procurement. The 3rd party entity will vet and continually monitor individual contractors' compliance with applicable safety and/or risk and insurance program requirements.

2. **Safety Communication**
   Safety communication covers all the avenues and forums in which National Grid and the contractor communicates safety. Communication begins early in the bidding phase and is on-going as an integral part of the contractor-customer relationship. The goal is to ensure clarity, transparency and to limit misunderstandings.

3. **Safety Compliance**
   Safety compliance is the process of ensuring that the necessary technical provisions of the contract are being followed. National Grid will assign a project representative or other designee to provide guidance and oversight. The Contractor is responsible for their employees and subcontractors and shall be held accountable for ensuring compliance with all applicable safety rules while working on National Grid property, rights of way (ROWs) and our assets. Primary contractors are required to notify National Grid of any subcontractors and ensure that there is an appropriate contractual relationship in place in line with the terms and conditions of their contract.

1.3 Risk Ranking of Work

1. National Grid characterizes and ranks risk by the scopes of work performed. The categories are classified as high, medium or low risk. Prior to being considered for work at National Grid, contractors who perform High or Medium Risk work must be pre-qualified in ISN. See Appendix A for more information regarding the National Grid Contractor Risk Matrix.

2. Activities that are designated as "high risk" means that catastrophic event can result if safety measures are not followed. Activities designated as "medium" risk present certain opportunities for moderate to significant injuries, property or reputational damage, and/or loss of service and/or possibly business continuity. Activities designated as "low" risk may still require safety compliance and control measures, although the contractor performing the work does not necessarily need to be enrolled in ISN, if that is the only classification of work that contractor performs for National Grid.

3. The designation High Risk, Medium Risk, or Low Risk, refers only to the inherent risk associated with the work activity and is not an opinion on the ability of a contractor to work safely.

4. If ,at any time, the risk changes from low to medium/high, per the risk matrix, then the medium/high risk process shall be followed. It's the contractor's responsibility to identify if the risk changed and to escalate to National Grid personnel.

5. The Procurement Agent will notify the bidder/contractor at the beginning of the procurement process if their contracted service has been ranked as high or medium risk.

1.4 Bidder Information Request – High and Medium Risk Work

1. Any contractor bidding on high or medium risk work shall be required to complete a questionnaire regarding the Contractor's safety program, compliance and history of occupational illnesses and injuries (ISNetworld New Vendor Onboarding application form, located on the ISNetworld website). Contractors will also be required to demonstrate in ISN that all employees, including subcontractors, are qualified to perform the scope of services.

2. ISNetworld then thoroughly reviews contractors' qualifications against a prerequisite list of National Grid criteria. National Grid has established that contractors performing high or medium risk work <u>MUST HAVE and MAINTAIN a grade of "C" or better</u> in the ISN system to perform work and services for National Grid. ISN will track and manage the National Grid pre-

qualified contractor bidder lists. This bidder list is the first step for a contractor in establishing a working relationship with National Grid. For active ISN contractors, ISN will request updated information monthly. Contractors who do not have a current PO, contract, or authorized scope of work with National Grid will be considered as a Prospective bidder and will be asked to submit information quarterly. It is understood that insurance may not be maintained within National Grid standards, however, once a contractor is awarded a contract, proper and adequate insurance must be provided to ISNetworld to achieve a passing grade. Lack of insurance or inadequate insurance is an immediate “F” grade in the ISN system per National Grid criteria.

3. Project representatives may request an exemption or variance from requiring a contractor to be placed in ISNetworld for various reasons. A Supplier Exemption Request form (located in the safety policies and procedures section of Grid:home) shall be completed, documented and signed by the business unit VP and Safety Policies & Programs Director prior to contract award.

4. The information that the Bidder provides National Grid via ISN serves as the basis for assessing safety qualification. For this reason, it is important for contractors to maintain transparency throughout the process. National Grid and ISN will review all submitted information. Any effort in avoiding complete disclosure will disqualify the Bidder from bidding work at National Grid.

1.5 Safety Compliance

1. Medium/high risk contractors certify that they have been informed of National Grid safety requirements, that employees and subcontractors have the appropriate qualifications to perform the work, and agree to comply with all applicable safety requirements. This will be accomplished by the contractor signing the N-1402 Contractor Safety Requirements Acknowledgment Form in ISN annually and when there are revisions to N-1402.

2. National Grid representatives evaluate contractor compliance by conducting routine site visits, Compliance Assessments (CA’s), Effective Safety Discussion (ESD) visits and attending periodic contractor safety meetings. Contractors should also perform and document safety self-assessments to ensure compliance to federal, state, local and National Grid regulations. This combined effort enhances, solidifies safety compliance and has the added benefit of quality control / quality assurance of the work performed.

3. Contractors bidding on new work shall provide worker qualifications to the National Grid procurement representative via the “Bidder Information Request” form and/or ISN National Grid On-boarding form.

4. If a safety violation is observed by a National Grid representative, the violation will be discussed with the contractor at the time of discovery.

5. Contractor employees enrolled in ISNetworld that are involved in any accident, incident or significant near-miss event, will be required to lead an investigation and root cause determination process. In addition, the contractor must implement corrective actions and establish measures to prevent a recurrence through an incident investigation process and document the details within ISN.

6. Individual contractor personnel who habitually violate any safety rules should be identified, and the contractor should remove the individual(s) from the project. National Grid reserves the right to remove any contractor employee(s) who violate safety rules or procedures; pose a safety risk to themselves, other contractors; our employees; or the general public.

7. If a contractor is observed to be operating in a manner that creates an imminent danger to persons or property, it is the responsibility of all individuals observing the hazard to cease the hazardous operation impacted until the issue has been resolved to the satisfaction of National Grid, the Owners Representative or Safety Representative.

8. Contracts/POs shall require the contractor to immediately forward any citations, notices, or OSHA reportable cases per 29 CFR 1904.39 from a National Grid project, upon receipt to the appropriate project representative and/or ISN. The project representative shall distribute copies of the citation or notice to senior management, Safety, Procurement, and the Legal Department.

9. Willful and/or repeat violations of safety requirements by the contractor may be considered a breach of the contract and reason for contract termination.

10. If the contractor’s overall safety performance is viewed as being unsatisfactory or noncompliant with contract provisions, and if the contractor is unwilling to demonstrate satisfactory program improvement, the result may be considered a breach of the contract and reason for contract termination.

11. National Grid project managers and/or construction supervisors shall document safety compliance by completing a “Contractor Performance Evaluation” for each project. This documents both positive and negative

safety performance or behaviors and this feedback will be used in the decision process for awarding future contracts.

2.0 GENERAL SAFETY REQUIREMENTS

2.1 Introduction

1. All contractors are required, and expected to comply with all applicable requirements of the Occupational Safety and Health Administration (OSHA), and all other applicable federal, state and local laws, ordinances, regulations, and other project and site-specific permits unless superseded by identified National Grid procedures.

2. This document represents policies and safety-related work methods unique to National Grid and they may be more stringent than OSHA regulations. Contractors must follow these requirements as well as their own rules or regulations that meet or exceed OSHA and other regulatory requirements.

3. National Grid will provide more detailed information and guidance regarding specific procedures prior to commencement of work.

4. Per OSHA 1910.136(a) general requirements, the employer shall ensure that each affected employee uses protective footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole, or when the use of protective footwear will protect the affected employee from an electrical hazard, such as a static-discharge or electric-shock hazard, that remains after the employer takes other necessary protective measures.

2.2 Applicability

Applies to: All contractors, as needed

1. In any contracted task, where a safety observer is required, it is the responsibility of the contractor to provide that person and ensure that he/she is qualified to perform the role when needed.

2. A 4:1 pitch shall be maintained when using an extension ladder or the ladder shall be tied off and/or secured and 3 points of contact shall be maintained by the climber. If both hands are needed to perform work, then fall protection is required.

3. Although not preferred, if hard hats are worn backwards, the suspension adjuster must always face the rear. Class E hard hats are required for all electrical work.

4. ASTM F1117 Dielectric (DI) footwear is required when:
   - Workers on the ground are working within 50' of the master ground connection point to earth.
   - Operating a wire trailer and pulling/tensioning machine.
   - Operating a winch truck or reel trailer with its payout in an energized area that may result in inadvertent contact.
   - Hand digging in close proximity to energized cables within the tolerance zone.
   - Making repairs in a trench to a faulted primary cable without de-energizing any adjacent energized primary cables within close proximity.
   - Using approved live line tools to move energized primary cables in a trench.
   - If removing underground cable rubber covering or arc suppression blankets from an energized cable.
   - Working within minimum approach distance (MAD) of downed electrical wires or foot patrolling for such wires.
   - If setting poles in proximity to energized lines or equipment and using truck controls from the ground.

5. National Grid expects that all cargo will be secured in accordance with U.S. DOT requirements.

   - As of January 2004, the Federal Motor Carrier Safety Administration (FMCSA) within the U.S. DOT published Cargo Securement Rules 393.100-136 Subpart I – Protection Against Shifting and Falling Cargo.

6. Chaps are required to be worn by ANY person using a chainsaw to make a cut on the ground or assisting in that cut and within striking distance. Other situations where cut off machines are used, chaps designed for the purpose of providing durable protection from abrasion, spatter and sparks from cutting ferrous metals shall be required; however, a hazard assessment should be completed to determine the need. Always use proper cutting techniques and push blades away from the body when using tools that may slip or inadvertently make contact with the leg. Never leave any equipment running while not in use.

7. All applicable contractors must meet the requirements of drug and alcohol testing in accordance with FMCSA DOT 49 CFR Part 40 and Pipeline and

Hazardous Materials Safety Administration (PHMSA) DOT 49 CFR Part 199. National Grid shall monitor contractor compliance to the drug and alcohol regulatory requirements through Transportation Advisor or ISNetworld as needed.

8. Contractors who drive regularly in delivery of service for National Grid shall:

   a. Have a safe motor vehicle operations policy which must be communicated to their employees before they begin driving for company business. The contractor is expected to follow National Grid's *Safe Motor Vehicle Operations* policy to include the following:
      - Prior to moving any vehicle, the driver shall perform a "circle of safety" inspection. This is to confirm not any person, animal, equipment, or property will be injured or damaged when the vehicle is moved.
      - Drivers should back into or pull through a parking space so that when you re-enter the vehicle, the first move is forward.
      - No driver shall use a hand-held mobile telephone while driving a vehicle for National Grid business.
      - The driver shall eliminate or minimize sources of potential driving distractions to include, eating, smoking, reading, writing, grooming, use of any electronic devices, mirror or seat adjustment. These shall be done when the vehicle is not in motion.

   b. Comply with all requirements of all federal, state and local regulations regarding safe motor vehicle operations.

   c. Ensure that new and existing employees have a valid Driver's License in accordance with requirements of specific job duties and classification/type of the vehicle they are operating. Contractors must have an acceptable driving record. If their driving record is unacceptable, the driver shall not be permitted to operate a vehicle on behalf of National Grid.

   d. Provide vehicles in safe operating condition, in accordance with federal state and local regulations. The vehicle should be equipped with proper safety equipment as appropriate for the vehicle type and its intended use.

e. Track and evaluate any vehicular accidents or incidents experienced by their employees. Corrective actions, such as driver coaching, corrective action driver training and medical/vision tests should be recommended and acted upon where appropriate. All accidents or near misses while performing work for National Grid shall be communicated to the National Grid project representative or designee and documented in the ISN system.

f. For more information, contact a National Grid representative for a copy of the National Grid Safety Policy *Safe Motor Vehicle Operations*

9. All contractors that require the use of heavy equipment shall ensure that competent, appropriately licensed, skilled and qualified personnel are in control of this equipment at all times. In addition, contractors shall ensure the following:

- Equipment is inspected for safety and use at the beginning of the work period of shift. All failing or defective equipment and components shall be removed from service.

- Equipment is under the control of trained operators who are always aware of their location and the locations/presence of persons working near the equipment, its swing zones and blind spots.

- While operating heavy equipment, operators shall ensure that loose fitting vests, jackets or other garments/items shall not be worn that could inadvertently get caught on equipment controls. Upon exiting the heavy equipment, the operator shall immediately put on their hi-vis vest/garment.

- Equipment is kept free of debris, water, oil, grease, mud or anything that could create a slip/fall hazard inside the cab.

- Keep hands, feet, and clothing away from power-driven and moving parts.

- Equipment cab windows should be kept clean and free of mud, ice, snow and/or fog for maximum visibility.

- Never carry passengers on heavy equipment or any equipment unless it is equipped to do so.

- Ensure that stabilizers are extended prior to starting a task.

- Before making a swing, operators shall always look out the windows and mirrors for confirmation that the area is clear. If visual confirmation is impaired or the operator is unsure due to weather, lighting or other interferences, the operator shall cease operation until an independent spotter can check the swing area and confirm it is clear.

- All excavations shall have signs posted, demarcation and controlled to prevent unauthorized persons from entering and falling inadvertently into the excavation. Excavations shall only be opened under the supervision of a competent person for excavation.

- All pot holing/test holing and exploratory excavations shall utilize vacuum excavation whenever near known or the possibility of unknown hazards such as live electrical or gas conveyances. When using vacuum excavation in combination with air blowing/air knife tools, all persons in the immediate area shall be wearing safety glasses in addition to a full face shield.

- No one is to work under a suspended load.

- Never use a bucket to lift personnel.

- Ensure stabilizers are in the upright and stored position before moving equipment.

- Operators shall not leave heavy equipment running unless the following requirements are met:

    - Parking break is engaged and wheels are chocked (if applicable)

    - Surroundings create no hazard of unqualified personnel entering unattended equipment

    - Vehicles and equipment idling limited to that designated state and local environmental regulations (generally, 3 to 5 minutes maximum). See table below for additional information

Region	Vehicles	Idling Limit	Exemptions Include
New York	Diesel trucks	5 minutes	• Traffic conditions • Temperatures < 25°F and motionless for two hrs • Hybrid electric engine charging battery vehicles • To provide power to auxiliary sources
NYC	All Motor vehicles	3 minutes	• Emergency vehicles • Loading/unloading • Temperatures <40°F
New Hampshire	Diesel/ Gas vehicles	5 minutes >32°F 15 minutes -10°F to 32°F No Limit <-10°F and no nuisance created	• Traffic conditions • Emergency vehicles takeoff power for auxiliary uses • Vehicles being serviced or repaired • Operated solely to defrost windshield
Massachusetts	All Motor Vehicles	5 minutes	• Vehicles being serviced or repaired • Vehicles in operation for which associated power is needed • Delivery vehicle in which engine power is needed
Rhode Island	Diesel Motor Vehicles	5 minutes	• Traffic conditions • Operate defrosting, heating, or cooling equipment to ensure health and safety of the driver or passenger. • Temperatures between 0 & 32°F - 15 minutes per hour. If < 0°F idling as needed for heat • To provide power to auxiliary sources • Vehicles being serviced or repaired
Vermont	All Motor Vehicles	5 minutes within any 60-minute period	• Emergency/public safety vehicles while engaged in "official operations" • Idling necessary to operate safety equipment • Vehicles in operation for which associated power is needed • Vehicles being serviced or repaired

- All lifts that occur on National Grid properties, ROWs or near critical assets require formal lifting plans developed by the contractor and reviewed with the National Grid project representative. Some lifts will also require formal critical lifting plans and this may include PE or geotechnical assessments to ensure a stable lifting base for the crane or other apparatus.

10. All temporary, metal fencing installed or located under transmission lines shall be grounded and have signage according to National Grid grounding standards. Contact a National Grid representative for a copy of the Engineering Documents ST 03.05.001ST 03.06.001 and SP 08.00.001.

3.0 ADMINISTRATIVE SAFETY REQUIREMENTS

3.1 Worker Qualification Assurance

1. In order to meet National Grid safety requirements, the contractor must describe how workers, including subcontractors, are qualified. The contractor must supply information concerning the type of skills assessment performed, training programs and how they ensure that employees

demonstrate competencies. National Grid reserves the right to review this information and request additional training requirements. All documents shall be uploaded and maintained in the ISN system for high/medium contractors. For work on process safety assets, the contractor shall ensure all workers and sub-contractors are trained and receive appropriate refresher training to maintain their appropriate level of certification and qualifications needed to perform work safely.

2. For low-risk contractors who perform activities that require PPE, which excludes office-based contractors and/or consultants, or other non-physical low-risk contractors, the contractor is required to watch an on-boarding video annually prior to any jobs starting for that year. The contractor employees and subcontractors are required to watch the video to be clear on safety expectations. Contractor to ensure that any new employees performing services for National Grid watch the on-boarding video if they hadn't watched it in the annual release. A link to the video can be obtained from the Project Representative.

3. Medium/high risk contractors shall complete an annual in-person on-boarding hosted by National Grid supervisor or project manager. The on-boarding shall emphasize required qualifications, HASP requirements, and requirements on revisions to HASPs when changes to the scope of work on the site or changes to risk occur. The National Grid supervisor or project manager are to conduct the on-boarding and determine the appropriate material to be used to communicate and emphasize the expectations.

4. Contractors shall conduct their own safety self-assessments.

Periodic field visits and/or verbal contact shall be conducted by the National Grid supervisor or project manager who are familiar with the work and existing scope. The National Grid supervisor or project manager shall review the work performed during the field checks and/or verbal contact and can ask the contractor to provide qualifications upon request.

During the field visits/verbal contacts, National Grid supervisor or project manager shall also review existing HASPs and/or job briefs as applicable for current work scope and require any revisions based on observations. The field checks/contacts are to be documented using Compliance Assessments, Contractor Evaluations, or ESDs.

If HASP or job brief does not cover observed hazards and risk mitigation, work shall be stopped until a revised HASP or job brief and approval of the revision occurs, which is required before work can continue.

The frequency of the field visits/verbal contacts are based on risk perception of the job, including variability of conditions, and if there is greater chance of serious injury or fatality based on high-energy presence (gravity, pressure, energy). Higher volume of visits should be conducted if it's a new contractor, based on contractor's performance (review IMS, Compliance Assessments, etc.), or if variations exist including: change in project scope, weather, change in crew and/or subcontractors, change in equipment on site, new high energy factors are present (greater chance of SIF), and long duration job.

5. The contractor shall provide management personnel qualifications through resumes or other documents. National Grid may interview and/or approve management personnel if considered necessary.

6. For work on Process Safety assets (Gas Transmission, Generation, LNG, LNG Transportation and CNG), contractors shall provide a description of their experience in the business asset and specific tasks including similar projects, lists of licenses/certifications, and references from previous similar projects. Contractors shall be made knowledgeable of National Grid process safety requirements that are relevant to their specific work activities by the business hiring them.

3.2 Meetings

Applies to: All contractors; as needed

1. The pre-bid meeting is coordinated by National Grid Procurement to provide bidders with an opportunity to become acquainted with contractual requirements and specific safety issues concerning the project, including company-specific safety rules and known site conditions.
   a. For contractors working on Major Hazard Assets, contractual language including designation of site medical facilities, locker rooms, bathrooms, etc. should be discussed by the project team with the contractor at this time.
2. At this time, Procurement will notify the prospective bidders of the following:
   a. If they are required to submit a project safety plan (HASP) prior to the pre-construction meeting

b. The cost of specific safety equipment, practices and personal protective equipment shall be factored into their bid/proposal.

3.3 Project Health & Safety Plan (HASP)

Applies to: Contractors performing high or medium risk work

All HASPs shall be submitted to the National Grid project owner for review and approval before work commences. The National Grid project owner shall ensure the HASP meets National Grid criteria and includes all aspects of the project prior to a review by Field Safety (if applicable). The project owner shall review the HASP. Field Safety shall also review the HASP after the business conducts its review only if the work is unique, there's a new project manager or supervisor, the work involves PHAs, or there's unfamiliarity with the project or safety standards.

If changes are required, a new HASP shall be created and rereviewed.

If the scope of work on the job site changes from the approved HASP, work shall be stopped. The HASP shall be revised and rereviewed by National Grid Business (Field Safety review as applicable), and work can continue once the revised HASP has been reviewed for risk controls of changed scope. Until the HASP is updated work shall remain stopped. Failure to update the HASP will be considered a violation of safety requirements in line with section 1.5. It's the contractor's responsibility to inform National Grid personnel if the scope changes.

1. Contractors who perform high or medium risk-ranked services shall submit a project-specific HASP plan prior to the start of the project and/or at pre-construction meeting. The HASP is to be followed by the contractor's employees and its subcontractors.
2. At a minimum, the HASP shall include the following elements:
   a. Roles and Responsibilities
   b. Scope of Work
   c. For contractors working on Major Hazard Assets - List of all equipment contractor is expected to use in work activities and indication that it meets regulatory and National Grid requirements
   d. For contractors working on Major Hazard Assets - List of contractor materials to be brought onto work site for review and approval by National Grid

e. Task and hazard identification and risk assessment of the hazards

f. Hazard mitigation/control procedures and work methods

g. Incident investigation and reporting

h. Compliance and monitoring

For an example of a HASP, a National Grid representative can provide related policies and procedures under the *Contractor Safety* website in Grid:home.

3. The following requirements shall be included in the HASP for all work at contaminated sites. The HASP shall be site-specific and meet the requirements of 29 CFR 1910.120(b)(4)(ii). The HASP must include at a minimum:

   a. A safety and health risk or hazard analysis for each site task and operation

   b. Personal Protective Equipment to be used by employees for each of the site tasks and operations

   c. Medical surveillance requirements

   d. Frequency and types of air monitoring and personnel monitoring to be used

   e. Site control measures

   f. Decontamination procedures

   g. An emergency response plan for safe and effective responses to emergencies, including the necessary PPE and other equipment

   The contractor/National Grid project representative shall contact the Environmental Department for guidance on site requirements and to initiate any required regulatory notifications.

For contractors performing bulk commodity transportation activities, a risk assessment including the potential consequences, frequency and safeguards to be used shall be performed and included in the HASP. If a preexisting National Grid requirement is in place for managing bulk commodity transportation activities, one shall follow those requirements, with no additional risk assessment being required.

Every contracted and subcontracted employee, including those working alone, performing work on the project shall review the HASP to ensure steps in the plan are adhered to in order to mitigate hazards during the pre-job orientation. These mitigation steps shall be incorporated into all work plans and job briefs.

Truck drivers for daily, non-hazardous material deliveries such as stone, gravel, concrete material or porta john cleaning are exempt from completing a job brief unless there are potential hazards associated to the driver or delivery. A National Grid representative shall talk to the driver to determine if a job brief is needed.

In addition, all workers shall sign an attendance sheet during the pre-job orientation that they have reviewed the plan, will adhere to the mitigation steps and they fully understand the plan. This document will be kept at the job site and available for review as needed and if requested by any National Grid representative, or any other parties.

A. Roles and Responsibilities

The HASP shall identify who is providing project oversight and how they are qualified. For example, if the work requires excavation, there must be someone on-site who is qualified as an excavation competent person.

For multi-employer work-sites, the general contractor is responsible for all their employees and subcontractors. The safety plan shall clearly state this responsibility.

If requested to do so, Contractors shall designate a competent person to participate in or conduct a process hazard analysis (PHA) regarding a portion or the entirety of the project. National Grid will not be responsible for training the contractor on the PHA methodology.

B. Scope of Work

The Contractor shall clearly and briefly state the scope of work as provided by National Grid. The plan must specifically address the project or services requested by National Grid.

C. Task and Hazard Identification and Risk Assessment

The contractor shall perform a risk assessment by identifying all significant tasks, the anticipated hazards and hazard mitigation procedures.

If, at any time, the risk level changes on the job site, the contractor is to stop work until a revised HASP or job brief is created and discussed on site and reviewed by National Grid personnel.

Contractors performing work where their employees are exposed to fatigue, shall assess fatigue risk in their HASPs and identify the mitigations they will take to manage the risk to their employees.

The contractor's cost to provide adequate safety measures and to comply with National Grid requirements must be considered and budgeted in the bid/proposal.

D. Hazard Mitigation Procedures and Work Methods

For each hazard, the contractor shall specify measures that will be taken to eliminate, control or mitigate these hazards.

A table below is an example of a method to simply and clearly organize and present the task, hazard, and mitigation steps:

Location: Substation Yard		
Task	**Hazard**	**Mitigation Steps**
Material Handling	Contact with overhead energized lines/equipment	Off load in the clear and have a safety observer present

E. Incident Investigation and Reporting

All work related incidents involving injury or illness to employees, the public or property damage (including contractor vehicle accidents) shall be reported to the National Grid project representative and documented in the ISN system.

F. Compliance Monitoring

To ensure that both contractor employees and subcontractors will achieve safety compliance, jobs with over 100 workers at any point in time or in excess of $1 million will require a full time safety professional hired by the contractor. This safety professional must be qualified, competent and be on site anytime work is performed. Qualifications of this safety representative must be acceptable to National Grid prior to hire by the contractor and may be documented in the ISN system.

For other jobs that don't meet the above criteria, contractors shall monitor jobs in line with their safety management system.

G. Environmental Compliance

Unless otherwise specified and based on the scope of work, any potential environmental risks shall be determined and addressed by the contractor following all applicable National Grid procedures. For more information, contact a National Grid representative regarding Environmental Procedure No.6 *Contracted Services* and Environmental Procedure No.25 Appendix A, *Environmental Screening Checklist.*

3.4 Contractor Orientation/Pre-Construction Meeting

Applies to: All contractors, as needed

1. A National Grid project representative, construction supervisor, or other designated National Grid representative that hires the contractor shall hold a contractor orientation and/or pre-construction meeting prior to the contractor working for National Grid. Other attendees may include: the Safety department, Environmental representatives, as well as contractor management as needed.

2. It is intended to serve as a method to provide the contractor with the tools necessary to educate their employees and subcontractors on National Grid's procedures and requirements. The session is not intended to train the contractor management, their employees or subcontractors.

3. All contractors are required to attend a National Grid orientation program specific to the type of work they will be performing. Contractor management representation shall also be present meeting and all documentation of attendance shall be kept at the job site and available to any National Grid representative. For visitors and contractors working on Major Hazard Assets, site orientation shall at a minimum include the following:

    - General site hazards
    - Specific hazards involved in each task the employee may perform
    - Safety policies and work rules, including Process Safety policies
    - Location of emergency equipment like fire extinguishers, eyewash stations, and first-aid supplies
    - Smoking regulations and designated smoking areas if applicable
    - Steps to take following an accident or injury

- Proper reporting of emergencies, accidents, and near misses
- Selection, use, and care of personal protective equipment
- Emergency evacuation procedures, routes, and security systems
- Safe housekeeping rules
- Safe use of tools and equipment
- Hazardous materials in use and location of safety data sheets

Site access shall not be granted to contract employees working on process safety assets until orientation is conducted.

4. The contractor's Project Health & Safety Plan will be discussed at this meeting including a final review of the safety hazards checklist to ensure proper hazard identification and mitigation plan has been implemented.

5. These hazard mitigation measures shall be reviewed and work shall not commence until these hazards have been adequately addressed. The National Grid project representative will discuss the methods by which compliance will be achieved to National Grid safety requirements with the contractor.

6. An Emergency Call List shall be exchanged with the National Grid project representative for high or medium risk projects or as applicable. This list must contain 24-hour contact information for key contractor and project personnel, including the project representative and Safety representatives. This list should be distributed to all concerned, as determined by the project team, prior to the start of work. For contractors working on process safety assets who have an emergency response role, the emergency response plan shall be updated to clarify the contractor's role in the event of an emergency on site.

7. For routine maintenance services, a review of associated safety issues and specific facility issues, restrictions or practices, such as evacuation procedures, shall be discussed with the contractor upon initial hiring. Any changes in the facility that may affect the safety of contractor or National Grid employees or third parties must be communicated immediately.

3.5 Job Safety Briefs

Applies to: All contractors; as needed

1. Job safety briefs shall be documented in writing. Written job safety briefs, permits, and/or plans shall be available at the job site for inspection and retained for 30 days after the job is completed.

2. National Grid reserves the right to perform a safety stand-down with any contractor for purposes including, but not limited to: recent injuries, incidents or near misses; identified hazards at job site or equivalent, and for other reasons to communicate with the contractor crew.

3. Each crew shall conduct these job safety briefs prior to commencing work at the job location. A new job brief is required when there are changes to the day's work order or plan, when there are changes in weather conditions, when a new worker or company joins the crew, and if the crew members take any extended breaks (i.e. lunch breaks). Working alone: A contractor working alone need not conduct a job brief; however, the contractor must review the hazards associated with the job as if a formal job brief had been performed.

4. Each worker must have the opportunity to voice concern. The work cannot begin until each worker signs off on the job safety brief stating that they have discussed the work, raised any questions, and agree with the plan.

5. Visitors to the work site shall be asked to read and sign the job brief acknowledging they understand contents. Contractors shall review the job brief and discuss the elements of the hazards and mitigation steps with each visitor prior to entering the job site. If a visitor refuses to sign, the general foreman will note it on the brief and will not allow the visitor to enter.

6. SITE SIGNAGE: An assessment of the work site should be conducted by the National Grid project representative overseeing the work with the contractor to determine if site signage will be needed to protect site visitors, the public or any other persons entering the work site. If Site Signage is required at the site, the signage shall be posted at the main entrance to the work site. The sign shall direct all visitors to check in with the Person in Charge (PIC), be escorted to the designated safe area and advised of all work currently in progress. The visitor is expected to comply with all related safety requirements and sign off on the Job Brief before entering the work site.

3.6 Safety Meetings

1. In addition to job safety briefs, the contractor shall have regular safety meetings with their employees and subcontractors. Contractors performing high or medium risk work shall have weekly safety meetings, while low risk contractors, at a minimum, shall have safety meetings monthly and attendance must be documented.

2. The safety meetings shall include the following topics: statistics, incidents, near misses, updates on old business and new business raised. It will include the round table discussion by the workers and the action items discussed. Meeting minutes must be documented and shall include specific action items, their due dates, persons responsible and a completion date. This documentation shall be available for inspection during the project period, and for 30 days after the project is completed. For contractors working on Process Safety assets, meeting minutes from contractor shall be shared and discussed with National Grid site management.

3. Routine Safety meetings/calls between National Grid and the Contractor shall be coordinated on a regular basis. Safety meetings may include but are not limited to ESD/Compliance Assessments, Safety Briefs, Safety Day discussions and regularly scheduled calls to promote safety and best safety practices. Contractors working on Process Safety assets for more than 6 months shall schedule leadership visits to discuss process safety topics.

4. Contractors are to perform their own safety self-assessments.

5. Contractors working on process safety assets for greater than three (3) months, or as needed, shall hold project planning meetings to discuss short term and long term work items. Project planning meetings shall include safety performance monitoring against project targets and should include a National Grid SHE representative for jobs on Major Hazard Assets in addition to a National Grid site representative.

3.7 Incident Investigation

Applies to: All contractors (regardless of risk ranking)

1. All contractors are required to report any work-related incidents involving injury or illness to employees, the public or property damage to the National Grid project representative. The first priority is to ensure that anyone injured receives medical treatment. Examples of incidents may include, but is not limited to: injury, property damage, adverse public impact, near miss, a hazardous condition and road traffic collisions (RTC).

2. Contractors will then be responsible to perform an incident investigation immediately following the incident and document root cause/corrective actions in the ISN system and to National Grid.

Incident Response Steps

In the event of an incident, the contractor shall provide details of the incident to National Grid that follows the steps below.

1. Contractor supervisor collects basic information about the incident from the employee or witnesses:
    - What happened?
    - Who and how many people were injured?
    - What treatment was administered?
    - What was the nature and seriousness of the injury?
    - Where did the incident occur?
    - When did the incident occur (date, time of day)?
    - Were there any witnesses?

2. Contractor supervisor immediately calls the project representative or other National Grid point of contact. All incidents shall be entered into the Incident Management System (IMS) as soon as possible by the National Grid project representative or National Grid designee. When dialing 1-866-322-5594, the caller will be prompted to select option 2 for anything other than an employee injury.

3. Contractor shall conduct an investigation within 24 hours of the incident that will identify contributing factors and root cause analysis relating to the incident and the corrective actions that will be taken to prevent future occurrence. This information will be documented in the ISN system.

4. Contractor vehicle accidents occurring during the performance of work will also be investigated and reported to National Grid.

Other Reporting

National Grid may periodically request the following annualized data for all work activities limited to National Grid operations:

- Lost Time Incident (LTI) rate for workers
- Restricted Work rate
- OSHA Recordable Incident (ORI) rate

4.0 TECHNICAL SAFETY REQUIREMENTS

4.1 Personal Protective Equipment (PPE) Requirements – General

Applies to: All contractors (regardless of risk ranking)

1. The contractor and their employees, including subcontractors are expected to follow the same rules and protocols as National Grid personnel. Basic PPE attire at construction sites and other similar work zones include, at a minimum:

    - Hard hat
    - ASTM F2413 EH rated safety shoes
    - Safety glasses with side shields
    - Any contractor who is exposed to vehicular traffic shall wear ANSI 107 certified class 3 hi-vis vest or garment.
    - All contractors who are exposed to vehicular traffic and are exposed to energized electrical equipment or live gas are required to wear ANSI 107, class 3 hi-vis vest or garment, that also meets ASTM 1506 FR standard with a minimum Arc rating of HRC 1. All FR vests must be lime green/yellow. When FR clothing is required the FR vest shall be worn over appropriately rated FR clothing. Please reference the Gas PPE Matrix.
    - All contractors that are exposed to vehicular traffic, but will never be exposed to energized electrical equipment or live gas shall wear at a minimum ANSI certified class 3 vest or garment that is orange OR wear the FR vest in lime green/yellow.
    - ASTM 1506, HRC Category 1 FR vests must be in lime green or yellow. Any vest that does not meet the ASTM 1506, HRC 1 FR rating must be orange.

Storm contractors that do not have a Contractor of Choice contract should follow their existing practices and rules. All other contractors shall refer to the US Department of Transportation's Manual on Uniform Traffic Control Devices (MUTCD) to determine the correct class of hi-vis clothing / vests.

2. The contractor shall ensure that their employees and subcontractors use protective safety toe footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole, and where such employee's feet are exposed to electrical hazards. In

addition, during inclement weather conditions or adverse events, the addition of anti-slip footwear or outer foot wear may be appropriate.

3. Guidance for additional PPE is referenced in other sections of this document.

4.2 Flame Resistant Clothing Requirements

Applies to: All contractors; as needed

1. Flame Resistant (FR) clothing shall be worn when personnel work on energized equipment/lines or when distance and position will expose the worker to electric arc or flame hazards. FR clothing shall also be worn during live gas work as outlined in the gas PPE Matrix (Gas Policy SHE01001) and within LNG operations locations as required. FR clothing also includes arc- resistant rain gear. This additional ensemble may also be required as part of the job for contractor personnel. Contact a National Grid representative for a copy or to view the PPE matrix.

2. FR clothing shall be worn as the outermost layer of clothing and when workers measure voltages, test or ground electrical equipment/lines.

3. FR clothing shall be worn when work requires the use of rubber protective equipment or the use of insulated live line tools.

4. FR clothing shall be worn when workers control/operate electrical equipment over 50 volts at the device location or are within 10 feet of equipment which is being physically operated/ worked on by another worker.

5. Visitors are not required to wear FR clothing in substations or production plants unless they are engaged in electrical work. The National Grid project representative will be able to determine whether FR clothing will be required based on the specific contractor task. Note: Gas contractor FR requirements may differ slightly. Please refer to National Grid PPE Matrix for Gas operations within Gas Policy SHE01001 as needed.

6. FR clothing shall meet a minimum arc rating of 8 cal/cm^2 (HRC 2) for energized electrical equipment unless otherwise specified based on increased potential exposure as indicated in the Arc Flash Tables in H-807 *Arc Flash Analysis and Mitigation* program.

7. Additional FR clothing protection is required when performing work on the distribution system in NY North and New England (legacy National Grid) stations. Contact a National Grid representative for a copy. (NG

Employees: If the link does not work, copy and paste the URL into your internet browser) Arc Flash Awareness and Mitigation (sharepoint.com)

8. Contractors who may be involved with tasks requiring the implementation of this program shall be informed by National Grid. Contractors will be required to follow all aspects of OSHA and any other applicable regulation as it applies to the tasks they perform.

4.3 Rubber Gloves and Sleeves

1. Rubber glove use is required for work on all electrical apparatus at 50 Volts or greater. Rubber gloves shall be donned before the worker leaves the ground and shall be worn until the worker returns to the ground (commonly referred to as "ground to ground", "cradle to cradle")
2. Class 0 gloves are required for exposures up to 1000 Volts.
3. Class 2 gloves are required for voltages between 1000-15,000 Volts.
4. Rubber sleeves must be worn where work is conducted within the MAD of primary electrical apparatus that is not tested, de-energized and grounded.
5. For voltages 23 kV and above, workers can use specialized equipment or work practices as long as these workers have been appropriately trained and qualified. National Grid may request training records from the contractor.
6. Rubber glove exceptions for specific jobs (other than those listed in this section) are permitted only with the dated, written approval of a Division Director.
7. It is the contractor's responsibility to wear class 2 rubber gloves when grounding trucks or equipment due to a possible difference in potential.

Exceptions

No rubber gloves are required:

- When working in a properly established equi-potential zone.
- When the operator remains at the same potential as the equipment by being off the ground and on the equipment.

- When a qualified worker performs transmission "hot stick" work on lines 69 kV or greater and no other energized wires are on the pole or structure below the worker.

- When work is performed on transmission structures carrying only energized conductors (115kV and above) and the Live Line Techniques are not being employed. While performing these activities, the worker shall utilize conductive clothing such as conductive gloves, boots, leg straps and/or any other applicable conductive clothing.

- When climbing a steel structure to perform structural reinforcements while maintaining MAD from energized conductors or apparatus.

- When climbing a steel structure to access an area that has been properly grounded.

4.4 Isolation of Energized Apparatus

1. **Non-Reclosing Criteria and Live-Line Maintenance and Construction:** The appropriate interrupting devices (breakers, reclosers, circuit switches, etc.) will be placed on NON-RECLOSING in accordance with National Grid tagging procedures.

2. **Tagging Out Lines or Apparatus**

   The National Grid Construction Supervisor or designee shall coordinate all switching and tagging in accordance with the most current EOP on Clearance and Control.

   Upon receipt of Clearance, the project representative will present the Contractor's Person in Charge with the "Contractor Permission to Work Form" (Form NG0060), which states the specific apparatus that has been de-energized and that certain device(s) are tagged in the Protective Position and will remain so until the Contractor's Person in Charge informs the construction supervisor or designee of the completion of the work utilizing the "Contractor Completion of Work" section of the "Contractor Permission to Work" form.

   The original transferred copy needs to be returned after the completion of work section is filled out & signed. In some cases the tailboard is outside & is susceptible to elements & damage; a copy shall be utilized in the field instead of the original.

No work will be performed until the “Contractor Permission to Work Form” is received from the construction supervisor stating that the equipment has been de-energized and a clearance to work has been given. The Contractors Permission to Work Form and a written grounding plan shall be attached to the crews Job Briefing and be kept at the work location.

After the “clearance” is received from the National Grid Construction Supervisor, the various substation conductor bus and equipment to be worked will be tested and “Grounds” installed. Grounds shall be rated for the fault current of the line/equipment being grounded. (Note: Rubber Gloves and FR clothing are required when installing and removing grounds). The contractors “Person in Charge” (Construction Supervisor/General Foreman) shall be responsible for determining the location and number of grounds.

Vehicles and equipment may utilize a single 4/0 cu for grounding inside the substation. Employees working on de-energized lines and equipment shall always work between grounds.

Prior to the application of any personal protective grounds, the circuit to be worked on must be tested for the presence of voltage using an approved potential detector. The worker must verify the detector is in operating order prior to and after testing for voltage. MAD must be maintained during the testing, and appropriate PPE shall be worn. Testing for voltage shall be done at the point where the grounding devices are to be attached. All phases of the circuit to be worked on shall be tested at each location that grounds are installed.

When an Air Gap is required to create a work zone, the component (a tap) shall be removed in whole from the system unless removal of the component is impracticable or creates an additional hazard based on National Grid management in charge of the job. If the component (a tap) is deemed impracticable to be removed in whole it shall be disconnected from one end, isolated from all other conductors and properly secured to ensure accidental energization will not create a hazard. When National Grid switches out lines or apparatus, any grounds that may be installed shall only be considered a visual reference, and shall not be considered a means to protect the Contractor’s employees. The Contractor is responsible to install their personal grounds, in accordance with all OSHA, Federal, State and local safety procedures. National Grid may provide guidance on the minimum size of the grounds to be used based on circuit available fault current. Refer to *Electric Operating Procedure D002,* for applicable grounding size. Ground rods shall be fully driven into the earth away from the workers and work area. T-Bar ground rods are not to be used on National Grid property.

The National Grid Construction Supervisor shall review the contractor's plan for the quantity and locations of grounds, ensuring that the work the contractor is performing is between grounds, covering all potential sources. All three phases shall be grounded. (In stations, from each phase to the station ground grid). Grounds shall be placed as close to the work area as reasonably possible, between the work area and all potential sources of inadvertent energization. A copy of the grounding plan shall be kept with the job safety brief.

It is the contractor's responsibility to account for all their grounds. The contractor shall provide, maintain, and enforce a ground tracking program suitable to National Grid. In the instance of a zone expanding/collapsing, remaining grounds shall be listed on the Contractor Permission to Work Form and verbally communicated to the construction supervisor.

3. **Grounding Mobile Equipment**

When mobile equipment requires grounding, it shall be solidly grounded by means of appropriate sized copper cable while using rubber gloves. The cable shall be fastened to a securely attached clean metallic portion of the equipment, or shall be fastened to a grounding stud provided for the purpose at one end and an adequate ground at the other end.

Non insulated booms such as digger derricks that have the possibility of encroaching the MAD shall be grounded and barricaded. The ground is to trip the circuit and the barricade is to protect anyone who may become in contact with the truck during this energization.

4. **Minimum Approach Distance (MAD)**

Refer to OSHA 29 CFR 1910.269 for more information and details regarding qualified and unqualified workers.

4.5 Appointment of a Safety Observer

A safety observer shall be required if an employee (operator) determines that it is difficult to accurately determine the distance between the equipment (minimum approach distance) and energized parts. The Safety Observer shall never be a substitute for minimum approach distance (MAD), personal protective equipment

(PPE), insulate/isolate techniques or work area identification as a form of employee protection.

The person in charge of the work (contractor or National Grid), shall appoint a qualified employee or employees to perform the task of a safety observer. The personal in charge shall:

1. Ensure a documented job brief is completed and includes the name of the safety observer, additional subjects such as the location of gas lines, energized equipment, in or adjacent to the work area and the limits of any de-energized work area
2. Discuss the scope of work and communication techniques used to warn or notify the equipment operator of hazardous conditions.
3. Communicate any changes to work and job completion to the safety observer
4. Select another safety observer if there is a need for the existing observer to have break in service.

The safety observer is a qualified employee who has been appointed by the person in charge based on the hazard assessment and the job brief. The safety observer shall:

1. Observe the worker performing the task/activity until all hazards have been eliminated or the task/activity has been completed
2. Have shown proficiency in the task/activity being observed and have a full understanding of the job and the hazards associated with the task/activity.
3. Remain continuously focused on the task/activity being performed and not perform or assist any other job activities while observing the worker performing the task/activity
4. Notify the person in charge if there is a need to have a break in service. Work must stop until a new observer is appointed or the safety observer returns.

A safety observer shall also be required when a critical lift is being performed. A critical lift plan shall be required during the following circumstances:

1. An object is lifted over energized apparatuses or assets where a failure of the lifting equipment or rigging could result in a significant safety hazard or cause significant disruption in service to National Grid customers.
2. The crane or other lifting apparatus is anticipated to be operated above 80% of its rated capacity for the specific load chart for the lift.

3. A man basket (pinned or suspended) is to be utilized. All fall protection rules shall be followed when in a man basket.
4. Two cranes will be used in concert to lift a single object
5. Internal substation construction involving all power transformers, control houses, capacitor banks and transmission breakers.
6. Lifts in LNG or Gas plants where a hazard assessment or job brief identifies a significant risk.
7. The lifted load will be less than twice the minimum approach distance (MAD) of the nearest energized part. Until a qualified electrical worker confirms the MAD, loads and equipment shall maintain a 20 foot distance. Once nominal voltage is established, the MAD will be according to OSHA tables.
8. The lifted load is hoisted over buildings or the general public.

4.6 Work Zone Traffic Control

1. If work activity is on or near a road, the contractor and their subcontractors shall comply with all applicable parts of the most current US Department of Transportation's Manual on Uniform Traffic Control Devices (MUTCD), state, local Work Zone Traffic Control requirements and the National Grid Work Zone Traffic Control Manual. Please contact your National Grid representative for a copy of the manual found in the Safety Homepage on the Grid:home.

2. If pedestrian traffic is disrupted, pedestrians should be provided with a path that is reasonably safe, convenient and accessible. Pedestrians should not be led into conflicts with work site vehicles, equipment or operations.

3. If working in areas covered by state permits issued to National Grid, contractors shall comply with the provisions (work practices and notifications) of the permit language. These permits must be available on the job site upon request.

4.7 Qualified Gas Worker

Applies to gas projects/activities

1. Gas contractor employees will be operator qualified as required and defined according to the Code of Federal Regulations, Transportation, 49, Subpart 192.801 through 192.809.

2. Until these qualified employees have demonstrated proficiency in the work practices involved, they are considered employees undergoing on-the-job training and must be under the direct supervision of a qualified person at all times. According to the definition of a "qualified employee", the employee also must have demonstrated an ability to perform work safely at his or her level of training.

3. National Grid requires contractors with gas qualified employees to provide documentation on how they qualify their workers.

4. Additionally any qualifications' of contractor personnel shall be in full accordance with the Company's Operator Qualification written plan, (OQ Plan) Refer to the most current list of covered tasks in accordance with National Grids' Operator Qualification Program and the Northeast Gas Association, (NGA).

4.8 Qualified Electrical Worker

Applies to electrical projects/activities

1. According to 1910.269(a)(2)(ii), a qualified electrical employee must be trained and competent in the following prior to starting work:
    - The skills and techniques necessary to distinguish exposed live parts of electrical equipment
    - The skills and techniques necessary to determine the nominal voltage of exposed live parts
    - The MAD specified in 1910.269 corresponding to the voltages to which the qualified employee will be exposed
    - The proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment

2. Until these qualified employees have demonstrated proficiency in the work practices involved, they are considered employees undergoing on-the-job training and must be under the direct supervision of a qualified person at all times. According to the definition of a "qualified employee", the employee also must have demonstrated an ability to perform work safely at his or her level of training.

3. National Grid requires contractors with electrically qualified employees to provide documentation on how they qualify their workers.

4.9 Qualifying Non-Electrical Worker

Applies to: All qualifying non-electrical contractors working near energized lines and equipment; as needed

1. The contractor shall provide orientation for non-electrical workers entering and working within restricted areas such as a substation and those working near energized lines and equipment.

2. The information provided to these workers must meet the requirements of paragraph 1910.269(a)(2)(ii). However, the orientation and training may not be as comprehensive as the qualified electrical worker would be.

   They must know:

   - What is safe and not safe to touch in the specific areas they will be entering;
   - The maximum voltage of the area;
   - The MAD for the maximum voltage within the area;
   - Proper use of personal protective equipment and in the work practices necessary for performing their specific work assignments within the area.

3. Until these workers have demonstrated proficiency in the work practices involved, they are considered to be employees undergoing on-the-job training and must be under the direct supervision of a qualified person at all times.

4.10 Asbestos, Lead and other Hazardous Materials

1. Asbestos and lead materials associated with electrical and gas equipment includes, but is not limited to: cement-type cable covering, cable wrap, wire coatings, coal tar pipe wrap, and transite panels and conduits. Asbestos and lead materials may also be present in building materials including but not limited to: paint, mastics, caulking, insulation and roofing materials.

2. Where asbestos and other hazardous material is present and likely to be disturbed, the National Grid project representative and contractor shall coordinate how the asbestos, lead or other hazardous materials will be

managed and shall consult National Grid's Safety & Environmental department as appropriate.

3. Removal of this material must be done by individuals specifically trained and qualified to handle asbestos and lead. Refer to National Grid Safety Procedures, F-615, F-617 and F-619 for guidance on asbestos and lead handling and removals. For more information, contact a National Grid representative for a copy of these procedures.

Note: Contractors who will encounter asbestos or lead as part of their work shall reference in their safety plan how they will address this hazard.

4.11 Lift Plans for Work Near Energized Electrical Equipment

1. All work involving hoists, cranes or other lifting equipment **within 10' of energized electrical equipment** must have a detailed lift plan/procedure.

2. As a minimum Lift Plans shall include the following:

    a. Designated Operator and Signal person

    b. Detailed travel and flight path that ensures the boom and material being raised is controlled 100% of the time and will maintain the appropriate clearance

    c. Designated cover up and isolation to ensure employee and equipment safety in the event of an unplanned action or failure

    d. Emergency action plan with detailed instructions to respond to unplanned/uncontrolled event during the lift or positioning of the lifting equipment.

    e. Documented load weight and equipment lifting limits

    f. Rigging equipment and methods that will be used during the lifting. Sign off/approval from the management official responsible for the work

4.12 Fall Protection

1. Fall protection or fall restriction devices shall be used when working at heights over 4 feet. When using portable straight and extension ladders,

three points of contact shall be maintained. If 3 points of contact cannot be maintained a work positioning belt is required.

Step ladders shall be set up on level and stable surfaces, fully open with braces locked. Work positioning belts are not required for properly set up step ladders.

2. All fall protection shall be inspected before use each day to determine if equipment is in good working condition. Defective equipment shall not be used and shall be removed from service.

3. A worker may enter or exit an aerial lift (at heights above four (4) feet) provided that fall protection such as guardrails or a fall arrest system is used while the worker moves between the lift and the working surface. Before any such transfer is made, the employee shall be properly tied-off to an adequate support, the pole or structure prior to and in the direction of the transfer.

Exceptions to fall protection shall be in accordance with Federal & State requirements.

4.13 Herbicide Application

1. Vegetation spraying shall be conducted unescorted only by contractor employees who have been designated as a Qualified Electrical Worker, where applicable.

2. The spray applicator shall have ID cards issued by Security with background checks available from the contractor.

3. National Grid management shall require a schedule of the spraying in their areas.

4. Once spraying begins, the contractor must contact local management on a daily basis to inform them of progress or changes to the schedule.

5. The contractor shall post all stations with dated signs indicating when the station was sprayed. These signs should not inhibit access to the station.

6. The contractor shall ensure that any stored materials and equipment do not get covered with “overspray”. Overspray represents a substantial safety hazard and cannot be allowed.

7. When applying herbicides, contractor employees shall wear appropriate PPE in accordance with product labels.

5.0 UNDERGROUND OPERATIONS WORK

In addition to the other requirements referenced in this document, this section covers requirements that are specific to underground operations work.

5.1 PPE Requirements

All contractors shall comply with the applicable PPE and WZTC requirements referenced in Section 4.0.

5.2 Enclosed Space Assessment, Ventilation, Entry and Rescue

Refer to the National Grid EOP-UG006 *Underground Inspection and Maintenance* and National Grid Safety Procedure I-902 *Enclosed Space Procedure* for more information regarding enclosed space requirements.

1. Contractors are required to follow all procedures in this document in regards to enclosed spaces (manholes, sidewalk vaults, etc.), including assessment, ventilation, entry and rescue.

2. Each enclosed space shall be tested prior to removing manhole lids and entry. Atmospheric testing shall be continuous for the duration of the entry using a calibrated, industry approved atmospheric tester.

3. When performing hot lead work or when indicated by atmospheric monitoring, engineering controls such as forced mechanical ventilation shall be used when working in National Grid manholes at all times.

4. All contractors who are qualified electrical workers will treat these spaces as “enclosed spaces” and follow non-entry rescue provisions.

5. In some situations a boom is allowed for retraction from an enclosed space. Refer to Safety Procedure I-902 for more information.

6. Steel cable or wire rope for non-entry rescue is prohibited.

5.3 Equipment Safety Inspection

1. Inspect underground facilities (manholes, vaults, hand holes, splice boxes, junction boxes, pad mount transformers, switchgear and submersible equipment, etc.) each time a crew performs work at one of these facilities. All separable components in these facilities shall be inspected by infrared instrumentation. A National Grid representative can provide details from the

National Grid EOP-UG001 *Infrared – Non-Contact Thermometer Inspection Requirement for Underground Equipment* for more information.

2. The infrared (IR) thermometer or camera shall, at a minimum, have a range of -25°F to 1400°F with a plus or minus 1% accuracy. For more details and current operating procedures, contact a National Grid representative regarding EOP UG001.

3. The format for data collected shall follow the National Grid EOP UG006 *Underground Inspection and Maintenance* requirements. Please contact a National Grid representative for more information.

4. "Touch Potential" testing of metal street lighting poles is required as a part of any maintenance work. For more information, a National Grid representative can provide a copy of the National Grid EOP G016 *Elevated Equipment Voltage Testing* and National Grid Work Methods Bulletin #04-26 *Touch Potential Testing of Metal Street Lighting Poles.*

5. Touch Potential testing results shall be recorded on the job safety brief and the manhole inspection form which shall be given to the National Grid Construction Supervisor or designee.

6. All contractors working for National Grid shall use materials and equipment in accordance with the manufacturing guidelines. It is the contractors' responsibility to understand the manufacturers' limits and prescribed use of their tools and equipment before each use.

7. Workers shall test and verify that the underground cable is de-energized and guillotine the cable if needed from outside the hole. Rubber gloves shall be worn at all times while performing this task.

6.0 OVERHEAD LINE WORK

In addition to the other requirements referenced in this document, this section covers requirements that are specific to overhead line work.

6.1 PPE Requirements

All contractors shall comply with the applicable PPE and WZTC requirements referenced in Section 4.0. In addition, contractors will follow ground-to-ground and cradle-to-cradle use of rubber gloves while performing work on energized overhead lines. Any foreign wire, including those on a pole or structure constitutes an energized source and requires the use of rubber gloves (ex: Cable TV, telephone, fire alarm wire, etc.).

6.2 Fall Protection

All contractors who climb structures such as wood poles or transmission towers shall utilize enhanced fall protection equipment (fall arrest devices) and techniques (ex: *Buckingham Buck-Squeeze, Miller StopFall* or *Jelco Pole Choker*). When working on wooden and steel structures, a full body harness and lanyard shall provide 100% fall protection at all times (100% tie off, Shepperd's Hook, etc.). Climbers shall never be allowed to drop or slide down a pole or structure more than two feet.

Exceptions to fall protection shall be in accordance with Federal & State requirements.

6.3 Pole/Structure Inspection

Contractor shall ascertain the structural integrity of the pole or other structure prior to installation, removal, repair or modification of the equipment on the structure.

1. Prior to climbing any pole, an inspection and test of the condition of any pole being climbed shall be performed. The weight of the employee, the equipment being installed and other working stresses (such as the removal or re-tensioning of conductors) can lead to the failure of a defective pole or one that is not designed to handle the additional stresses.

2. If the pole is found to be unsafe to climb or to work from, it must be secured so that it does not fail while an employee is on it. The pole can be secured by a line truck boom, by ropes or guys, or by lashing a new pole alongside it. [29 CFR 1910.269(q)] If measures cannot secure the pole, the contractor must cease operations and notify the National Grid Construction Supervisor or designee

6.4 Electrical Work Methods

1. Jumpers of any type shall not be used to keep transformers, risers or transformer banks energized for the purpose of changing potted porcelain cutouts. A National Grid representative can provide information to the National Grid Electric Operation Procedure (EOP) D001 *Cutouts – Open Type* for more information.

2. Potted porcelain cutouts must be changed out when work is being completed on a pole even if this is not planned in the scope of the work provided.

3. Properly rated and inspected slings, chains or tongs shall be utilized to move poles and equipment. Winch lines must not be wrapped around poles or looped around transformer ears to lift without a sling or chain.

6.5 Transmission Overhead Lines

1. For work on transmission circuits, red tape shall be placed around any energized pole, pole structure, or tower adjacent to the de-energized line.

2. When one circuit of a double circuit pole or tower line is de-energized for work, a red or orange flag shall be placed on the energized side of the pole or tower nine feet below the lowest energized conductor. In addition, a red or orange flag shall be placed on the lower cage on the side toward the energized circuit at each arm level as employees work on them or pass them.

3. All contractors using ATV's, UTV's or RTV's for transmission or forestry work, are required to follow all local OHRV requirements for PPE and driving safety. Training shall include classroom and in-field instruction as well as a formal driving assessment on an annual basis for each type of vehicle planned for use: i.e. UTV specific training for UTV's and ATV specific training for ATV use. All contractor employees must be fully trained and qualified before use. Proof of individual operator training certifications for each operator shall be available at all times. US DOT rated helmets and safety glasses/goggles are required for any vehicle that does not have a seatbelt and a roll cage. In equipment with a roll cage and seatbelt, operators can utilize a hard hat and chin strap.

4. At the end of each day, unless other arrangements have been made for an extended outage, grounds will be removed and the National Grid project representative will be notified that all personnel are "clear" of the conductor bus work and equipment.

5. Wherever transmission line workers "touch" wires, a personal ground shall be installed at the work area to establish an equipotential zone, unless workers are engaged in live-line barehand work (29 CFR 1926.964)

7.0 SUBSTATIONS

In addition to the other requirements referenced in this document, this section covers requirements that are specific to substations work.

For additional information, a National Grid representative can provide a copy of the National Grid Substation Maintenance Procedure SMP 499.01.2 *Protective Grounding Procedure* under the Substation Work Methods Grid:home page for specifics regarding substation grounding practices.

Grounding plans for substation, major distribution and transmission projects will be submitted to the National Grid construction supervisor a minimum of 1 week prior to construction for review. This plan will show the steps, work area limits and ground cable size and amount. Once reviewed with the National Grid and prior to starting the job, the plan will be reviewed by the contractors with all employees and subcontractors on the project.

The use of an “Equipotential” step/platform or a conductive mat is required for access and egress from the following:

a. Crane or any other equipment, including aerial lift equipment, that is connected to the substation ground grid and/or bonded to transmission line conductors when working outside of the station fence
b. In the rights-of-way
c. In areas inside the substation where there is no ground grid present.

When work is performed inside the substation and there is a ground grid available, the “Equipotential” step/platform or conductive mat is not necessary.

All vehicles shall be grounded and barricaded per OSHA standards and the National Grid Electric Operating Procedure G026 *Mechanized Equipment Grounding*.

Proper clearances shall be maintained from adjacent energized substation bus, energized portions of substation equipment and other transmission lines at all times.

Use of proper insulated tooling (shotguns and sticks) shall be utilized per NECA standard maintaining MAD.

7.1 PPE Requirements

1. All contractors shall comply with the applicable PPE and WZTC requirements referenced in Section 4.0.

2. Contractors who perform any ground breaking activities in a substation within a pre-marked area will require Dig Safe marks to be in place; otherwise, the job must be suspended and the National Grid construction supervisor or project representative shall be notified of the condition.

3. When using non-insulated man-lifts, and if provided by the manufacturer, a secure point of attachment for lifelines, or lanyards or deceleration devices shall be utilized, independent of the means to support or suspend the employee. Workers feet shall also always remain on the floor.

7.2 Notification of Control Authority When Entering a Substation

1. When a contractor enters and exits a National Grid substation, the contractor shall ensure that the System Control Center is notified. While work is being conducted, gates must be monitored at all times or the gates shall be locked. For more information, contact a National Grid representative regarding National Grid EOPG022 *Substation Security*.

2. Unescorted entry in substations can only be provided to contractors who provide assurance that their employees and subcontractors are electrically qualified as specified in 29 CFR 1910.269. Refer to Section 4.0 of this document

3. All National Grid specifically identified bulk power stations will require NERC-CIP training, certification and approval prior to entry to those sites.

7.3 Substation Work Area Identification (SWAI)

1. Contractors who will be working in substations shall follow the SWAI procedure. National Grid will provide a copy of this procedure if required by the project. For more information, contact a National Grid representative regarding National Grid SMP499.10.2 *Substation Work Area Identification Procedure*.

2. Qualified contractors as referenced in section 4.8 of this document shall install their own work area identification. National Grid shall arrange work area identification for non-qualified workers as required.

3. Designated storage areas for items not being used will be posted in the yard and should be the only place these items are kept.

8.0 GAS OPERATIONS WORK

In addition to the other requirements referenced in this document, this section covers requirements that are specific to Gas operations work. For more information, contact a National Grid representative regarding National Grid General Safety Requirements SHE1001 *Gas Policy* which can be found following this link:
http://dc-gasweb1/MelSite/WMSafetyAll.asp .

8.1 PPE Requirements

1. All contractors shall comply with the applicable PPE and WZTC requirements referenced in Section 4.0.

2. The contractor shall wear all appropriate PPE and Class 2 rubber gloves for personal protection when digging or probing within 2 feet of known electrical conductors and when the location of energized conductors is unknown.

8.2 Gas Operations

1. Any contractor who performs covered tasks shall be operator qualified (OQ) as defined in the DOT Title 49 CFR, Subpart N and all applicable state requirements pursuant to the state the contractor is working in. Additionally, any qualifications of contractor employees shall be in full accordance with the Company's Operator Qualification written plan, (OQ Plan) Refer to the most current list of covered tasks in accordance with National Grids' Operator Qualification Program and the Northeast Gas Association, (NGA).

    a. The Operator Qualified status of contractor employees must be regularly updated and accessible through the ISN system. This listing must detail employees' current tasks they are qualified for, the next recertification date, associated documentation and a documented annual acknowledgement in ISN on their qualified workers as referenced in section 3.1 of this document.

    b. Contractor personnel involved with covered tasks may require certification by National Grid and an orientation of the involved tasks and National Grid Company standards. National Grid reserves the right to validate contractor qualifications prior to performing Live Gas work.

    c. Atmospheres are to be tested with a properly calibrated Combustion Gas Indicator (CGI) or Gas Measurement Instrument

(GMI) in accordance with National Grid excavation procedures as required.

d. Each employee in an excavation shall be protected from cave-ins by an adequate protective system, such as sloping, benching or an appropriate shoring system. For more information, contact a National Grid representative regarding National Grid Safety Procedure M-1301 *Standards for Working in Excavations.*

9.0 FORESTRY AND VEGETATION MANAGEMENT

In addition to the other requirements referenced in this document, this section covers requirements that are specific to vegetation management work.

9.1 PPE Requirements

1. All contractors shall comply with the applicable PPE and WZTC requirements referenced in Section 4.0.

2. Flame Resistant Clothing is not required per the applicable OSHA Forestry standard. Forestry contractors must instead wear natural fiber clothing when working within 10 feet of energized equipment.

3. Forestry contractors must wear a properly adjusted full-body fall protection harness connected to an appropriate lanyard when working from an aerial lift. The lanyard must connect to an attachment anchored to either the boom or bucket mounting hardware. Attachment points anchored through only the fiberglass portion of the bucket are not acceptable.

4. Forestry contractors will be required to wear chaps while operating a chainsaw or when assisting and/or working in close proximity to a chainsaw that is being operated.

5. Saws shall not be left unattended with the engine running.

6. When a contractor employee carries a saw, the engine shall be off and/or covered or the saw shall be carried with the blade to the rear and locked.

7. Tree crews will not be allowed to fly their buckets in between the primary and secondary cables if the MAD will be violated in process of doing so.

9.2 Equipment and Work Methods

1. Forestry contractors shall utilize fiberglass sticks and stick saws for work around energized equipment. Additionally, integrity tests shall be performed and documented annually. Test results and expirations shall be available on each vehicle as needed.

2. Forestry contractors shall perform and document dielectric testing of all aerial units annually. Test results and expirations shall be available on each vehicle as needed.

3. For lump sum or unit price mileage trimming projects, a single foreman may supervise up to four (4) bucket trucks on the same project. The minimum qualifications for the "lead" person on each of the other trucks shall be a Journeyman Tree Trimmer or equivalent (Qualified Line Clearance Tree Trimmer). At least one other employee on the truck shall be an OSHA defined, Qualified Line Clearance Tree Trimmer Trainee. For Upstate New York only, it is understood that a Qualified Line Clearance Tree Trimmer shall carry the title, wage and benefits as outlined in IBEW LU 1249's existing contract of a Journeyman Treeman and that a Qualified Line Clearance Tree Trimmer Trainee shall carry, at a minimum, the title, wage and benefits as outlined in IBEW LU 1249's existing contract of a Treeman Trainee, 2nd year.

9.3 Training

1. Forestry contractor management will be required to attend safety council meetings hosted by National Grid as required. The contractor shall ensure that all appropriate safety personnel for the National Grid territory are in attendance.

2. Forestry contractors shall implement and provide the required training and certification programs necessary to provide OSHA defined Qualified Line Clearance Tree Trimmers or Qualified Line Clearance Tree Trimmer Trainees. Contractors shall be able to provide the documentation relative to these training and certification programs upon request by National Grid. Forestry contractors shall provide an updated HASP by April 1st of each year for all work being conducted at National Grid.

3. All contractors using ATV's, UTV's and RTV's for transmission or Forestry work are required to follow all local OHRV requirements for PPE and Driving safety

10.0 LNG PRODUCTION, TRANSPORT AND HANDLING

In addition to the other requirements referenced in this document, this section covers requirements that are specific to LNG Production facilities.

All contractors working at LNG plants will sign in and out of plants daily in the contractors log book. All other gas supply facilities and subcontractors require authorization under the contractor management official. If required by the project, trained National Grid plant personnel shall initially, and as needed, review and re-issue as needed, a work permit process which shall which describe the work being performed, valves with their locations and Lock-out/Tag-out numbers.

10.1 PPE Requirements

1. All contractors shall comply with the applicable PPE and WZTC requirements referenced in Section 4.0 and shall include FR outer clothing.

2. Cryogenic protective gloves/gauntlets and face shields are required when making connections to load / unload LNG. National Grid retains the right to enhance PPE requirements as conditions warrant. The use of additional PPE shall be based on the task performed and the PPE matrix for work in production plants.

10.2 Training

1. Contractors who transport LNG/propane at National Grid facilities are required to be certified in first aid/CPR and are required to complete frost-bite awareness training. Documentation of training records shall be maintained in the ISN system.

2. National Grid expects contractors working at LNG plants to meet the requirements of 49 CFR 193 Subpart H for health, training or experience and/or any applicable National Grid procedures that supersede the above requirements. Contractors shall provide documentation on their qualified workers, as referenced in section 3.1 of this document.

3. All Contractor personnel performing work in LNG plants must meet the requirements of the National Fire Protection Association (NFPA), part 59.

11.0 ELECTRIC GENERATION

In addition to the other requirements referenced in this document, this section covers requirements that are specific to Electric Generation.

11.1 PPE Requirements

1. All contractors shall comply with the applicable PPE and WZTC requirements referenced in Section 4.0

2. Hearing protection is required when working anywhere inside a generation plant and/or outside the plant where noise may be excessive. Acoustic barriers shall be maintained by the contractor as needed.

3. Safety shoes with a minimum height of six-inches are required in Generation plants.

4. Contractors working in generation plants are required to wear 8-Cal clothing protection. For additional guidance, a National Grid representative can provide reference to Electricity Distribution Operations Grid:home webpage under Electric Generation's Policies and Procedures EGO-028 *Personal Protective Clothing* & EGO-029 *Personal Protective Equipment*.

11.2 Training

1. Required training may include; PCB's, asbestos, mercury, confined space awareness and excavation competent person requirements. HAZCOM is required by contractors working in generation plants as applicable.

2. Contractors who work at a National Grid Generation Station shall attend an orientation regarding plant safety and as required, US Coast Guard Maritime Security (MARSEC) policies.

3. Equipment training is required per federal, state and local regulations and National Grid procedures. Operators of any powered industrial vehicle must be qualified and documentation shall be documented.

11.3 Equipment & Excavations

1. All excavations shall be performed in accordance with EGO-0005 *Procedure for Excavation in National Grid Generation Facilities* and National Grid Safety Procedure M-1301 *Standards for Working in Excavations.* For additional information, contact a National Grid representative for copies.

2. Gasoline and diesel powered fork trucks shall NOT be used inside the plant or other enclosed facility. Only propane/electric fork trucks are permitted except where additional hazards may exist.

3. All wood products necessary for the work must be made of flame retardant material.

11.4 Equipment Isolation

For isolation of hazardous energy sources while working in Generation plants, please contact a National Grid representative regarding EGO-0010, *Control of Hazardous Energy Sources-Work Permit System.*

12.0 CIVIL CONSTRUCTION

In addition to the other requirements referenced in this document, this section covers requirements that are specific to civil construction work.

12.1 PPE Requirements

1. All contractors shall comply with the applicable PPE and WZTC requirements referenced in Section 4.0.

2. Rubber gloves shall be worn while carrying out work in and around energized or identified direct buried lines, live duct banks, transformer enclosures, manholes, switch gear and other electrical apparatus when performing civil investigations, installations or repairs.

12.2 Enclosed Space Assessment and Ventilation

Contact a National Grid representative regarding the National Grid EOP-UG006 *Underground Inspection and Maintenance* and National Grid Safety Procedure I-902 *Enclosed Space Procedure* for more information regarding enclosed space requirements.

1. Contractors are required to follow all procedures in this document in regards to enclosed spaces (manholes, sidewalk vaults, etc.), including assessment, ventilation, entry and rescue.

2. Each enclosed space shall be tested prior to removing manhole lids and entry. Atmospheric testing shall be continuous for the duration of the entry using a calibrated, industry approved atmospheric tester.

3. When performing hot work or when indicated by atmospheric monitoring, engineering controls such as forced mechanical ventilation shall be used when working in National Grid manholes at all times.

7. All contractors who are qualified electrical workers will treat these spaces as “enclosed spaces” and follow non-entry rescue provisions.

8. In some situations a boom is allowed for retraction from an enclosed space. Refer to Safety Procedure I-902 for more information.

9. Steel cable or wire rope for non-entry rescue is prohibited.

12.3 Equipment Safety Inspection

All contractors shall comply with the applicable equipment safety inspection procedures referenced in Section 5.3

12.4 Excavation Requirements

All excavation work shall be performed under the control of a competent person. All soils in National Grid territories are to be considered class “C”, considered unstable and shall require all excavations be performed in accordance with OSHA 1926.651, EGO-0005 *Procedure for Excavation in National Grid Generation Facilities* and National Grid Safety Procedure M-1301, *Standards for Working in Excavations.* For more information, contact a National Grid representative for a copy.

Crews that are performing Excavations shall include an excavation log with their job brief that states the soil type, expected depth and length as well as final depth and length. All required steps need to prevent collapse will be documented on this form as well prior to entry.

Protective systems shall be used for certain manhole installations. These scenarios are covered below:

- The hazard assessment, competent person and/or National Grid supervisor deems it necessary
- If an excavation for a manhole in a roadway is completed and installation of manhole and backfill is not able to be done before the day is complete, a protective system will be required before road plating
- Installation of any manhole 3 way or greater in size/

Where trench boxes are required to be built on site, the contractor shall submit a PE stamped plan and the location shall be designated on the excavation drawings.

All lifts (not limited to materials and equipment) shall be planned and rigged by a competent person. A lift plan shall be provided for all “critical lifts” and must be submitted by a qualified professional to the National Grid representative prior to the lift taking place.

12.5 Cable fault finding and replacements

For excavation work needed to support faulted cables and emergency cable locates, the use of Cable Avoidance Tooling (CAT) shall be used in addition to Dig Safe requirements as an added safeguard to further pin point unidentified buried cables.

For excavations within the tolerance zone, all hand digging in and around direct buried cables shall require basic PPE, non-metallic handled shovels, rubber gloves, FR clothing and EH rated work boots with Dielectric (DI) over shoes.

All excavation equipment shall be grounded in accordance with NG EOP G026. For additional information, contact a National Grid representative.

The use of GPR (Ground Penetrating Radar) shall also be required to verify the Dig Safe/811 locates after award of the project and prior to excavation. This shall include electric URD, UCD and Substation projects.

12.6 Technical Review

Where and when applicable, all trench and excavation work shall be reviewed and stamped by a civil PE in the state of record and will be executed under the supervision of a trenching and excavation competent person. All leading edges of trenches and excavations shall be appropriately demarcated, clearly posted and controlled to prevent unauthorized persons from entering and inadvertently falling into the excavation. All trenches and excavations shall be closed as soon as practical/possible. All excavations shall be fully controlled for the duration of the exposure by adequately substantial means to withstand the environment and conditions expected to be present.

All pot holing/test holing and exploratory excavations shall utilize vacuum excavation whenever near known underground utilities or hazards, and when the potential for unknown hazards such as live electrical or gas conveyances exist. When using vacuum extraction in combination with air blowing/air knife tools, all persons in the immediate area shall be wearing safety glasses in addition to a full face shields.

13.0 CONSTRUCTION PROJECTS AT CONTAMINATED SITES

In addition to other requirements referenced in this document, all work on contaminated sites must be conducted per the requirements of 29 CFR 1910.120, including the worker qualification and training requirements of 1910.120(e).

14.0 AVIATION

1. Helicopter Crews of two or more shall perform a preflight documented job brief.

2. Helicopter work shall require the use of aviation helmets for both the pilot and passengers.

3. Helicopter pilots and passengers shall participate in the "Flying in the Wire and Obstruction Environment" training prior to flight.

4. Helicopter pilots shall meet the following minimum flight time experience:
   a. 2000 hours as Pilot in Command or Second in command of a rotor craft
   b. 1000 hours in a turbine rotorcraft / helicopter
   c. 100 hours in a helicopter of the make and model to be utilized at National Grid
   d. 300 hours flight time in Wire Environments

For more information, contact a National Grid representative for a copy of EOP T012 *Helicopter Utilization & Notifications.*

15.0 TRANSPORTATION RISKS

Contractor shall define transportation related activities that can have potential process safety consequences. National Grid shall determine if additional risk assessment is needed and contractor shall participate in the assessment. Contractor shall modify their process to mitigate risk that is determined to be intolerable.

APPENDIX A: NATIONAL GRID CONTRACTOR RISK MATRIX

National Grid Contractor Risk Matrix

Category	**Description of Work**	**Impact of Work**	**Examples to be included in this category (including, but not limited to)**
Medium / High Risk Exposure **Tier I** **Inclusion in ISN Program is Required**	Physical Work, activity, or service that is performed on National Grid property site or is performed off-site where Owner Client has responsibility and is liable for work performed. Includes, but is not limited to, any activity requiring confined space entry, elevated work, work on operating systems involving hazardous energy, work on contaminated sites, and most work requiring a general work permit, hot work permit, or confined space permit.	Work, activity, or service having: • A potential for causing a catastrophic operational incident; • Access to operations; and/or • A direct role in site operations or maintenance, where failure could result in serious harm to employee or public well-being, company assets, or the environment Also includes any Contractor personnel's job function which has no direct or very limited supervision for operational checks.	• Maintenance, Construction and demolition contractors • Chemical cleaning, tank cleaning • Electricians and Instrumentation Technicians • Movers • Welding • Heavy equipment operations • Well drilling and testing • Environmental investigation, remediation, monitoring activities • Hazardous waste handling and/or transport • Excavation • Food service and handling • Equipment Inspection (e.g., X-ray & other NDT) • On-site sampling / gauging activities (not including escorted storm water sampling) • Common carriers transporting Owner Client-owned LNG or petroleum products • Landscaping services • Snow Removal • Janitorial services

			• Vacuum truck affecting/involving process operations • Oil Spill Response Organizations (OSRO) • Work conducted in a high-risk area (i.e. substations, LNG plants, etc.) • Working at elevations greater than 4 ft (includes, but is not limited to): ○ Working in buckets (includes technical advisors) • Working on ladders (straight ladders, extension ladders or step ladders taller than 4ft)
Low Risk Exposure **Tier II** **Inclusion in ISN Program is NOT Required**	Work that is office based such as: • Consultants that do not perform work or activities as described in the Medium/High Risk exposure category • Offsite services • On-site vendor pick-up/delivery and repair services • Work performed by public and private utilities	Work, activity, or service having an indirect role and no, or limited, access to operations or maintenance where failure could result in serious harm to employee or public well-being, company assets, or the environment.	• Mail/package/part delivery or pick-up (e.g. UPS, Fed EX, vendor-specific) • Samples pick-up by laboratory/courier • Office machine servicing (copiers, printer, computer, etc.) • Laboratory apparatus servicing • Storm water Sampling Labs/Contractors (When Escorted by Owner Client personnel) • Deliver/supply services (vending machine, bottled water, laundry) • Municipal waste pick-up • General trash removal services • Off-site repair/fabrication shops (such as pump, safety valve, piping, vehicle)

	• Personnel on-site with Visitor Status, when escorted		• Telephone, electric, local municipal utility services • Regulatory representatives • Technical representatives • Engineering services (when escorted by Owner) • Auditors
A SHE VP can require any contractor to be part of ISN when deemed as a potential risk to National Grid			

Appendix B

Community Air Monitoring Plan

Community Air Monitoring Plan
Williamsburg Works Site

In accordance with NYSDEC and NYSDOH requirements for a Community Air Monitoring Plan (CAMP), a perimeter air-monitoring plan will be implemented at the site during each phase of the field activities. The objective of the perimeter air-monitoring plan 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 involved with the site field activities) from potential airborne contaminant releases as a direct result of field activities. The perimeter air-monitoring plan is a stand-alone document and will be available on site. The VOC Monitoring, Response Levels, and Actions are presented as follows.

Air Monitoring Response Levels and Actions

	VOCs
Response Level	**Actions**
>5 parts per million (ppm) above background for 15-minute average	▪ Temporarily halt work activities ▪ Continue monitoring ▪ If VOC levels decrease (per instantaneous readings) below 5 ppm over background, work activities can resume
Persistent levels >5 ppm over background <25 ppm	▪ Halt work activities ▪ Identify source of vapors ▪ Corrective action to abate emissions ▪ Continue monitoring ▪ Resume work activities if VOC levels 200 feet downwind of the property boundary or half the distance to the nearest potential receptor is <5 ppm for a 15-minute average ▪ If VOC levels are >25 ppm at the perimeter of the work area, activities must be shutdown
	Particulates
Response Level	**Actions**
>100 µg/m^3 above background for 15-minute average or visual dust observed leaving the site	▪ Apply dust suppression ▪ Continue monitoring ▪ Continue work if downwind PM-10 particulate levels are <150 mcg/m3 above upwind levels and no visual dust leaving site
>150 µg/m^3 above background for 15-minute average	▪ Stop work ▪ Re-evaluate activities ▪ Continue monitoring ▪ Continue work if downwind PM-10 particulate levels are <150 µg/m3 above upwind levels and no visual dust leaving site

Sources:

New York State Department of Health Community Air Monitoring Plan, June 20, 2000

New York State Department of Environmental Conservation Division Technical and Administrative Guidance Memorandum – Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites, October 27, 1989.

Appendix C

Field Sampling Plan

GEI Consultants

Consulting
Engineers and
Scientists

Field Sampling Plan
Portion of the Williamsburg Works Site

Brooklyn, New York
AOC Index No. A2-0552-0606
Site #: 224055

Submitted to:
National Grid
One MetroTech Center
Brooklyn, NY 11201

Submitted by:
GEI Consultants, Inc., P.C.
455 Winding Brook Drive, Suite 201
Glastonbury, CT 06033
860-368-5300

July 2021
Project 093060

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Section 1

Introduction

STANDARD OPERATING PROCEDURE

1. Introduction

This document presents the Standard Operating Procedures (SOPs) for the Atlantic and New England Regions of GEI Consultants, Inc. (GEI). The primary intent of the document is to promote consistency in application of Standard Operating Procedures (SOPs) for environmental field and some office operations. Application and use of SOPs will be considered and may be discussed in annual staff reviews.

This SOP document encompasses a broad range of activities to improve the planning, implementation, and documentation of most environmental field and some office operations. The methodologies presented in this manual may not be applicable to site-specific situations. If you are uncertain about a procedure, confirm its adequacy with the project manager, client, and/or regulatory bodies to confirm that procedures are consistent with their expectations.

The document is organized according to the chronological sequence of typical work flow proceeding from project setup to field activities, data collection, and report preparation tasks.

Two types of documents are contained herein:

- General Guidance Procedures – Documents intended to be informative and not prescriptive. These documents are designed to provide necessary background information to adequately understand the process.
- Standard Operating Procedures – Documents intended to describe standard procedures and limitations.

2. SOP Layout Design

2.1. Header Information

- Each SOP contains within its name a two letter abbreviation of the general category in which it belongs (i.e. RE-001 means it is in Site Reconnaissance). 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. The revision number is provided in the header of each SOP.
- 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

- Each footer contains the page number and total page numbers as well as a second reference to the SOP name. This should help organize and collate pages.

2.3. Body of Text

- Limitations are provided to describe precautions or common issues associated with the performance of the procedure.
- References provide sources consulted for development of the SOP.
- Attachments provide reference to external documentation that should be reviewed in conjunction with the SOP.
- At least one contact person is provided at the bottom of each SOP. These people should be contacted with any questions or comments on the particular SOP. The contact can clarify the SOP or edit as necessary.

2.4. Process for editing/updating SOPs

Should you need to make a global change to an existing SOP, the current .pdf version can be found on the Intranet.

In order to make your changes, you will need to request a WORD copy of the SOP from Andrea Hippler or Ryan Hoffman. Once you have made your changes, the SOP should be e-mailed to Andrea Hippler and Ryan Hoffman with a note as to what changed.

This document has been provided to all staff performing environmental field tasks for GEI's Atlantic and New England Regions.

3. Attachment

Attachment A – Acronym List

STANDARD OPERATING PROCEDURE

Abbreviations and Acronyms

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
CERCLA	Comprehensive Environmental Response, Cleanup, and Liability Act
CFR	Code of Federal Regulations
COC	Chain of Custody
DL	Detection Limit
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DQO	Data Quality Objectives
EC	Engineering Controls
EIS	Environmental Impact Study
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FS	Feasiblity Study
FWRIA	Fish and Wildlife Resources Impact Analysis
GAC	Granular Activated Carbon
GC/MS	Gas Chromatograph/Mass Spectrometer
GFAA	Graphite Furnace Atomic Absorption Spectrometry
GIS	Geographic Information Systems
GPR	Ground-penetrating Radar
HASP	Health and Safety Plan
HOC	Halogenated Organic Compound
HDPE	High Density Polyethylene
HPLC	High Pressure Liquid Chromatography
HSO	Health and Safety Officer
IC	Institutional Controls
ICP	Inductively Coupled Plasma Atomic Emission Spectrometry
IDW	Investigation Derived Waste
LEL	Lower Explosive Limit
LNAPL	Light Non-Aqueous Phase Liquid
MCL	Maximum Contaminant Level (for EPA Drinking Water Standards)
MDL	Method Detection Limit
MGP	Manufactured Gas Plant
MSDS	Material Safety Data Sheet
NAPL	Non-aqueous Phase Liquids

NCP	National Contingency Plan
NPL	National Priority List
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
QHHEA	Qualitative Health and Human Exposure Assessment
RAO	Remedial Action Objectives
RAP	Remedial Action Plan
RCRA	Resource Conservation Recovery Act
RD	Remedial Design
RI	Remedial Investigation
RFP	Request For Proposal
RP	Responsible Party
SARA	Superfund Amendments and Reauthorization Act
SCGs	Standards, Criteria, and Guidance
SMP	Site Management Plan
SOP	Standard Operating Procedure
SOW	Scope of Work or Statement of Work
SPLP	Synthetic Precipitate Leaching Procedure
STEL	Short-Term Exposure Limit
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compounds
SWMU	Solid Waste Management Unit
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Indentified Compound from Mass Spectrometry
TOC	Total Organic Carbon
TOSCA	Toxic Substance Control Act
TPH	Total Petroleum Hydrocarbons
TWA	Time Weighted Average
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
USGS	United States Geologic Survey
VOC	Volatile Organic Compounds
WP	Work Plan
XRF	X-Ray Fluorescence

MEASUREMENTS

ppm	Parts per million
ppb	Parts per billion

ppbv	Parts per billion by volume
ppmv	Parts per million by volume
bgs	Below Ground Surface
msl	Mean Sea Level
ppbv	Parts per billion by volume
µg/L	Microgram per liter
µg/Kg	Microgram per kilogram
µg/m3	Microgram per cubic meter
mg/L	Milligram per liter
mg/kg	Milligram per kilogram
Mf/L	Million fibers per liter

Section 2

Pre-Mobilization Activities (PM)

STANDARD OPERATING PROCEDURE

PM-001 Utility Markout and Clearance

1. Objective

Describe typical utility markout/clearance procedures prior to and during excavation. All markout procedures should be performed in accordance with local and state regulations.

Many states, by law, require that utility companies are notified before excavation begins. Actual procedures and requirements differ by state. City/state government may have additional requirements for utility markout procedures. Check the requirements in the locality before beginning. Also check with the GEI project manager to determine whether it is most appropriate for GEI or the drilling/excavation subcontractor to handle mark out and clearance.

2. Execution

Public Utility Markouts

- The drilling/excavation locations should be marked with white paint, stakes, or flags.
- The contractor should call the appropriate one call communication network for the state the work is being conducted in. Refer to the Reference section in this SOP for contact information. Contractors shall provide all necessary information to the one call system. Sample location maps may be provided to clarify sampling locations. The contractor shall provide GEI with the utility clearance ticket number.
- If necessary, contact the municipalities or other utility owners to mark their water, sewer, or other lines if they do not belong to the one call system. The contractor should keep a record of these calls.
- Utility plans, if available, should be obtained from the property owner or municipal offices.
- Prior to excavation, a visual check should be made that all utilities companies and municipalities have marked their locations. This includes looking for signs that a utility exists, and verifying that the markings agree with a visual check. If they do not, contact the appropriate utility to remark their locations.
- Utilities will generally only markout and clear utilities in roadways or other public property up to the property boundary. Owners of fiber optic cables, natural gas pipelines, and other high hazard utilities will often markout on private property if requested. The contractor should request this. See section on private utility clearance below.
- Public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation should adopt the American Public Works Association (APWA) Uniform Color Code using ANSI standard Z535.1 Safety Colors for temporary marking and utility identification, as follow:

<u>The APWA Uniform Color Code</u>

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 & Gaseous Material
5. **Orange** – Communications, Alarm or Signal Lines, Cables or Conduit
6. **Blue** – Potable Water
7. **Purple** – Reclaimed Water, Irrigation and Slurry Lines
8. **Green** – Sewers and Drain Lines

However, not all organization do use these colors. Make sure the color scheme is understood.

- The excavator/contractor and consultant begins work on the scheduled work date and time (if all the facility operators have responded) taking care to find and preserve any markings that have been made.
- If markings may be disturbed during work, establish offset marks to create reference points for the underground utilities. Take photographs of the markings before starting work.
- When digging near a buried utility, the excavator/contractor and consultant should be aware of their proximity to the utility and use caution.
- If there is uncertainty about the accuracy of the markings or there are too many utilities in a given location to excavate or drill safely, consideration should be given to hand-digging the first few feet, vacuum excavation, or use of a utility location company as detailed below in Private Utility Markouts.
- Some clients may require hand or vacuum clearance to a minimum depth. Check with the GEI project manager.
- If exposing a utility, the excavator/contractor should provide proper support and protection for the utility to prevent damage. Contact the utility operator for support, guidance, or assistance.
- When the excavation is complete, the excavator/contractor should provide proper backfill for any utilities that have been exposed.

Private Utility Markouts

- Utility markouts on private property should follow the steps outlined above in public utility markouts with the additions below.
- If work is conducted on private property where public utilities may not provide markouts and the property owner cannot provide accurate utility plans, it is

recommended to use a company to determine the utility locations using one or more of the following technologies:

i. 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 tracewire, or by an induced current via radio waves.

ii. Sewer Sonde: For non-metallic lines where internal access is possible (such as clean-out ports in a sewer), a beacon or 'sonde' that emits a signal to the 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 a simple sonde.

iii. 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. GPR should be considered for high risk utilities (e.g. PVC natural gas lines without trace wire) where line-of-sight project from site entry point to a kiosk or other building is uncertain.

- Utility markout on private property should include clearance for other types of underground structures such as underground storage tanks, septic systems, utility or access tunnels, and in-ground irrigation systems.

3. Limitations

- Markout notification time usually does not include holidays. Make sure holidays are considered and markout time is scheduled accordingly. Do not conduct excavation or drilling prior to the required wait time. Do not mark excavation locations using spray paint if it is raining or snowing enough so that the paint markings will be washed away. Consider using long stakes instead of paint if snow is predicted. Excavations within the tolerance zone should be performed with non-powered hand tools until the marked utility is exposed. The tolerance zone may be determined by the utilities, law or codes.
- When excavating close to an underground utility, it is good practice for the contractor/excavator to have a spotter assist and guide the machine operator.
- Take care not to damage the conduit or protective coating of a utility. If the excavator/contractor damages this, leave the damaged utility exposed and immediately call the utility owner.
- If contact to a gas utility occurs, notify police, fire, and emergency personnel, and evacuate employees and general public. No attempt should be made to tamper with or correct the damaged utility.

4. References

Connecticut
Name: Call-Before-You-Dig (CBYD)
Telephone: 811 or 1-800-922-4455
Website: www.cbyd.com
Wait time after notification: 2 business days (excluding holidays)
Expiration of markout: 30 days

Massachusetts, Maine, New Hampshire, Rhode Island and Vermont
Name: Dig Safe
Telephone: 811 or 1-888-DIG-SAFE
Website: www.digsafe.com
Wait time after notification:
MA, ME, NH, and RI: 3 business days (excluding holidays)
VT: 2 business days (excluding holidays)
Expiration of markout: 30 days

New York State
Name: Dig Safely New York
Telephone: 811 or 1-800-962-7962
Website: www.digsafelynewyork.com
Wait time after notification: 2 business days (excluding holidays)
Expiration of markout: 30 days

New York City/Long Island
Name: New York City One Call Center
Telephone: 811 or 1-800-272-4480
Website: www.nycli1calldsi.com
Wait time after notification: 2 to 10 days (excluding holidays)
Expiration of markout: 30 days

New Jersey
Name: New Jersey One Call
Telephone: 811 or 1-800-272-1000
Website: www.nj1-call.org
Wait time after notification: 2 business days
Expiration of markout: 45 days

5. Attachment

Attachment A – Standard Utility Color Codes

6. Contact

Anne Leifer

Attachment A – Standard Utility Color Codes

Color Code	Utility Description
Red	Electric
Yellow	Gas-Oil
Orange	Communications
Blue	Water
Green	Sewer
White	Proposed Excavation

Section 3

Field Documentation (FD)

STANDARD OPERATING PROCEDURE

FD-001 Field Notebook

1. Objective

Describe methods for documentation of field activities.

Documentation of site activities is a crucial part of the field investigation process. The field notebook serves as the record of field activities performed or observed during the project. It provides a factual basis for preparing field observation reports, if required, and reports to clients and regulatory agencies. Example field notes are provided in Attachment A.

2. Execution

- Use a separate all-weather bound notebook for each site/location/project number. Spiral notebooks should not be used because pages can be easily removed.
- Write neatly using black or blue pen, preferably a waterproof pen. Use of pencil is also acceptable only with approval of the project manager, such as in but not limited to, certain field conditions [e.g., cold or wet weather].
- 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.
- Record activities as they occur. Record only facts and observations, regardless of whether they appear to be relevant at that time.
- Identify conditions or events that could affect/impede your ability to observe conditions (e.g. snow-covered ground surface, inability to access areas of interest).
- Neatly cross out mistakes using a single line and initial them. Erasures are not permitted.
    - If an error is made on an entry in the field notebook, the individual who made the entry should make the corrections. The corrections must be initialed and dated by the person making the correction.
- Sign or initial and date the bottom of every page with an entry if the project requires such documentation.
- Place a diagonal line through unused portions of a page.
- Record the following information upon each arrival at the site:
    - Date/time/weather.
    - GEI personnel.
    - Purpose of visit/daily objectives.
    - People (client, contractor, landowners, etc.) present upon GEI arrival.

- Record the following information during the course of the day:
    - Conversations with contractors/subcontractors, clients, visitors, GEI staff, landowners (site or abutters). If possible, record complete names, titles, and affiliations.
    - Time of arrival and departure of individuals.
    - Activities as they occur.

- Additional examples of observations to record may include and are not limited to:
    - Type and quantity of monitoring well construction materials used.
    - Use of field data sheets or electronic logging equipment (e.g. boring logs, monitoring well sampling logs, etc.).
    - Ambient air monitoring data.
    - Field equipment calibration information.
    - Locations and descriptions of sampling points.
    - Contractor/Subcontractor progress.
    - Sample media (soil, sediment, groundwater, etc.).
    - Sample collection method.
    - Number and volume of sample(s) collected and sample bottle preservatives used.
    - Sample identification number (s) and date and time of sample collection.
    - Approximate volume of groundwater removed before sampling.
    - Any field observations made such as pH, temperature, turbidity, conductivity, water level, etc.
    - References for maps and photographs of the sampling site(s).
    - Information pertaining to sample documentation: bottle lot numbers/ dates, method of sample shipments, chain-of custody record numbers, and overnight shipping numbers.
    - Surveying data (including sketches with north arrows).
    - Changes in weather.
    - Rationale for critical field decisions.
    - Recommendations made to the client representative and GEI Project Manager.
    - Site sketch of conditions at the end of the day.
    - Summary of work completed/work remaining.
    - Allow time at the end of the day to complete entries in the notebook.

3. References

New Jersey DEP Field Sampling Procedures Manual, August 2005.

ASFE Daily Field Report for Geotechnical Field Observation, 2nd Edition (2001), ASFE, Inc.

4. Attachments

Attachment A - Example Field Notes

5. Contact

Melissa Felter
Leslie Lombardo

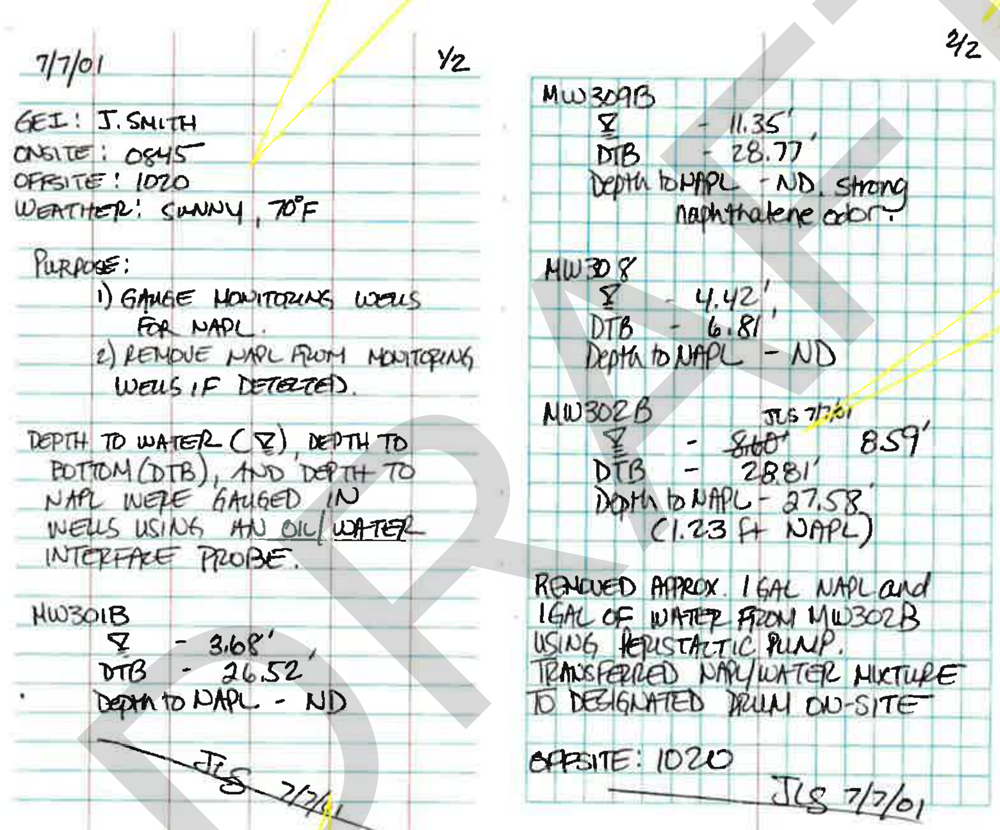
SOP FD-001

Attachment A – Example Field Notes

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

Each page is numbered

Errors are single line crossed out and initialed


7/7/01 1/2

GEI: J. SMITH
ONSITE: 0845
OFFSITE: 1020
WEATHER: SUNNY, 70°F

PURPOSE:
1) GAUGE MONITORING WELLS FOR NAPL.
2) REMOVE NAPL FROM MONITORING WELLS IF DETECTED.

DEPTH TO WATER (∇), DEPTH TO BOTTOM (DTB), AND DEPTH TO NAPL WERE GAUGED IN WELLS USING AN OIL/WATER INTERFACE PROBE.

MW301B
∇ - 3.68'
DTB - 26.52'
Depth to NAPL - ND

JLS 7/7/01

2/2

MW309B
∇ - 11.35'
DTB - 28.77'
Depth to NAPL - ND, Strong naphthalene odor.

MW308
∇ - 4.42'
DTB - 6.81'
Depth to NAPL - ND

MW302B
∇ - ~~8.60'~~ JLS 7/7/01 8.59'
DTB - 28.81'
Depth to NAPL - 27.58'
(1.23 ft NAPL)

REMOVED APPROX. 1 GAL NAPL and 1 GAL OF WATER FROM MW302B USING PERISTALTIC PUMP. TRANSFERRED NAPL/WATER MIXTURE TO DESIGNATED DRUM ON-SITE.

OFFSITE: 1020

JLS 7/7/01

Blank Space crossed out and initialed

Bottom of each page signed and dated

STANDARD OPERATING PROCEDURE

FD-002 Field Observation Report

1. Objective

Describe methods to generate a Field Observation Report.

The Field Observation Report is used to record a summary of activities, observations, and decisions made during the day's field work. The daily field observation report serves as a permanent record of the day's activity for the Project Manager (PM), In-House Consultant (IHC), and/or client.

2. Execution

- If required, at the close of the day's field work, a Field Observation Report should be prepared by the individual responsible for the field notebook. This report should be completed before leaving work for the day. Contents of the report should include, at a minimum, the following information:
    - A record of person(s) present at the site, time of arrival, departure times (e.g., GEI, contractor(s), client, etc.).
    - A record of the daily objective(s) and the activities performed (e.g., drilled five borings in the overburden).
    - A summary of deviation(s) from the field plan or objectives.
    - A summary of field decisions made, who made them, and the basis for such decisions.
    - A diagram, sketch, and/or map showing the location and extent of the work or other significant observation(s) made during the day.
    - Recommendations that may result from field observations and actions that may result from implementation of those recommendations.
    - A summary listing and field sketch showing location(s) of field activity.
- Submit a draft report to the PM/IHC for review. 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. Limitations

- The Field Observation Report is not a substitute for the field notebook.
- Not all projects require daily Field Observation Reports.
- The Field Observation Report should be based primarily on factual information. Opinions, if necessary, should be identified as such. 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 sign-off unless explicitly authorized by the PM/IHC.

4. References

New Jersey DEP Field Sampling Procedures Manual, August 2005

ASFE Daily Field Report for Geotechnical Field Investigations, 2nd Edition (2001), ASFE, Inc.

5. Attachments

Attachment A - Example Field Observation Report

6. Contact

Melissa Felter
Leslie Lombardo

FIELD OBSERVATION REPORT

Project :	Guard Booth Upgrades	**Date:**	November 8, 2006
Client :	ACME Industries	**Report No.**	1
Contractor:	ABC Contracting	**Page:**	1 of 2
Subcontractor:	NA	**GEI Proj. No.**	99999-0

SOP FD-002 - Attachment A – Example Field Observation Report

Time of Arrival: 0700 **Departure: 1440** **Weather: Overcast, Raining, 55^{0}F**

Persons Contacted, Company
Jane Doe, ABC Contracting

GEI Representatives
Bill Smith

Purpose of Site Visit: To observe excavation of soils for new guard booth and sidewalk.

Observations:

1. **Excavation**
   a. Areas for guard booth and sidewalk were laid out by ABC with stakes, string, and spray paint. Locations were between the pavement and wetland area; no excavation occurred in the wetland area.
   b. Staging area for soil stockpile was located to the west of the excavation, along the fenceline; polyethylene sheeting was placed beneath the pile.
   c. HDPE membrane delivered to site; stored in garage area through the inside fence.
   d. ABC crew began hand digging area for sidewalk and guard booth. Sidewalk area measured 22 feet long by 4 feet wide by 4 inches deep. Guard booth area measured 12 feet long by 10 feet wide by 9 inches deep. Utility pole and bollard locations started today.
   e. Rain continued to get worse in the afternoon; ABC covered the entire excavation and soil stockpile with poly sheeting and secured the sheeting with grade stakes.

2. **Subgrade Preparation**
   a. Subgrade preparation for the sidewalk and guard booth areas at the site is complete.

3. **Dewatering**
   a. No dewatering occurred today.

4. **Air Monitoring**
   a. During excavation, I monitored the breathing zone of the workers with an organic vapor meter (OVM). No headspace readings were measured in soil samples S-1 through S-8.

FIELD OBSERVATION REPORT

Project :	Guard Booth Upgrades	**Date:**	November 8, 2006
Client :	ACME Industries	**Report No.**	1
Contractor:	ABC Contracting	**Page:**	2 of 2
Subcontractor:	NA	**GEI Proj. No.**	99999-0

Picture 1: Sidewalk excavation and bollard layout

By: Bill Smith	**Reviewed By:**

STANDARD OPERATING PROCEDURE

FD-003 Sample Management and Chain of Custody

1. Objective

Describe methods to label sample containers, manage the samples, and prepare Chain of Custody documentation for the samples. Sample transport is also addressed.

2. Project Setup

When setting up a sampling event, inform the recipients of the samples (laboratories) and recipients of laboratory results (data group and project managers). Discuss with the laboratory the sampling media, turnaround times, and reporting limits for appropriate regulatory criteria for the site. Include the data group on correspondence so that turnaround times, data validation, and project deliverable schedules can be tracked successfully.

- Laboratory - Number of samples, analyses needed: bottle orders and holding times, turnaround times needed, reporting limits needed for regulatory criteria.
- Data group - Number of samples, analyses requested, turnaround times and reporting limits requested, data validation needed, regulatory criteria to use for tabulating results, deliverables needed, and project name and number.
- Schedule - Inform the laboratory and Data Group of schedule delays, changes to analyses, and expediting.

3. Sampling Execution

- Review the work plan prior to sampling to determine the following:
  - Sample matrix and sampling method.
  - Required analysis and sample volumes.
  - Sample container type and preservative requirements.
  - Required analysis methods and/or report formats.
  - The turnaround time required by the project.
  - If the data will be sent directly from the laboratory to the data validator, Project Manager, or Data Group.
  - Holding time restrictions for sampling media and analytical methods.
  - Sample naming convention used for this project site.
- Sample labels should be filled out using a waterproof or permanent marker or pen. Required information includes:
  - Sample ID.
  - Date and time (military time) of sample collection.
  - Project number.
  - Sample preservatives.
  - Sampler's initials.
  - Laboratory analytical methods.

- Place the label on the jar or bottle, not on the cap. Sample custody begins at this time.
- Record the above information in the field notebook.
- Individually wrap sample jars with packing material, if needed. See SOP SC-002 for guidance on packaging samples for shipment to the laboratory by way of common carrier. Place samples in a cooler with bagged ice or freezer packs (blue ice) immediately after collection. Add sufficient ice or freezer packs to cool samples to approximately 4°C.
- Complete a chain of custody (COC) for the samples as described below. GEI or laboratory COCs may be used as long as they contain fields for all required sample information as described in Section 2.1.

3.1. Chain-of-Custody (COC) Completion

- Fill out COC neatly and in permanent ink. Alternatively, an Excel version of the GEI COC is available and can be filled out electronically.
- Certain analyses (i.e. air analysis by TO-15) require specialized, laboratory issued COCs. Make sure any specialized COCs are available before sample collection.
- Record the project name and number, the sampler's name(s) and the state where the samples were collected.
- For each sample, enter the sample identification number, date and time (military time) collected, the number of sample containers, and any additional information to fulfill project, client or regulatory requirements.
- Record the type of analysis (including laboratory method; e.g. EPA-SW846 Method XX) requested and the preservative (if appropriate) in the vertical boxes.
- 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 notebook. If required by the Project Manager or Data Group, also document this information on or attach a note to the GEI copy of the COC.
- Trip blanks for large sites should be named similar to the samples they are collected with so that there are not two of the same sample name for the same site. For example, "OU1TB-122509" and "OU3TB-122509" would avoid any mistakes.
- Strike incorrect entries on the COC with a single line, followed by the initials of the person making the correction, the date, and the correct entry.
- When sample custody is 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., Federal Express, 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.

- If the samples are placed in a designated secure area (e.g. GEI sample fridge), note this location in the "Received by" box on the COC.
- GEI uses both single sheet and triplicate COCs. If using the triplicate COCs (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.
- If you are using the single sheet COC, make a copy of the COC after it has been signed by the lab courier and forward it to the Data Group.
- Prior to sample shipment by common carrier, the COC must be placed inside the cooler in a Ziplock bag or other watertight package.
- 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.
- If a courier is used to transport samples to the laboratory (lab courier or GEI personnel), the courier signs the COC in the "Received by" box.
- Place a custody seal on the cooler if shipping via common carrier.
- Transport samples to the laboratory as soon as possible. It is preferable to transport the samples directly to the laboratory from the field. Samples brought back to the office for storage prior to submission to the laboratory must be kept cold (4° C).
- Unused sampling containers/media that are sent back to the lab should be included on a separate COC.
- After the samples are sent to the laboratory, the GEI copy of the COC must be forwarded to the Data Group: datagroup@geiconsultants.com.

4. Limitations

- Keep the number of people involved in handling samples to a minimum.
- Where practical, only allow people associated with the project to handle the samples.
- Always document the transfer of samples from one person to another on the COC.
- The COC should always accompany the samples.
- Give samples positive identification at all times that is legible and written with waterproof or permanent ink.
- When sending samples via a common carrier, use one COC per package.
- Where practical, avoid sending samples from more than one site with separate COCs in a single package.

5. 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

6. Attachments

Attachment A - Example Chains of Custody

Attachment B - Shipping Info Pics

7. Contact

Leslie Lombardo

Chain of Custody Record

STL-4124 (0901)

STL Connecticut
128 Long Hill Cross Road
Shelton, CT 06484
Tel: 203-929-8140

Example
COC

SEVERN TRENT **STL**
Severn Trent Laboratories, Inc.

Client: GEI	Project Manager: Dave Terry	Date: 12-31-07	Chain of Custody Number: 00452
Address: 455 Winding Brook Dr	Telephone Number (Area Code)/Fax Number: 860 368 5300 / 860 368 5307	Lab Number:	Page 1 of 1
City: Glastonbury; State: CT; Zip Code: 06033	Site Contact: M. Felter; Lab Contact: Paul Hobart		
Project Name and Location (State): Carroll Gardens NY	Carrier/Waybill Number: FedEx 9383 7603 0879		
Contract/Purchase Order/Quote No.:			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis: VOC 8260B	SVOC 8270C	TO-15 + NAPHTHALENE	Special Instructions/ Conditions of Receipt
CGSB-01 (0-2)	12-31-07	1130				X	X						X	X		
CGSB-02 (3-4)	12-31-07	1250				X	X						X	X		
CGSB-02 (3-4) MS	12-31-07	1250				X	X						X	X		
CGSB-02 (3-4) MSD	12-31-07	1250				X	X						X	X		
CGSB-XX (5-6)	12-31-07	0800				X	X						X	X		
CGTB-123107	12-31-07	1400				TB				X			X			
CGGW-01	12-31-07	1430		X			X			X			X	X		
CGSG-01	12-31-07	0700-1500	X												X	CANISTER# 2013 REGULATOR# 779

~~NEW JERSEY: "CLP data package deliverables"~~

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal
☐ Return To Client ☒ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☒ Other See Contract

QC Requirements (Specify): NYS Cat B ASP deliverable
Send EDD to datagroup@geiconsultants.com
send to Lorie MacKinnon

1. Relinquished By: Melissa J Felter	Date: 12-31-07	Time: 1600	1. Received By: FedEx WAYBILL 923117-4432	Date: 12-31-07	Time:
2. Relinquished By:	Date:	Time:	2. Received By:	Date:	Time:
3. Relinquished By:	Date:	Time:	3. Received By:	Date:	Time:

Comments
USED FLOW CONTROLLER FOR AIR SAMPLE INCLUDED

[DIST]RIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

EXAMPLE COC

Chain-of-Custody Record

Laboratory: Accutest

Laboratory Job # (Lab use only)

GEI Consultants
400 Unicorn Park Dr.
Woburn, MA 01801
PH: 781.721.4000
FX: 781.721.4073

Project Information

Project Name: MWRA - Low Service Storage Tank

Project Location: Stoneham, MA

Project Number: 093400

Project Manager: D. Aghjayan

Send Report to: rseigener@geiconsultants.com

Send EDD to: labdata@geiconsultants.com

Page _1_ of _1_

MCP PRESUMPTIVE CERTAINTY REQUIRED – YES NO

If Yes, Are MCP Analytical Methods Required? YES NO NA
If Yes, Are Drinking Water Samples Submitted? YES NO NA
If Yes, Have You Met Minimum Field QC Requirements? YES NO NA

Sample Handling

Samples Field Filtered: YES NO NA

Sampled Shipped With Ice: YES NO

Lab Sample Number	GEI Sample ID	Collection Date	Collection Time	Matrix	No. of Bottles	Sampler(s) Initials	PCBs	VPH Fractions Only	EPH Fractions Only	SVOCs	VOCs, % Solids**	Conductivity	RCRA 8 Metals*	TPH by GC/FID DRO	Sample Specific Remarks
						Preservative	None	MeOH	None	None	MeOH	None	None	None	
	093400-LS6-S5(19'-21')	12/29/2009	9:30	SO	3	JMR		x			x				
	093400-LS6-COMP (FILL)	12/29/2009	9:30	SO	1	JMR	x		x	x		x	x	x	
	093400-LS6-COMP (NATIVE)	12/29/2009	15:00	SO	1	JMR	x		x	x		x	x	x	
	093400-LS8-COMP	12/29/2009	14:00	SO	1	JMR	x		x	x		x	x	x	
	093400-LS9-S4 (8'-8'-5")	12/30/2009	14:30	SO	3	JMR		x			x				
	093400-LS9-COMP	12/30/2009	15:00	SO	1	JMR	x		x	x		x	x	x	

MCP Level Needed: GEI requires the most stringent Method 1 MCP standard be met for all analytes whenever possible.

Relinquished by	Date	Time	Received by
1. Joseph M. [illegible] (sampler)	12/30/09	16:30	1. GEI FRIDGE
2. GEI FRIDGE	1/4/10	1310	2. Naomi [illegible]
3. Naomi [illegible]	1/4/10	1310	3. [illegible]
4.			4.

Turnaround Time (Business days):
Normal _X_ Other ____
10-Day ____ 7-Day ____
5-Day ____ 3-Day ____

Before submitting rush turnaround samples, you **must** notify the laboratory to confirm that the TAT can be achieved.

Additional Requirements/Comments/Remarks:

Please use MA Landfill List

* Please run TCLP analysis for RCRA 8 Metals results that exceed the 20 times rule.

** Please use % solids sample for VOC and VPH analysis of 093400-LS6-COMP (FILL), 093400-LS6-COMP (NATIVE), 093400-LS8-COMP, and 093400-LS9-COMP

Chain-of-Custody Record

Laboratory:

Laboratory Job # (Lab use only)

GEI Consultants
455 Winding Brook Drive, Suite 201
Glastonbury, CT 06033
PH: 860.368.5300
FX: 860.368.5307

Project Information

Project Name/Number:

Project Location:

Project Contact:

Phone Number:

Page __ of __

Send Report to:

Send EDD to: datagroup@geiconsultants.com

Deliverables:

If Yes, Have You Met Minimum Field QC Requirements? YES NO NA

Preservative

Analysis

Sample Handling

Samples Field Filtered YES NO NA

Samples Shipped With Ice YES NO

Lab Sample Number	GEI Sample ID	Collection Date	Collection Time	Matrix	No. of Bottles	Sampler(s) Initials										Sample Specific Remarks

Relinquished by: (signature)	Date:	Time:	Received by: (signature)
Relinquished by sampler: (signature) 1.	Date :	Time:	Received by: (signature) 1.
Relinquished by: (signature) 2.	Date :	Time:	Received by: (signature) 2.
Relinquished by: (signature) 3.	Date :	Time:	Received by: (signature) 3.
Relinquished by: (signature) 4.	Date :	Time:	Received by: (signature) 4.

Turnaround Time (Business days):

Normal ____ **Other** ____
10-Day ____ **7-Day** ____
5-Day ____ **3-Day** ____

Before submitting rush turnaround samples, you **must** notify the laboratory to confirm that the TAT can be achieved.

Additional Requirements/Comments/Remarks:

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

PACKING SAMPLES FOR SHIPMENT BACK TO THE LABORATORY

A. Line cooler with bubble wrap and large plastic bag. Use absorbent pad inside the bag if bottles contain preservatives.

B. Wipe outside of bottles and put glass in individual bubble bags & seal. Place bottles & the temperature blank into cooler. Leave room for ice in between bottles & on top.

C. Place double bagged or loose ice randomly around bottles throughout the cooler.

D. Place large bag of ice or loose ice on top of the bottles. In warm weather, the cooler should be packed with as much ice as possible.

E. Close outer bag, compress excess air out of bag, twist top and knot. If necessary, use more bubble wrap to fill the dead air spaces. Place chain of custody (COC) and other paperwork in plastic bag and seal. Place on top of cooler.

F. Close cooler, place signed and dated Custody Seals over opening. Tape over the Custody Seal and seal cooler securely. Fill out overnight shipping waybill and attach to the top or handle of the cooler. Attach Saturday delivery stickers if needed. Ship according to DOT regulations.

Rev 011209

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

PACKING SAMPLES FOR SHIPMENT BACK TO THE LABORATORY

A. Line cooler with bubble wrap and large plastic bag. Use absorbent pad inside the bag if bottles contain preservatives.

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D. Place large bag of ice or loose ice on top of the bottles. In warm weather, the cooler should be packed with as much ice as possible.

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F. Close cooler, place signed and dated Custody Seals over opening. Tape over the Custody Seal and seal cooler securely. Fill out overnight shipping waybill and attach to the top or handle of the cooler. Attach Saturday delivery stickers if needed. Ship according to DOT regulations.

STANDARD OPERATING PROCEDURE

FD-004 Photo Documentation

1. Objective

Describe methods to document and retain photographic records.

Keeping a record of photographs taken is crucial to their validity as a representation of existing conditions.

2. Execution

- Photographs of a site, individual samples, or other observations should be taken using a digital camera.
- Set the camera to record the time and date for each photograph.
- All photographic records, along with the following information, should be recorded in the field notebook (SOP FD-001).
    - If applicable, the compass direction describing the direction the photograph was taken (e.g. looking southeast). This may not apply to photographs of individual samples.
    - Brief description of what the photograph is intended to show.
- The field notebook should note who took the photographs.
- The photographs should be electronically backed up on a computer or other data storage device.
- If photographs will be used in a report, memo, or letter, they 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. Limitations

- Some clients and regulatory agencies require photographs of every subsurface soil sample collected. These photographs typically include a "whiteboard" which indicates the site, the boring ID, and the depth of the sample, while logging details are recorded in the field notebook. Under these circumstances, it is not necessary to include compass directions or descriptions.

4. References

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

5. Attachments

Attachment A – Example of Photo Documentation Template

6. Contact

Melissa Felter
Leslie Lombardo

Attachment A – Example of Photo Documentation Template
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-006 Handheld Global Positioning Receiver Operation

1. Objective

Use handheld global positioning system (GPS) receivers to locate sample points and site features with “Mapping-Grade” accuracy.

Use handheld GPS receivers to “stake out” proposed sample point locations within the limits of “Mapping Grade” accuracy.

2. Execution

- Handheld GPS receivers provide a low-cost and user-friendly method for locating sample points and site features with a fair degree of horizontal accuracy.
- In simplistic terms, GPS works by measuring the distance from numerous orbiting satellites to a point on the earth surface. Individual satellites broadcast their real-time location in terms of x,y and z coordinates, and the distance from each satellite is measured as a function of the length of time that a time-stamped signal takes to reach the receiver. Built-in GPS software derives new points by intersecting the distances from known orbital locations – in much the same way that points are located by intersecting tape-measured distances from building corners or other pre-existing site features.
- Late-model handheld GPS receivers utilize a real-time differential correction technique called WAAS (Wide Area Augmentation System). This system was designed to provide greater confidence and reliability in using GPS data for commercial aircraft landing approaches, and the additional correction improves all GPS operations.
- Handheld GPS receivers display navigational information on a variety of standard pages. Although each manufacturer uses slightly different formats, all receivers toggle back and forth between the following visual presentations:
- A “satellite” page displays the relative orbital location of all GPS satellites that are currently being tracked by the receiver. The display may include information on the real-time geometrical strength of the solution: satellite intercepts that cross at right angles provide more accurate solutions than intercepts that cross at acute or obtuse angles.
- A “track” page that displays the travel path of the receiver while it is turned on, along with the relative location of recorded points. Many GPS models have a “track-back” function that will guide the user on the same path back to the starting point
- A “navigation” page that displays instantaneous location and the real-time direction and velocity of travel. Some units provide two pages to display this information in different formats. Most units will report the overall “course

made good" (straight-line bearing and distance from the starting point) at any point.

- A "waypoint" page that allows users to "Go To" a created point or previously recorded point by providing a straight-line bearing and distance to the point. The information is instantaneously updated as the user moves along; some units display a pointing arrow that directs the user to the direction of travel. Be careful of go-to lines that lead through swamps or over cliffs – if you will be travelling in difficult terrain have a paper copy of the USGS quadrangle and a compass on hand for navigation.
- Signal strength degrades significantly next to buildings and underneath tree canopy. Most GPS receivers have an "averaging" function to improve the accuracy of shielded locations. GPS users can also improve precision by locating points three times, at different times of the day. Two of the solutions will generally be closer to each other than to the third and can be averaged for a more reliable fix.
- Most GPS receivers default to latitude and longitude, but data is more accurate and easier to input and when expressed in UTM coordinates to the nearest meter. The handheld GPS setup will have a function somewhere to change to UTM. Most of Connecticut is in UTM Zone 18 but the easternmost parts are in Zone 19.
- Consult "Corpscon" the datum translator available from the National Geodetic Survey website. Corpscon translates instantly from latitude/longitude to UTM coordinates to state plane coordinates and provides tools to identify UTM Zones. Also consult the Trimble, Garmin and Magellan websites for technological improvements and discussion of advanced techniques.

3. Limitations

- Handheld GPS receivers operating in unobstructed locations are currently reckoned to provide 2-5 meter accuracy, meaning that the true location of measured points lie within an "error ellipse" with axes of 2-5 meters centered on the measured location. In other words, even under the best of conditions a real-time GPS solution may be as much as 20 feet off the true horizontal location of a point.
- Due to geodetic restrictions, vertical locations (elevations) have less than half the accuracy of horizontal locations, meaning that even under the best of conditions, a surface elevation displayed on a handheld GPS receiver may be off by more than 50 feet.
- Horizontal and vertical data derived from handheld GPS receivers should never be considered more than relatively accurate, and this level of uncertainty should be identified in any discussion of positional tolerance.

4. References

Trimble Website: .trimble.com
Garmin Website: .garmin.com

Magellan Website: .magellangps.com
National Geodetic Survey: ://www.ngs.noaa.gov/

5. Contact

Matt O'Neil

Section 4

Drilling Methods (DM)

STANDARD OPERATING PROCEDURES

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 4 - Field Documentation.

2. Hollow-Stem Augers (HSAs)

Borings can be installed in unconsolidated formations using solid-stem or 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, 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. Drilling mud 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. 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 VOC and 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 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 install small-diameter wells used to collect groundwater samples.

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 the method include the fact that the data quality achieved is often suitable only for screening purposes. Direct-push methods typically result in very turbid 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. Due to the narrow diameter of the direct-push rods, samples are often collected with peristaltic pumps. When samples are collected for volatile organic compounds (VOCs) using peristaltic pumps, some of the volatiles may be lost due to the pressure drop produced by the suction lift. In such cases, the VOC data must be qualified accordingly. For this reason, use of the peristaltic pump for collecting groundwater samples for VOC analysis is not recommended and approval for its use should first be obtained from the project manager or geologist.

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 Tertiary Butyl Ether (MTBE) are suspected or the contaminant plume appears to be diving in the aquifer.

6. Contact

Matt Glunt
Cathy Johnson

STANDARD OPERATING PROCEDURE

DM-002 Hollow-Stem Auger

1. Objective

Describe standard operating procedures for drilling of overburden soil borings using hollow-stem augers.

2. Execution

- Confirm that the 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 steam-cleaned or pressure-washed. Record observations in the field notebook (See SOP FD-001).
- Observe that the augers are vertical when the first section is advanced into the ground.
- Use a 140-lb hammer to drive the sampler, unless conditions necessitate using a 300-lb hammer (see SOPs SM-001, *Split-Spoon Sampling* and SM-0003, *Soil Classification,* for details). Count and record the number of blows per 6-inch increments, confirming blow counts with driller if necessary).
- Decontaminate the split-spoon sampler after each use (see *Equipment Decontamination,* SOP QA-001) or use another decontaminated split-spoon sampler.
- Ensure that the drillers advance the augers only after they have inserted the auger plug (to prevent soil from entering the augers while advancing to the next sample interval).
- Request that the drillers remove the auger cutting bit/plug and insert the split-spoon sampler into the interior of the augers. 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.
- If subsurface soil samples are being collected with split-spoon samplers, ensure that the drillers use a 30-inch drop of the 140-pound hammer. The number of blow-counts for each 0.5 foot penetration provides important geotechnical data.
- Repeat until the borehole has been drilled to the desired depth.
- If a monitoring well is not installed in the soil boring, fill the boring with either cement/bentonite grout or properly-tamped and hydrated bentonite. Check with Project Manager and/or the appropriate regulatory personnel before using drill cuttings to backfill the boring.

- If a monitoring well will be installed, refer to SOP DM-007.
- 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. If the boring location will not be surveyed, measure each location from on-site reference points and record the information in the field notebook so that the location can be plotted on site figures.

3. Limitations

- 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 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 SOP DM-008 *Monitoring Well Telescoping Techniques*) 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 sands start to flow into the auger, pour clean water into the augers and keep the augers filled during sampling.
- 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.
- Down-hole drilling equipment should be steam cleaned or pressure-washed between holes unless otherwise directed by the project manager.
- Record when standard operating procedures are deviated from. The drilling inspector should also record any detected odor from the boring and depth encountered.

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

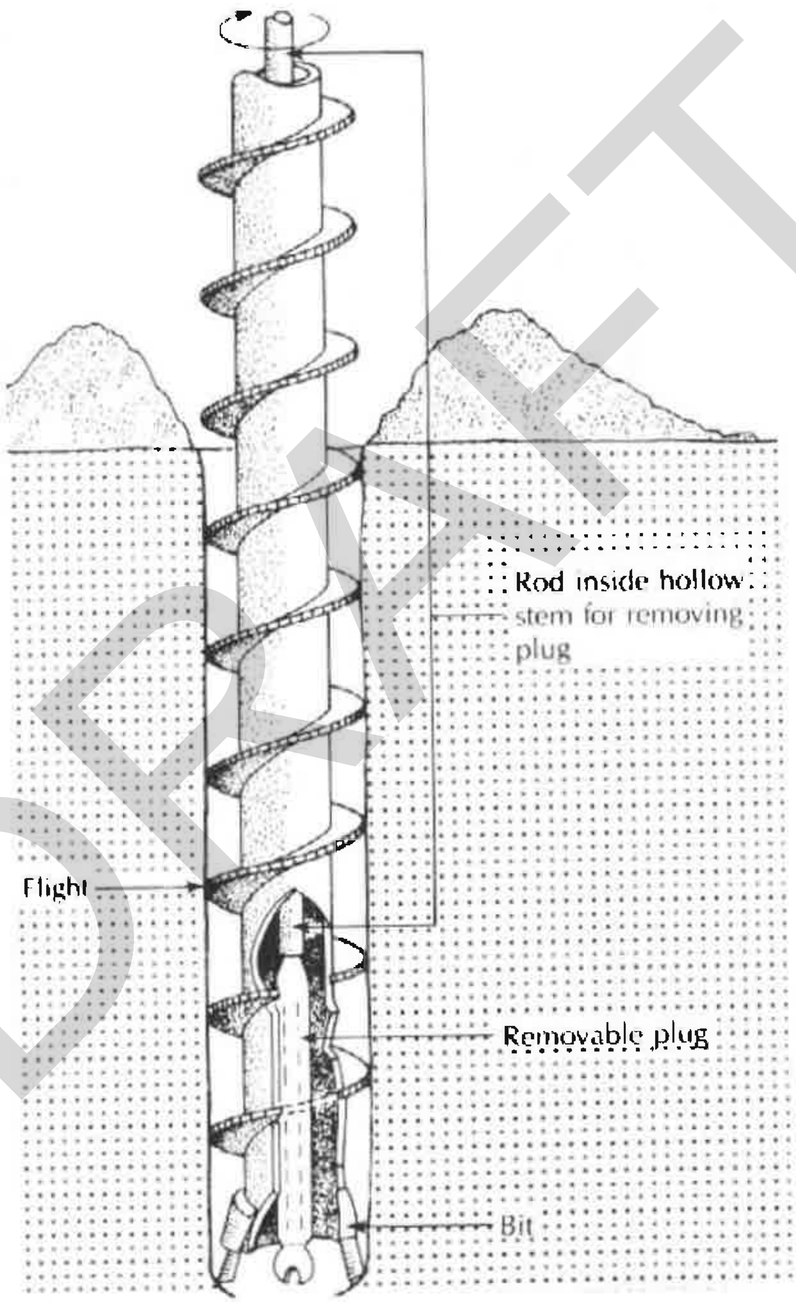
Attachment A – Hollow-Stem Auger

6. Contact

Cathy Johnson

SOP DM-002

Attachment A – Hollow Stem Auger



STANDARD OPERATING PROCEDURE

DM-004 Sonic Drilling

1. Objective

Describe common sonic drilling procedures.

Prior to drilling confirm that utility clearance has been completed and that the drilling rig has been appropriately decontaminated.

2. Execution

- Collect soil cores in runs of 5 to 10 feet. Some sonic rigs can collect a 20 foot sample, but the process generates a significant amount of heat that may degrade sample quality.
- Classify and sample the soil located within the liner.
- Excess soil should be placed in a 55-gallon drum for disposal.
- The core barrel should be cleaned with tap water following each use.
- The core barrel is then advanced within the isolation casing to collect the next soil core interval.
- Add water between the inner core barrel and the outer override casing. This will reduce friction between the casings and adsorb heat.
- Maximize drilling advance rate. The faster the core barrel is advanced, the less likely the core barrel will heat up. 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 soil that 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 should facilitate settlement of the sandpack and grout. Upon completion, no casing is left in the ground other than the well casing and screen.

3. Limitations

- 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:
    - 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.
    - 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.
    - If the soil is to be sampled for volatile organic compounds (VOCs), acrylic liners must be used.
    - 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:
        - Acetate liners in the core barrel so that the soil core does not have to be extruded out of the core barrel.
        - Limit the length of soil core generated during a given downhole run.
        - Implement practices to reduce the residence 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

5. Contact

Melissa Felter

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

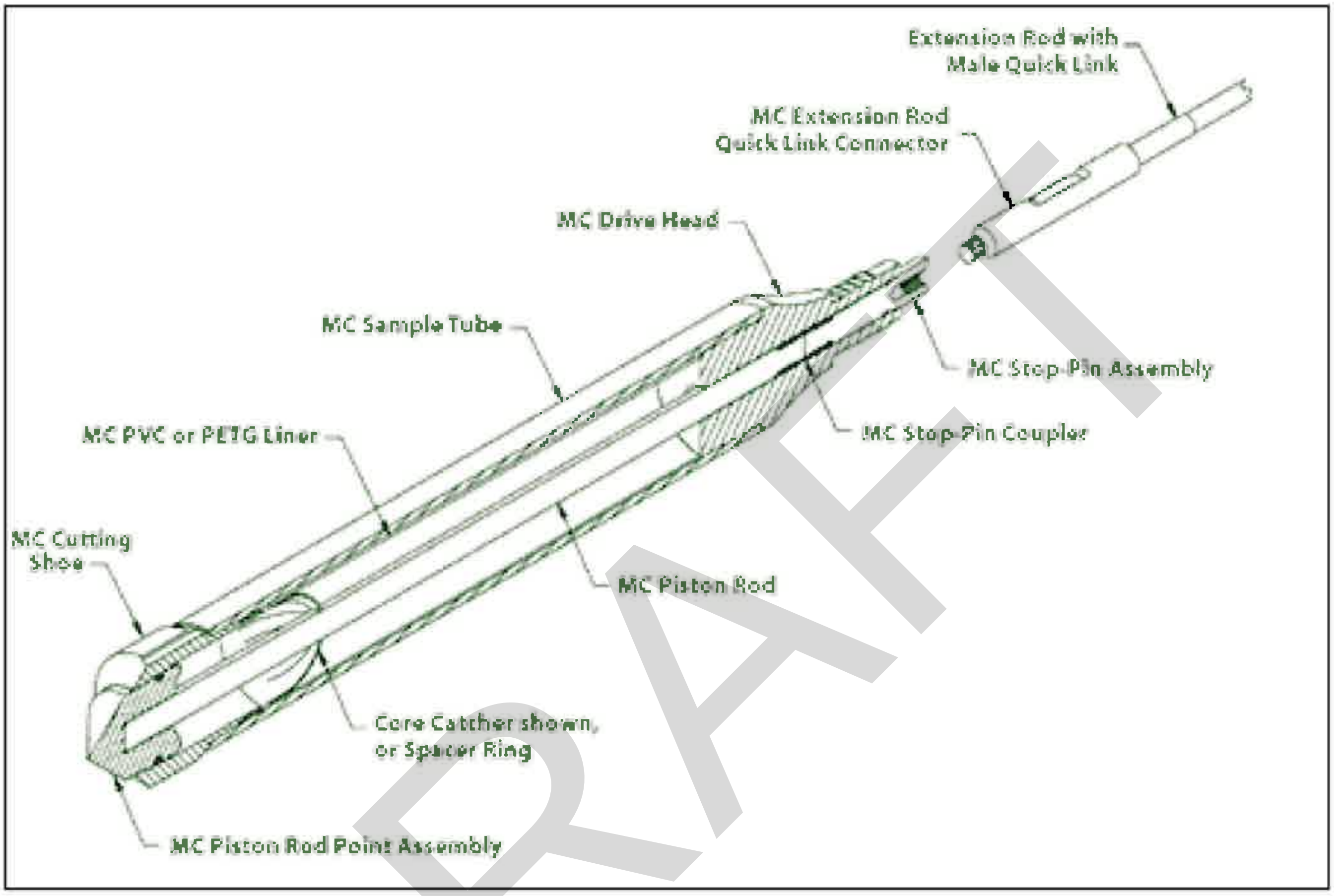
Attachment A – Geoprobe® with Macrocore® Sampler Assembly

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

DM-007 Monitoring Well Construction and Installation

1. Objective

Describe installation procedures for overburden monitoring wells screened across or below the groundwater table.

Well dimensions (well diameter, screen length, and screen slot-diameters) will be specified in the Work Plan. This SOP assumes the monitoring wells will be constructed of flush-joint PVC pipe and the screened section will have factory-slotted openings.

2. Execution

Attachment A provides a diagram of typical shallow, intermediate, and deep groundwater monitoring well construction detail. A Groundwater Monitoring Well Installation Log is in Attachment B.

- Measure and record the depth of the completed soil boring before beginning the well installation.
- If possible, 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 split-spoon samples 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.
- If it is not possible to accurately measure the depth to groundwater in the borehole due to low permeability in the formation, use the saturated soil depth observed in the collected samples or measured water depth in a nearby existing monitoring well to estimate the depth to water in the borehole.
- For shallow monitoring wells, select the monitoring well screen and riser lengths so that the slotted section of the screen intersects the groundwater table. Screen lengths of 15 feet or less are preferred and 10 foot screens are most common. If the water table is seasonally high or low or if the well is in a location where the water table is likely to be tidally influenced, appropriately place the screened section to allow for the screen to intersect likely future water tables.
- For intermediate or deep wells screened entirely below the water table, select the monitoring well screen and riser lengths as described in the Work Plan. Screen lengths of 10 feet or less are preferred.
- If the borehole is deeper than the desired well depth or the bottom of the well is close to a change in soil strata, then fill the base of the borehole with bentonite. Keep in mind that bentonite swells when hydrated, and that filter

sand should be placed at the bottom of the borehole above the bentonite before installing the well.

- Prevent well materials from contacting foreign substances during installation. Precautions may include requiring the driller to wear clean gloves while handling well materials and requiring that well materials not be placed onto the ground or pavement without a protective barrier such as polyethylene sheeting being present
- Confirm that the driller installs a minimum one-inch sump with a bottom cap to the bottom of the well screen. See the Work Plan for locations that may require larger sumps.
- Monitoring wells can be constructed of either 1, 1.5, 2 or 4 inch inner diameter (ID) Schedule 40 threaded flush-jointed PVC. Refer to the work plan for the site-specific requirements. Flush-threaded well materials should be used. Do not allow the driller to use glues, as they typically contain solvents that could affect on groundwater quality.
- Stainless steel well materials may be used if required in the Work Plan. Select slot size based on grain size of the formation and on requirements in the Work Plan.
- Confirm that the driller places at least 12 inches of clean uniformly graded medium quartz filter sand pack into the base of the borehole, if required in the Work Plan.
- The driller should remove the drilling casing/augers from the borehole slowly, at a maximum of 2-foot intervals, at the same time that filter sand is added. The drillers should take frequent measurements of the depth to sand.
- Confirm that the driller has added 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.
- The driller should place a 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 before grouting the remaining annular space, or otherwise backfilling the remaining annular space as discussed with the Project Manager. Tamp seal. It should extend 1 to 2 feet above the filter sand.
- If required by the Work Plan, the driller should use bentonite-cement and grout the annular space from the top of the bentonite seal to the ground surface. Bentonite cement grout should be placed using tremie methods. Grout should be mixed in approximately the following proportions: 7.5 gallons water to one 94-lb bag of cement to 2-4 lbs of pulverized bentonite. The grout must be mixed using a pump (such as one on the rig) to ensure proper mixing.
- The drillers should cut the monitoring well riser at an angle or make "V"-notch in the riser pipe as a benchmark for surveying and groundwater measurements. The driller should cut the well riser so that the top of the well will be approximately 3 inches below the top of protective casing. The top of

the riser should be close enough to the top of the surface casing to allow reading of depth markings on a water level indicator tape.

- The protective surface casing is 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.
- The protective casing should be set by placing cement in the annular space between the protective casing and the borehole up to the ground surface. If possible, the driller should slope the cement 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 and is completed with a steel "stick up" pipe, additional protection such as steel pole bumpers around the steel "stick up" pipe may be necessary.
- If possible a locking cap should be placed on the steel "stick up" pipe. If the surface casing is flush mounted, a locking expansion plug should be placed, if possible, inside the top of the well riser pipe.
- All well locations should be photodocumented in accordance with SOP FD-004 Photodocumentation.
- Label the outside of the protective well casing with a paint pen. If the well is not going to be surveyed, measure the location to nearby landmarks so that the well may be located in the future and plotted on figures. 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*).

3. Limitations

- Do not screen across different hydrostratigraphic units (for example, outwash sands, confining layers or 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 should 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 drill cuttings to backfill during monitoring well installation unless specified by the work plan or project manager.

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

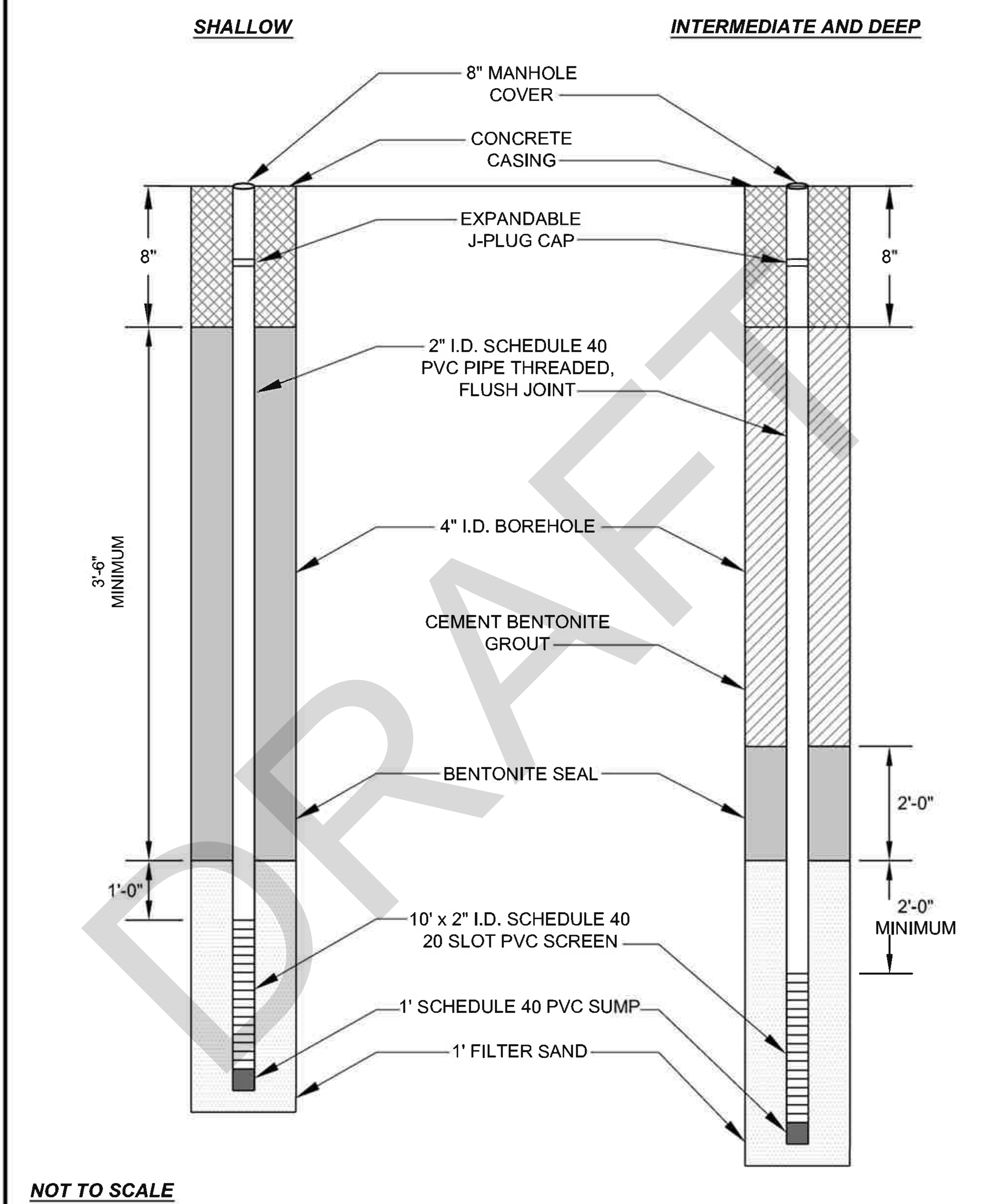
Attachment A – Typical Shallow, Intermediate, and Deep Groundwater Monitoring Well Construction Detail

Attachment B – Groundwater Monitoring Well Installation Log

6. Contact

David Terry
Anne Leifer

Attachment A - Well Detail



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TYPICAL SHALLOW, INTERMEDIATE AND DEEP GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL

June 2008

I:\GEI\SOPs\ Well Detail.dwg \Jun 10, 2008

Groundwater Well Installation Log

Well ID

Project ______________________

City / Town ______________________

Client ______________________

Contractor ______________________

Driller ____________ **GEI Rep.** ____________

GEI Proj. No. ____________

Location ____________

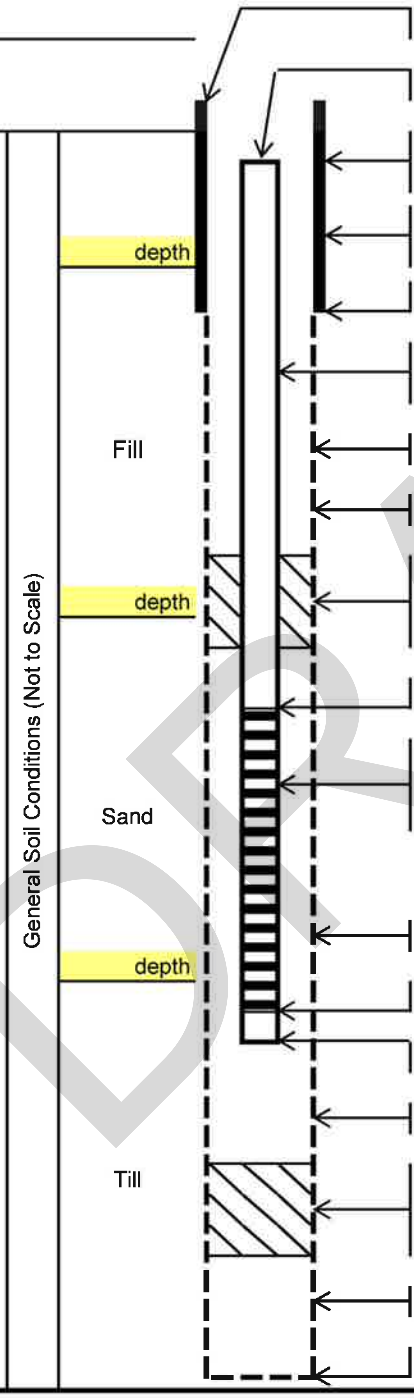
N ____________

E ____________

Install Date ____________

Survey Datum: ____________

Ground Elevation:



Length of Surface Casing above Ground ____________

Dist. Top of Surf. Casing to Top of Riser Pipe ____________

Type and Thickness of Seal around Surface Casing ____________

ID of Surface Casing ____________

Type of Surface Casing ____________

Depth Bottom of Surface Casing ____________

ID and OD of Riser Pipe ____________

Type of Riser Pipe ____________

Type of Backfill around Riser Pipe ____________

Diameter of Borehole ____________

Depth Top of Seal ____________

Type of Seal ____________

Depth Bottom of Seal ____________

Depth Top of Screened Section ____________

Type of Screen ____________

Description of Screen Openings ____________

ID and OD of Screened Section ____________

Type of Filter Material ____________

Depth Bottom of Screened Section ____________

Depth Bottom of Silt Trap ____________

Depth Bottom of Filter Material ____________

Depth Top of Seal ____________

Type of Seal ____________

Depth Bottom of Seal ____________

Type of Backfill below Filter Material ____________

Bottom of Borehole ____________

Date	Time	Distance to ▼ below top of riser pipe

Notes:

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STANDARD OPERATING PROCEDURE

DM-009 Monitoring Well Development

1. Objective

Describe standard procedures to remove fluids from monitoring wells (introduced during drilling) and maximize the movement of groundwater into the well by removing fine particles in the well and sand pack around the screen.

2. Execution

To prevent cross contamination between monitoring wells, use dedicated equipment and/or appropriately decontaminated equipment to perform monitoring well development. See SOP QA-001 Equipment Decontamination and the Work Plan for more information.

For deep or large diameter monitoring wells, it may be necessary to use a re-usable pump system, such as a Grundfos pump, to develop monitoring wells.

- Calculate the volume of water in the monitoring well (one well volume) using the following table:

Well diameter (inches)	Volume (gal/ft)
1	0.04
1.5	0.09
2	0.16
3	0.36
4	0.65
6	1.50

  The equation used to establish these volumes is presented in Section 4.

- Calculate or estimate the amount of water introduced to the borehole during drilling. At a minimum, this is the amount of water that should be removed during development. Removing less water than was introduced and allowing additional time for the surrounding formation to clear of injected drilling fluids may be considered as an alternative if the volume of introduced water was large.

- Record the volume of water purged in the field notebook or on the Monitoring Well Sampling Form (Attachment A).

- Collect a sample of water from the monitoring well with the selected submersible pump (e.g. 12-volt whale pump or Grundfos pump), a bailer, or a

Waterra system. Record the physical properties (color, turbidity, odors, etc.) of the sample.

- The volume of water that should be removed will depend on the work plan, local regulatory guidance, and/or the volume of water that was introduced during drilling and well installation. Typical guidance for the removal volume includes:

    - Ten well volumes.
    - The volume of fluid added during drilling.
    - The volume required to remove enough suspended particles so that the turbidity of the water is less than 50 nephelometric turbidity units.

If needed, pump the ground water into a 5-gallon pail so that the volumetric flow rate and total water volume from the pump or bailer can be calculated.

Measure the groundwater level in the well during development to assess if the pumping rate is sufficient to create a drawdown in the well.

Observe the groundwater every few well volumes during the pumping and record the physical properties (color and turbidity).

If required by the Work Plan, conduct surging in the monitoring well. See the Work Plan for the method of well surging to be used. If surging is necessary, do so only after initial pumping at the well has occurred and fine sediments have been removed.

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.

3. Limitations

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. They may also damage the pump.

If the ground water in the monitoring well is contaminated, the water removed during well development may need to be placed in a properly-labeled drum and disposed of in accordance with local, state, and federal regulations (see SC-003 Investigation Derived Waste).

If the soils around the well screen are composed of fine-grained silts and clays, over-pumping and mechanical surging is not recommended since these more vigorous techniques can cause mixing of the fines into the filter pack. To develop these wells, use of a bailer is recommended.

There are occasions when the turbidity of groundwater cannot be meaningfully reduced. On these occasions, a minimum of ten volumes should be removed, and the Project manager should be consulted.

Sampling of groundwater should generally not occur within one week after development. In some regions or regulatory jurisdictions, a minimum of two weeks may be required before sampling. If no water was introduced to the formation during drilling, this waiting period may be shortened if required by the project. See the Work Plan for additional information.

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.

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

Massachusetts Department of Environmental Protection, "WSC-310-91Standard References for Monitoring Wells, Section 4.5 Decommissioning of Monitoring Wells", January 1991

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

5. Attachments

Attachment A - Monitoring Well Sampling Form

6. Contact

Anne Leifer

MONITORING WELL SAMPLING RECORD

GEI Consultants

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

STANDARD OPERATING PROCEDURE

DM-010 General Guidance on Monitoring Well Abandonment

1. Objective

Describe methods to abandon a monitoring well.

The goal of monitoring well abandonment is to seal the borehole so it cannot act as a conduit for movement of contaminants or liquids from the ground surface to the water table or between aquifers.

General procedures for well abandonment are provided below but do not supersede state or local regulations. Make sure all well abandonment procedures adhere to appropriate regulations.

2. Execution

The following methods for abandoning unconsolidated (overburden) and consolidated (bedrock) monitoring wells should be performed by a licensed drilling contractor, if required by law or regulatory authorities. The following listed methods are general guidance for abandoning monitoring wells. The Work Plan and state and local requirements should be reviewed for additional requirements.

2.1 Unconsolidated (overburden) Monitoring Wells

Unconsolidated (overburden) monitoring wells should be abandoned in the following manner, see the Work Plan for additional requirements:

- Remove the protective casing and concrete pad.
- If possible, overdrill the monitoring well casing and sand pack using hollow-stem augers or casing to at least one foot below the depth of the boring/well as indicated in the soil boring log.
- If possible, remove the monitoring well riser, sand pack, bentonite seals and grout.
- Once the well materials have been removed, add cement/bentonite grout using tremie methods starting at from the bottom of the borehole as the augers or casing are removed.
- If the well materials cannot be removed by overdrilling, the riser should be cut off at a depth of between two and five feet below the ground surface and the remaining well materials may be filled with grout using tremie methods. The grout mixture will be as specified for the well installation (see SOP DM-001 General Guidance on Determination of Appropriate Drilling Methods)
- Add grout to the point where the riser was cut off or to a depth of approximately two feet below the ground surface. From that point up to ground surface, backfill with native soil material surrounding the boring/well.

2.2 Consolidated (bedrock) Monitoring Wells

Consolidated (bedrock) monitoring wells or open holes will be abandoned in the following manner. See the Work Plan for additional requirements:

- Remove the protective casing and concrete pad;
- Remove the monitoring well materials from the hole. If the materials cannot be removed, cut off the well riser between two feet to five feet below grade. If feasible, cutting off the riser at five feet is optimal.
- Add cement/bentonite grout via tremie methods from the bottom of the well up to the ground surface. The grout mixture should be as specified for the well installation SOP DM-001 General Guidance on Determination of Appropriate Drilling Methods
- Add grout to the point where the riser was cut off or to a depth of approximately 2 feet below ground surface. From that point up to ground surface, backfill with native soil material surrounding the boring/well.

3. 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.

Massachusetts Department of Environmental Protection, "313 CMR 3.00, Registration of Well Drillers and Filing of Well Completion Reports".

Massachusetts Department of Environmental Protection, "Standard References for Monitoring Wells, Section 4.6 Decommissioning of Monitoring Wells", January 1991

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

4. Contact

Anne Leifer

Section 5

Sample Collection and Field Screening (SC)

STANDARD OPERATING PROCEDURE

SC-001 Environmental Sample Types and Sampling Strategies

1. Objective

Describe types of samples and strategic approaches to sample locations.

Refer to Attachment A for guidance on compatible sampling materials.

2. Sample Types

Grab Samples

A grab (or discrete) sample is a single aliquot (part of the sampled media) collected from a single location at a specific time.

Surface soil samples are typically "grab" samples. Volatile organic samples are always grab samples because the least amount of sample disturbance is necessary.

Composite Samples

Composite samples are non-discrete samples composed of more than one aliquot collected from different sampling locations and/or at different points in time. Analysis of composite samples produces an average value.

Composite samples are frequently collected to characterize waste soil that has been stockpiled for eventual disposal. Several grab samples are collected from the stockpile and are blended together into a single sample.

Screening Samples

Screening samples may be grab or composite in nature. However, they offer potential advantages such as rapid results and low cost. The trade-off is that they may only provide results within a range and/or they may have elevated detection limits. Screening samples are most often used to evaluate presence/absence and/or indications of the potential magnitude of impacts.

3. Sampling Strategies

Generally, there are three sampling strategies: random, systematic, and judgmental sampling.

- Random sampling involves collection of samples in a non-systematic 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.
- Judgmental sampling is the collection of all other samples. This sampling might be from areas most likely to be contaminated, areas most likely to be clean, or areas where information is lacking.

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. Attachments

Attachment A - General Guidelines for selecting equipment

5. Contacts

Ryan Hoffman

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-002 Environmental Sample Handling

1. Objective

Describe appropriate environmental sample handling procedures.

The procedures include collection and transport of environmental samples to a laboratory for chemical analysis. Appropriate sample handling should ensure that samples are properly:

- labeled and documented;
- preserved;
- packaged; and
- transported

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.
- A waterproof or permanent ink pen should be used for all labels. The label should have an adhesive backing and be placed on the jar or bottle, not on the cap. In addition, clear packing tape can be placed over the sample label to secure it to the bottle as moisture from the samples can loosen the label adhesive.
- Record the following information on the label and in the field notebook (See SOPs FD-001 and FD-003):
    - Project number
    - Sample identification (i.e. MW-201 or SS-2)
    - Date and time (military time) of collection
    - Sampler's initials
    - Analysis methods
    - Preservative, if present
- Pre-preserved laboratory jars are preferable and should be used whenever practicable. If sample jars are not pre-preserved, add preservative as appropriate.
- At each sampling location, samples should be collected in order of volatility, most volatile first. Samples collected for volatile analysis should be placed in sample containers immediately upon retrieval of the sample.
- Aqueous samples for volatile analysis should be collected without air bubbles.
- The collection and preservation method of soil samples for volatile analysis may depend on project, client, or state regulatory requirements. Check with your Project Manager and/or SOPs SM-001 and SM-002 where appropriate.

- Care must be taken to avoid getting soils on the threads of sample jars, which can cause a faulty seal.
- If compositing samples in the field, specify the basis for composite (i.e. volume, weight, spoon recovery, etc.) and record in the field book the procedure for compositing the sample.
- Once samples have been collected and labeled, place samples in a cooler with sufficient bagged ice or freezer packs (blue ice) (if allowed) to chill samples to 4°C. If using ice, use double-bagged ice.
- Complete the chain-of-custody (COC) (SOP FD-003).
- If transporting the samples by way of a shipper:
  - i. The sample cooler should have water drains securely sealed with duct tape, both on the inside and outside of the cooler.
  - ii. Place a layer of packing material on the bottom of the cooler as a cushion.
  - iii. Individually wrap each sample bottle with bubble packing or suitable packing material and place the wrapped bottles upright in the cooler with sufficient packing material between samples to avoid breakage.
  - iv. Methanol preserved samples for volatiles analysis should be packed so they remain upright with the soil completely covered by the methanol during transport.
  - v. Place a layer of packing material on top of the sample bottles.
  - vi. Place bagged ice or freezer packs 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.
  - vii. Place the completed and signed chain-of-custody form in a sealable plastic bag and place on top of the packing material in the cooler, or tape it to the inside lid of the cooler.
  - viii. Fill out the appropriate shipping or courier forms and attach to the top or handle 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 signed and dated custody seal on the cooler.
- All samples should be submitted to the laboratory as soon as possible. In many cases, same day shipping will be required by the client or the project manager. Be clear on this before beginning the field work.
- A copy of the waybills should be kept by the field supervisor to track shipments if necessary.

3. Limitations

- If samples are shipped on a Friday, call the laboratory ahead of time to confirm that personnel will be at the laboratory to receive and log-in the samples.
- During warm weather, make sure to use plenty of ice in the shipping container.

- Field personnel should be aware of analyses which have short hold times and schedule sampling events and shipping accordingly. Shipment of samples for analyses with short hold times must be arranged for in advance. Refer to the project work plan, quality assurance project plan, or state/federal regulations for holding time and preservative information. Contact the laboratory ahead of time when shipping samples with short hold time to ensure the lab is prepared for these analyses.
- For glassware containing preservatives (e.g., HCl, HNO_3), take care not to overfill the container, thus flushing the preservative out of the bottle.
- Never composite samples for VOCs in the field. Collect individual aliquots and direct the laboratory to perform compositing, if needed.
- Collection of aqueous samples should not be performed over the opening of a monitoring well. Preservatives from overfilling, 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

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

Preservation Techniques for Volatile Organic Compound (VOC) Soil Sample Analyses, WSC#99-415. Massachusetts Department of Environmental Protection.

5. Contacts

Leslie Lombardo

STANDARD OPERATING PROCEDURE

SC-003 Investigation Derived Waste

1. Objective

Describe characterization and management of Investigation Derived Waste (IDW) resulting from site investigation activities.

IDW is solid and/or aqueous waste generated during environmental site investigations.

2. Execution

- Determine the suspected contamination type and impacted media based on previous investigations, available analytical data, and/or site history.
- Consider the following when selecting IDW management option(s):
  - Anticipated volume of IDW to be generated during on-site activities
  - Potential contaminants and their concentrations
  - Proximity to population centers and the potential for unauthorized site access
  - Potential exposures to workers
  - Potential for environmental impacts
  - Community concerns
  - Potential storage areas
  - Regulatory constraints
  - Potential on-site treatment options
  - Duration of storage
  - Client concerns or requirements
- Review IDW Management Options summarized in Attachment A for each media suspected of contamination.
- Select IDW Management Option(s) prior to the commencement of field activities that will generate waste materials.
- Include the selected IDW Management Option(s) in the Field Plan or other project documents.

Considerations and guidelines for IDW management for specific field tasks are provided below.

2.1. Test Pit Excavation

- Segregate contaminated soil from uncontaminated soil using visual and/or field screening methods.
- Use appropriate barrier (such as two layers of 6-ml plastic sheeting) for temporary stockpiling of contaminated soil adjacent to test pit.

- Backfill test pits with uncontaminated soil, unless otherwise directed by project manager.
- If directed by the Project Manager to return contaminated soil to the test pit, backfill soil in the same order as the soil was excavated from the test pit.

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 it is acceptable to the client and the governing regulatory agency. If not, 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-I.D. augers).
- Segregate contaminated drilling fluid from uncontaminated fluid for rotary wash borings.
- Drilling fluid management options include pouring the drilling fluid on the ground near the boring location, if acceptable to the client and governing regulatory agency, or containerizing the fluid in drums or tanks.

2.3. Well Development/Sampling

Contaminated groundwater removed from wells by pumping or bailing for the purpose of well development and sampling may be poured on the ground near the well, if it is acceptable to the client and the governing regulatory agency. Otherwise, it should be containerized in drums or tanks.

2.4. Decontamination Fluids

Decontamination fluids may be poured on the ground in the vicinity of the well if approved by the project manager. Alternatively, the fluids may be containerized in drums or tanks.

2.5. Disposable Personal Protective Equipment

Disposable personal protective equipment (PPE) should be managed like any other IDW. However, with the clients' and project manager's approval, it may be removed from the site and disposed of as ordinary rubbish if it has not come into contact with contaminated materials.

3. Limitations

- The simplest IDW management option is to return the IDW to its source location.
- However, the selected IDW management options must meet state/federal regulations and have the client's approval. Consult with state/federal policies for IDW-related matters.

- The client is responsible 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.

5. Attachments

Attachment A - Summary of Investigation Derived Waste Management Options

6. Contacts

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Attachment A: - SUMMARY OF IDW MANAGEMENT OPTIONS
GEI Consultants, Inc. Standard Operating Procedures
Management of Investigation - Derived Waste

Type of IDW	Generation Processes	Management Options	Remarks
Soil	Boring/monitoring well installation Test pit excavation Soil sampling	Return to source location immediately after generation	Acceptable, if authorized by the client, the governing regulatory agency, and the project manager.
		Spread around boring, test pit, or original source location	Acceptable, if authorized by the client, the governing regulatory agency, and the project manager.
		Containerize and temporarily store on site	Can temporarily store in stockpiles or covered containers (i.e. drums, roll-off containers). Stockpiles must be underlain by plastic sheeting and covered with plastic sheeting. Plastic sheeting must be secure. Storage consistent with state/federal regulations.
		Send to off-site, treatment or disposal facility within appropriate timeframes	Requires proper shipping documents (i.e. manifest, Bill of Lading, etc.), analytical characterization
		Store for future treatment and/or disposal.	Storage consistent with state/federal regulations. If a RCRA hazardous waste, must meet RCRA Container/Waste Pile/Tank requirements (see notes)
		Store temporarily awaiting laboratory analysis.	Storage consistent with state/federal regulations. Can temporarily store in stockpiles or covered containers (i.e. drums, roll-off containers). Stockpiles must be underlain by plastic sheeting and covered with plastic sheeting. Plastic sheeting must be secure.
Sediment/Sludge	Sludge pit sampling Sediment sampling	Return to source immediately after generation	Acceptable, if authorized by the client, the governing regulatory agency, and the project manager.
		Store temporarily on site.	Storage consistent with state/federal regulations.
		Send to off-site facility within 90 days	Requires manifests, analytical characterization
		Store for future treatment and/or disposal.	Storage consistent with state/federal regulations. If a RCRA hazardous waste, must meet RCRA Container/Waste Pile/Tank requirements (see notes)

Attachment A: - SUMMARY OF IDW MANAGEMENT OPTIONS
GEI Consultants, Inc. Standard Operating Procedures
Management of Investigation - Derived Waste

Type of IDW	Generation Processes	Management Options	Remarks
Aqueous liquids (groundwater, surface water, drilling fluids, other wastewater)	Well installation/development Well purging during sampling Ground water discharge - pump tests Surface water sampling	Pour onto ground close to well	Non-hazardous liquids only. Should not exhibit a sheen or separate phase product. Do not discharge to the ground up-gradient of the source location. Ensure that it is permissible by local, state, and Federal regulations Is acceptable to the client, the governing regulatory agency, and the project manager.
		Store temporarily on site	If a RCRA hazardous waste, must meet RCRA Container/Waste Pile/Tank requirements (see notes)
		Send to off-site commercial treatment unit within appropriate timeframes	Refer to State regulations for appropriate timeframe. Requires appropriate shipping documents (i.e., manifest, Bill of Lading), analytical characterization
		Send to POTW	Obtain appropriate discharge permit(s)
		Store for future treatment and/or disposal.	Storage consistent with state/federal regulations. Consistent with final remedial action
		Discharge to surface water	OK if it complies with state and federal regulations. Obtain appropriate discharge permit(s).
Decontamination fluids	Decontamination of PPE and equipment	Store temporarily on site	If a RCRA hazardous waste, must meet RCRA Container/Waste Pile/Tank requirements (see notes)
		Send to off-site facility within appropriate timeframes	Requires manifests, analytical characterization
		Store for future treatment and/or disposal. Storage consistent with state/federal regulations.	Consistent with final remedial action
Disposable PPE	Sampling, drilling, and test pit excavation observation, other on-site activities	Store temporarily on site	Dispose of appropriately after characterization
		Place in on-site industrial dumpster	Project-specific determination required – must be acceptable to client and project manager
		Send to off-site facility within 90 days	Project-specific determination required
		Store for future treatment and disposal.	Storage consistent with state/federal regulations. Project-specific determination required

Notes:

1) PPE - personal protective equipment
2) POTW - publicly owned treatment works
3) Generation processes listed here are provided as examples.
   IDW may also be generated as a result of other site activities.
4) RCRA Container/Waste Pile/Tank requirements:
   Containers; 40 CFR 264 Subpart I and 265 Subpart I
   Waste Piles; 40 CFR 264 Subpart L and 265 Subpart L
   Tanks; 40 CFR 264 Subpart J and 265 Subpart J

STANDARD OPERATING PROCEDURE

SC-004 Headspace VOC Screening

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1. Objective

Describe methods to obtain site-specific measurement of the total volatile organic compound (VOC) concentrations present in the headspace of a jar containing soil.

This information can be used for several purposes:

- Segregate soil based on degree of contamination.
- Identify samples for quantitative analysis of VOCs.
- 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 headspace (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, lamp, and results of calibration 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. 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 jar with the sample location and sample depth.
- 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 vehicle 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. Limitations

- The instruments may work poorly in the rain and in freezing temperatures. Under such conditions, operate the instrument in a heated vehicle or building if possible.

- 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.
- Note that states may have specific procedures for field monitoring. In Massachusetts, the Massachusetts Department of Environmental Protection (DEP) requires that screening of gasoline-contaminated soil be performed in accordance with Attachment II of the DEP's policy #WSC-94-400 Interim Remediation Waste Management Policy for Petroleum Contaminated Soils. Consult this procedure or any relevant guidance documents for assistance.

4. References

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

5. Contacts

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Section 6

Solid Matrix Sampling (SM)

STANDARD OPERATING PROCEDURE

SM-001 Soil Sampling Techniques Including Split-Spoon

1. Objective

Describe standard procedures for the collection of surface and subsurface soil samples.

The definition of "surface" soil varies considerably between regulatory organizations. Surface soils may be classified as soils between the ground surface and 2 inches below ground surface, ground surface and 6 inches below ground surface, and even as much as ground surface and 24 inches below ground surface.

The definition of subsurface soil will vary in relation to the definition of surface soil. In general, subsurface soil is everything deeper than surface soil.

Refer to state-specific regulations for the definitions of surface and subsurface soils.

2. Execution

2.1. Surface Soil Sampling

Collection of surface soil samples can be accomplished with tools such as spades, shovels, trowels, scoops, etc. 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 decontaminated 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 compound (VOC) analysis is to be performed, transfer the sample directly into an appropriate labeled sample container with a stainless steel lab spoon, small diameter core device, or equivalent and secure the cap tightly.
- Place the remainder of the sample into a decontaminated stainless steel, plastic, or other appropriate 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 container and mix thoroughly.
- When compositing is complete, place the sample into appropriate labeled containers and secure the caps tightly.

2.2. Sampling with Hand Augers and Thin Wall Tube Samplers

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are generally better for direct sample recovery because they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and generally cannot be used below a depth of approximately three feet.

2.2.1 Auger Sampling

- Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first three to six inches of surface soil for an area approximately six inches in radius around the drilling location.
- Attach the decontaminated auger bit to a drill rod extension, and attach the "T" handle to the drill rod.
- Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.
- After reaching the desired depth, carefully remove the auger from the hole. When sampling directly from the auger, collect the sample after the auger is removed from the hole.

2.2.2 Thin-Walled Core Sampling

- Remove auger tip from the extension rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.
- Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Do not scrape the borehole sides. Avoid hammering the rods as the vibrations may cause the boring walls to collapse.
- Remove the tube sampler, and unscrew the drill rods.
- Remove the cutting tip and the core from the device.
- Discard the top of the core (approximately 1 inch), as this may represent material knocked down from the sides of the boring and not the layer of interest. Place the remaining core into the appropriate labeled sample container.

One type of thin-wall sampler is depicted in Attachment A (this is typically used with a mechanical drill rig).

For either method, If VOC analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, small diameter core sampler, or equivalent and secure the cap tightly. VOC samples should be collected first to minimize the potential for losing volatiles prior to sample collection.

Place the remainder of the sample into a stainless steel, plastic, or other appropriate container and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, 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 into the container and mix thoroughly.

When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow previous steps, making sure to decontaminate the auger and tube sampler between samples.

Abandon the hole according to applicable state regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

2.3. Sampling at Depth with a Split-Spoon (Barrel) Sampler

Split-spoon sampling is generally used with a mechanical drill rig to collect undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split-spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split-spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted. A diagram of the split-spoon sampler assembly is provided as Attachment A.

When split-spoon soil sampling is performed to gain geologic information, work should be performed in accordance with ASTM D1586-08a, "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". The following procedures are used for collecting soil samples with a split-spoon:

- Select the size (length and diameter) of split-spoon sampler based on the amount of soil that is needed for characterization. The ASTM standard for N-values is 1 3/8 - inch I.D (2-inch O.D.). Specify spoon size and basket type to driller prior to mobilization to the site. Split spoon samplers are typically available in 1 3/8 – and 3 – inch I.D. sizes. A larger barrel may be necessary to obtain the required sample volume. Note on the boring log where larger split spoon barrels are used because the ASTM standard penetration test does not apply when driving split spoons larger than 1 3/8 I.D. (2-inch O.D.).

- Select a soft or stiff basket for the spoon (a softer basket generally works better for loose or soft material).
- Prior to hammering the split spoon to collect the sample, verify that the split-spoon is seated at the beginning of the desired sample interval. If it is seated above the interval, have driller clean out the hole prior to sampling. Record all depth measurements relative to ground surface.
- Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top. See diagram in Attachment A.
- Place the sampler in a perpendicular position on the sample material.
- For all soil samples, use a 140-lb hammer falling 30 inches to drive the sampler, unless conditions necessitate using a 300-lb hammer.
- Record in the site fieldbook or on field data sheets the length of the tube used to penetrate the material being sampled, the split-spoon inside and outside diameters, and the hammer weight,
- Count and record the number of blow counts per 6-inch increments (confirming blow counts with driller if necessary).
- Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The length of recovery and soil type should be recorded on the boring log. If a soil sample is desired, a decontaminated stainless steel knife or spatula should be used to divide the tube contents in half, longitudinally. If possible, avoid collecting soil that has come in contact with the walls of the spoon, and soil at the top of the spoon.
- Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.
- Note any material in the nose (shoe) of the spoon.
- Immediately collect a sample for VOCs (if required by the site-specific field sampling plan) by collecting soil from the entire length of the split spoon, unless otherwise specified by the project manager. When the most impacted interval is sampled for laboratory analysis, screen the spoon with the field instrument first, then collect the soil sample for VOC analysis from the appropriate interval.

3. Limitations

- Weather conditions (e.g., frozen ground) may prevent the collection of samples and should be considered prior to sample collection.
- Tools plated with chrome or other materials should not be used.
- Be aware of local laws regarding subsurface utility clearance prior to conducting subsurface investigations. Contact DigSafe or local utility companies as required.
- Be aware of the length of the drill string, the sample depth, and the required stickup of the drill string to ensure accurate sample interval measurement.
- If drilling with hollow-stem augers, the removal of the drill string from the hole, prior to attaching the split-spoon sampler, may cause soils to be sucked up

into the augers (blow-in running sands). Upon recovery, determine if there is blow-in in the split spoon sampler. In general, blow-in is more unconsolidated than the rest of the sample and lacks stratification (do not include blow-in for recovery of sample collection).

- If soils consist of loose sands or soft clay, the drill string and sampler may advance slightly under its own weight, giving a false depth for soil collection.
- Never sample more than two spoons consecutively without advancing the augers unless material is tight. Do not let the split spoon penetrate more than it can hold.
- In many instances, groundwater will fill the auger and the split-spoon.

4. References

ASTM D1586-08a, "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". 2008.

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

5. Attachments

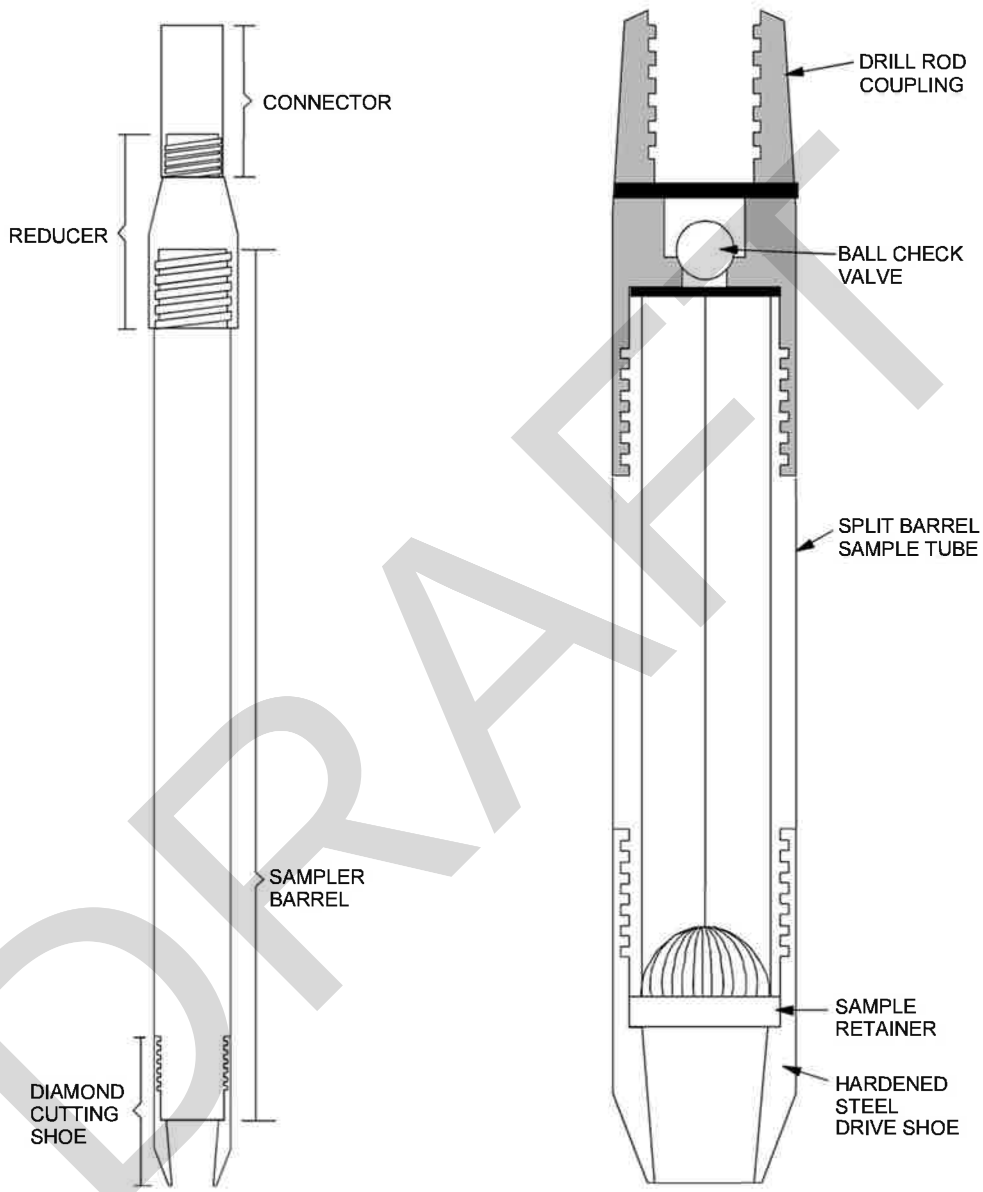
Attachment A - Sampler Design Assembly

6. Contacts

Matt Glunt
Chris Pray

THIN WALL HQ CORE SAMPLER (2" width x 60" length)

SPLIT-SPOON SAMPLER (2" width x 24" length)



STANDARD OPERATING PROCEDURES SM-001	GEI Consultants	**THIN WALL AND SPLIT-SPOON SAMPLERS**	
NEW ENGLAND AND ATLANTIC REGIONS	June 2011	Attachment A	

STANDARD OPERATING PROCEDURE

SM-003 Classification of Soil Samples in the Field

1. Objective

Describe methods to classify soil samples collected in the field in a consistent manner.

2. Execution

- Describe soil samples according to *ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)* and Attachments A and B. This standard is the basis for the Unified oil Classification System.
- Identify and record the soil in terms of the major and minor constituents (i.e., sand gravel, silt, clay), Unified Soil Classification Symbol, sample structure, plasticity and dilatancy for fine-grained soils, color, local or geologic name if known (e.g., Boston Blue Clay or 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.
- Record sampler type, blow counts, soil description, etc. on the boring log (see Attachment C).
- GEI consistently applies one modification to the ASTM standard: Use "widely graded" and "narrowly graded" instead of "well-graded" and "poorly graded," respectively.

3. Limitations

Certain projects or clients will require the use of other classification systems. Other classification systems should not be used unless specifically required by the client. If the client requires that we use the Burmister method, obtain the details from the client. An example breakdown is shown below, but some clients (MassDOT, for example) have their own breakdown.

- “and” = 35-50%
- “some” = 20-35%
- “little” = 10-20%
- “trace” = 1-10%

- Describing soil samples is often difficult during cold or wet weather. Make sure your field notes describe these conditions. When possible, collect archive samples and verify sample descriptions in the office.

- The ASTM Standard Practice for Classification of Soils for Engineering Purposes (D2487) may be used in conjunction with the Visual-Manual Method to confirm the soil classification. D2487 includes laboratory testing.

4. References

ASTM D2487-06e1, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM, 2006.

ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), ASTM, 2009.

Field Guide for Soil and Stratigraphic Analysis, Midwest Geosciences Group Press, 2001-2005.

Coarse-Grained Soils Visual-Manual Descriptions, GEI Consultants, Soil Description Chart.

Fine-Grained Soils Visual-Manual Descriptions, GEI Consultants, Soil Description Chart.

5. Attachments

Attachment A – GEI Soil Description Charts (2007)
Attachment B – Visual Manual Descriptions with example boring log
Attachment C – Describing the Plasticity of Soil Samples

6. Contacts

Cathy Johnson

GEI Consultants

FINE-GRAINED SOILS
VISUAL-MANUAL DESCRIPTIONS

SOILS WITH ≥50% FINES

Group				Name
CL	<30% plus No. 200	<15% plus No. 200		LEAN CLAY
		15-25% plus No. 200	% Sand ≥% Gravel	LEAN CLAY WITH SAND
			% Sand <% Gravel	LEAN CLAY WITH GRAVEL
	≥30% plus No. 200	% Sand ≥% of Gravel	<15 % Gravel	SANDY LEAN CLAY
			≥15% Gravel	SANDY LEAN CLAY WITH GRAVEL
		% Sand <% of Gravel	<15 % Sand	GRAVELLY LEAN CLAY
			≥15% Sand	GRAVELLY LEAN CLAY WITH SAND
ML	<30% plus No. 200	<15% plus No. 200		SILT
		15-25% plus No. 200	% Sand ≥% Gravel	SILT WITH SAND
			% Sand <% Gravel	SILT WITH GRAVEL
	≥30% plus No. 200	% Sand ≥% of Gravel	<15 % Gravel	SANDY SILT
			≥15% Gravel	SANDY SILT WITH GRAVEL
		% Sand <% of Gravel	<15 % Sand	GRAVELLY SILT
			≥15% Sand	GRAVELLY SILT WITH SAND
CH	<30% plus No. 200	<15% plus No. 200		FAT CLAY
		15-25% plus No. 200	% Sand ≥% Gravel	FAT CLAY WITH SAND
			% Sand <% Gravel	FAT CLAY WITH GRAVEL
	≥30% plus No. 200	% Sand ≥% of Gravel	<15 % Gravel	SANDY FAT CLAY
			≥15% Gravel	SANDY FAT CLAY WITH GRAVEL
		% Sand <% of Gravel	<15 % Sand	GRAVELLY FAT CLAY
			≥15% Sand	GRAVELLY FAT CLAY WITH SAND
MH	<30% plus No. 200	<15% plus No. 200		ELASTIC SILT
		15-25% plus No. 200	% Sand ≥% Gravel	ELASTIC SILT WITH SAND
			% Sand <% Gravel	ELASTIC SILT WITH GRAVEL
	≥30% plus No. 200	% Sand ≥% of Gravel	<15 % Gravel	SANDY ELASTIC SILT
			≥15% Gravel	SANDY ELASTIC CLAY WITH GRAVEL
		% Sand <% of Gravel	<15 % Sand	GRAVELLY ELASTIC SILT
			≥15% Sand	GRAVELLY ELASTIC SILT WITH SAND
OL/OH	<30% plus No. 200	<15% plus No. 200		ORGANIC SOIL
		15-25% plus No. 200	% Sand ≥% Gravel	ORGANIC SOIL WITH SAND
			% Sand <% Gravel	ORGANIC SOIL WITH GRAVEL
	≥30% plus No. 200	% Sand ≥% of Gravel	<15 % Gravel	SANDY ORGANIC SOIL
			≥15% Gravel	SANDY ORGANIC SOIL WITH GRAVEL
		% Sand <% of Gravel	<15 % Sand	GRAVELLY ORGANIC SOIL
			≥15% Sand	GRAVELLY ORGANIC SOIL WITH SAND

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

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

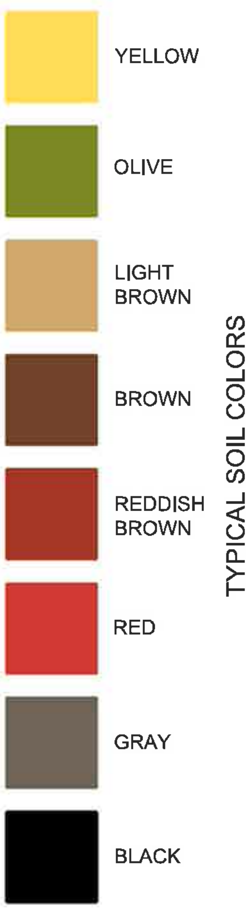
Peat refers to a sample composed primarily of vegetable matter in varying stages of decomposition. The description should begin: PEAT (PT) and need not include percentages of sand, gravel or fines.

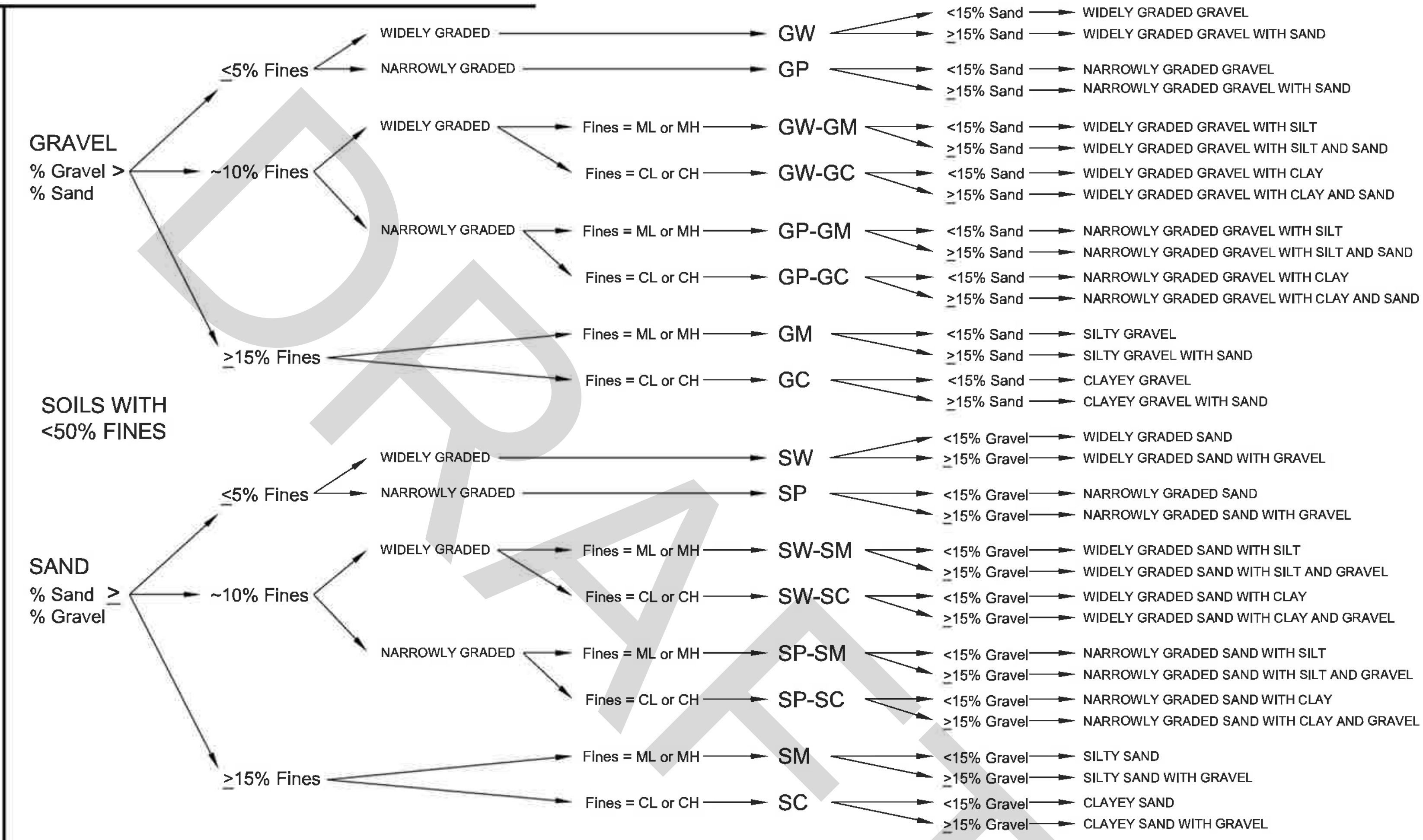
CRITERIA FOR DESCRIBING PLASTICITY

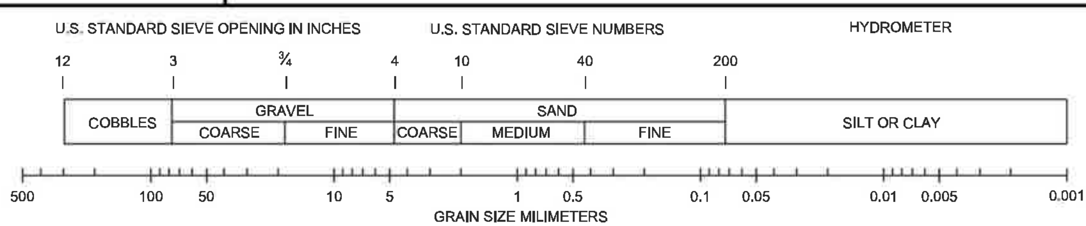
Description	Criteria
Nonplastic ML	A 1/8-in. (3 -mm) thread cannot be rolled at any water content
Low Plasticity ML, MH	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit *
Medium Plasticity MH, CL	The thread is easy to roll and not much time is required to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

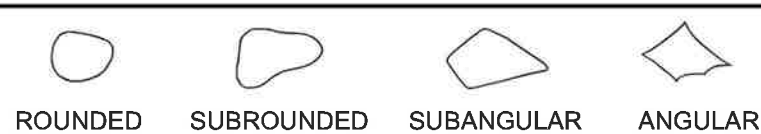
* Toughness refers to the strength of the thread near plastic limit. The lump refers to a lump of soil drier than the plastic, similar to dry strength.

COARSE-GRAINED SOILS
VISUAL-MANUAL DESCRIPTIONS









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

Describing the Plasticity of Soil Samples

M. Paster – November 2008

References ASTM D 2487 – Soil descriptions – lab
ASTM D 2488 – Soil descriptions – field
ASTM D 4318 – Atterberg limits testing

GEI Practice for Boring and Test Pit Logs

Describe the fines as:

Non-plastic
Low plasticity (The GEI laminated sheets incorrectly use "slightly plastic" for "low plasticity.")
Medium plasticity
High plasticity

Example: ~25% low plasticity fines

Toughness and dry strength:

You should use these tests to help decide how plastic the fines are. Record the results in the remarks column of the field log, but not in the soil description and not necessarily in the typed log.

On final logs, if Atterberg limits tests have been performed:

Do not use the descriptive terms non-plastic, low plasticity, etc. for samples on which Atterberg limits tests have been run. Instead, just give the percentage of fines and then report the actual Atterberg limits at the end of the description.

For example, the end of a silty sand description might be:
. . . ~25% fines, ~10% gravel max size ½ inch, gray. PL=23, LL=35.

(Atterberg limits tests are performed on the fraction of the sample finer than the No. 40 sieve, not just the fines. So the Atterberg limits data applies to the sample, not just to the fines.)

Hints:

High plasticity soils are rare in New England. If you think it's high plasticity, it's probably medium. Some Boston blue clay and some Connecticut River varved clays are high plasticity, but if you think you've found some, check with the project manager.

In New England, if ~10% fines or more, generally stick with GM, SM, ML, and CL. Occasionally GC, SC, CH. Don't use MH unless you have Atterberg limits data.

Estimating plasticity in the field, GEI guidance based on ASTM D 2488:

Plasticity	1/8-inch thread	Dry strength	Toughness
non	Cannot be rolled at any water content.	Dry specimen crumbles when handled.	Only slight pressure needed to roll thread near plastic limit.
low	Thread can barely be rolled.	Dry specimen crumbles with some finger pressure.	Slight to medium pressure needed to roll thread near plastic limit.
medium	Thread is easy to roll. Not much time needed to reach plastic limit.	Dry specimen crumbles with considerable finger pressure.	Medium pressure needed to roll thread near plastic limit.
high	Takes considerable time rolling and kneading to reach plastic limit.	Dry specimen cannot be broken with finger pressure.	Considerable pressure needed to roll thread near plastic limit.

Non-plastic vs. low plasticity:

ASTM D 2488 (soil descriptions - field) defines non-plastic and low plasticity based on the 1/8-inch thread as shown in the table above.

ASTM D 4318 (Atterberg limits testing) indicates that a sample should be called non-plastic for either of the following cases:

- The liquid limit test (dropping the cup) or the plastic limit test (rolling out the thread) cannot be performed because the plasticity is too low.
- The plastic limit is greater than or equal to the liquid limit.

Unfortunately, there are some soils that are low plasticity based on D 2488 (a thread can be rolled), but are non-plastic based on D 4318 (the liquid limit cannot be measured or PL≥LL).

GEI considers these soils to have low plasticity, because that is how they "look" and "feel." We want to document this information so that other people will have a better feel for what the soil looks like and how it behaves. So, if the soil was low plasticity based on D 2488, but non-plastic based on D 4318, that should be explained in the letter or report, and possibly in a note on the log.

BORING LOCATION: Maple Ave Sidewalk	DATE START/FINISH: 2/14/07 - 2/15/07		**B101**
GROUND ELEVATION (NGVD):	DRILLED BY: Geologic: M. Costigan		
GROUNDWATER EL.: DATE:	LOGGED BY: T. Kohl/M. Yoko	TOTAL DEPTH (FT): 25	PG. 1 OF 1

EL. FT.	DEPTH FT.	SAMPLE TYPE and NO.	SAMPLE BLOWS PER 6 IN.	SAMPLE PEN IN.	SAMPLE REC IN.	PID JAR HS / REMARKS	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
	0							4" pavement
	0.5–2.5	S1	13-9 17-14	24	0	0.5 ppm	FILL	S1: Redrove 0.5 to 3.5 ft. Recovery 11": WIDELY GRADED SAND (SW) ~85% sand, ~10% gravel to 1", <5% nonplastic fines, brown. Contains brick fragments and ash. Fill.
	2.5–5					hard drilling 3 to 4 ft, possible boulder	FILL	
	5–7	S2	7-7 11-13	24	8	2.0 ppm	FILL	S2: NARROWLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) ~65% mostly fine sand, ~25% gravel to 3/4 inch ~10% non-plastic fines, brown. Fill.
	7–9	S3	9-10 2-1	24	16	0.0 ppm	FILL / ORGANICS	S3 (0-10"): Similar to S2. S3 (10"-16"): ORGANIC SILT (OL) ~100% slightly plastic fines, dark gray, organic odor, contains white shell fragments.
	12–14	S4	WOH 1-2 1	24	15	0.0 ppm	ORGANICS	S4: Similar to S3, bot 6".
	14–17					hard drilling at 15.5 ft	TILL	
	17–19	S5	20-35 50/3"	15	8	Top of rock ~19 ft. Roller bit to 20 ft.	TILL	S5: SILTY SAND WITH GRAVEL (SM) ~60% mostly fine sand, ~25% slightly plastic fines, ~15% gravel to 1/2 inch, olive. Glacial Till.
	20–25	C1	RQD 70%	60	54	lost ~10 gallons drill fluid from 23 to 25 ft	ROCK	C1: SCHIST, hard, slight weathering at joint surfaces, joints at ~30 degrees from horizontal and generally parallel to foliation, gray. Marlborough Formation.
	25							Bottom of Boring 25 ft. Truck-mounted drill rig. 4-inch casing to 19 ft. Safety-hammer with rope and cathead for SPT. Backfilled with drill cuttings.

Depth scale: 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5, 25, 27.5, 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
RQD–LENGTH OF SOUND CORES > 4 IN./ LENGTH CORED, %
S–SPLIT SPOON SAMPLE
U–UNDISTURBED SAMPLES, UF–FIXED PISTON, UO–OSTERBERG
GROUNDWATER

NOTES:
1: Groundwater at 10 ft depth at start of day 2/15/07.

PROJECT 07999-0
DATE

GEI Consultants

EXAMPLE SOIL DESCRIPTIONS

SANDY SILT (ML) ~60% slightly plastic fines, ~40% mostly fine sand, 1" thick layer of fine to medium sand with <20% fines, gray.

LEAN CLAY (CL) ~90% moderately plastic fines, ~10% fine sand, olive. Boston Blue Clay. Sv = 0.5, 0.5, 0.8 tsf, Qp = 1.0, 1.5, 1.6 tsf

Stratified CLAYEY SAND (SC) and WIDELY GRADED SAND (SW) SC layers 1 to 2 inches thick consist of fine sand with ~30% moderately plastic fines, gray. SW layers 1 to 4 inches thick consist of fine to coarse sand, ~10% gravel to 1/2 inch, <5% fines, brown. Hydraulic Fill.

EXAMPLE ROCK DESCRIPTIONS

(0-9"): GRANITE, hard, one piece, joint surface slightly weathered, pink.
(6-60"): PHYLLITE, joints ~ 45° generally parallel to foliation, 9" to 44" moderate to severe jointing and joint weathering. 44" to 60" single piece, green-gray.

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

GEOPROBE AND ROTOSONIC

When SPTs are not performed, 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 O.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 on viscosity, the NAPL may drain from a soil sample. ("Sample saturated with green, sticky substance.")
- **Blebs** - Discrete sphericals of NAPL in a soil matrix that was not visibly coated or saturated. ("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.

STANDARD OPERATING PROCEDURE

SM-004 Test Pit Excavation

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

Russ Morang
Mike Quinlan

Field Descriptions of Samples at Urban Impacted Sites

The intent of this document is to provide field personnel guidelines for logging soil conditions and observed impacts in a consistent and factual manner. This guidance recognizes that prejudging field conclusions regarding the potential source(s) or nature of a particular impact should be avoided and instead conclusions should be based on multiple lines of evidence (field observations, laboratory physical and chemical analyses, historic site uses, location of observed impacts, etc.).

SOIL LOGGING

- All soils are to be logged using the **Unified Soil Classification System** (ASTM D 2488 field descriptions).
- A photograph of the entire sample core should be taken. Additional photographs may be necessary to document impacted material.
- A calibrated **PID** (Photoionization Detector) should be used to screen all soil samples. PID readings should be taken every 6 inches of recovery and the interval reading should be included on the boring logs.
- The soil sample core should be scored or cut along the long axis so that the all of the soil lithology can be observed, when practical.
- **Moisture terms**: dry, moist and wet.
- **Color terms –**Color terms should be used to describe the “natural color” of the sample as opposed to staining caused by contamination (see below).
- **Representativeness –** Soil logs should include specific notes if the field representative believes that there is a possibility the soil sample being described is not representative of the interval sampled or is indicative of multiple sources of contamination.
- **Intervals for Description** – the field description should be for discrete intervals within the sampler, specifically pointing out small-scale units and changes within each sample interval. The description should also include the amount of sample recovered and note other conditions (such as a change in drilling conditions, etc.), as well as consistently adjusting the sample interval described (i.e. – identify the percentage of sample actually recovered and note any potential causes of the loss if possible) and note other conditions (such as a change in drilling conditions, etc.).

DESCRIPTION OF CONTAMINANTS

Visual Contamination Descriptors

- **NAPL** (Non Aqueous Phase Liquid) **–** a separate phase liquid that may be lighter than water (LNAPL) or denser than water (DNAPL). NAPL arises from a variety of industrial sources and can have varying consistency (viscosity) and can range from non-viscous to highly viscous (taffy-like). NAPL observations should be accompanied by applicable olfactory with smell for industrial sources (see descriptors below) and other visual observations (e.g., color and viscosity).

- **Sheen –** iridescent sheen. This is not to be used to describe a “bacterial sheen”, which can be distinguished by its tendency to break up at angles on the water surface; whereas a non-bacterial sheen will be continuous and will not break up.

- **Blebs –** discrete, spherical shaped NAPL in or on the soil matrix. Include additional descriptors to the extent practicable such as the approximate size and quantity (number of blebs or qualitative estimate) to the extent practical.

- **Coated –** soil grains are coated with NAPL – there is not sufficient NAPL present to saturate the pore spaces. Use modifiers such as light, moderate or heavy to indicate the degree of coating.

- **Saturated –** the entirety of the pore space for a sample interval is saturated with NAPL. Care should be taken to ensure that the saturation described is not related to water in the sample. Depending on the viscosity, NAPL saturated materials may freely drain from a soil sample and should be documented accordingly.

- **Stained –** visible, unnatural discoloration of the soil, with no visible free product.

- **Solid NAPL –** NAPL that is in a solid or semi-solid phase. The magnitude of the observed solid NAPL should be described (discrete granules or a solid layer).

  Other Visual Impacts and Descriptors– Other visual impacts that are not naturally occurring should also be noted along with appropriate visual descriptors. These other visual observations could include the observation of debris, wood chips, staining, anthropogenic materials, or other notable visual characteristics and general observations characterizing common urban fill. The above impacts should be described using other visual descriptors as applicable. Descriptors may include, but not be limited to, color, consistency, thickness, etc.

Olfactory Descriptors

- Note odors similar to mothballs, driveway sealer, highway paving oil or other odors that are acrid, burnt, or sulfur-like, etc.
- Other odors that are not believed to be natural should also be identified with descriptors such as organic, ammonia, sweet, chemical etc., as applicable.
- Use modifiers such as strong, moderate or slight to indicate intensity of the observed odor.
- In instances where multiple odors are present, a combination of descriptors should be used to clearly identify where these co-mingled impacts are present.

DNAPL/LNAPL

- **Density of NAPL –** a jar shake test can be performed to preliminarily determine in the field whether observed NAPL is either denser or lighter than water. Care should be taken in recording and interpreting the results, as experience indicates that the apparent result immediately following the test may change with time. Laboratory testing for density of the NAPL is recommended to confirm results. The depth at which the NAPL is encountered on soil with respect to the groundwater surface is not diagnostic and should not be used a basis for identifying the density of NAPL in the field.

- **Viscosity of NAPL –** if NAPL is present a qualitative description of viscosity should be made. The following should be used:

  Highly Viscous (taffy-like)
  Viscous (No. 6 fuel oil or bunker crude-like)
  Low viscosity (No. 2 fuel oil-like or water-like)

GROUNDWATER SAMPLING OBSERVATIONS

- Any observations of sheen, blebs, NAPL, smearing or coating of the sampling equipment, odor, etc. made during groundwater sampling are to be included in the groundwater sample collection log.

COLOR CHART (ATTACHED) For Use in Cross-Sections, Extent Maps, and Similar Interpretative Depictions

The color chart attached is intended to help visually depict the nature and location of impacts observed during an investigation. The chart would be used for new sites or sites transitioning from the Site Characterization to the Remedial Investigation phase (or are in the early stages of the Remedial Investigation phase). The colors should be included in investigation summaries on cross sections to support an understanding of the nature and extent of impacts. In addition, the colors may also be placed on boring logs (although not a requirement) in the final report. In either case, the colors will be used in interpretive depictions of nature and extent once the lines of evidence support a determination of the appropriate color selection. Since the investigation of a site is dynamic, the use of a particular color or a combination of colors may change if other lines of evidence suggest such a change is appropriate.

In instances where multiple impacts are present, a combination of colors should be used (such as a color with cross hatching) to clearly identify where these co-mingled impacts are present.

Color Descriptions of Samples at Urban Impacted Sites

Color	Description	RGB Color	Auto Cad Index
	NAPL SATURATED	255,0,0	10
	NAPL COATED MATERIAL	255,0,255	210
	SOLID NAPL	129,64,0	34
	NAPL BLEBS, GLOBS, SHEEN	255,191,0	40
	STAINING, ODOR	255,255,0	50
	INDUSTRIAL IMPACTS - (PETROLEUM OR OTHER UNNATURAL) SATURATION & SHEENS	0,191,255	140
	INDUSTRIAL IMPACTS - (PETROLEUM OR OTHER UNNATURAL) STAINING & ODORS	170,234,255	141
	WOOD CHIPS/BLUE DISCOLORATION/SULFER-LIKE ODOR	0,0,255	170
	NO OBSERVED IMPACTS	0,165,0	92

Note: In instances where multiple impacts are present, a combination of colors should be used (such as a color with cross hatching) to clearly identify where these co-mingled impacts are present.

Section 7

Groundwater (GW)

STANDARD OPERATING PROCEDURE

GW-001 Water Level and NAPL Measurement

1. Objective

Describe procedures to measure the depth to water and non-aqueous phase liquid (NAPL) thickness in an open borehole, cased borehole, monitoring well or piezometer.

2. Equipment and Materials

Field forms and/or field notebook.

- Decontamination fluids
- Bailer
- Weighted cotton string
- Oil/Water interface probe
- Water level meter (if oil/water interface probe is not available)

Water level and NAPL measurements can be collected by a variety of methods. A water level meter is used to collect depth to water measurements however an oil/water interface probe or other methods must be used to gauge NAPL depths. An electronic oil/water interface meter, consists of a cable divided into incremental measurements of 0.01 feet, and probe that consists of an infra-red circuit that detects the presence of a liquid, and a conductivity circuit that differentiates between conductive liquid (water) and non-conductive liquid (LNAPL or dense non-aqueous phase liquid [DNAPL] product). Typically, a steady tone and light indicate a non-conductive liquid (e.g. product) and an intermittent tone and light indicate a conductive liquid (e.g. water). Refer to the manufacturer's instructions for details. Alternately, water level and NAPL measurements can be collected using a water level meter, clear bailer and weighted cotton string. Each method of data collection is described below.

3. General Information

- The water level in a monitoring well or piezometer should be allowed to stabilize for a minimum of 24 hours after development or construction before groundwater elevation and/or NAPL measurements are collected. The water level in a borehole can be measured during drilling; however, this should be noted in the field notebook.
- Water levels in multiple wells should be collected within the shortest timeframe practicable.
- Water and NAPL levels should be measured from the designated survey point as specified by the surveyor or highest point (or "V" notch) on the PVC. If the well is new, mark the datum point with an indelible marker and note reference location in

field book. Discuss with the project manager what reference point should be used to collect water measurements for specific sites.

- Water level and/or NAPL measurements should be made before any water is removed from wells because doing so may influence groundwater levels in the area of the investigation.
- Measurements should be made approximately three 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).
- Water level and/or NAPL measurements should first be collected at the wells that are least contaminated and proceed towards the wells that are most contaminated. Decontaminate the water level meter or oil/water interface probe prior to initial use and after use at each location. If NAPL is encountered at a well where it was previously not observed, contact your project manager before continuing.
- Refer to the oil/water interface probe or water level meter instruction manual for guidance on indicator signals, as these may differ by manufacturer.

4. Execution

4.1 Water Level and NAPL Measurements Using Interface Probe

- Open wells to the atmosphere and allow them to equilibrate prior to collecting LNAPL depth measurements.
- LNAPL Depth (if present): Measure the LNAPL/air interface by slowly lowering the interface probe to the LNAPL surface. Be ready to stop as soon as the probe signals the LNAPL surface.
- Record the depth to LNAPL.
- Groundwater Depth: Continue slowly lowering the probe until it signals the presence of water.
- Record the depth to water.
- The LNAPL thickness is determined by subtracting the water depth from the LNAPL depth.

The depth and thickness of DNAPL can sometimes be determined by slowly lowering the interface probe past the LNAPL (if present) and water layers. Record the depth to the DNAPL layer. Finally, measure the depth to the well bottom.

The DNAPL thickness is determined by subtracting the DNAPL depth from the depth to well bottom.

- Decontaminate the interface probe and tape according to SOP QA-001.
- Dispose of any NAPL-impacted debris properly.
- Check with the Project Manager if you are uncertain of the appropriate disposal method.

4.2 LNAPL Measurements Using Clear Bailer

If LNAPL is suspected at a site, an oil/water interface probe should be used when gauging water level and NAPL measurements. However, a water level meter and a clear bailer may be used instead to estimate approximate LNAPL thickness if an oil/water interface probe is not available.

- Open wells to the atmosphere and allow them to equilibrate prior to collecting LNAPL depth measurements.
- Slowly lower the water level meter until contact with fluid is indicated by the meter.
- Record the depth to fluid measurement.
- Lower a clear bailer into the well and slowly into the LNAPL. Do not submerge the bailer.
- Slowly raise the bailer out of the well and measure LNAPL thickness in the bailer using a ruler or tape measure.

Calculating Depth to Groundwater
The depth to water can be calculated as follows:

DTW = DTF + PT
DTW = Depth to Groundwater
DTF = Depth to Fluid
PT = Measured Product Thickness

Calculating Corrected Depth to Groundwater
Once the LNAPL thickness is known and the depth to groundwater is known, the corrected depth to groundwater can be calculated.

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

4.3 DNAPL Measurements Using Weighted Cotton String

A weighted cotton string may be used to estimate approximate DNAPL thickness.

- Secure cotton string.
- Secure clean steel nuts and/or washers.

- Tie the string to the nuts/washers, so that there is adequate weight.
- Lower the weighted string into the well slowly, until a firm bottom is sensed.
- Remove the weighed string and measure the DNAPL coated portion of the string.
- Record the thickness.
- Dispose of any NAPL-impacted debris properly. Check with the Project Manager if you are uncertain of the appropriate disposal method.

5. Health and Safety Considerations

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the site specific Health and Safety Plan (HASP). The collection and accumulation of NAPL presents the potential for significant hazards that need to be managed. A detailed job safety analysis (JSA) should be completed prior to the start of work.

6. Considerations

- Weak batteries in water level and oil/water interface meters 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 or NAPL. As such, it is recommended that electronic ground water-level indicators be tested before they are brought out into the field.
- Electronic oil/water interface meters do not respond to distilled water. Do not use de-ionized water to test these units.
- Wells that are not vertical may result in probe contact with the side of the well casing providing a false measurement. Once the probe has come in contact with ground water 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 ground water-level measurement should then be collected. If the signals from the unit are not abrupt or reproducible, the probe and tape may need to be retrieved and dried off before trying again.
- Accumulation of sediment, organic material, or floating debris in 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 ground water-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 it cannot contact the inner casing.
- Well gauging equipment should be properly decontaminated between wells and piezometers to avoid cross contamination.
- Water levels in wells may be influenced by changes in river stages, pumping of nearby wells, precipitation, tides, etc.
- Using a bailer to estimate LNAPL thickness can result in 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.
- The optical sensor on interface probes may become damaged if solvents are used to clean NAPL from the probes.
- The optical sensor may become smeared when used to measure NAPL, 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.
- 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 LNAPL can pose a problem when measuring the level of groundwater. Floating LNAPL can depress the groundwater level in a monitoring well or piezometer and distort the measurement. Therefore, the Corrected Depth (CD) formula shown above should be applied to groundwater level measurements in monitoring points where LNAPL are present:
- Some interface probes are factory-calibrated based on an assumed conductivity of NAPL and water, both of which may vary. An interface probe that is functioning properly may not be able to discern different NAPLs at all sites.
- An interface probe may not successfully provide both LNAPL and DNAPL measurements in the same well because the probe is coated by LNAPL and loses its ability to detect DNAPL.
- DNAPL, in particular, may be only slightly heavier than water, or may be neutrally buoyant. As a result, it can be easily disturbed. Once it is disturbed, meaningful measurements can be difficult or impossible to obtain. As such, all tapes or probes used for measurements should be used slowly.

7. References

U.S. EPA Environmental Response Team Standard Operating Procedures SOP: 2043,"Water Level Measurement" REV: 0.0, 2/11/00

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

8. Contacts

Ryan Hoffman – (781) 721-4091 Boston

STANDARD OPERATING PROCEDURE

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

1. Objective

Provide procedural guidance for routine recovery of non-aqueous phase liquids (NAPL).

2. Equipment and Materials

The following materials and equipment may be necessary for this procedure:

- SOP GW-001 Water Level and NAPL Measurement
- Oil/water interface probe
- Appropriate pump and required tubing/piping
- Double check valve bailers and string
- Drums or buckets for NAPL collection
- Proper personal protective equipment (PPE) including gloves and protective eyewear
- Drum labels
- Field data sheets or logbooks
- Decontamination supplies and plastic sheeting
- Additional equipment identified by site-specific work plan and health and safety plan (HASP)

3. General Information

Refer to SOP GW-001 and record the depth to NAPL and depth to water measurements If you are using an oil/water interface probe, first check to see if the unit is functioning correctly. Note: De-ionized water will not provide a correct reading. Check the interface probe battery and replace if necessary.

Interface probes usually distinguish between NAPL and water by sounding solid or intermittent tones. See the manufacturer's instructions for details.

4. Execution

4.1 General Measurement Procedures

Using an oil/water interface probe will provide a depth to water and a depth to NAPL in each monitoring well. Refer to probe manual to determine changes between liquid types (water, light non-aqueous phase liquid [LNAPL] and dense non-aqueous phase liquid [DNAPL]). To achieve accurate depth measurements, ensure the oil/water interface probe is decontaminated (GEI SOP QA-001) prior to and between each measurement taken at each well.

To calculate the volume of NAPL in monitoring wells with well diameters specified below, use the following respective equations:

Light non-aqueous Phase Liquid (LNAPL) Volume

$$LNAPL\, V = (DTW - P_1) \times C$$

Dense Non-Aqueous Phase Liquid (DNAPL) Volume

$$DNAPL\, V = (TD - P_2) \times C$$

Where, V = Volume
DTW = Depth to Water
TD = Total Depth
P_1 = Depth to LNAPL
P_2 = Depth to DNAPL

Conversion factors (C) for wells based on well diameter size are noted in the table below.

Well Diameter (inches)	Conversion Factor (liters)	Conversion Factor (gallons)
2	0.6178	0.1632
4	2.4711	0.6528
6	5.561	1.469

Note: Well diameter sizes are noted for outer diameter. Conversion factors assume Schedule 40 PVC riser and screen, if well is constructed of different material appropriate conversion factors must be used to calculate accurate NAPL volume.

Once measurements have been taken and calculations have been made, collection of NAPL may commence.

4.2 NAPL Collection Procedures

Collection of NAPL shall be accomplished using common recovery techniques or technologies including:

- Peristaltic pump
- Bailer

Some projects require on-going NAPL recovery efforts. For these projects installation of dedicated recovery methods should be considered.

Special care shall be taken to prevent any recovered NAPL from spilling or coming into contact with the ground and sampling personnel. This includes the use of proper personal protective equipment (PPE), including gloves and protective eyewear (Tyvek® if necessary), along with plastic sheeting set beneath the pump, tubing, and collection container (sealed top 55-gallon drum or 5-gallon bucket with lid), and the surrounding work area. A site-specific work plan, HASP and job specific job safety analysis need to be developed prior to the start of work. The specific operating procedures for common recovery methods are discussed in the following sections.

4.2.1 Sampling and Recovery via Peristaltic Pump:

LNAPL

- Take and record the required measurements prior to commencing pumping.
- Cut a length of poly tubing (T1) that is long enough to extend approximately 12-inches beyond the LNAPL layer. Cut an additional length of poly tubing (T2) that will be connected to the discharge side of the peristaltic pump silicone tubing that is long enough to extend from the pump to the NAPL collection container. Cut a length of silicone tubing (approximately 8-inches) for use in the peristaltic pump head.
- Insert the silicone tubing into the peristaltic pump head. Check the flow direction of the pump to ensure that the pump will be removing fluid and not pumping air into the well when removal begins.
- Insert T1 into the intake side of the silicone tubing. Lower the intake side into the well and secure in place just below the top of LNAPL.
- Insert T2 into the discharge side of silicone tubing and secure to the NAPL collection container with a clamp.
- Turn pump flow rate to lowest setting. Turn the pump on and slowly increase the pump rate to begin LNAPL removal from the well. Use the oil/water interface meter to measure the depth to LNAPL. Lower the intake tubing as necessary until all of the LNAPL has been recovered from the well.
- Once the LNAPL has been recovered from the well, collect and preserve a sample if required, in accordance with laboratory standards.
- Following completion of LNAPL recovery, disconnect the tubing from the pump, secure the well and road box, and clean/decontaminate the pump and oil/water interface probe, prior to moving to the next location.
- Impacted tubing will either be containerized for proper disposal or left in well for reuse.

DNAPL

- Take and record the required measurements prior to commencing pumping.
- Cut a length of poly tubing (T1) that is long enough to extend to the bottom of the well including additional length to attach to the pump intake. Cut an additional length of poly tubing (T2) that will be connected to the discharge side of the

peristaltic pump silicone tubing that is long enough to extend from the pump to the NAPL collection container. Cut a length of silicone tubing (approximately 8-inches) for use in the peristaltic pump head.

- Insert the silicone tubing into the peristaltic pump head. Check the flow direction of the pump to ensure that the pump will be removing fluid and not pumping air into the well when removal begins.
- Insert T1 into the intake side of the silicone tubing. Lower the intake side into the well and secure in place just above the bottom of the well.
- Insert T2 into the discharge side of silicone tubing and secure to the NAPL collection container with a clamp.
- Turn pump flow rate to lowest setting. Turn the pump on and slowly begin to remove DNAPL from the well. DNAPL removal will be complete when the pump begins to discharge water. Use the oil/water interface meter to check the DNAPL thickness during the removal process. Take care not to pump an excessive amount of water.
- Once the DNAPL has been purged from the well, collect and preserve a sample if required, in accordance with laboratory standards.
- Following completion of DNAPL recovery, disconnect the tubing from the pump, secure the well and road box, and clean/decontaminate the pump and oil/water interface probe, prior to moving to the next location.
- Impacted tubing will either be containerized for proper disposal or left in well for reuse.

4.2.2 Sampling and Recovery via Double Check Valve Bailer:

LNAPL

- Take and record the required measurements prior to commencing bailing.
- Ensure the work area is covered in plastic sheeting to avoid potential spills of water and/or NAPL.
- Tie the bailer to a piece of string that will allow the bailer to reach just below the LNAPL layer. Use the oil/water interface meter to determine the appropriate depth.
- Using slow and controlled motions while lowering (and raising) the bailer to the appropriate depth, commence bailing LNAPL out of the well and draining the bailer directly into collection container.
- Once the LNAPL has been purged from the well, collect and preserve a sample, if required, in accordance with laboratory standards.

DNAPL

- Take and record the required measurements prior to commencing bailing.
- Ensure the work area is covered in plastic sheeting to avoid potential spills of water and/or NAPL.
- Tie the bailer to a piece of string that will allow the bailer to reach the bottom of the well.
- Using slow and controlled motions while lowering (and raising) the bailer to the bottom, commence bailing DNAPL out of the well and draining the bailer directly into collection container.
- Once the DNAPL has been purged from the well, collect and preserve a sample, if required, in accordance with laboratory standards.

4.3 Waste Management and Disposal

Investigation derived waste should be managed in accordance with GEI SOP SC-003. DNAPL waste management and disposal should be evaluated on a site by site basis.

4.4 Troubleshooting Information

If there are any performance problems with the oil/water interface probe which result in inability to achieve the proper measurements presented in Section 5.1, or if there are any problems with the peristaltic pump, consult the appropriate section of the probe instruction manual for the checkout and self-test procedures. If the problem persists, consult the manufacturer's customer service department immediately for further instructions.

Lower temperatures can affect the ability to pump and/or bail NAPL. Weather should be taken into consideration when scheduling gauging and recovery sampling events.

4.5 Data and Records Management

All information pertaining to maintenance of the oil/water interface probe and the peristaltic pump shall be maintained in the project file. Field measurements (depth to water, NAPL, etc.) and all calculations (NAPL column length, volume of NAPL, etc.) shall be recorded on the appropriate field data sheets or in the logbook consistent with GEI SOP Section 5.

4.6 Limitations

- NAPL gauging and recovery can be challenging and requires adaptive thinking. A variety of measurement and collection techniques may be necessary to properly execute the work.
- Exposure to NAPL can accelerate the required maintenance/replacement intervals for tools and equipment.

5. Health and Safety Considerations

The health and safety considerations for the work associated with this standard operation procedure, including both potential physical and chemical hazards, will be addressed in the site specific Health and Safety Plan (HASP). The collection and accumulation of NAPL presents the potential for significant hazards that need to be managed. A detailed JSA should be completed prior to the start of work.

6. References

U.S. EPA. Ground Water Issue: Dense Non-aqueous Phase Liquids, EPA/540/4-91-002, March 1991.

7. Contact

Kathleen Slimon
Mike Quinlan

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

Saskia Oosting

GEI Consultants

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:

<u>Well Volume Conversion:</u>

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

<u>Stabilization Criteria:</u>
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 PROCEDURE

GW-004 pH and Temperature Measurement

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1. Objective

Describe methods for measuring the pH and temperature of liquids using a combination pH/temperature meter.

2. Execution

Calibration

- 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. Solutions chosen should be similar to the expected pH of the liquids tested (pH 7 and 4 buffer solutions are preferred in most cases for groundwater or surface water measurements).
- Check calibration at the end of the day by reading the two solutions used in calibration. Also perform additional field checks as needed based on observed readings (i.e., inconsistent readings). Record measurements and time of measurement in the field book or sample sheet. If the readings are outside +/– 0.2 pH units, recalibrate the meter.

Sample Measurement

- Immediately prior to testing a sample, decontaminate testing container and probe assembly with one rinse of distilled water. Do not use methanol to rinse the probe. Methanol rinses could damage the probe.
- Gently dry the probe with a paper towel and shake 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. Measure and record pH reading after stabilization or 60 seconds, whichever is sooner. A reading has stabilized if pH units have not changed +/– 0.1 pH units during a 30 second period.
- Record pH to the nearest 0.1 unit and temperature to the nearest whole number.

3. Limitations

- Coatings and particulates may affect the response of the probe; more thorough cleaning using a weak alconox solution and distilled water rinse and gently wiping the probe surface with a paper towel 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.
- Do not use buffer solutions 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. Contacts

Saskia Oosting

STANDARD OPERATING PROCEDURE

GW-005 Turbidity Measurement

1. Objective

Describe calibration and use of a Hach nephelometer/turbidimeter.

The meter is used to measure turbidity of liquids by quantifying how much light passes through them. Turbidiity readings are required to be read using a portable (e.g Hach) instrument directly from the tubing before going through the flow-through cell.

This SOP is specific to a Hach turbidimeter. Follow manufacturer's recommendations for other meters.

2. Execution

i. Turn the meter "ON".
ii. Rinse the sample cell 3 times with distilled water.
iii. Fill the cell to the fill line with distilled water and then cap the cell.
iv. Wipe off excess water and streaks with a non-abrasive lint-free paper or cloth (preferably lens paper).
v. Open the cover and insert the cell (arrow to the front) into the unit and close the cover.
vi. Press "READ" and wait for the 'light bulb' icon to go off. Record the reading.
vii. Using the Gelex standards, repeat steps above. Record all measurements (note anomalies).
viii. Fill the cell with sample liquid to the fill line (about 15 mL) and replace the cap on the cell.
ix. Wipe off excess water and any streaks with a non-abrasive lint-free paper or cloth (lens paper).
x. 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.
xi. Insert the sample cell, arrow to the front, in the instrument. Close the lid.
xii. Select manual or automatic range selection by pressing the range key.
xiii. Use signal average mode if the sample causes a noisy signal (display changes constantly). Select signal averaging mode by pressing the "Signal Average" key.
xiv. Press Read. The display will show "---- NTU" and then the turbidity in NTU. Record the result after the lamp symbol turns off.
xv. Rinse the cell with distilled water.
xvi. Confirm the validity of the sample measurement by double-checking with one of the Gelex standards.

xvii. Periodically check the turbidity meter during the day by using the Gelex secondary standards provided.

xviii. Perform a post calibration at the end of the day and record all measurements.

3. Limitations

If the turbidity measurements are for National Pollutant Discharge Elimination System (NPDES) reporting purposes, all samples with values above 40 NTU must be diluted with turbidity free water (e.g. distilled water) and sample turbidity is calculated by multiplying the reading of the diluted sample by the dilution factor.

4. References

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

5. Contacts

Saskia Oosting

STANDARD OPERATING PROCEDURE

GW-006 Specific Conductance Measurement

1. Objective

Describe standard methods to measure conductivity of water using a field conductivity meter.

2. Execution

- Calibrate the meter according to equipment manufacturer's instructions at the beginning of each day of use. Calibration shall be performed using a standard KCl or other solution recommended by the manufacturer.
- Record the make, model, and serial or identification number of the instrument and calibration information in the field notebook.
- Check calibration at the end of the day by measuring the standard used in calibration and record in field book. Also perform additional field checks as needed based on observed readings (i.e., inconsistent readings). 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 container and probe assembly with distilled water.
- Gently dry the probe with a paper towel and shake container to remove excess solution.
- Pour sample into the container and insert probe. Stir sample with the probe for approximately 10 seconds. Let the probe equilibrate in the sample solution for another 30 seconds. Measure conductivity and record in the field notebook.
- Record conductivity to the nearest whole number.

3. Limitations

- Oily coatings and particulates may affect the probe's response; more thorough cleaning using a weak alconox solution and distilled water rinse and gently wiping the probe surface may be required to clean the surface of the probe.
- If sample liquid is contaminated, (e.g. stained, conductance >0.75 mS/cm), rinse probe with distilled water immediately after measuring sample to minimize fouling of probe.
- Do not use calibration solutions 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. Contact

Brian Conte
Saskia Oosting

STANDARD OPERATING PROCEDURE

GW-007 Dissolved Oxygen Measurement

1. Objective

Describe calibration and field use of dissolved oxygen meter.

2. Execution

- Place instrument in the intended operating position (vertical, tilted, or horizontal) before it is prepared for use and calibrated.
- Recalibration may be necessary when the instrument operating position is changed.
- Attach the prepared probe to the Probe connector of the instrument and adjust the retaining ring finger tight. Check that membrane is intact and check for presence of air bubbles under membrane. If bubbles are present or membrane is damaged, prepare probe again according to manufacturer's instruction.
- Place approximately 1/8 inch of water into the bottom of the calibration cup. Place the probe into the cup and engage only one thread of the calibration cup onto the probe to ensure that the DO probe is readily vented to the atmosphere. Make sure the DO and temperature probes are not in contact with the water. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperature to equilibrate.
- Calibrate meter according to the procedures outline in the instrument manual. Calibrate probe to a zero oxygen solution provided by manufacturer, and water saturated air.
- The calibration procedure may require correction factors or input of site-specific barometric pressure and temperature. Correction factors can be found at:

  http://water.usgs.gov/owq/FieldManual/Chapter6/6.2_v2.1.pdf

- Otherwise, use appropriate instruments at the site to determine temperature and pressure.
- Perform Dissolved Oxygen Measurement using the following procedure:
  - i. Submerge probe in flow-through chamber or water body.
  - ii. Gently raise and lower probe in sample.
  - iii. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen.
  - iv. Read and record the temperature and the value of the dissolved oxygen in mg/L.
  - v. Document field analysis data and general observations in the field log book or groundwater sampling sheet.

3. Limitations

- Collect DO measurements in the field during sampling. Storing samples in containers will alter the DO concentration of the sample.
- Detection Limit (DL) = 0.1 mg/L for 0-10 mg/L range; do not record values less than Detection Limit: a zero reading is recorded < 0.1 mg/L.

4. References

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

5. Contacts

Saskia Oosting

STANDARD OPERATING PROCEDURE

GW-008 Temporary Groundwater Sampling Points

1. Objective

To define the procedures for installation of temporary groundwater sampling points (hereafter referred to as well point) for measuring depth to groundwater and collecting groundwater samples. Well points may aid in the placement of permanent monitoring wells.

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. No filter or gravel pack is used in the installation.

Well point installations are not the only type of temporary monitoring wells. Alternative temporarily well constructions should be discussed with the project manager and may be more appropriate based on-site conditions.

2. Execution

2.1. Installation

- The well point can be placed with the use of a conventional hollow-stem auger rig, Geoprobe®, 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 contamination downward with the point resulting in analytical sample results which are biased high. In areas with contamination above the desired screening zone, the well points should be installed with the aid of either hollow-stem augers or Geoprobe®, to "case off" contamination from the upper layer.

- 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.

- If the well point is used for piezometeric data, make a survey mark on top of the casing as a reference point for water level measurements.

- Caution must be used when using well points in areas of contaminated soil. Possible cross contamination may be introduced to the screen as it passes through the zone of contamination.

2.2. Sampling Procedures

Development of a well point is not required prior to sampling. Sampling of groundwater or collecting piezometric data must be performed by one of several recommended methods described in this manual.

After sample collection, (See Groundwater Sampling SOP) the well point is removed by back hammering or pulling the tool out with the rig hydraulics.

3. References

ASTM D6001 - 05 Standard Guide for Direct-Push Water Sampling for Geoenvironmental Investigations

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.

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

4. Contacts

Saskia Oosting

STANDARD OPERATING PROCEDURE
GW-010 Slug Tests

1. Objective

Describe methods to use slugs, pressure transducers, and data loggers to collect data that will support calculation of horizontal hydraulic conductivity of distinct geologic strata.

General Information

Slug tests are performed on single monitoring wells to estimate the hydraulic conductivity of the aquifer in which the well is screened. The test consists of adding or removing a known volume (slug) to or from the well to instantaneously change the water level. Subsequently, the recovery of the water level back to the static water level is measured. The resulting data are used to determine the hydraulic conductivity of the aquifer test zone using an appropriate analytical method.

Falling head tests can only be performed in fully-penetrating wells (well screened completely below the water table). Rising head tests can be performed in both fully- and partial-penetrating wells.

2. Execution

2.1 Setup

- Determine how water levels will be recorded. If the geologic materials in the test zone are expected to be slightly permeable (e.g., a glacial till or clay), then measurements may be recorded manually with an electronic water level indicator. If the geologic materials in the test zone are expected to be moderately- or highly-permeable (e.g., outwash sands), record measurements using a pressure transducer attached to an automatic data logger.

  The remainder of this SOP assumes that an automatic data logger is being used to measure water levels.

- Check to see if test equipment functions prior to leaving for the site.
- Decontaminate the transducer and cable using alconox and distilled water. Do not use methanol. Do not use transducer in wells containing non-aqueous phase liquid (NAPL).
- Make initial water level measurements
- Test wells in the following order: from the least contaminated to the most contaminated, and from low to high expected permeability, where possible.
- Measure the static water level (i.e., depth to water) in the well to be tested manually using an electronic water level indicator. Record all

measurements taken during the test in the field log book or on the attached log form.

- Install the pressure transducer as far below the deepest point of insertion of the slug bar or bailer as possible. Allow the transducer to thermally equilibrate for 15 to 30 minutes (to allow instrumentation wiring to expand/contract) before measurements are taken.
- Secure the transducer cable at ground surface with tape or weight to keep the transducer at a constant depth.
- Cover sharp edges of the well casing with duct tape to protect the transducer cables.
- Transducer measurement setup: For wells screened in sand and silty sand, a linear setting of one reading per second is generally used. In coarser soil where full recovery may occur over a few seconds, a linear setting for more frequent readings is necessary. If a transducer is used for silt and clay, a linear setting of one reading per minute, or a logarithmic setting, may be used to avoid risk of exceeding the memory capacity of the transducer.

2.2 Field Procedure – Rising Head Test

In this test, a slug is inserted in the well prior to the test and the water level is allowed to return back to static level. The test is then started by removing the slug from the well and immediately measuring rising water levels. In wells where recovery is slow, this test can be performed by pumping or bailing water from the well and immediately starting measurements.

- Record the initial water level and other setup information on the attached form.
- Fully submerge the slug bar or bailer into the water column of the well.
- Allow the water level in the well to return to static condition after both the slug and transducer have been inserted. The transducer readout should indicate the height of water above the transducer.
- When the water level in the well has returned to static condition, start the transducer ("Start Test" if using Win Situ software). Periodically view graphical data during the test, to confirm adequate data collection.
- Rapidly remove the slug bar or bailer from the water column and well. Avoid moving or pulling up the transducer cable when removing the slug.
- Continue recording water levels with the transducer until the water level has recovered to within 15 percent of the original static water level relative to the initial test displacement (85 percent recovery), or until one hour has elapsed. If less than 50 percent recovery has been achieved after one hour, continue to collect measurements every 10 to 20 minutes.
- Where possible, repeat the test to establish the repeatability of measurements and calculated hydraulic conductivity results.
- As soon as practicable, download data stored in the transducer and transfer data.

2.3 Field Procedure – Falling Head Test

In this test, a slug is inserted in the well at the start of the test and the falling water levels are measured immediately. In wells where recovery is slow, this test can be performed by adding water to the well and immediately starting measurements.

- Record the initial water level and other set up information on the attached form.
- Allow the water level in the well to return to static conditions after the transducer has been inserted. The transducer readout should indicate the height of water above the transducer.
- When the water level in the well has returned to a static condition, begin recording transducer readings (“Start Test” if using Win Situ software).
- Fully submerge the slug bar or bailer into the water column of the well.
- Periodically view graphical data during test, to confirm adequate data collection. The transducer should continue to record water levels until the water level has recovered to within 15 percent of the original static water level relative to the initial test displacement (85 percent recovery), or until one hour has elapsed. If less than 50 percent recovery has been achieved after one hour, continue to collect a measurement every 10 to 20 minutes.
- Where possible, repeat the test to establish the repeatability of measurements and calculated hydraulic conductivity results.
- As soon as practicable, download data stored in the transducer and transfer data.

3. Additional Information

- Do not perform hydraulic conductivity tests on wells that have not previously been developed and allowed to equilibrate.
- It is critical to either add or remove the slug to the well as quickly as possible and to start collecting depth-to-water measurements immediately.
- The early-time data is critical because the rate of recovery of head in the well is exponential. Collect measurements frequently at the start of all variable head tests.
- The time required for a slug test to be completed is a function of the volume of the slug, the hydraulic conductivity of the formation, and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. Two bailers connected in series can be used to increase the slug volume, provided the water column is deep enough.
- Decontaminate all down well equipment before using it in the well.

- NAPL will damage the transducer. Gauge recovery manually in these instances.
- Where possible, take periodic water level readings manually during recovery. The manual data are used to check for transducer noise or movement.
- If using automatic data loggers, download the data as soon as possible. Batteries in the data loggers may run down and result in a loss of data.
- Be prepared to containerize water generated from rising head tests if the water is contaminated.
- Where possible, take more than one pressure transducer to site. This will provide backup and allow testing of multiple wells simultaneously.

4. Calculations

The simplest interpretations of piezometer recovery are Hvorslev (1951) and Bouwer and Rice (1976). The analyses assume a homogenous, isotropic medium in which soil and water are incompressible. Spreadsheets and software are available to calculate hydraulic conductivity from slug test data according to the methods below.

Hvorslev's expression for hydraulic conductivity (K) is:

$$K = \frac{r^2 \ln (L/R)}{2\, L\, T_0} \qquad \textit{for } L/R > 8$$

where:
K = hydraulic conductivity [ft/sec]
r = casing radius [ft]
L = length of open screen (or borehole) [ft]
R = filter pack (borehole) radius [ft]
$\boldsymbol{T_0}$ = Basic Time Lag [sec]; value of t on semi-logarithmic plot of $H\text{-}h/H\text{-}H_0$ vs. t, where H-h/H-Ho = 0.37
H = initial water level prior to removal of slug
$\boldsymbol{H_0}$ = water level at t = 0
h = recorded water level at t > 0

(Hvorslev, 1951; Freeze and Cherry, 1979)

The Bouwer-Rice expression for hydraulic conductivity (K) is:

$$K = \frac{r^2 \ln (R_e/R) \ln(h_o/h_t)}{2\, L\, t}$$

where:
r = casing radius [ft]
t = time of drawdown measurement since start of test [sec]

h = drawdown of water in well at time = t [ft]
h_o = drawdown of water in well at t = 0 (initial drawdown) [ft]
L = length of open screen (or borehole) [ft]
R_e = effective radius (radius of influence) [ft]
R = gravel pack radius [ft]

Both the Hvorslev and Bouwer-Rice methods can be applied for partially-penetrating wells. Hvorslev is generally applicable only to fully penetrating wells.

5. References

Bouwer, H., "The Bouwer and Rice Slug Test – An Update," Ground Water, vol. 27(3), 304, 1989.

Butler, James, J., Jr. "Improving the Quality of Parameter Estimates Obtained from Slug Tests", Ground Water, Vol. 34, No. 3, May-June 1996.

Butler, James J., Jr., "The Design, Performance, and Analysis of Slug Tests", Kansas Geological Survey, Lewis Publishers, 1997.
Chirlin, G.R. (1989), A Critique of the Hvorslev Method for Slug Test Analysis: The Fully Penetrating Well.

Fetter, C.W. (1994), Applied Hydrogeology, 3rd edition.

Freeze, R. Allen and John A. Cherry, 1979. Groundwater, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Hvorslev, M.J., "Time Lag and Soil Permeability In Ground-water Observations," U.S. Army Corps of Engrs. Waterways Experiment Station Bulletin No. 36, 1951.

Lambe, T.W, and R.V. Whitman (1969), Soil Mechanics.

Sanders, Laura L., "A Manual of Field Hydrogeology", Prentice-Hall, Inc., 1998.

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: 2046,"Slug Tests" REV: 0.0, 10/03/94

6. Attachments

Attachment A – Slug Test Data Form

7. Contacts

Andy Adinolfi
Saskia Oosting

Attachment A. Slug Test Data Form

SITE ID: ________________

SLUG TYPE (solid/bailer/pumped)

LOCATION/WELL ID ___________

SLUG DIAMETER: _____________

DATE: ________________________

SLUG LENGTH: ______________

FIELD PERSONNEL: ______________

____

METHOD:

RISING HEAD ____________

FALLING HEAD __________

DATALOGGER TYPE:

____

____

COMMENTS:

____

____

===

SETUP

Time _______________
Depth to Water - Initial Static(before installing troll/slug) ___________
Confirm well recovers to static after installing slug, or note otherwise
____

===

MANUAL CONFIRMATORY MEASUREMENTS

ELAPSED TIME (min.)	DTW	ELAPSED TIME	DTW
____________	_____________	_______________	_______________
____________	_____________	_______________	_______________
____________	_____________	_______________	_______________
____________	_____________	_______________	_______________
____________	_____________	_______________	_______________

Form based on:
USEPA, 1994; Sanders, 1998.

STANDARD OPERATING PROCEDURE

GW-011 Constant Head Permeability Testing

1. Objective

Describe procedures for performing constant head borehole permeability testing in granular soils. Constant head permeability testing is used when the soil permeability is sufficiently high for testing to be practical.

2. Execution

- All borehole permeability testing shall be performed below the static groundwater table. As the boring is advanced, attempt to determine the static groundwater level by:
  - Observing the water content of samples collected from the boring to identify the transition from moist to saturated soil.
  - For higher permeable soils, allowing the water level in the borehole to stabilize before performing the test.
  - If the borehole is left open overnight or for an extended period, measure the static groundwater level in the borehole at the beginning of the next day.
  - Measure the water level in nearby observation wells or piezometers.
  - If a well or piezometer is installed in the borehole, measure the water level in the well or piezometer after the water level has stabilized.
- Advance the drill casing to the top of the test zone and clean the borehole to the bottom of the casing.
- Obtain a split spoon sample in the test zone below the bottom of the casing.
- Advance the borehole 2 feet below the bottom of the casing using a side discharge roller bit. The roller bit should be only slightly smaller than the inside diameter of the casing. Record the diameter of the casing and the diameter of the roller bit. Avoid jetting the borehole walls or bottom during cleaning. Continue flushing the borehole until return water is clear.
- Measure the depth to groundwater in the borehole over a 10 to 15 minute period to observe if the groundwater elevation has approximately stabilized. Compare the saturated soil depth estimated from split-spoon samples to the measured water level in the borehole.
- Using a weighted tape, sound the bottom of the borehole to verify that the hole is cleaned to the correct depth and caving hasn't occurred. If more than 3 inches of wash remains in the borehole, lower the roller bit back to the bottom of the borehole and continue to clean the borehole.
- Measure and record the depth to the bottom of the borehole to the nearest 0.05 feet.
- Determine the length of the test zone (L = distance from the bottom of the casing to the bottom of the borehole) to the nearest 0.05 feet and record on the field form.
- Add clean water to fill the casing.

- Using a calibrated flow meter, adjust the flow rate into the casing so the water level remains within 0.5 inches of the top of the casing. Once the water level has stabilized, take a flow meter reading at the start of the test (time=0). Record the inflow volume at regular intervals (generally 1 minute) for a period of 10 minutes.
- Check the depth to the bottom of the borehole after completion of the test to check for caving.
- Record all measurements and observations on the Borehole Permeability Test Field Data Form.

3. Limitations

Site-specific conditions must be evaluated to determine appropriate test intervals. Test interval shall be determined by the Project Manager or their designee.

4. References

GEI Procedure No. 44, Borehole Permeability Testing in Granular Soils

U.S. Department of the Interior Bureau of Reclamation Ground Water Manual, Chapter 10: Permeability Tests in Individual Drill Holes and Wells.

5. Attachments

Attachment A - GEI Borehole Permeability Test Field Data Form – Constant Head

6. Contacts

Steve Hawkins

BOREHOLE PERMEABILITY TEST - CONSTANT HEAD
FIELD DATA FORM

PROJECT:	BORING :
LOCATION:	PROJ NO.:
CLIENT:	TEST NO.:
PERF'D BY: DATE:	PAGE NO.:
CALC'D BY: DATE:	GROUND
CHECKED: DATE:	SURF. EL.:

STANDPIPE/RISER DETAILS

Riser inside diameter,d,inches: ________

Riser length, feet: ________

Riser stick up above
ground surface, feet: ________

Groundwater depth below
ground surface, H, feet: ________

Test Start Time: ________

Test End Time: ________

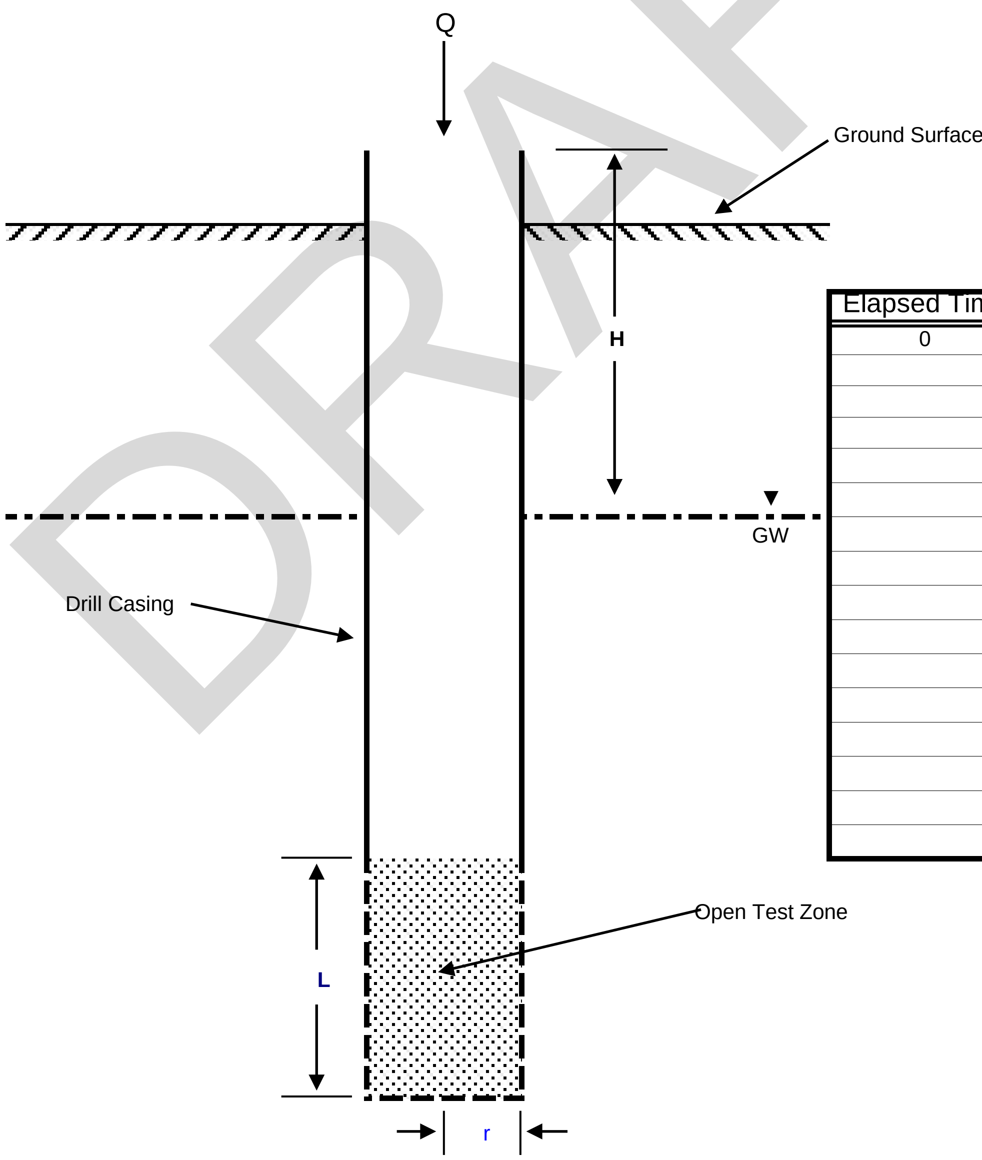
TEST INTERVAL DETAILS

Depth to bottom, feet
(below ground surface): ________

Depth to top, feet
(below ground surface): ________

Length, L, inches: ________

Water flow to achieve
constant head, Q: ________
(volume/time)



Elapsed Time	Inflow	Overflow
0		

NOTES: 1. Based on the Constant Head Permeability Test SOP:
Created for the CT River Levee Projects, GEI Consultants
October 2008.

STANDARD OPERATING PROCEDURE

GW-014 Dense Non-Aqueous Phase Liquid (DNAPL) Measurement and Recovery

1. Objective

Provide procedural guidance for routine gauging and recovery of dense non-aqueous phase liquids (DNAPL) related to former manufactured gas plant (MGP) operations.

2. Execution

2.1 Equipment and materials

The following materials and equipment are necessary for this procedure:

- Oil/water interface probe
- Appropriate pump and required tubing/piping
- Double check valve bailers and string
- Drums or buckets for NAPL collection
- Proper PPE including gloves and protective eyewear
- Drum labels
- Field data sheets or logbooks
- Decontamination supplies and plastic sheeting
- Additional equipment identified by site-specific work plan and HASP
- Example specifications of DNAPL management equipment is included as Attachment A.

2.2 General Measurement Procedures

Using an oil/water interface probe will provide a depth to water and a depth to product in each monitoring well. Refer to probe manual to determine changes between liquid type. To achieve accurate depth measurements, ensure the oil/water interface probe is decontaminated (GEI SOP QA-001 prior to and between each measurement taken at each well.

To calculate the volume of product in monitoring wells with these specifications, take the following measurements:

- Total well length
- Depth to water
- Depth to product (s) – c1 and c2

Using the following equations, determine the length of the water column and the length of the product column:

[1] (a) – (b) = Water column length (d)
[2] (a) – (c1) = Product column length (e) dense non-aqueous phase liquid (DNAPL)

Calculate the volume of DNAPL product in the well using the following equation:

DNAPL for a 2" diameter well
[4] (e) x 0.1632 = Volume (gallons) of product in well
(e) x 0.6178 = Volume (liters) of product in well

DNAPL for a 4" diameter well
[4] (e) x 0.6528 = Volume (gallons) of product in well
(e) x 2.4711 = Volume (liters) of product in well

DNAPL for a 6" diameter well
[4] (e) x 1.469 = Volume (gallons) of product in well
(e) x 5.561 = Volume (liters) of product in well

Once measurements have been taken and calculations have been made, collection of dense non-aqueous phase liquid (DNAPL) may commence.

2.3 DNAPL Collection Procedures

Collection of DNAPL shall be accomplished using common recovery techniques or technologies as follows:

- Peristaltic pumps
- Bailers
- Positive displacement down hole pumps (e.g. Hammerhead, Blackhawk pumps, etc)

Special care shall be taken to prevent any purged DNAPL causing a spill and coming into contact with the ground and sampling personnel. This includes the use of proper personal protective equipment (PPE), including gloves and protective eyewear (Tyvek® if necessary), along with plastic sheeting set beneath the pump, tubing, and collection container (sealed top 55-gallon drum or 5-gallon bucket with lid), and the surrounding work area. A site-specific work plan, HASP and job specific job safety analysis need to be developed prior to the start of work. Examples of DNAPL specific management equipment and tools are included as Attachment A. The specific operating procedures for common recovery methods are discussed in the following sections.

2.3.1 *Sampling and recovery via peristaltic pump with dedicated tubing:*

- Take and record the required measurements prior to commencing pumping.
- Connect the dedicated tubing to the peristaltic pump with the long end of the silicon tubing set to discharge water and product directly into either a 5-gallon bucket or a 55-gallon closed-top drum, ensuring that the entire set-up is underlain by plastic sheeting.
- Begin purging the well, occasionally checking the depth to water and depth to product.
- Once the DNAPL has been purged from the well, a sample will be collected and preserved if required, in accordance with laboratory standards.

- Following completion of NAPL recovery, disconnect the tubing from the pump, secure the well and road box, and clean/decontaminate the pump and oil/water interface probe, prior to moving to the next location.
- Impacted tubing will either be containerized for proper disposal or left in well for reuse.

2.3.2 Sampling and recovery via double check valve bailer:

- Take and record the required measurements prior to commencing bailing.
- Ensure the entire work area is covered in plastic sheeting to avoid potential spills of water and/or product.
- Tie the bailer to a piece of string that will allow the bailer to reach the bottom of the well.
- Using slow and controlled motions while lowering (and raising) the bailer to the bottom of the well, commence bailing product out of the well and draining the bailer directly into either a 5-gallon bucket or a 55-gallon closed-top drum.
- Once the NAPL has been purged from the well, collect and preserve the analytical sample, if required, in accordance with laboratory standards.

2.3.3 Sampling via piston-style pumps (HammerHead, Blackhawk etc)

For significant accumulations of DNAPL a variety of dedicated pumping technologies exist. Refer to manufacturer-specific operating procedures and site specific means and methods.

2.4 Waste Management and Disposal

Investigation derived waste should be managed in accordance with GEI SOP SC-003. Additional care should be taken with DNAPL while infrequent the potential for hazardous waste characteristics does exist. DNAPL waste management and disposal should be evaluated on a site by site basis as discussed in Section 3.

2.5 Troubleshooting Information

If there are any performance problems with the oil/water interface probe which result in inability to achieve the proper measurements presented in Section 5.1, or if there are any problems with the peristaltic pump, consult the appropriate section of the probe instruction manual for the checkout and self-test procedures. If the problem persists, consult the manufacturer's customer service department immediately for further instructions.

Lower temperatures can affect the ability to pump and/or bail NAPL. Weather should be taken into consideration when scheduling gauging and recovery sampling events.

2.6 Data and records management

All information pertaining to maintenance of the oil/water interface probe and the peristaltic pump shall be maintained in the project file. Field measurements (depth to water, product, *etc.*) and all calculations (product column length, volume of product, *etc.*) shall be recorded on the appropriate field data sheets or in the logbook consistent with GEI SOP Section 5.

2.7 Health and safety considerations

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the site specific Health and Safety Plan (HASP). The collection and accumulation of NAPL presents the potential for significant hazards that need to be managed. A detailed job safety analysis (JSA) should be completed prior to the start of work.

3. Limitations

- DNAPL gauging and recovery can be problematic and requires adaptive thinking. A variety of measurement and collection techniques may be necessary to properly execute the work.
- Exposure to DNAPL can accelerate the required maintenance/replacement intervals for tools and equipment.
- A site specific work plan, HASP and JSA needs to be developed prior to commencing work. The documents should address: safety, recovery technologies, waste containment and waste management.

4. References

U.S. EPA. Ground Water Issue: Dense Non-aqueous Phase Liquids, EPA/540/4-91-002, March 1991.

5. Attachments

Attachment A – Example specifications of DNAPL recovery and management tools and equipment.

6. Contact

Kathleen Slimon
Mike Quinlan

Section 8

Air Sampling and Monitoring (AR)

STANDARD OPERATING PROCEDURES

AR-001 General Guidance on Work Zone Monitoring Methods

1. Objective

Protect human health by measuring air quality at the perimeter of a work area.

2. Execution

Walk-around perimeter and work zone monitoring for Total Volatile Organic Compounds (TVOC), Respirable Particulate matter less than 10 microns (RPM_{10}), and odor will occur along the perimeter of the project site on a regular and as-needed basis. Specific site conditions that will trigger walk-around perimeter or work zone monitoring include:

- visible dust
- odor complaints
- detection of TVOCs and/or RPM_{10} at levels approaching or exceeding action levels
- direction by the site oversight consultant or client

Perimeter air monitoring and work zone monitoring, in the absence of any specific triggering criteria, will be conducted on a regular basis during the normal work day. Particular attention will be given to the direction of any residences or other sensitive receptors.

At the time when a triggering condition is observed, the walk-around perimeter and work zone monitoring will occur continuously until the conditions that triggered the monitoring have subsided. Additional temporary monitoring points may be established due to changing site or meteorological conditions.

TVOC concentrations will be monitored and recorded using a Rae Systems MiniRAE 2000 Portable Ionization Detector (PID) or equivalent. RPM_{10} will be measured and recorded using a MIE personal DataRAM 1200 (PDR-1200) portable real-time aerosol monitor equipped with a PM-10 monitor and Gilian personal air sampling pump. AR-002 Suspended Particulate Matter in Ambient Air using the MIE DataRAM Real-time Aerosol Monitor (Portable) provides guidance on the use of this meter. Odors will be noted based on the n-butanol scale, as adapted from ASTM E544-99.

At each monitoring point, the 15-minute average value of TVOC and RPM_{10}, sample time, and sample location will be collected and recorded. The odor intensity based on the n-butanol scale will be monitored over a 15-minute period and recorded. At each location, air temperature, wind direction, and wind speed may be monitored and recorded using a hand-held wind meter.

Odors as a function of naphthalene concentration will be monitored over a 15-minute period and recorded. To measure naphthalene concentrations, the zNose™ Model 4200 system will be used. The zNose™ is an ultra-fast gas chromatograph (GC) that is capable of analyzing airborne concentrations of VOCs and SVOCs in less than one minute. The zNose™ uses a surface acoustic wave (SAW) detector that changes in vibration frequency as compounds elute from the column and condense onto the surface of the detector.

The zNose™ is a portable instrument and will be positioned downwind of the remedial activities. Up to five samples will be analyzed for naphthalene concentrations over a 15-minute period. The concentrations will be averaged to produce a 15-minute result. The calibration will be checked at the start of the day, at mid-day, and at the end of the day. An air blank will be run every two hours. A blank will also be run if a reading exceeds the calibration range of the instrument.

The zNose™ also has the capability of generating fingerprint images of the chemical constituents in the vapor called VaporPrints™. A VaporPrint™ of an air sample can be collected through a headspace analysis. This VaporPrint™ can be compared to others generated at the perimeter and off-site to see if remedial operations are the source of the odors. VaporPrints™ can allow for identification of odors that may not be affiliated with remedial operations.

To monitor cyanide (as hydrogen cyanide gas), a real-time hand-held meter in conjunction with the Dräger Chip Measuring System (CMS) will be used. Types of continuously monitoring equipment include the V-RAE by Rae Systems and the Mini-Warn by Dräger Safety Systems and are available from rental equipment suppliers. Due to potential interference from sulfur compounds, hydrogen sulfide gas (H_2S) will also be monitored for comparison to the hydrogen cyanide gas levels detected. Hydrogen cyanide gas detections will also be confirmed with CMS Dräger tubes due to this interference. The Dräger CMS can quantify other gases that could potentially provide false positives for hydrogen cyanide gas (including sulfur dioxide, hydrogen sulfide, phosphine gas, chlorine, and nitrogen dioxide) detected by the real-time meter.

At each location, air temperature, wind direction, and wind speed will be monitored and recorded using a hand-held wind meter.

3. References

New York State Department of Environmental Conservation. 2010. DER-10 / Technical Guidance for Site Investigation and Remediation. Division of Environmental Remediation. May 3, 2010. Appendix 1A. pp. 204-206

ASTM E544 - 99(2004) Standard Practices for Referencing Suprathreshold Odor Intensity

4. Attachments

None

5. Contact

Chris Gordon/Mike Quinlan

STANDARD OPERATING PROCEDURE

AR-002 Air Sampling for Dust (Particulate Matter) using the MIE DataRAM™ Real-Time Aerosol Monitor

1. Objective

Describe standard procedures for the real-time monitoring of airborne particulate matter using a MIE DataRAM™ model DR-2000 real-time aerosol monitor.

The MIE DataRAM™ is a real-time, portable monitor that measures airborne particulate matter. It is capable of monitoring total suspended particulate matter, particulate matter less than 10 microns (PM_{10}), and particulate matter less than 2.5 microns ($PM_{2.5}$) by using an appropriate orifice to control the size of the particles being measured. The DataRAM can be programmed to collect continuous real-time data, or to record time averaged data.

2. Materials

- MIE DataRAM™ model DR-2000
- Shelter/Enclosure - a pre-constructed enclosure capable of protecting the instrumentation from severe weather conditions during sample collection
- Omnidirectional inlet
- Inlet heater
- $PM_{2.5}$/PM_{10} impactor
- IBM compatible computer loaded with MIE DataRAM™ software
- Field notebook

3. Meter Calibration

- Assemble all necessary DataRAM™ attachments.
- Make sure the power selector switch on the rear panel is in the "on" position. Turn on the power by pressing the "on" button on the front display panel of the DataRAM™. "Main Menu I" will appear on the screen.
- Activate the zero mode by pressing the button indicating zero.
- When the screen indicates the zero mode is complete, activate the span check mode by pressing the button indicated, and follow the prompts that appear on the screen.
- Record the time of the zeroing and the calibration difference percent in the field notebook. If the zeroing procedure takes longer than 5 minutes press "exit" and then "off," and then put the power switch on the rear panel of the instrument in the "off" position. Wait several minutes, turn on the power and zero the instrument again. If the calibration difference percent is more than $\pm 5\%$ then follow the "Calibr Diff" Resetting Procedure in the DataRAM™ Instruction Manual.
- Set the DataRAM™ to automatically log data. Refer to the Instruction Manual for details on how to set the data logging function.

- Record the instrument flow rate from the parameters menu in the field notebook.

4. Sample Collection

- Set the DataRAM™ at the predetermined sampling location in a rain or weatherproof containment, with only the inlet tubing exposed to ambient air.
- Start the run.
- When sampling is completed, terminate run and download data using the RS-232 cable connector and the MIE DR-COM software.
- Once the data file has been successfully downloaded and saved in an appropriate location, clear the data from the instrument memory.

5. Limitations

Each instrument must be calibrated using the internal reference standard and zeroed at the start of each sampling event and at a frequency of once per day throughout the duration of the sampling event.

The DataRAM™ can be programmed to collect continuous real-time data, or can collect "averaged" real-time data. These various options should be addressed prior to field operations and must be referenced in an approved work plan. This work plan must be available to all field personnel.

Project objectives will usually dictate the sampling location. In general, for air monitoring, meters are usually placed near breathing height and away from objects that can interfere with air motions. Since the DataRAM™ is measuring particulate matter, placement of the instrument directly on the ground should be avoided to prevent the sampling of dust concentrations that may not be representative of the air that is intended to be sampled (e.g. air at breathing height).

6. References

Code of Federal Regulations, 40 CFR 50, Appendix J, Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere.

Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, D.C. EPA-454/B-08-003 December, 2008.

7. Contacts

Chris Gordon
Mike Quinlan

STANDARD OPERATING PROCEDURE

AR-003 Air Sampling for PM_{10} Particulate Matter using the High-Volume Sampler Method

1. Objective

Describe standard procedures for the collection of air samples for laboratory analysis of PM_{10} particulate matter using the high volume sampler method.

2. Materials

- General Metal Works (GMW) Model IP 10-8000 or equivalent. The GMW sampler can be rented.
- Calibration kit, as specified for the selected sampler.
- PM_{10} sampling filters, to be supplied by the contract laboratory. A Whatman QM-A quartz filter is currently the only commercially available PM_{10} filter that satisfies all criteria specified in 40 CFR 50, Appendix J. .
- Ice chest for sample storage or shipping.

3. Sampling

This method measures the mass concentration of particulate matter with an aerodynamic diameter equal to or less than 10 micrometers (µm). A high volume (HV) sampler draws a known volume of ambient air at a constant flow rate through a size selective inlet and through one or more filters. Particulates of 10 µm or smaller are collected on the filter(s) during the prescribed time period. Each sample filter is weighed before and after sampling to determine the net weight gain of the collected PM_{10} sample.

A HV sampler consists of two basic components: a specially designed inlet that transmits only particles equal to or less than 10 µm in diameter and a flow control system capable of maintaining a constant flow rate within the design specifications of the inlet.

3.1. Sampler Installation

- On receipt of the sampler, 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. Check all power cords and tubing for crimps, cracks, and breaks. The HV sampler should be placed on a sturdy platform or table, with the air inlet 4 to 6 feet above ground level.
- The sampler should be strategically placed according to the work plan or objectives of the study and located free of any obstructions to ambient air flow.
- The HV sampler requires 110 V AC power. The electrical outlet should be protected by a ground fault interrupter and water proof electrical connectors should be used.

- Operate the sampler for 30 minutes to ensure that the motor is operating at full performance.
- Calibrate the sampler in accordance with the instructions provided with the appropriate calibration kit. Proper calibration of the sampler is critical.
- Field personnel should be familiar with both the sampling unit and the calibration procedure before attempting to record data.

3.2. Sampling Procedure

- Operate sampler as per manufacturer's instructions.
- Filters are received from the laboratory numbered and pre-weighed in their individual envelope or folder within an envelope. Powder free latex gloves, or equivalent, should be worn during the handling of filters. Only touch the edges of the filter.
- Examine the filter support screen to confirm that it is clean. If it appears to be dirty, wipe it clean using lint free wipes such as laboratory wipes or equivalent. Check the gasket to be sure that it is in good condition. The filter is placed on the support screen with the numbered side facing down. Tighten thumb nuts on alternate corners to properly align and seat the gasket. The nuts should be only hand tightened to avoid damaging the gasket.
- Record the sampler serial number, filter ID number, sampler location, sampling date, and the operator's initials in the field notebook, any field data sheets being used, and on the back of a clean chart and install the chart in the flow recorder.
- Turn the sampler on and allow it to equilibrate to operating temperature, about 3 to 5 minutes. Verify that the recorder is operating and that the pen is inking. Allow the sampler to run for the required sampling interval.
- When sampling interval is completed, turn off the sampler and carefully remove the filter as soon as possible. Sample degredation can occur if the filter is left in the sampler for an extended period of time. The filter should be folded in half with the exposed side inward and the folded filter carefully placed in its respective folder and/or envelope. When removing and folding the filter touch only the outer edges. Powder free latex gloves, or equivalent, should be worn when handling filters.
- Record the following parameters in the field notebook and in any field data sheet being used:
    1. Elapsed time of sampling interval in minutes
    2. Average recorder response in arbitrary units
    3. Starting flow rate and ending flow rate
- The average flow rate for GMW Model IP 10-8000 sampler should be close to 1.13 m^3/min.
- Calculate the total flow rate for the sampling interval by time weighted averaging the flow rate readings. Air monitoring results where the flow rates

varied more than +/- 10%, from beginning to end, should be qualified accordingly and discussed with the project manager.

- The exposed filters, folded in half, are placed back into their shipping envelope and forwarded with completed chain of custody forms to the contracted laboratory for analyses. Follow the contracted laboratory's instructions for handling and returning the exposed filters.

4. General Guidance

The total volume of air sampled is determined from the measured volumetric flow rate and the sampling time. The mass concentration of PM_{10} in the ambient air is calculated as the total mass of collected PM_{10} particles divided by the total volume of air sampled. The PM_{10} measurement is expressed as micrograms (µg) per standard cubic meter (µg/std M^3). The sampled volume must be corrected to EPA standard conditions, 25° C, 760 mm Hg or 101 kPa.

A field blank may be collected, which consists of an unexposed filter removed from its envelope, put in place in the HV sampler, immediately removed, folded, replaced in its envelope and sent to the laboratory. Field blanks, if collected, should be taken at a frequency of one per twenty samples. If fewer than twenty samples will be collected during one week, collect one field blank weekly during sampling.

5. References

Code of Federal Regulations, 40 CFR 50, Appendix J, Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere.

Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Specific Methods (Interim Edition), Addendum to Section 2.11 Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere (High-Volume Sampler Method), US Environmental Protection Agency, Office of Research and Development, Washington, D.C. EPA/600/R-94/038b April 1994.

Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program, US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, D.C. EPA-454/B-08-003 December, 2008.

6. Contacts

Chris Gordon
Melissa Felter

STANDARD OPERATING PROCEDURE

AR-005 Hydrogen Cyanide Work Zone Air Monitoring Procedures

1. Objective

Describe real-time monitoring of hydrogen cyanide gas during field activities.

2. Equipment

To monitor cyanide (as hydrogen cyanide gas), the GEI field representative should utilize a real time handheld meter in conjunction with the Dräger Chip Measuring System (CMS) during subsurface activities including subsurface excavations, borings and monitoring well installation, materials handling, and groundwater sampling in areas with confirmed or suspected cyanide impacts.

Continuous monitoring equipment includes the V-RAE by Rae Systems and the Mini-Warn by Dräger Safety Systems, and are available from rental equipment suppliers. Due to potential interference from sulfurs, hydrogen sulfide gas (H_2S) should also be monitored for comparison to the hydrogen cyanide gas levels detected. Hydrogen cyanide gas detections will also be confirmed with CMS Dräger tubes due to this interference. The Dräger CMS can quantify other gases that could potentially provide false positives for hydrogen cyanide gas (including sulfur dioxide, hydrogen sulfide, phosphine gas, chlorine, and nitrogen dioxide) detected by the real time meter.

3. Calibration

Prior to commencing work on-site, the real-time cyanide meter should be calibrated in accordance with the equipment manufacturer's specifications. If the meter is calibrated in the field, the daily calibration results should be recorded in the field notebook.

4. Execution

Cyanide will be monitored around the perimeter of the work zone on a regular basis. Continuous monitoring should be completed every fifteen minutes if sulfur odor or suspected purifier waste material (former MGP sites only) is encountered. Measurements should be monitored in the breathing zone and should be recorded into the field notebook or on an applicable form. In the event that hydrogen cyanide is detected, the GEI field representative should proceed as follows:

4.1. Action Level: HCN ≤1 ppm for 15-minute average using real time meter

- Run CMS Dräger tube.
- Continue monitoring with real time meter.
- Continue work if CMS Dräger tube for hydrogen cyanide reads <2 ppm.

4.2. Action Level: 1 ppm < HCN < 2ppm for 15-minute average using real time meter.

- Run CMS Dräger using hydrogen cyanide gas chip and confirm <2 ppm concentration.
- Continue monitoring with real time meter.
- Run CMS Dräger tube using sulfur dioxide, hydrogen sulfide phosphine chip to evaluate potential interference.
- Recalibrate the real time meter and continue to monitor the work zone.

4.3. Action Level: HCN 2 ppm on CMS Dräger tube

- Stop work and move (with continuous monitoring meter) at least 25 feet upwind from excavation or until continuous monitoring meter registers <1 ppm.
- Run CMS Dräger hydrogen cyanide chip and re-evaluate activities
- Continue monitoring with real time meter.
- Allow area to ventilate and continue to monitor while returning to the work zone.
- Do not move into an area when readings are >1 ppm without confirming with additional CMS Dräger measurement.
- May resume work if Dräger tube for cyanide reads <2 ppm.

5. Limitations

No air purifying respiratory protection is available for hydrogen cyanide gas.

The American Conference of Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for Hydrogen Cyanide is 4.7 ppm.

6. References

Code of Federal Regulations, 40 CFR 50, Appendix J, Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere.

Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Specific Methods (Interim Edition), Addendum to Section 2.11 Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere (High-Volume Sampler Method), US Environmental Protection Agency, Office of Research and Development, Washington, D.C. EPA/600/R-94/038b April 1994.

7. Contacts

Ryan Hoffman

Section 9

Quality Control – Quality Assurance (QA)

STANDARD OPERATING PROCEDURE

QA-001 Equipment Decontamination

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1. Objective

This SOP describes methods used to decontaminate reusable sampling equipment for projects that require collection of organic and inorganic analytical samples. The goal is to minimize cross-contamination between samples. This maximizes confidence that field samples will be representative of specific locations and conditions.

Refer to the work plan or project manager to determine if different decontamination methods are acceptable.

2. Execution

- All contractor-provided equipment (augers, rods, spoons, backhoe buckets) should be decontaminated by steam cleaning or pressure washing prior to coming on site. If there is doubt about cleanliness of drilling tools, they should be decontaminated before use at the site.
- Sampling equipment decontamination is a sequential procedure consisting of the following steps:
    - Alconox-solution wash (or equivalent non-phosphate detergent)
    - Potable water rinse
    - A ten percent reagent grade nitric acid wash should be used to strip potential inorganic contaminants from sampling devices.
    - Laboratory grade 100 percent methanol, should be used to strip potential organic contaminants from sampling devices.
    - Three distilled/deionized water rinses.
- Alconox solution is a mixture of approximately 1 cup of Alconox per 1 gallon of potable water. Alconox solution wash requires scrubbing the equipment with a brush soaked in Alconox solution to remove visible contamination or dirt from sampling devices.
- Split-spoon samplers must be decontaminated prior to collecting each sample. The procedure follows:
    - Overall wash and scrub in a bucket of Alconox solution
    - Potable water rinse.
    - 10% nitric rinse
    - 100% laboratory grade methanol rinse
    - Three distilled-water rinses.

  The same procedure is applied to all devices that may contact soil or groundwater slated for analytical samples - spoons and knifes used to inspect or sample soils; water level indicators; oil/water interface probes.

Equipment used for well development of multiple wells must be decontaminated between wells.

Pumps and tubing should be flushed using a minimum of one gallon of Alconox-solution followed by a gallon of potable water. Some projects may require methanol (in much lower quantities) and distilled water instead of or in addition to the Alconox-solution and potable water.

For pumps and tubing, a final rinse of the sampling equipment may be performed with the water being sampled.

Equipment blanks measure the effectiveness of the decontamination procedures. Blanks should be collected per guidance provided in QA-002, Field Quality Control Samples.

3. Limitations

- Do not store the deionized/distilled water in polyethylene bottles, use Nalgene, glass, or Teflon. Polyethylene may leach phthalates.
- Do not attempt to decontaminate string or rope - replace it.
- Due to eye and skin absorption hazards, safety glasses and gloves must be worn when handling decontamination solvents.
- Decontamination procedures may also require modification based on state or federal requirements.
- Steam cleaning or pressure washing with potable water is generally an acceptable decontamination method for drilling equipment (i.e., augers). Check with the work plan.
- Dedicated equipment need not be decontaminated beyond initial decontamination prior to field use.

4. References

Environmental Response Team (ERT), US EPA. Sampling Equipment

Decontamination, SOP No. 2006, Revision 0.0. August 11, 1994.

US EPA Region 9. Sampling Equipment Decontamination, SOP No. 1230, Revision 1.September 1999.

5. Contacts

Mackenzie Fannon
Pat King

STANDARD OPERATING PROCEDURE

QA-002 Field Quality Control Samples

1. Objective

Field Quality Control (QC) samples are used to monitor the reproducibility and representativeness of field sampling. The QC samples are handled, transported, and analyzed in the same manner as the associated field samples. QC samples may include trip blanks, equipment blanks, and field duplicates.

2. Execution

2.1. Trip blanks

- Used to monitor possible sources of contamination from transport, storage, inadequate bottle cleaning, or laboratory methodologies.
- Sample containers filled at the laboratory with analyte-free water are transported to and from the site, and are not opened until time of analysis.
- Trip blanks are stored with the sample containers prior to and after field activities and remain with the collected samples until analyzed.
- Generally, one trip blank per volatiles analysis (e.g. volatile organic compounds) shipment.
- Consider submitting a trip blank when sample shipment is by Fed Ex or other large carrier, or laboratory courier.
- Trip blanks should be recorded in the field notebook and on the chain-of-custody that same as all other samples.

2.2. Equipment blanks

- Equipment blanks (also known as equipment rinsate blanks) are used to monitor possible sources of contamination associated with sample collection. Monitors on-site sampling environment, sampling equipment decontamination, sample container cleaning, the suitability of sample preservatives and analyte-free water, and sample transport and storage conditions
- Equipment blanks are collected by pouring laboratory supplied or distilled or deionized water over sampling tools that have been decontaminated per the work plan, into sample containers.
- Equipment blanks are stored with the associated field samples until submitted for analysis.
- Generally collected when site conditions indicate site related contamination is a concern. Check project-specific work plan and/or quality assurance project plan for required frequency.
- Prepare equipment blanks immediately after the equipment is cleaned in the field and before leaving the sampling site.
- Prepare equipment blanks by rinsing the decontaminated sampling equipment set with the appropriate type of analyte-free water and collecting the rinse water in appropriate sample containers.

- If a potable water rinse is the typical final step, collect the equipment blank with analyte-free water after the potable water rinse.
- Equipment blanks should be recorded in the field notebook and on the chain-of-custody that same as all other samples.

2.3. Field Duplicates

- Used to evaluate the precision and representativeness of the sampling procedures.
- Field duplicates are two samples collected from the same location using the same procedures. Both samples are submitted to the laboratory as individual samples with different sample identification.
- Field duplicates from groundwater sampling for all analyses except volatiles analysis are collected by alternating filling sample containers from the same sampling device. Field duplicates for volatiles analysis are filled sequentially.
- Soil or sediment field duplicates are collected by homogenizing the sample for all analyses except volatiles. The homogenized sample is then divided into two equal portions and placed in separate sample containers. Field duplicates for volatile analysis are collected at two adjacent sampling locations.
- Each sample is assigned different sample identifications.
- Field duplicates are generally collected at frequency of 1/20 samples. Check project-specific work plan and/or quality assurance project plan for required frequency.
- All field QC samples should be labeled in the field and submitted “blind” to the laboratory – as if they are separate, primary samples.
- Field duplicates should be recorded in the field notebook and on the chain-of-custody that same as all other samples.
-

2.4. Matrix-Spike samples (MS/MSD)

- Matrix spike and matrix spike duplicate samples (MS/MSDs) are environmental samples that are spiked in the laboratory or in the field with a known concentration of a target analyte(s) to verify percent recoveries.
- Matrix spike and matrix spike duplicate samples are primarily used to check sample matrix interferences. They can also be used to monitor error due to laboratory bias and poor precision. However, a data set of at least three or more results is necessary to statistically distinguish between laboratory performance and matrix interference.
- Generally, the laboratory is required to extract and analyze MS or MS / MSDs at a minimum frequency of 5% of samples being analyzed for the target analyte(s). If the project or client criteria require an MS or MS/MSD, collect sufficient volume in the appropriate containers, and designate the sample to be used as the MS or MS/MSD on the chain of custody.
- Calculate the percent recovery for all spiked analytes for both the MS and MSD. For MS/MSDs also calculate the relative percent difference (RPD). The

RPD for each spiked analyte is calculated using the amount detected not percent recovery. If your data will be subjected to validation, the % recovery and the RPD will generally be determined by the validator.

2.5. Typical QA/QC Frequency

- QA/QC frequency is determined by project, client or regulatory criteria and should be verified prior to sample collection. Generally, QA/QC samples are collected according to the frequency described below:

Duplicate Samples	One per sampling event, one per 10 samples collected, or one every two weeks, whichever comes first.
Equipment Blanks	For each equipment type that is not dedicated or disposable - one per sampling event, one per 20 samples collected, or one every two weeks, whichever comes first.
Trip Blanks	One per sample delivery group, or in each cooler containing VOC soil or aqueous samples, depending on project.
MS or MS / MSDs	One MS or MS/MSD per sampling event, one per 20 samples collected, or one every two weeks, whichever comes first.

3. Limitations

- Trip blanks must never be opened in the field.
- Trip blanks are usually for VOCs only because less volatile compounds are not likely to cross-contaminate other samples by simply being in close proximity.
- Laboratory-grade water must be used during the collection of equipment blanks.
- Field duplicates must have different sample identifications.

4. References

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (November 1986), U.S. Environmental Protection Agency Department of Solid Waste, Washington, D.C.

U.S. Environmental Protection Agency Office of Emergency and Remedial Response, 1990, Quality assurance/quality control guidance for removal activities: EPA/540/G-90/004, Sampling QA/QC Plan and Data Validation Procedures Interim Final, April, 1990.

5. Contact

Pat King

Appendix D

Quality Assurance Project Plan

GEI Consultants

Consulting
Engineers and
Scientists

Quality Assurance Project Plan

Parcel 6 Portion of Williamsburg Works Site

Brooklyn, New York
ACO Index No. A2-0552-0606
Site #: 224055

Submitted to:
National Grid
2 Hanson Place
Brooklyn, NY 11217

Submitted by:
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September 2024
Project 093060

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Abbreviations and Acronyms

ASP	Analytical Service Protocols
ASTM	American Society for Testing and Materials
CAS	Chemical Abstract Service
CMS	Chip Measurement System
CLP	Contract Laboratory Protocol
COC	Chain Of Custody
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., P.C.
LCS	Laboratory Control Sample
LEL	Lower Explosive Limit
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
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
RL	Reporting Limit
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SD	Standard Deviation
SOP	Standard Operating Procedures
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Identified Compounds
TOX	Total Organic Halides
TPH	Total Petroleum Hydrocarbons
USDOT	United States Department of Transportation
VOC	Volatile Organic Compound

Quality Assurance Glossary

"Analytical Services Protocol" or "ASP" means the New York State Department of Environmental Conservation (NYSDEC's) compendium of approved EPA and NYSDEC laboratory methods for sample preparation and analysis and data handling procedures.

"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 on-site inspections and evaluation of principles of credentials and proficiency testing.

"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.

"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.

"PAH" means polycyclic aromatic hydrocarbon as defined by United States Environmental Protection Agency (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, and 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, and Multi-Concentration" in effect as of the date on which the laboratory is performing the analysis.

"Tentatively identified compound" or "TIC" means a non-targeted compound detected in a sample using a GC/MS analytical method, which has been tentatively, identified using a mass spectral library search. An estimated concentration of the TIC is also determined.

"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 organics" 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.

1. Purpose

GEI Consultants, Inc. (GEI) has prepared this Quality Assurance Project Plan (QAPP) for the Williamsburg Works site located in Brooklyn, New York (the Site). The QAPP is a companion document to the draft *Supplemental Remedial Investigation Work Plan – Parcel 6 Portion of Williamsburg Works Site* (SRIWP) dated September 2024 and Field Sampling Plan (FSP) dated December 2020. The project location is shown on Figure 1 of the SRIWP. The QAPP presents the project scope and goals, organization, objectives, sample handling procedures and specific QA/QC procedures for samples collected under the SRIWP.

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.
- Laboratory data are validated so they can be applied to developing a conceptual understanding of the nature and extent of contamination of soils and ground waters at the Williamsburg Works site.
- 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 NYSDEC:

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

2. Project Goals and Objectives

On behalf of National Grid, GEI prepared an SRIWP to investigate the nature and extent of impacts at the Williamsburg Works site in the Williamsburg neighborhood of Brooklyn, New York (Site). This QAPP was prepared to provide quality assurance guidelines for sampling proposed at the Site. The Site was used to manufacture gas from 1850 until prior to 1941.

3. Project Organization and Responsibility

Qualified Environmental Professional (QEP) is responsible for the implementation of the scope of work, including the supervision of contractors, field activities, and the evaluation and interpretation of data. The Consultant will direct the sampling activities and coordinate submittal of samples to testing laboratories. The project organization and key personnel for the Consultant are listed below:

- Program Manager: Jim Ash
- Project Manager (PM): Melissa Felter
- Field Team Leader: TBD
- Quality Assurance Officer: Lorie MacKinnon
- Corporate Health & Safety Officer: Steve Hawkins
- Data Validator: Lorie MacKinnon
- Data Manager: Jaimie Wargo

The primary responsibilities of each of these personnel are described in the following table.

Key Project Personnel and Responsibilities		
Position	**Consultant Personnel**	**Areas of Responsibilities**
Program Manager	Jim Ash	• Overall program oversight • Project management • Project schedule • Client contact regarding project related issues • Personnel and resource management • Review of project submittals • Budgeting
Project Manager (PM)	Melissa Felter	• Client contact regarding project related issues • Coordination of contractors • Technical development and implementation of Work Plan and Field Sampling Plan • Personnel and resource management • Preparation and review of project submittals • Preparation of project submittals • Budgeting

Key Project Personnel and Responsibilities		
Position	**Consultant Personnel**	**Areas of Responsibilities**
Field Team Leader	TBD	• Client contact regarding project related issues on day to day basis as part of field operations • Coordination of contractors • Implementation of Work Plan and Field Sampling Plan • Personnel and resource management • Preparation of project submittals
Quality Assurance Officer	Lorie MacKinnon	• QA/QC for sampling and laboratory performance
Data Validator	Lorie MacKinnon	• Perform data validation activities • Prepare data usability summary reports • Evaluate data with regards to quality objectives
Data Managers	Jaimie Wargo Julie Dicostanzo	• Manage raw data from the laboratory

A New York State Department of Health (NYSDOH) Environmental Laboratory approval Program (ELAP) approved laboratory will be utilized to perform standard analytical chemistry parameters for soil and groundwater samples including:

- Volatile Organic Compounds (VOCs) by EPA Method 8260C
- Semi volatile Organic Compounds (SVOCs) by EPA Method 8270D
- Target Analyte List (TAL) Metals including tin by EPA Method 6000/7000 series
- Total Cyanide by EPA Method 9014 (groundwater only)
- Free Cyanide by EPA Method 9014 (soils only)
- Disposal Parameters (total metals, Toxicity Characteristic Leaching Procedure (TCLP) by EPA 1311, Resource Conservation Recovery Act (RCRA) 8 metals by EPA 6000/ 7000 series, TCLP pesticides EPA 8081A, TCLP herbicides by 8151A, TCLP VOC by EPA 8260B, TCLP SVOC by EPA 8270C, paint filter test, ignitability by EPA 1030 (soils)/EPA 1010 (water), corrosivity by EPA 9040 (water)/ 9045 (soils) , reactivity [cyanide by EPA 7.3.3.2 and sulfide by EPA 7.3.4.2] by , total petroleum hydrocarbons (TPH) by EPA 8015B/ 418.1, total PCBs by EPA 8082, flashpoint, total organic halides (TOX) EPA 450.1, and % solids)

Table 1 provides a summary of soil analyses. Table 2 provides a summary of groundwater analyses. Table 3 provides a summary of quality assurance samples, holding times and analysis for each media.

Drilling contractors will be identified once the work plan is approved.

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, reporting limit, 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 provided in the Work Plan. All analytical data will be provided by the laboratory using the New York State ASP Category B deliverable format.

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 and groundwater from the former Site operations, compared to NYSDEC Part 375 soil cleanup objectives and New York State Ambient Groundwater 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. Laboratory MDLs and PQLs for soils and groundwater are located on Tables 4 and 5, respectively. Soil clean-up objectives and groundwater standards and guidance values are located on Tables 6 and 7.

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 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.

Laboratory MDLs and PQLs for soils and groundwater are located on Tables 4 and 5, 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. The laboratory accuracy will be evaluated in accordance with laboratory quality assurance plan and standard operating procedures located in Appendix A.

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. Field duplicate RPDs must be less than 50% for soil samples and less than 30% for aqueous samples. These criteria apply only if the sample and/or duplicate results are >5x the quantitation limit; if both results are <5x the quantitation limit, the criterion will be doubled. Duplicate samples are described in below in subsection 5.1.5. Table 3 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 in below in subsection 5.1.5. Table 3 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 the SRIWP and FSP 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. These are provided in Table 3 and within Appendix A.

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 SRIWP and FSP are 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., mg/L]); for air (weight/unit volume [i.e., mg/m3]).
- Use common chemical name with corresponding chemical abstract system (CAS) code.
- Report all data for soils on a dry-weight basis.

5. Sampling Plan

Environmental sampling will include subsurface soil, groundwater, and waste characterization sampling. Subsurface soil borings and monitoring wells will be installed utilizing drilling methods presented in the FSP. 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. Analytical samples and analysis methods are described in the SRIWP, and sampling methods and procedures are described in the FSP.

5.1 Sample Type, Location, and Frequency

Samples required by the SRIWP are described below.

5.1.1 Subsurface Borings Soil Sampling

Soil borings locations will be sampled utilizing drilling methods listed in the FSP. Soil borings may be completed as permanent monitoring wells. The actual number of subsurface soil samples and their location may be modified based upon subsurface utilities and property access. The number and location of samples will vary based upon access and subsurface obstructions. Soils will be evaluated through visual, olfactory, and field screening observations in accordance with the FSP. Soil samples will be collected and submitted for laboratory analysis in general accordance with the SRIWP and the FSP. Monitoring wells will be installed in accordance with the SRIWP and FSP. A summary of subsurface soil samples and analysis are located in Table 1.

5.1.2 Groundwater Sampling

Monitoring wells will be gauged and sampled. Groundwater samples will be collected from monitoring wells screened across the water table or targeted intervals at the proposed sample locations. Groundwater samples will be collected and submitted for laboratory analysis in general accordance with the FSP and SRIWP. 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 in general accordance with the FSP. A summary of groundwater samples and analysis are located in Table 2.

5.1.3 Investigation-Derived Waste Sample Collection

Waste classification sampling may be conducted for soil and liquid wastes. The purpose of characterizing a waste is for its proper off-site disposal. Composite samples will be collected from the on-site waste storage vessels (drums or roll-off) for parameters required by the approved disposal facility. Soil samples will be collected utilizing stainless steel sampling tools, shovel, or auger that had been decontaminated. Liquid samples will be collected utilizing disposable bailer, peristaltic pump, a pump with tubing, or other similar methods. These samples will be handled in general accordance with sample handling procedures presented in the FSP. Investigation derived waste samples will be analyzed for parameters listed in Section 3 or other analyses that are required by the National Grid-approved facility.

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 in Table 3.

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 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 4.3. 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 be submitted daily for PFAS analysis. 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 form 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 3 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 United States 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 United States EPA specifications. The containers will be pre-preserved, where appropriate (Table 3).

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
- All equipment used to collect samples for VOCs and SVOC analysis will then receive a methanol rinse followed by a de-ionized water rinse.
- All equipment used to collect samples for metals analysis will then receive a 10% nitric acid solution rinse followed by a de-ionized 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 and excavation equipment will be decontaminated in general accordance with methods described in the FSP.

Groundwater sampling pumps will be cleaned by washing and scrubbing with an Alconox/water solution, rinsing with tap water and irrigating with de-ionized water.

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 National Grid at 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. Each page of the logbook will be signed in permanent ink and dated. 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 PM for completeness and representativeness. Logbooks will be supported by daily activity reports as described in the FSP.

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) WW -SB-01 (10-15) **GROUNDWATER SAMPLES** Monitoring Well-ID WW-MW-01	**FIELD BLANKS** SAMPLE-ID – [DATE] WW-FB-033107 **MATRIX SPIKE/DUP** SAMPLE [ID] [DEPTH] [EITHER MS OR MSD] WW-SB-01 (10-15) MS/MSD WW-MW-01 (10-15) MS/MSD **TRIP BLANKS** SAMPLE- ID [DATE] WW-TB-063007 **BLIND DUPLICATES** SAMPLE -ID[XX][DATE] WW-SB-XX-063007 WW-MW-XX-063007

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 Work Plan and 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 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 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 final evidence 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 has been identified for use to implement sampling required by the SRIWP.

Subsurface Soil Sampling Activities:

- RAE Systems MultiRAE Plus equipped with VOC (10.6 eV lamp), lower explosive limit (LEL), percent oxygen, hydrogen sulfide and hydrogen cyanide.
- RAE Systems MiniRAE (PID) with 10.6 eV lamp.
- Drager Chip Measurement System (CMS) and compound specific chips (including benzene, hydrogen sulfide, hydrogen cyanide, etc.).
- Dust Trak Aerosol Monitor [particulate monitor].

Groundwater Sampling Activities:

- In-Situ Multi-Parameter Troll 9000.
- YSI 6280 XLM water quality meter.

Similar field equipment can be substituted that perform the same functions can be substituted if selected equipment is not available from equipment supplier.

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. These procedures are as required in the respective analytical methodologies summarized in Tables 1 and 2 of this QAPP.

8. Sample Preparation and Analytical Procedures

Analytical samples will be collected in general accordance with the FSP and as specified in the SRIWP. Tables 1 and 2 provide a sample collection matrix that is separated by media. Analytical samples will be collected into laboratory-preserved sample containers and will be preserved as indicated in Table 3.

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 DUSR according to NYSDEC requirements will be provided by the analytical laboratory.

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 PM 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

The consultant will be responsible for performing an independent validation of the analytical data. Project-specific procedures will be used to validate analytical laboratory data. The basis for the validation will be the USEPA CLP National Functional Guidelines for Organic Data Review (February 2005) and the USEPA CLP National Functional Guidelines for Inorganic Data Review (October 2004), modified to accommodate the criteria in the analytical methods used in this program, and Region II Standard Operating Procedures (SOPs) for CLP Organic Data review (Revision 11, June 1996) and Evaluation of Metals for the CLP Program (Revision 11, February 1992). Critical functions for determining the validity of generated data are: (1) strict adherence to the analytical methods, (2) assurance that the instrumentation employed was operated in accordance with defined operating procedures, (3) assurance that quality parameters built into the analytical procedures have been adhered to, and (4) confirmation that the DQOs have been met.

Table 3 highlights the QC criteria and holding time requirements for all analyses conducted under this program. These criteria will be used to evaluate and qualify the data during validation.

The consultant or qualified contracted personnel will validate analytical samples collected under the SRIWP. Samples collected for waste classification will not be validated. Validation will include all technical holding times, as well as QC sample results (blanks, surrogate spikes, laboratory duplicates, MS/MSDs, and LCSs), tunes, internal standards, calibrations, target compound identification, and results calculations.

For all analyses, the laboratory will report results, which are below the laboratory's reporting limit; these results will be qualified as estimated (J) by the laboratory. The laboratory may be required to report TICs for the VOC and SVOC analyses; this will be requested by the consultant on an as-needed basis.

The overall completeness of the data package will also be evaluated by the data validator. Completeness checks will be administered on all data to determine whether full data deliverables were provided. The reviewer will determine whether all required items are present and request copies of missing deliverables.

Upon completion of the validation, a report will be prepared. This report will summarize the samples reviewed, elements reviewed, any nonconformance with the established criteria, and validation actions. Data qualifiers will be consistent with EPA National Functional Guidelines. This report will be in a format consistent with NYSDEC's DUSR.

9.3 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.

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 8260C and SVOC 8270D analyses.
- Method and/or instrument blanks.
- Surrogate spikes for organic analyses.
- Internal standard spikes for VOC 8260C and SVOC 8270D analyses.
- Detection limit determination and confirmation by analysis of low-level calibration standard.

The laboratory quality plan for the selected ELAP is located in Appendix A.

Field quality control samples will include:

- Equipment blanks as outlined in Table 3.
- Field duplicate samples as outlined in Table 3.
- Trip blanks as outlined in Table 3.
- MS/MSDs as outlined in Table 3.

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 know 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, 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 field will be provided by the equipment vendor. The following equipment has been identified for use to implement the SRIWP.

Subsurface Soil Sampling Activities:

- RAE Systems MultiRAE Plus equipped with VOC (10.6 eV lamp), LEL, percent oxygen, hydrogen sulfide and hydrogen cyanide.
- RAE Systems MiniRAE 2000 PID with 10.6 eV lamp.
- RAE Systems VRAE Surveying Monitor with LEL, hydrogen cyanide, hydrogen sulfide, carbon monoxide, and percent oxygen.
- Drager CMS and compound specific chips.
- Dust Trak Aerosol Monitor.

Groundwater Sampling Activities

- In-Situ Troll 9000
- YSI 600 XLM

Similar equipment will be substituted that perform the same functions can be substituted if selected equipment is not available from equipment supplier.

Laboratory equipment calibration and maintenance procedures are specified in the ELAP laboratory quality manual located 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:

$$RL = \frac{Lowest\ conc.\ std\ (ng)}{Volume\ injected\ (uL)}\ x\ \frac{Sample\ aliquot\ (mL\ or\ g)}{Final\ volume\ (mL)}\ x\ DF\ x\ \frac{100}{(100\ -\ \%M)}$$

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:

$$RPD = \frac{(Larger\ Value\ -\ Smaller\ Value)}{[(Larger\ Value + Smaller\ Value)/2]}\ x\ 100\%$$

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:

$$Percent\ RSD = \frac{Standard\ Deviation}{Mean}\ x\ 100\%$$

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 proposed in the Work Plan.

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 the work plan and Section 10 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 field sampling plan and Work Plan

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 SRIWP 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), 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.

No staff member will initiate corrective action without prior communication of findings through the proper channels.

Corrective action in the laboratory will be completed in accordance with the quality assurance procedures located in the 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 Field Sampling Matrix
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Sample I.D.	Sample Location	Sample Number: 1. Shallow soils within observed impacts (0 to 5' bgs) and below recent fill; 2. Subsurface soils within heaviest observed impacts below 5 feet (if present); 3. Subsurface soils below deepest observed visual impacts. IF NO IMPACTS ARE OBSERVED: 1. Shallow soils (0 to 5' bgs) and below recent fill; 2. Water table interface;					Analysis (Method[1])			
		Number Samples Proposed	Number Samples Collected	Date Collected	Heaviest Impacted Zone below previous sample (if present)	Subsurface soils below deepest observed visual impacts (only if impacts are present)	VOCs (8260C)	SVOCs (8270D)	TAL Metals (6000/7000)	Free Cyanide (9014)
Subsurface Soils										
WW-MW-208D	Parcel 6	3					3	3	3	3
WW-MW-209D	Parcel 6	3					3	3	3	3
WW-MW-210D	Parcel 6	3					3	3	3	3

Notes:
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
TAL - target analyte list
1. Chemical analysis test methods specified are from U.S. EPA SW-846 test methods.

Table 2. Groundwater Field Sampling Matrix
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Sample I.D.	Sample Location	SAMPLE SELECTION PROTOCOL: Collect one groundwater sample at the water table or installed monitoring well depth.				Water Quality Measurements						Analysis (Method[1])			
		Sample Number			Sample Zone										
		Number Samples Proposed	Number Samples Collected	Date Collected	Water Table	pH	Specific Conductance	Temperature	Oxidation Reduction Potential (ORP)	Turbidity	Dissolved Oxygen	VOCs (8260C)	SVOCs (8270D)	TAL Metals (6000/7000)	Total Cyanide (9014)
WW-MW-208S, I and D	Parcel 6	3										1	1	1	1
WW-MW-209S, I and D	Parcel 6	3										1	1	1	1
WW-MW-210S, I and D	Parcel 6	3										1	1	1	1

Notes:
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
TAL - target analyte list
1. Chemical analysis test methods specified are from U.S. EPA SW-846 test methods.

Table 3. Analytical Methods/Quality Assurance Summary Table
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Media	Number of Primary Samples	QA/QC Samples				Total Number of Samples	Analytical Parameters	Method	Preservative	Holding Time	Container
		TB	FB[2]	DUP	MS/MSD						
Subsurface Soil	9	3	1	1	1	15	VOCs	8260C	Cool to 4°C	14 days to analysis	3 Encore or Terracore samplers
	9	0	1	1	1	12	SVOCs	8270D	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	9	0	1	1	1	12	TAL Metals	6000/7000	Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	Wide mouth 8-oz. and 4oz. clear glass jars1
	9	0	1	1	1	12	Free Cyanide	9013A/ ASTM Method D4282-02	Cool to 4° C	14 days	Wide-mouth amber 8-oz.
Groundwater	9	1	1	1	1	13	VOCs	8260C	pH<2 with HCl, Cool to 4°C	14 days to analysis	(2) 40 mL VOA vials
	9	0	1	1	1	12	SVOCs	8270D	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	(2) 1 L amber glass jar
	9	0	1	1	1	12	TAL Metals	6000/7000	pH<2 with HNO_3; Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	(1) 500 mL polyethylene container
	9	0	1	1	1	12	Total Cyanide	9012	NaOH to pH>12/Cool to 4°C	14 days to analysis	(1) 500 mL polyethylene container

Notes:
[1]: SVOC, TAL metals, herbicides, pesticides and PCBs will be collected from the (1)- 8 oz jar and the (1)- 4 oz jar
[2]: Soil field blanks will include bottles listed in groundwater section of the table.
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
TAL - target analyte list
ASTM - American Society for Testing and Materials
°C- Degrees Celsius
L - Liter
oz. - ounce
mL - Milliliter
HNO3 - Nitric acid
HCl - Hydrochloric Acid

Table 4. Quantification Limits for Soils
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Metals by EPA Method 6000/7000 series			
Aluminum	258	20	mg/Kg
Antimony	11.7	1.14	mg/Kg
Arsenic	8	1.22	mg/Kg
Barium	2	0.18	mg/Kg
Beryllium	2	0.5	mg/Kg
Cadmium	3	1	mg/Kg
Calcium	85	11.6	mg/Kg
Chromium	3	0.34	mg/Kg
Cobalt	2	0.42	mg/Kg
Copper	5	0.8	mg/Kg
Iron	145	10.2	mg/Kg
Lead	9	0.76	mg/Kg
Magnesium	35	9.2	mg/Kg
Manganese	2.5	0.64	mg/Kg
Mercury	0.05	0.02	mg/Kg
Nickel	6.25	0.44	mg/Kg
Potassium	200	40	mg/Kg
Selenium	16	1.6	mg/Kg
Silver	3	0.32	mg/Kg
Sodium	94	20	mg/Kg
Thallium	20	4.17	mg/Kg
Vanadium	4	0.36	mg/Kg
Zinc	20	3.8	mg/Kg
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270D			
1,2,4-Trichlorobenzene	333	55.96	ug/Kg
1,2-Dichlorobenzene	333	56.43	ug/Kg
1,2-Diphenylhydrazine	333	32.86	ug/Kg
1,3-Dichlorobenzene	333	50.49	ug/Kg
1,4-Dichlorobenzene	333	52.75	ug/Kg
2,2-oxybis (1-chloropropane)	333	47.18	ug/Kg
2,4,5-Trichlorophenol	1667	120.96	ug/Kg
2,4,6-Trichlorophenol	333	85.18	ug/Kg
2,4-Dichlorophenol	333	108.95	ug/Kg
2,4-Dimethylphenol	333	172.3	ug/Kg
2,4-Dinitrophenol	1667	114.87	ug/Kg
2,4-Dinitrotoluene	333	60.09	ug/Kg
2,6-Dinitrotoluene	333	60.57	ug/Kg
2-Chloronaphthalene	333	48.46	ug/Kg
2-Chlorophenol	333	86.27	ug/Kg
2-Methylnaphthalene	333	52.92	ug/Kg
2-Methylphenol	333	89.03	ug/Kg
2-Nitroaniline	1667	42.32	ug/Kg
2-Nitrophenol	333	115.71	ug/Kg
3,3-Dichlorobenzidine	667	88.96	ug/Kg
3-Nitroaniline	1667	68.54	ug/Kg
4,6-Dinitro-2-methylphenol	1667	239.28	ug/Kg
4-Bromophenyl phenyl ether	333	51.16	ug/Kg
4-Chloro-3-methylphenol	333	112.76	ug/Kg

	Reporting Detection Limit	Method Detection Limit	Units
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270D (Continued)			
4-Chloroaniline	333	107.34	ug/Kg
4-Chlorophenyl phenyl ether	333	45.74	ug/Kg
4-Methylphenol	333	179.39	ug/Kg
4-Nitroaniline	667	48.17	ug/Kg
4-Nitrophenol	1667	141.69	ug/Kg
Acenaphthene	333	55.32	ug/Kg
Acenaphthylene	333	40.59	ug/Kg
Aniline	333	73.83	ug/Kg
Anthracene	333	54.55	ug/Kg
Benzidine	3333	1134.9	ug/Kg
Benzo(a)anthracene	333	45.31	ug/Kg
Benzo(a)pyrene	333	41.16	ug/Kg
Benzo(b)fluoranthene	333	93.11	ug/Kg
Benzo(ghi)perylene	333	36.99	ug/Kg
Benzo(k)fluoranthene	333	37.12	ug/Kg
Benzoic acid	1667	90.33	ug/Kg
Benzyl alcohol	333	62.93	ug/Kg
Bis(2-chloroethoxy)methane	333	57.03	ug/Kg
Bis(2-chloroethyl)ether	333	44.86	ug/Kg
Bis(2-ethylhexyl)phthalate	333	44.37	ug/Kg
Butyl benzyl phthalate	333	43.04	ug/Kg
Carbazole	333	48.63	ug/Kg
Chrysene	333	41.6	ug/Kg
Dibenzo(a,h)anthracene	333	36.71	ug/Kg
Dibenzofuran	333	52.67	ug/Kg
Diethyl phthalate	333	48.88	ug/Kg
Dimethyl phthalate	333	51.27	ug/Kg
Di-n-butyl phthalate	333	43.98	ug/Kg
Di-n-octyl phthalate	333	34.97	ug/Kg
Fluoranthene	333	41.87	ug/Kg
Fluorene	333	43.39	ug/Kg
Hexachlorobenzene	333	48.52	ug/Kg
Hexachlorobutadiene	333	67.85	ug/Kg
Hexachlorocyclopentadiene	333	247.96	ug/Kg
Hexachloroethane	333	59.22	ug/Kg
Indeno(1,2,3-cd)pyrene	333	33.74	ug/Kg
Isophorone	333	60.02	ug/Kg
Naphthalene	333	56.66	ug/Kg
Nitrobenzene	333	40.4	ug/Kg
n-Nitrosodimethylamine	333	48.87	ug/Kg
n-Nitroso-di-n-propylamine	333	44.63	ug/Kg
n-Nitrosodiphenylamine	333	49.76	ug/Kg
Pentachlorophenol	1667	287.85	ug/Kg
Phenanthrene	333	38.58	ug/Kg
Phenol	333	96.98	ug/Kg
Pyrene	333	45.56	ug/Kg
Pyridine	667	39.9	ug/Kg

	Reporting Detection Limit	Method Detection Limit	Units
Volatile Organic Compounds (VOCs) by EPA Method 8260C			
1,1,1-Trichloroethane	5	0.84	ug/Kg
1,1,2,2-Tetrachloroethane	5	1.21	ug/Kg
1,1,2-Trichloroethane	5	1.04	ug/Kg
1,1-Dichloroethane	5	0.81	ug/Kg
1,1-Dichloroethene	5	1.09	ug/Kg
1,2,3-Trichloropropane	5	1.62	ug/Kg
1,2,4-Trichlorobenzene	5	0.61	ug/Kg
1,2-Dichloroethane	5	0.99	ug/Kg
1,2-Dichloropropane	5	1.06	ug/Kg
2-Butanone (MEK)	10	1.78	ug/Kg
2-Chloroethylvinylether	5	1.37	ug/Kg
2-Hexanone	10	2.53	ug/Kg
4-Methyl-2-pentanone (MIBK)	5	1.18	ug/Kg
Acetone	20	3.15	ug/Kg
Acrolein	20	3.1	ug/Kg
Acrylonitrile	5	1.19	ug/Kg
Benzene	5	0.86	ug/Kg
Bromodichloromethane	5	0.84	ug/Kg
Bromoform	5	0.99	ug/Kg
Bromomethane	5	0.82	ug/Kg
Carbon disulfide	5	0.61	ug/Kg
Carbon tetrachloride	5	0.78	ug/Kg
Chlorobenzene	5	0.79	ug/Kg
Chloroethane	5	1.89	ug/Kg
Chloroform	5	0.53	ug/Kg
Chloromethane	5	0.9	ug/Kg
cis-1,2-Dichloroethene	5	1.04	ug/Kg
cis-1,3-Dichloropropene	5	0.78	ug/Kg
Dibromochloromethane	5	0.41	ug/Kg
Dichlorodifluoromethane	5	1.25	ug/Kg
Ethylbenzene	5	0.79	ug/Kg
Isopropyl ether	5	0.44	ug/Kg
Methylene chloride	20	2.21	ug/Kg
Methyl-tert-butyl-ether (MTBE)	5	0.93	ug/Kg
Styrene	5	1.06	ug/Kg
tert-Butyl alcohol	20	4.69	ug/Kg
Tetrachloroethene	5	0.7	ug/Kg
Toluene	5	0.84	ug/Kg
trans-1,2-Dichloroethene	5	0.58	ug/Kg
trans-1,3-Dichloropropene	5	0.92	ug/Kg
Trichloroethene	5	0.68	ug/Kg
Trichlorofluoromethane	5	0.6	ug/Kg
Trichlorotrifluoroethane	5	0.63	ug/Kg
Vinyl acetate	10	2.7	ug/Kg
Vinyl chloride	5	0.87	ug/Kg
Xylenes (total)	5	1.96	ug/Kg

Table 4. Quantification Limits for Soils
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Free Cyanide by EPA Method 9016			
Cyanide	TBD	TBD	ug/Kg

Notes:
mg/kg - milligrams per kilogram
ug/Kg - micrograms per kilogram
TBD - To Be Determined
EPA - Environmental Protection Agency
ASTM - American Standard for Testing and Materials

Table 5. Quantification Limits for Groundwater
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Cyanide by EPA Method 9012			
Cyanide, Total	10	1	ug/L
Metals by EPA Method 6000/7000 series			
Aluminum	500	92	ug/L
Antimony	20	5.4	ug/L
Arsenic	40	3.9	ug/L
Barium	5	0.74	ug/L
Beryllium	5	0.54	ug/L
Cadmium	10	1.1	ug/L
Calcium	300	56	ug/L
Chromium	10	1.3	ug/L
Cobalt	10	1.8	ug/L
Copper	10	4.3	ug/L
Iron	100	54	ug/L
Lead	10	3	ug/L
Magnesium	100	26	ug/L
Manganese	15	6.9	ug/L
Mercury	0.4	0.07	ug/L
Nickel	10	1.9	ug/L
Potassium	400	191	ug/L
Selenium	30	5	ug/L
Silver	6	1.1	ug/L
Sodium	400	98	ug/L
Thallium	40	10	ug/L
Vanadium	6	1.5	ug/L
Zinc	50	11	ug/L
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270D			
1,2,4-Trichlorobenzene	10	0.68	ug/L
1,2-Dichlorobenzene	10	0.74	ug/L
1,2-Diphenylhydrazine	10	0.84	ug/L
1,3-Dichlorobenzene	10	0.68	ug/L
1,4-Dichlorobenzene	10	0.46	ug/L
2,2-oxybis (1-chloropropane)	10	0.62	ug/L
2,4,5-Trichlorophenol	50	0.78	ug/L
2,4,6-Trichlorophenol	10	0.79	ug/L
2,4-Dichlorophenol	10	0.84	ug/L
2,4-Dimethylphenol	10	0.73	ug/L
2,4-Dinitrophenol	50	5.13	ug/L
2,4-Dinitrotoluene	10	0.8	ug/L
2,6-Dinitrotoluene	10	0.59	ug/L
2-Chloronaphthalene	10	0.73	ug/L
2-Chlorophenol	10	0.6	ug/L
2-Methylnaphthalene	10	0.64	ug/L
2-Methylphenol	10	0.59	ug/L
2-Nitroaniline	50	1.12	ug/L
2-Nitrophenol	10	0.75	ug/L
3,3-Dichlorobenzidine	10	0.98	ug/L

Table 5. Quantification Limits for Groundwater
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270D (Continued)			
3-Nitroaniline	50	0.67	ug/L
4,6-Dinitro-2-methylphenol	50	4.24	ug/L
4-Bromophenyl phenyl ether	10	0.91	ug/L
4-Chloro-3-methylphenol	10	0.51	ug/L
4-Chloroaniline	10	0.43	ug/L
4-Chlorophenyl phenyl ether	10	0.82	ug/L
4-Methylphenol	10	0.33	ug/L
4-Nitroaniline	20	1.05	ug/L
4-Nitrophenol	50	1.85	ug/L
Acenaphthene	10	0.8	ug/L
Acenaphthylene	10	0.75	ug/L
Aniline	10	0.63	ug/L
Anthracene	10	0.99	ug/L
Benzidine	100	2.15	ug/L
Benzo(a)anthracene	10	1.19	ug/L
Benzo(a)pyrene	10	1.08	ug/L
Benzo(b)fluoranthene	10	1.54	ug/L
Benzo(ghi)perylene	10	1.04	ug/L
Benzo(k)fluoranthene	10	0.91	ug/L
Benzoic acid	50	5.88	ug/L
Benzyl alcohol	10	0.99	ug/L
Bis(2-chloroethoxy)methane	10	0.87	ug/L
Bis(2-chloroethyl)ether	10	0.87	ug/L
Bis(2-ethylhexyl)phthalate	10	1.31	ug/L
Butyl benzyl phthalate	10	0.96	ug/L
Carbazole	10	1.11	ug/L
Chrysene	10	0.97	ug/L
Dibenzo(a,h)anthracene	10	1.34	ug/L
Dibenzofuran	10	0.82	ug/L
Diethyl phthalate	10	0.82	ug/L
Dimethyl phthalate	10	0.63	ug/L
Di-n-butyl phthalate	10	1.14	ug/L
Di-n-octyl phthalate	10	1.3	ug/L
Fluoranthene	10	1.08	ug/L
Fluorene	10	0.77	ug/L
Hexachlorobenzene	10	1.07	ug/L
Hexachlorobutadiene	10	0.84	ug/L
Hexachlorocyclopentadiene	10	2.21	ug/L
Hexachloroethane	10	1.06	ug/L
Indeno(1,2,3-cd)pyrene	10	1.17	ug/L
Isophorone	10	0.66	ug/L
Naphthalene	10	0.66	ug/L
Nitrobenzene	10	0.79	ug/L
n-Nitroso-di-n-propylamine	10	0.7	ug/L
n-Nitrosodiphenylamine	10	1.08	ug/L
n-Nitrosomethylethylamine	10	0.5	ug/L

Table 5. Quantification Limits for Groundwater
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270D (Continued)			
Pentachlorophenol	50	5.04	ug/L
Phenanthrene	10	0.66	ug/L
Phenol	10	0.35	ug/L
Pyrene	10	1.01	ug/L
Pyridine	20	2.31	ug/L
Volatile Organic Compounds (VOCs) by EPA Method 8260C (continued)			
1,1,1-Trichloroethane	5	0.4	ug/L
1,1,2,2-Tetrachloroethane	5	0.4	ug/L
1,1,2-Trichloroethane	5	0.6	ug/L
1,1-Dichloroethane	5	0.6	ug/L
1,1-Dichloroethene	5	0.7	ug/L
1,2,3-Trichloropropane	5	1.1	ug/L
1,2,4-Trichlorobenzene	5	0.9	ug/L
1,2-Dichloroethane	5	0.6	ug/L
1,2-Dichloropropane	5	0.9	ug/L
1,3-Dichloropropane	5	0.4	ug/L
2-Butanone (MEK)	5	1.2	ug/L
2-Chloroethylvinylether	5	0.6	ug/L
2-Hexanone	5	0.8	ug/L
4-Methyl-2-pentanone (MIBK)	5	0.7	ug/L
Acetone	5	1.4	ug/L
Acrolein	10	7.8	ug/L
Acrylonitrile	5	1.6	ug/L
Benzene	5	0.4	ug/L
Bromodichloromethane	5	0.4	ug/L
Bromoform	5	0.8	ug/L
Bromomethane	5	1.2	ug/L
Carbon disulfide	5	0.9	ug/L
Carbon tetrachloride	5	1	ug/L
Chlorobenzene	5	0.4	ug/L
Chloroethane	5	0.8	ug/L
Chloroform	5	0.7	ug/L
Chloromethane	5	0.5	ug/L
cis-1,2-Dichloroethene	5	0.6	ug/L
cis-1,3-Dichloropropene	5	0.5	ug/L
Dibromochloromethane	5	0.5	ug/L
Dichlorodifluoromethane	5	0.6	ug/L
Ethylbenzene	5	1	ug/L
Isopropyl ether	5	N/A	ug/L
Methylene chloride	5	0.4	ug/L
Methyl-tert-butyl-ether (MTBE)	5	0.3	ug/L
Styrene	5	0.5	ug/L
Tetrachloroethene	5	0.5	ug/L
Toluene	5	0.3	ug/L
trans-1,2-Dichloroethene	5	0.5	ug/L
trans-1,3-Dichloropropene	5	0.3	ug/L

Table 5. Quantification Limits for Groundwater
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Volatile Organic Compounds (VOCs) by EPA Method 8260C (continued)			
Trichloroethene	5	0.7	ug/L
Trichlorofluoromethane	5	0.6	ug/L
Trichlorotrifluoroethane	5	0.5	ug/L
Vinyl acetate	5	0.2	ug/L
Vinyl chloride	5	0.8	ug/L
Xylenes (total)	5	1	ug/L

Notes:
ug/L - micrograms per liter
EPA - Environmental Protection Agency

Table 6. Soil Cleanup Objectives
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Analytes	Unrestricted Use (ppm)	Residential Use (ppm)	Restricted-Residential Use (ppm)	Restricted-Commercial Use (ppm)	Restricted-Industrial Use (ppm)	Protection of Groundwater (ppm)	Protection of Ecological Resources (ppm)
Volatile Organic Compounds							
Acetone	0.05	100	100	500	1,000	0.05	2.2
Benzene	0.06	2.9	4.8	44	89	0.06	70
Butanone, 2-	0.12	100	100	500	1,000	0.12	100
Butylbenzene, n-	12	100	100	500	1,000	12	NE
Butylbenzene, tert-	5.9	100	100	500	1,000	5.9	NE
Butylbenzene,sec-	11	100	100	500	1,000	11	NE
Carbon tetrachloride	0.76	1.4	2.4	22	44	0.76	NE
Chlorobenzene	1.1	100	100	500	1,000	1.1	40
Chloroform	0.37	10	49	350	700	0.37	12
Dichlorobenzene,1,2-	1.1	100	100	500	1,000	1.1	NE
Dichlorobenzene,1,3-	2.4	17	49	280	560	2.4	NE
Dichlorobenzene,1,4-	1.8	9.8	13	130	250	1.8	20
Dichloroethane,1,1-	0.27	19	26	240	480	0.27	NE
Dichloroethane,1,2-	0.02	2.3	3.1	30	60	0.02	10
Dichloroethene, cis-1,2-	0.25	59	100	500	1,000	0.25	NE
Dichloroethene,1,1-	0.33	100	100	500	1,000	0.33	NE
Dioxane,1,4-	0.1	9.8	13	130	250	0.1	0.1
Ethylbenzene	1	30	41	390	780	1	NE
Methyl tert-butyl ether	0.93	62	100	500	1,000	0.93	NE
Methylene chloride	0.05	51	100	500	1,000	0.05	12
Naphthalene	12	100	100	500	1,000	12	NE
Propylbenzene, n-	3.9	100	100	500	1,000	3.9	NE
Tetrachloroethene	1.3	5.5	19	150	300	1.3	2
Toluene	0.7	100	100	500	1,000	0.7	36
Trans-1,2-dichloroethene	0.19	100	100	500	1,000	0.19	NE
Trichloroethane, 1,1,1-	0.68	100	100	500	1,000	0.68	NE
Trichloroethene	0.47	10	21	200	400	0.47	2
Trimethylbenzene, 1,2,4-	3.6	47	52	190	380	3.6	NE
Trimethylbenzene, 1,3,5-	8.4	47	52	190	380	8.4	NE
Vinyl chloride	0.02	0.21	0.9	13	27	0.02	NE
Xylene, total	0.26	100	100	500	1,000	1.6	0.26

Table 6. Soil Cleanup Objectives
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Analytes	Unrestricted Use (ppm)	Residential Use (ppm)	Restricted-Residential Use (ppm)	Restricted-Commercial Use (ppm)	Restricted-Industrial Use (ppm)	Protection of Groundwater (ppm)	Protection of Ecological Resources (ppm)
Semivolatile Organic Compounds							
Acenaphthene	20	100	100	500	1,000	98	20
Acenaphthylene	100	100	100	500	1,000	107	NE
Anthracene	100	100	100	500	1,000	1,000	NE
Benz[a]anthracene	1	1	1	5.6	11	1	NE
Benzo[a]pyrene	1	1	1	1	1.1	22	2.6
Benzo[b]fluoranthene	1	1	1	5.6	11	1.7	NE
Benzo[g,h,i]perylene	100	100	100	500	1,000	1,000	NE
Benzo[k]fluoranthene	0.8	1	3.9	56	110	1.7	NE
Chrysene	1	1	3.9	56	110	1	NE
Dibenz[a,h]anthracene	0.33	0.33	0.33	0.56	1.1	1,000	NE
Dibenzofuran	7	14	59	350	1,000	210	NE
Fluoranthene	100	100	100	500	1,000	1,000	NE
Fluorene	30	100	100	500	1,000	386	30
Hexachlorobenzene	0.33	0.33	1.2	6	12	3.2	NE
Indeno[1,2,3-cd]pyrene	0.5	0.5	0.5	5.6	11	8.2	NE
Methylphenol, 4-	0.33	34	100	500	1,000	0.33	NE
Cresol, m (methylphenol, 3-)	0.33	100	100	500	1,000	0.33	NE
Methylphenol,2-	0.33	100	100	500	1,000	0.33	NE
Pentachlorophenol	0.8	2.4	6.7	6.7	55	0.8	0.8
Phenanthrene	100	100	100	500	1,000	1,000	NE
Phenol	0.33	100	100	500	1,000	0.33	30
Pyrene	100	100	100	500	1,000	1,000	NE
Polychlorinated Biphenyls (PCBs)							
Total PCBs	0.1	1	1	1	25	3.2	1

Table 6. Soil Cleanup Objectives
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Analytes	Unrestricted Use (ppm)	Residential Use (ppm)	Restricted-Residential Use (ppm)	Restricted-Commercial Use (ppm)	Restricted-Industrial Use (ppm)	Protection of Groundwater (ppm)	Protection of Ecological Resources (ppm)
Metals							
Arsenic	13	16	16	16	16	16	13
Barium	350	350	400	400	10,000	820	433
Beryllium	7.2	14	72	590	2700	47	10
Cadmium	2.5	2.5	4.3	9.3	60	7.5	4
Chromium (VI)	1	22	110	400	800	19	1
Chromium (III)	30	36	180	1500	6800		41
Copper	50	270	270	270	10,000	1720	50
Lead	63	400	400	1000	3900	450	63
Manganese	1600	2000	2,000	10,000	10,000	2,000	1600
Mercury	0.18	0.81	0.81	2.8	5.7	0.73	0.18
Nickel	30	140	310	310	10,000	130	30
Selenium	3.9	36	180	1500	6800	4	3.9
Silver	2	36	180	1500	6800	8.3	2
Zinc	109	2200	10,000	10,000	10,000	2480	109
Cyanide							
Cyanide, Total	27	27	27	27	10,000	40	NE

Notes:
ppm - parts per million
ppb - parts per billion

Table 7. Groundwater Standards /Guidance Values
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Parameter	DQL[1]
Volatile Organic Compounds (ug/L)	
Acetone	50
Benzene	1
2-Butanone	50
Carbon Disulfide	NE
Carbon Tetrachloride	5
Chlorobenzene+A1	5
Chloroethane	5
Chloroform	7
Dibromochloromethane	50
1,2-Dichlorobenzene	3
1,3-Dichlorobenzene	3
1,4-Dichlorobenzene	3
1,1-Dichloroethane	5
1,2-Dichloroethane	**0.6**
1,1-Dichloroethene	5
trans-1,2-Dichloroethene	5
1,3-Dichloropropane	5
Ethylbenzene	5
Freon 113	5
Methylene chloride	5
4-Methyl-2-pentanone	503
Tetrachloroethene	5
1,1,1-Trichloroethane	5
1,1,2,2-Tetrachloroethane	5
1,2,3-Trichloropropane	**0.04**
1,2,4-Trichlorobenzene	5
Toluene	5
Trichloroethene	5
Vinyl chloride	2
Xylenes	5
Isopropylbenzene	5
n-Propylbenzene	5
p-Isopropyltoluene	5
1,2,4-Trimethylbenzene	5
1,3,5-Trimethylbenzene	5
n-Butylbenzene	5
sec-Butylbenzene	5
t-Butylbenzene	5
MTBE	10

Table 7. Groundwater Standards /Guidance Values
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Parameter	DQL[1]
Semivolatile Organic Compounds (ug/L)	
Acenaphthene	20
Acenaphthylene	NS
Anthracene	50
Benzo(a)anthracene	**0.002**
Benzo(a)pyrene	ND
Benzo(b)fluoranthene	**0.002**
Benzo(g,h,i)perylene	NE
Benzo(k)fluoranthene	**0.002**
Bis(2-ethylhexyl)phthalate	5
Butylbenzylphthalate	50
Chrysene	**0.002**
4-Chloroaniline	5
4-Chloro-3-methylphenol	**1**
2-Chlorophenol	**1**
Dibenzofuran	NE
Dibenz(a,h)anthracene	NE
3,3'-Dichlorobenzidine	5
2,4-Dichlorophenol	5
2,4-Dinitrophenol	**10**
2,6-Dinitrotoluene	5
Diethylphthalate	50
Dimethylphthalate	50
Di-n-butylphthalate	50
Di-n-octylphthalate	50
Fluoranthene	50
Fluorene	50
Hexachlorobenzene	**0.04**
Indeno(1,2,3-cd)pyrene	**0.002**
Isophorone	50
2-Methylnaphthalene	NE
2-Methylphenol	**1**
4-Methylphenol	**1**
Naphthalene	10
Nitrobenzene	**0.4**
2-Nitroaniline	5
2-Nitrophenol	**1**
4-Nitrophenol	**1**
3-Nitroaniline	5
Pentachlorophenol	**1**
Phenanthrene	50
Phenol	**1**
Pyrene	50
2,4,5-Trichlorophenol	**1**

Table 7. Groundwater Standards /Guidance Values
Quality Assurance Project Plan
Portion of K - Williamsburg Works Site
Brooklyn, New York

Parameter	DQL[1]
Total Metals (ug/L)	
Aluminum	NE
Antimony	**3**
Arsenic	25
Barium	1000
Beryllium	3
Cadmium	5
Calcium	NE
Chromium	50
Cobalt	NE
Copper	200
Iron	300
Lead	25
Magnesium	35,000
Manganese	300
Mercury	0.7
Nickel	100
Potassium	NE
Selenium	10
Silver	50
Sodium	20,000
Thallium	**0.5**
Vanadium	NE
Zinc	2000
Cyanide (ug/L)	
Cyanide	200

[1] DQL based on TOGS Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (June, 1998)
[2] DQL listed is for total PCBs
DQL = Data Quality Level
NE = None established
ND = Not detected when analyzed by method listed in Table 7
Compounds which will not achieve the DQL are highlighted

Appendix A

Laboratory Quality Manual

QUALITY MANUAL

of

ESS LABORATORY
Division of Thielsch Engineering, Inc.

185 Frances Ave.
Cranston, RI 02910

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Name	Function (Unit)	Signatures	Date
Laurel Stoddard	Laboratory Director	[illegible]	2/20/19
Sharyn Lawler	Quality Manager	Sharyn B Lawler	2/14/2019
Eric Baanante	Operations Manager	[illegible]	2/22/2019
Eric Baanante	Technical Manager	[illegible]	2/22/2019

Revision Number:	**13**	**Effective Date:**	**Jan 1st 2014**
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Revision Number:	**15**	**Effective Date:**	**Jan 1st 2016**
Revision Number:	**16**	**Effective Date:**	**Jan 1st 2017**
Revision Number:	**16-1***	**Effective Date:**	**Dec 19th 2017**
Revision Number:	**16-1****	**Effective Date:**	**July 1st 2018**
Revision Number:	**16-1*****	**Effective Date:**	**Oct 23rd 2018**
Revision Number:	**17**	**Effective Date:**	**March 1st 2019**

*Sections 6-2, 26-2; Appendices A, C, D; and Figure 26-2 updated to reflect current practice.
**Sections 16.1, 24.4 and 28; Appendices A, D updated to reflect current practice.
*** Section 23 updated to reflect current practice.

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Section 3

INTRODUCTION AND SCOPE
(TNI V1:M2 – Sections 1, 2, 3)

The purpose of this *Quality Manual* is to describe the management system for ESS LABORATORY. The *Quality Manual* defines the policies, procedures, and documentation that assure analytical services continually meet a defined standard of quality that is designed to provide clients with data of known and documented quality and, where applicable, demonstrate regulatory compliance.

The *Quality Manual* sets the standard under which all laboratory operations are performed, including the laboratory's organization, objectives, and operating philosophy. The *Quality Manual* has been prepared to assure compliance with the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 **–** Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1-M1 through M7-ISO-2009-Rev.0.2). This Standard is consistent with ISO/IEC 17025:2005 requirements that are relevant to the scope of environmental testing services and thus, the laboratory operates a quality system in conformance with ISO/IEC 17025:2005(E). In addition, the policies and procedures outlined are compliant with the requirements of other State and Federal accreditation and certification programs, as listed in Appendix D.

The *Quality Manual* is available to regulatory bodies and their representatives, in English.

3.1 Scope of Testing

The laboratory's scope of analytical testing services includes those listed in Appendix D.

3.2 Table of Contents, References and Appendices

The Table of Contents is in Section 2 and Appendices are in Section 29.

This *Quality Manual* uses the references included in Modules 1, 2 and 4 of the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis; the International Standard ISO/IEC 17025:2005(E), Clause 2; USEPA SW-846 On-line; US Title 40 CFR, Parts 136, 141, 142, 143; Massachusetts 310 CMR 42.00; APHA/AWWA/WEF Standard Methods 20th and 22nd Editions; pertinent ASTM Methods, and various other references, as listed in ESS LABORATORY SOPs.

3.3 Glossary and Acronyms Used

Quality control terms are generally defined within the Section that describes the activity.

3.3.1 <u>Glossary</u>

The **Terms and Definitions** used by ESS Laboratory may be found in the references listed below.

3.3.1.1 **The TNI Standard:** Modules 1-7 in the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1, M1 through M7, ISO-2009).

3.3.1.2 **ESS Laboratory Certificates of Analysis (Customer Reports) and SOPs.**

3.3.2 Acronyms

A list of acronyms used in this document and their definitions are:

AB	–	Accrediting Body
A2LA	–	American Association for Laboratory Accreditation
ANSI	–	American National Standards Institute
ASQC	–	American Society for Quality Control
ASTM	–	American Society for Testing and Materials
BLK	–	Blank
BS/BSD	–	Blank Spike/Blank Spike Duplicate (a/k/a LCS/LCSD)
°C	–	degrees Celsius
°F	–	degrees Fahrenheit
CAL	–	calibration
CAB	-	Conformity Assessment Body (A2LA)
CAS	–	Chemical Abstract Service
CCV	–	Continuing calibration verification
COC	–	Chain of Custody
DL	-	Detection Limit
DO	–	Dissolved oxygen
(I)DOC	–	(Initial) Demonstration of Capability
EPA	–	Environmental Protection Agency
g/L	–	grams per liter
GC/MS	–	gas chromatography/mass spectrometry
ICP-MS	–	inductively coupled plasma-mass spectrometry
ICV	–	Initial Calibration Verification
ISO/IEC	–	International Organization for Standardization/International Electrochemical Commission
lb/in2	–	pound per square inch
LCS/LCSD	–	Laboratory Control Sample/ Laboratory Control Sample Duplicate
LFB	–	Laboratory Fortified Blank
LIMS	-	Laboratory Information Management System (Promium “Element”)
LOD	-	Limit of Detection
LOQ	-	Limit of Quantitation
LLOQ	-	Lower Limit of Quantitation
MB	-	Method Blank
MDL	–	Method Detection Limit
mg/Kg	–	milligrams per kilogram
mg/L	–	milligrams per liter
MRL	-	Method Reporting Limit

MS	–	Matrix Spike
MSD	–	Matrix Spike Duplicate
NELAC	–	National Environmental Laboratory Accreditation Conference
NELAP	–	National Environmental Laboratory Accreditation Program
NIST	–	National Institute of Standards and Technology
PE	-	Performance Evaluation
PT	–	Proficiency Test(ing)
PTP	-	Proficiency Testing Provider
PTPA	–	Proficiency Testing Provider Accreditor
QA	–	Quality Assurance
QC	–	Quality Control
QM	–	*Quality Manual*
RL	–	Reporting level
RPD	–	Relative percent difference
RSD	–	Relative standard deviation
SOPs	–	Standard operating procedures
SVOC	–	Semivolatile organic compound
SPK	–	spike
STD	–	standard
TNI	-	The NELAC Institute
µg/L	–	micrograms per liter
UV	–	Ultraviolet
VOC	–	Volatile organic compound
WET	–	Whole effluent toxicity

3.4 Management of the *Quality Manual*

The Quality Manager is responsible for maintaining the currency of the *Quality Manual*.

The *Quality Manual* is reviewed at least annually by the Quality Manager and laboratory personnel to ensure it still reflects current practices and meets the requirements of any applicable regulations or client specifications. Sections of the manual are updated by making a change to the Section and then increasing the revision number by one (x-xx in the case of a minor revision). The cover sheet of the *Quality Manual* (Section 1) must be re-signed and the Table of Contents (Section 2) is updated whenever a Section is updated.

The *Quality Manual* is considered confidential within ESS LABORATORY and may not be altered in anyway except by approval of the Laboratory Director and Quality Manager. If it is distributed to external users, it is for the purpose of reviewing ESS LABORATORY's management system and may not be used for any other purpose without written permission.

Section 4

ORGANIZATION
(TNI V1:M2 – Section 4.1; ISO/IEC 17025/2005(E) - Clause 4.1)

ESS LABORATORY, a DIVISION OF THIELSCH ENGINEERING INC, a legally responsible entity, is a commercial analytical testing laboratory specializing in environmental chemistry. ESS Laboratory, while owned by Thielsch Engineering, Inc., maintains independent management systems, has no conflicting interests, and does not support the functions of Thielsch Engineering, Inc.

ESS Laboratory was established in 1978 and was acquired by Thielsch Engineering, Inc. in June of 1996. The laboratory has evolved into a state-of-the art facility that provides a wide range of Analytical Services in support of:

- Soil and Water Pollution Monitoring
- Environmental Impact Assessment
- Industrial Process Control
- Effluent and Emission Pollution Control

These services are provided to various customers including:

- Federal and State agencies
- Engineering Firms
- Private Industry/Homeowners

The laboratory is responsible for carrying out testing activities that meet the requirements of the TNI Standard, the ISO/EIC 17025 Standard and that meet the needs of the client and appropriate regulatory authorities. These objectives are achieved through application of the policies and procedures outlined in this Section and throughout the *Quality Manual*:

- The laboratory assures that it is impartial and that personnel are free from undue commercial, financial, or other undue pressures that might influence their technical judgment.

- Management and technical personnel have the authority and resources to carry out their duties, including the implementation, maintenance and improvement of the management system, and have procedures to identify and correct departures from the laboratory's management system.

- Personnel understand the relevance and importance of their duties as related to the maintenance of the laboratory's management system.

- Ethics and data integrity policy and procedures (see Section 5 – "Management" and Section 19 – "Data Integrity Investigations") ensure personnel do not engage in activities that diminish confidence in the laboratory's capabilities.

- Confidentiality is maintained. Every effort to protect customers' confidential information and proprietary rights, including procedures for protecting the electronic storage and transmission of results, is made.

4.1 Organization

The laboratory is a commercial organization. The Tax ID number is available on request, when applicable.

The laboratory conducts analytical operations in Cranston, RI and operates a satellite in Hopkinton, Mass, the latter being solely for the purpose of subsidiary customer field services and courier services. The management system covers work at both locations.

The Corporate Organization Chart can be found in Figure 4-1 below:

The laboratory's organization chart can be found in Appendix B.

Additional information regarding responsibilities, authority and interrelationship of personnel who manage, perform or verify testing is included in Section 5 –"Management" and Section 20 – "Personnel". These Sections also include information on supervision, training, technical management, job descriptions, quality personnel, and appointment of deputies for key managerial personnel.

The laboratory has the resources and authority to operate a management system that is capable of identifying departures from that system and from procedures during testing, and initiates actions to minimize or prevent departures. It is the policy of ESS Laboratory not to engage in any activities that may endanger trust in the independence of its judgement regarding its testing activities.

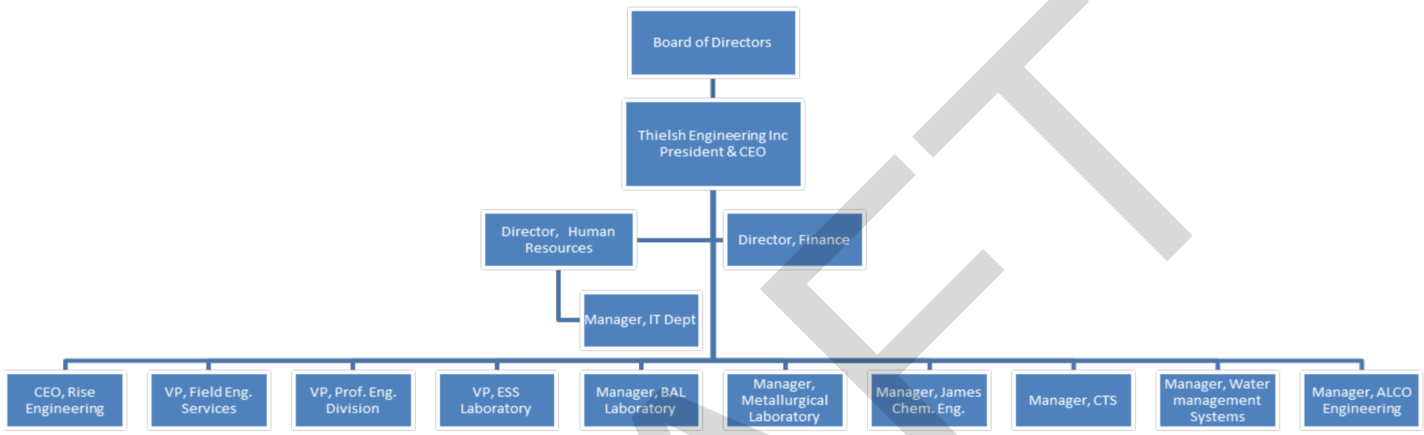
4.2 Conflict of Interest and Undue Pressure

The organizational structure indicated above minimizes the potential for conflicting or undue interests that might influence the technical judgment of analytical personnel.

Arrangements, such as policies and procedures to prevent commercial, financial or other influences that may negatively affect the quality of the work or negatively reflect on the competence, impartiality, judgment, quality of work or operational integrity are described in Appendix E.

In order to ease any scheduling pressures, employees are allowed flexible working hours, at the discretion of Management.

Figure 4-1 – Corporate Organization Chart



Section 5

MANAGEMENT

(TNI V1:M2 – Section 4.2; ISO/IEC 17025/2005(E) - Clause 4.2)

The laboratory maintains a management system that is appropriate to the scope of its activities.

5.1 Management Requirements

Top management ("Management") includes the Laboratory Director, Laboratory/ Operations/Technical Manager and the Quality Manager.

Management's commitment to good professional practice and to the quality of its products is defined in the Quality Policy statement, Section 5.3 below.

Management establishes, implements and maintains, by periodic review, a management system appropriate to the scope of its activities, ensuring that the laboratory documents its policies, systems, programs, procedures and instructions to the extent necessary to assure the quality of its data and ensures the integrity of the management system is maintained when changes to the management system are planned and implemented. 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.

Management has overall responsibility for the technical operations and has the authority needed to generate the required quality of laboratory operations. Management ensures communication within the organization to maintain an effective management system and to communicate the importance of meeting customer, statutory, and regulatory requirements. Management assures that management system documentation is known and available so that appropriate personnel can implement their part. When changes to the management system occur or are planned, managers ensure that the integrity of the system is maintained.

Management is responsible for carrying out testing activities that meet the requirements of the TNI Standard, the ISO/IEC 17025 Standard, various state-specific regulations, and that meet the needs of the client.

Managers implement, maintain, and improve the management system, and identify noncompliance with the management system of procedures by using available tools such as audit and surveillance results, control charts, participation in a suitable program of inter-laboratory comparisons where possible, data analysis, corrective and preventive actions, customer feedback and management reviews, in efforts to monitor trends. Managers initiate actions to prevent or minimize noncompliance.

Management ensures technical competence of personnel operating equipment, performing tests, evaluating results, or signing reports, and limits authority to perform laboratory functions to those appropriately trained and/or supervised.

Personnel are hired with sufficient education to meet written specified job requirements and undergo mandatory on-the-job training per SOP 80_0016, culminating in a formal Demonstration of Capability for each method they perform, at which time they may act independently, per written method requirements. See also Section 20 – Personnel, of this Quality Manual.

Management is responsible for defining the minimal level of education, qualifications, experience, and skills necessary for all positions in the laboratory and assuring that technical staff have demonstrated capabilities in their tasks and maintain records of such demonstrations. Training is kept up to date as described in Section 20 – "Personnel" by periodic review of training records and through employee performance review.

Management bears specific responsibility for maintenance of the management system. This includes defining roles and responsibilities to personnel, approving documents, providing required training and adequate supervision, providing a procedure for confidential reporting of data integrity issues, and periodically reviewing data, procedures, and documentation. The assignment of responsibilities, authorities, and interrelationships of the personnel who manage, perform, or verify work affecting the quality of environmental tests is documented in the ESS Laboratory Policy Manual (Job Descriptions) and in this section.

Management ensures that all sample acceptance criteria are verified and that samples are logged into the sample tracking system and properly labeled and stored.

Management is responsible for recording all analytical and operational activities of the laboratory and recording the quality of all data reported.

Management ensures that audit findings and corrective actions are completed within required time frames.

Designated deputies are appointed by management during the absence of the Laboratory Manager, Laboratory/Operations/Technical Manager or the Quality Manager, and always if the absence is more than 15 days.

5.2 Management Roles and Responsibilities

The following laboratory management staff members are considered key management personnel:

5.2.1 Laboratory Director

The Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the laboratory. The Laboratory Director provides the resources necessary to implement and maintain an effective quality and data integrity program.

5.2.1.1 Responsibilities

The Laboratory Director is responsible for:

a. Planning, directing and controlling the operation and development of the laboratory to meet financial and operational performance standards.

b. Building and leading a strong, cohesive management team that is continually focused on ESS Laboratory's key success factors in the areas of data quality, customer service, people management and financial discipline.

c. Ensuring that all operations are in compliance with the laboratory's quality assurance manual. Suspending any activities which do not meet the standards set forth in this quality manual.

d. Ensuring that personnel are free from any conflicts/undue pressures that might adversely affect the quality of their work.

e. Reviewing and approving all SOPs and policies prior to their implementation and ensuring all approved SOPs and policies are provided to laboratory personnel and are adhered to.

f. Ensuring that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits.

g. Continually improving the effectiveness of the management system.

5.2.2 Quality Manager

The Quality Manager (or Officer) is responsible for the oversight and review of quality control data, but is independent from laboratory operations, per the laboratory organizational chart (Appendix B). The Quality Manager's training and proof of experience in QA/QC procedures, knowledge of analytical methods, and the laboratory's management system are available in the employee's records, which are kept in the Quality Assurance Department.

5.2.2.1 Responsibilities

The Quality Manager is responsible for:

a. serving as a focal point for QA/QC;

b. arranging or conducting annual internal audits without outside (e.g., managerial) influence;

c. notifying management of deficiencies;

d. independent oversight and review of quality control data;

e. having knowledge of analytical methods for which data is reviewed.

f. monitoring corrective actions;

g. ensuring that the management system related to quality is implemented and followed at all times;

h. monitoring and maintaining laboratory certifications;

i. keeping this *Quality Manual* current by updating as needed;

j. has the authority and responsibility for ensuring all personnel understand their contribution to the quality system;

k. ensuring communication takes place at all levels within the laboratory regarding the effectiveness of the quality system;

l. evaluating the effectiveness of training;

m. ensuring that 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; and

n. using available tools, such as audit and surveillance results, control charts, proficiency testing results, data analysis, corrective and preventive actions, customer feedback, daily operations reports and management reviews in efforts to monitor trends and continually improve the quality system.

5.2.3 Laboratory/Operations Manager/Technical Manager

The Technical Manager (or designee) is a full-time laboratory staff member and supervises laboratory operations and data reporting. The Technical Manager's proof of experience in the fields of accreditation may be found in the pertinent training file which is maintained by the Quality Assurance Department.

If the Technical Manager is absent for fifteen (15) calendar days or more, a deputy (see Table 5-1 below) with appropriate qualifications will perform the Technical Manager's duties. Beyond a thirty-five (35) calendar day absence, management will notify the primary accreditation body in writing of the absence of the Technical Manager and the appointment of the deputy.

The Technical Manager is not the technical manager of more than one accredited environmental laboratory.

5.2.3.1 Responsibilities

The Technical Manager is responsible for:

a. meeting the general and education requirements and qualifications found in Sections 4.1.7.2 and 5.2.6.1 of the TNI Standard - EL-V1M2-2009 and in Massachusetts 310 CMR 42.00;

b. ongoing monitoring of timeliness of response to client needs, performance data, and the validity of the analyses for the laboratory;

c. managing operations in accordance with laboratory policies pertaining to hiring, training and individual performance review;

d. ensuring operations meet laboratory budgetary control procedures;

e. providing opportunities for training and cross training to ensure smooth operations and enhancement of employees growth; and

f. continually improving the effectiveness of the management system.

5.2.4 Departmental Technical Supervisors

5.2.5 Support System and Administrative Managers

5.2.5.1 Project (Customer Services) Managers

5.2.5.2 Administration Department Supervisor

5.2.5.3 Sample Receiving Department Supervisor

5.2.5.4 IT/LIMS Administrator

5.2.5.5 Purchasing Agent

5.2.4.6 Sales Executives

5.2.6 <u>Laboratory Key Personnel Deputies</u>

The following table defines who assumes the responsibilities of key personnel in their absence:

Table 5-1 Key Personnel Deputies		
Key Personnel	**Deputy(ies)**	**Comment**
Laboratory Director	Operations/Technical Manager	
QA Manager	Laboratory Director /QA Officer	
Operations/Technical Manager	Laboratory Director	
Departmental Supervisors	Operations/Technical Manager	
Supervisor, Project Management	Other Project Managers	
Admin Supervisor	Laboratory Director	
Purchasing Agent	Corporate Purchasing	
IT/LIMS Administrator	Laboratory Director	
Sample Receiving Supervisor	Operations Manager	
Logistics Manager	Project Manager(s)	
Sales Executives	Other Sales Executives	

5.3 Quality Policy

Management's commitment to quality and to the management system is stated in the Quality Policy below, which is upheld through the application of related policies and procedures described in the laboratory's *Quality Manual*, SOPs and policies.

Quality Assurance/Quality Control (QA/QC) in the laboratory is a company-wide function that depends upon cooperative working relationships and multi-level review. Responsibilities for QA/QC functions begin with the bench scientist and extend to the Laboratory Director. The primary level of quality assurance resides with the bench scientist who, after matriculation in the laboratory training program, is responsible for:

- Precisely following the analytical methods as documented in the Standard Operating Procedures (SOP).
- Good Laboratory Practices (GLP)
- Good Automated Laboratory Practices (GALP)
- Good documentation skills
- Carefully documenting each step in the appropriate format
- Conscientiously obtaining peer review as required
- Promptly alerting laboratory managers and/or QA staff members to problems or anomalies.

The supervisor of each laboratory department is responsible for the quality of the data generated by the scientists in that department. The laboratory implements and monitors the specific QC protocols and QA programs within the laboratory to ensure a continuous flow of high-quality data. The laboratory provides its scientists with up-to-date resources including space, equipment, instrumentation, and time in order to accomplish top-quality performance.

All laboratory personnel are responsible for assisting the Laboratory Director with the implementation and maintenance of their quality functions. These responsibilities may include monitoring QC practices, updating laboratory SOPs, and helping to manage analysis of Performance Evaluation samples.

Ultimately, the success of the QA program depends on the cooperation and support of the entire organization. ESS Laboratory's most valuable resource is its staff of dedicated professionals who take personal pride in the quality of their performance.

Management firmly believes that only by appropriately communicating the QA Plan to all employees, and ensuring that it is effectively implemented, can the needs of clients and regulatory bodies be met.

ESS Laboratory Quality Assurance Mission Statement

Our mission is to establish and implement a quality assurance program that provides our clients with data of known and documented quality in a timely manner.

From the moment an environmental sample arrives at the laboratory to the final reporting of reliable and accurate data, our quality assurance and quality control program is our key to continued success and, as company policy, is strictly enforced.

While the quality assurance manager directs and oversees all quality policies, we regard it as essential that employees at all levels of operation and management thoroughly understand the quality documentation and execute the program. The management of ESS Laboratory is committed to good professional practice, complying with all accreditation standards and improving the quality system and the effectiveness of the management system. Each ESS employee is individually responsible for realizing our commitment to quality and the achievement of our mission.

5.4 Ethics and Data Integrity System

The laboratory's Ethics and Data Integrity policy, program, training and investigations are discussed in Section 19 – "Data Integrity Investigations".

5.5 Documentation of Management/Quality System

The management system is defined through the policies and procedures provided in this *Quality Manual* and written laboratory Standard Operating Procedures (SOPs) and policies.

5.5.1 Quality Manual

The *Quality Manual* contains the following required items:

5.5.1.1 Document title;

5.5.1.2 Laboratory's full name and address;

5.5.1.3 Name, address (if different from above), and telephone number of individual(s) responsible for the laboratory;

5.5.1.4 Identification of all major organizational units which are to be covered by this quality manual and the effective date of the version;

5.5.1.5 Identification of the laboratory's approved signatories;

5.5.1.6 the signed and dated concurrence (with appropriate names and titles), of all responsible parties including the quality manager(s), technical manager(s), and the agent who is in charge of all laboratory activities, such as the laboratory director or laboratory manager;

5.5.1.7 The objectives of the management system and contain or reference the laboratory's policies and procedures;

5.5.1.8 The laboratory's official quality policy statement, which shall include management system objectives and management's commitment to ethical laboratory practices and to upholding the requirements of the referenced Standards; and

5.5.1.9 A table of contents, and applicable lists of references, glossaries and appendices.

This *Quality Manual* contains or references all required elements as defined by the TNI Standard - V1:M2, Section 4.2.8.4., and ISO/IEC 17025:2005(E), Clause 4.2.

5.5.2 <u>Standard Operating Procedures (SOPs)</u>

Standard operating procedures (SOPs) represent all phases of current laboratory operations including an effective date, revision number, and signature of the approving authorities, as designated in SOP 80_0012 (Document Control) and are available to all personnel. They contain sufficient detail such that suitably qualified personnel could perform the procedures. There are two types of SOPs used in the laboratory: 1) test method SOPs, which have specific requirements as outlined below, and 2) general use SOPs which document general procedures.

All technical SOPs (e.g., sample preparation, analytical procedures, sample storage, or sample receipt) shall be reviewed for accuracy and adequacy at least annually, and updated if necessary, and be readily accessible to all personnel. All such reviews shall be conducted by personnel having the pertinent background, are recorded, and made available for assessment.

Each accredited analyte or method has an SOP. Sometimes an SOP is a copy of a method, and any additions are clearly described. The laboratory's test method SOPs include the following topics, where applicable, per SOP 80_0012:

i. identification of the method;
ii. applicable matrix or matrices;
iii. limits of detection and quantitation;
iv. scope and application, including parameters to be analyzed;
v. summary of the method;
vi. definitions;
vii. interferences;
viii. safety;
ix. equipment and supplies;
x. reagents and standards;

xi. sample collection, preservation, shipment and storage;
xii. quality control;
xiii. calibration and standardization;
xiv. procedure;
xv. data analysis and calculations;
xvi. method performance;
xvii. pollution prevention;
xviii. data assessment and acceptance criteria for quality control measures;
xix. corrective actions for out-of-control data;
xx. contingencies for handling out-of-control or unacceptable data;
xxi. waste management;
xxii. references; and any tables, diagrams, flowcharts and validation data;
xxiii. data management and records;
xxiv. personnel qualifications;
xxv. equipment/instrument maintenance;
xxvi. computer hardware and software; and
xxvii. troubleshooting.

5.5.3 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows unless otherwise noted:

- Quality Manual
- SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Section 6

DOCUMENT CONTROL
(TNI V1:M2 – Section 4.3; ISO/IEC 17025/2005(E) - Clause 4.3

This Section describes how the laboratory establishes and maintains a process for document management. Procedures for document management include controlling, distributing, reviewing, and accepting modifications. The purpose of document management is to keep documents up to date and preclude the use of invalid and/or obsolete documents.

Documents can be SOPs, policy statements, standards, instruction manuals, specifications, calibration tables, charts, textbooks, posters, notices, memoranda, software, drawings, plans, etc. These may be on various media, whether hard copy or electronic, and they may be digital, analog, photographic or written.

The laboratory manages three types of documents: 1) controlled, 2) approved/uncontrolled, and 3) obsolete.

A controlled document is one that is uniquely identified, issued, tracked, and kept current as part of the management system. Controlled documents may be internal documents or external documents. Any documents providing instructions to laboratory personnel (e.g., operator aids) are considered part of the management system and are subject to document control procedures.

An approved document means it has been reviewed, and either signed and dated, or acknowledged in writing or by secure electronic means by the issuing authority(ies).

An uncontrolled document is watermarked with the ESS Logo and is watermarked "uncontrolled" at the top and bottom of the page.

Obsolete documents are documents that have been superseded by more recent versions or are no longer needed.

6.1 Controlled Documents

Documents will be reviewed, revised (as appropriate) and approved for use by authorized personnel in accordance with SOP 80_0012 (Document Control) and 80_0029 (Management of Procedure Documents), prior to issue.

Documents are reviewed (and revised, if necessary) at least annually to ensure their contents are suitable and in compliance with the current management systems requirements, and accurately describe current operations. Reviews (internal or external) of management system documentation shall be maintained and made available for assessment.

Approved hard copies of documents are available to staff at all locations where operations are essential to the effective functions of the laboratory; it is not laboratory policy to make SOPs available electronically.

Controlled internal documents are uniquely identified with 1) a unique name or number identification 2) date of issue, 3) revision identification, 4) page number, 5) the total number of pages (or a mark to indicate the end of the document), and 6) the signatures of the issuing authority (i.e. management) in accordance with SOPs 80_0012, 80_0016 and 80_0029. Documents are distributed by the Quality Assurance Manager in accordance with these SOPs.

A master list of controlled internal documents is maintained that includes location, and major revision number and dates. A master list of controlled external documents is also maintained that includes title, author, copyright date (where applicable), revision number or date of publication, and location. The controlled document list is maintained and kept in the QA Dept. files by the Quality Assurance Manager and is updated whenever revisions occur. Distribution lists of controlled documents are maintained by the Quality Assurance Manager. A list of active Standard Operating Procedures and major controlled internal documents is included as Appendix A.

6.1.1 Document Changes to Controlled Documents

Affected personnel are notified of changes to management systems documents and supporting procedures, including technical documents, in accordance with SOPs 80_0012, 80_0016 (Training) and 80_0029.

6.1.1.1 Paper Document Changes

Document changes are approved by the same function that performed the original review unless specifically designated otherwise.

The document management process allows for handwritten or minor modifications to documents. The date and approval is documented with the modifications and these changes are processed and tracked per SOP 80_0012.

All document modifications are approved. Changes that are not process modifications but clarifications may be performed without revision. Approval is required. The modified document is then copied and distributed, and obsolete documents are removed according to the master list of controlled documents.

Amendments/modifications to documents are incorporated into a new revision and reissued when the document is reviewed and updated on or before its scheduled review cycle.

A reason for the modification or change is provided as historical information in the revised document per SOP 80_0012.

6.1.1.2 Electronic Document Changes

Suggested revisions to electronic documents are presented to top management (Director, Operations and Quality) for review and approval. Changes to electronic documents are approved as outlined in SOP 80_0012.

Where practical, the altered text or new text in the draft is identified during the revision or review process to provide for easy identification of the modifications.

Procedures (Series 70 SOPs and 80_0040) have been established describing how changes in documents maintained in computerized systems are made and controlled.

6.2 Obsolete Documents

All invalid or obsolete documents are removed from general distribution, or otherwise prevented from unintended use.

Obsolete documents retained for legal use or historical knowledge preservation are appropriately marked and retained per SOP 80_0029. They are stamped "Archived" and initialed and dated by the QA Manager. Archived computer resident documents are kept on file in the QA Dept. for at least 10 years. Hardcopy documents may be retained, depending upon their nature.

Section 7

REVIEW OF REQUESTS, TENDERS AND CONTRACTS
(TNI V1:M2 – Section 4.4; ISO/IEC 17025/2005(E) - Clause 4.4)

The review of all new work assures that oversight is provided so that requirements are clearly defined, that the laboratory (lab) has adequate resources and capability and that the test method is applicable to the customer's needs. This process assures that all work will be given adequate attention without shortcuts that may compromise data quality.

NOTE: A request originates with a client who requires testing services; a tender is a proposal from the lab in response to the client's request, and a contract is the final agreement between lab and client.

Contracts for new work may be formal bids, signed documents, verbal, or electronic. The client's requirements, including the methods to be used, must be clearly defined, documented and understood. Requirements might include target analyte lists, project specific reporting limits (if any), project specific quality control requirements (if any), turnaround time, and requirements for data deliverables. The review must also cover any work that will be subcontracted by the laboratory.

7.1 Procedure for the Review of Work Requests

The Laboratory Director, Operations Manager, and Quality Manager determine if the laboratory has the necessary accreditations, resources, including schedule, equipment, deliverables, and personnel to meet the work request. The procedure is detailed in SOPs 80_0051 (Requests, Tenders & Contracts) and 80_0048 (Subcontracting).

Project Managers/Sales Representatives inform the client of the results of the review and if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to the complete the work satisfactorily.

The client is informed of any deviation from the contract including the test method or sample handling processes. All differences between the request and the final contract are resolved and recorded before any work begins. It is necessary that the contract be acceptable to both the laboratory and the client. Documentation of this process is described in SOP 80_0051.

The review process is repeated when there are amendments to the original contract by the client. The participating personnel are given copies of the amendments. The amendments are maintained per SOP 80_0051.

Note: For repetitive routine projects, the review might be made only at the initial inquiry stage, or on granting of a contract for on-going routine work performed under a general agreement with the client, provided the client's requirements don't change.

7.2 Documentation of Review

Records are maintained for every contract or work request, when appropriate. This includes pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. Documentation of this process is outlined in SOPs 80_0051 and 70_0004 (Work Order Management). Records of all project-related communication with the client (including e-mails, fax, telephone conversation etc.) are kept per SOPs 80_0051, 70_0004 and 70_0008 (Sample Log-in).

Section 8

SUBCONTRACTING OF ENVIRONMENTAL TESTS
(TNI V1:M2 – Section 4.5; ISO/IEC 17025/2005(E) - Clause 4.5

When ESS Laboratory subcontracts work, whether because of unforeseen reasons (e.g. workload, need for further expertise, or temporary incapacity) or on a continuing basis (e.g. through permanent subcontracting, agency or franchising arrangements), this work is placed with a competent subcontractor. A competent subcontractor is one that complies with the appropriate standard for the work in question.

A subcontract laboratory is defined as a laboratory external to this laboratory, or at a different location than the address indicated on the front cover of this manual, that performs analyses for this laboratory. This also includes a laboratory under the same corporate umbrella.

When subcontracting analytical services, the laboratory assures work requiring accreditation is placed with an appropriately accredited laboratory or one that meets applicable statutory and regulatory requirements for performing the tests.

8.1 Procedure

ESS Laboratory maintains a list of subcontractors.

A copy of any required certificate and certified analyte list(s) from subcontractors is maintained as evidence of compliance. This information is maintained by the Quality Assurance Dept. and is kept in a network directory folder.

The certificate and analyte list are checked by the project manager(s) in conjunction with the Quality Manager/Officer, as needed, to ensure the subcontracting laboratory has the appropriate accreditation to do the work.

ESS Laboratory notifies the client of the intent to subcontract the work, in writing, gaining the approval of the client to subcontract their work prior to implementation, preferably in writing. Any verbal instructions are documented.

The laboratory performing the subcontracted work is identified in the final report. The laboratory assumes responsibility to the client for the subcontractor's work, except in the case where a client or a regulating authority specified which subcontractor is to be used. Procedure is detailed in SOP 80_0048.

The Quality Manager/Officer reviews the certification and supporting documentation on file prior to initiation of any work. A listing of all approved subcontracting laboratories and supporting documentation is filed in a network directory. A letter or e-mail is sent to the subcontracting laboratory, which will be NELAC-Accredited, if required, requesting the following information;

1. A copy of the quality manual (optional)
2. A copy of necessary certifications, if not available on company website.

Section 9

PURCHASING SERVICES AND SUPPLIES
(TNI V1:M2 – Section 4.6; ISO/IEC 17025/2005(E) - Clause 4.6)

The laboratory ensures that purchased supplies and services that affect the quality of environmental tests are of the required or specified quality, by using approved suppliers and products.

The laboratory has procedures for purchasing, receiving, and storage of supplies that affect the quality of environmental tests.

9.1 Procedure

Management reviews and approves the supplier of services and supplies and approves technical content of purchasing documents prior to ordering, in accordance with SOPs 80_0020 (Vendor Qualification) and 70_0003 (Purchasing).

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products, the overall quality of their services, their past history and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, all purchases from specific vendors are approved by a member of the management staff (*standards and reagents must be of the appropriate analytical grade)*. No changes to brands or specifications is allowed without full review and approval by Management. Ongoing evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality, by signing packing slips or other supply receipt documents, after inspection. The purchasing documents contain the data that adequately describes the services and supplies ordered. The description may include type, class, grade, identification, specifications or other technical information.

The supplies received are inspected for breakage, leaks or any other damage. The supplies and chemicals are checked for description, vendor/source, quantity, receipt and expiration dates, concentration, lot/serial number certificate of analysis, calibration/verification records etc. per SOP 80_0013 (Supplies Review and Tracking). The supplies received are stored according to manufacturer's recommendations, laboratory SOPs or test method specifications.

Any documents received with the supplies and services, including specifications, certificates of analysis, warranties, maintenance records, calibration records etc., are kept on file, preferably electronically in the LIMS. Any such hard copy documents are filed by personnel in the department which ordered and received the supplies.

The purchased supplies and reagents that affect the quality of the tests are not used until they are inspected or otherwise verified as complying with requirements defined in the test method, in accordance with SOP 80_0013 and related departmental SOPs 20_0001, 30_0003, 40_0039, 50_0006 and 60_0001; however, see following note.

NOTE: EPA Method 8270D, Section 9.6.7 states "When new reagents or chemicals are received, the lab should monitor the blanks associated with samples for any signs of contamination. It is not necessary to test every new batch of reagents or chemicals *prior to sample preparation* if the source shows no prior problems."

This ruling may also be considered for application to other methods.

9.2 Approval of Suppliers

The Purchasing Agent maintains a list of approved suppliers. The list is also included in 80_0020 (Vendor Qualification), a copy of which is available to all departments.

Section 10

SERVICE TO THE CLIENT

(TNI V1:M2 – Section 4.7; ISO/IEC 17025/2005(E) - Clause 4.7)

The laboratory collaborates with clients and/or their representatives in clarifying their requests and in monitoring laboratory performance related to their work. Each request is reviewed to determine the nature of the request and the laboratory's ability to comply with the request within the confines of prevailing statutes and/or regulations, without risk to the confidentiality of other clients.

10.1 Client Confidentiality

The laboratory confidentiality policy is to not divulge or release any information to a third party without proper authorization. Third party requests for data and information are referred to the client. Data and records identified as proprietary, privileged, confidential, or affecting national security are exempt from disclosure.

All electronic data (storage or transmissions) are kept confidential, based on technology and laboratory limitations, as required by client or regulation. Confidential client data and correspondence are stored electronically in the laboratory information management system, user e-mail records, internal network directories and secure online websites, which are password-protected and may only be accessed by authorized employees or clients.

Procedures are outlined in various administrative SOPs (70_0004, 70_0005 and 70_0008).

10.2 Client Support

Communication with clients, or their representative(s), is maintained in a timely manner, to provide proper instruction and modification for testing. Technical staff is available to discuss any technical questions or concerns the client may have.

The client, or their representative, may be provided reasonable access to laboratory areas for witnessing testing or substantiating qualifications.

Delays or major deviations to the testing are communicated to the client immediately (preferably within one hour, or at latest by close of business that day), in writing or by telephone, by the project manager.

The laboratory will provide the client with all requested information pertaining to the analysis of their samples. An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

Value-added services include supplying data confidentially to clients as it is being generated, via the Element Data System *Client Connect* customer interface program.

The client will be notified by project management prior to changes in LIMS software or hardware configuration that will adversely affect customer electronic data.

10.3 Client Feedback

The laboratory seeks both negative and positive feedback following the completion of projects, and periodically for ongoing projects. Feedback provides acknowledgement, corrective actions where necessary, and opportunities for continuous improvement.

Negative customer feedback is documented as a customer concern (see Section 11 – "Complaints") in the ESS Incident Reporting system.

Feedback from clients is sought via a survey request on the ESS Laboratory website and by management/project managers/sales personnel during routine communications with clients, and is documented and circulated to staff members, normally by e-mail or verbally.

Section 11

COMPLAINTS

(TNI V1:M2 – Section 4.8; ISO/IEC 17025/2005(E) - Clause 4.8)

The purpose of this Section is to assure that customer complaints are addressed and corrected. This includes requests to verify results or analytical data. Complaints provide the laboratory an opportunity to improve laboratory operation and client satisfaction.

Complaints by customers or other parties are reviewed by management and an appropriate action is determined and implemented in a timely manner. All customer complaints are documented by the person receiving the complaint and addressed to the responsible manager.

If it is determined that the complaint has merit, the procedures outlined in Section 14 – Corrective Action are followed. If it is determined that a complaint is without merit, it is documented, and the client is contacted by project manager or sales executive.

A complaint, such as a concern that data is repeatedly late, should be reviewed for preventive action (see Section 15 – "Preventive Action") to minimize a future occurrence.

Section 12

CONTROL OF NON-CONFORMING ENVIRONMENTAL TESTING WORK
(TNI V1:M2 – Section 4.9; ISO/IEC 17025/2005(E) - Clause 4.9)

Non-conforming work is work that does not meet acceptance criteria or requirements. Non-conforming work can include departures from standard operating procedures or test methods or unacceptable quality control results (see Section 27 – "Quality Assurance for Environmental Testing"). Identification of non-conforming work can come through customer complaints, quality control, instrument calibration, evaluating consumable materials, staff observation, final report review, management reviews and internal and external audits.

12.1 Exceptionally Permitting Departures from Documented Policies and Procedures

Requests for departures from laboratory procedures are approved by top management and documented, and are only permitted after appropriate precision, accuracy and detection limit data have been generated and shown to satisfy client's criteria. The client must approve major modifications of any methods. Approved method variances are documented in the case narrative to the client. When SOPs representing different versions of the same method are available for use, the SOP title and method summary (which is found in the body of the SOP) describe the particular conditions of use for that method; such SOPs may only be used at client's direction or with client's approval, in writing.

Planned departures from procedures or policies do not require audits or investigations.

12.2 Non-Conforming Work

The lab policy for control of non-conforming work is to identify the nonconformance, determine if it will be permitted, and take timely and appropriate action commensurate with the risk to data quality. All employees have the authority to stop work on samples when any aspect of the process does not conform to laboratory requirements.

The responsibilities and authorities for the management of non-conforming work are detailed in SOP 80_0009 (Incident/Corrective Action). The procedure for investigating and taking appropriate corrective actions of non-conforming work are described in Section 14 – "Corrective Actions"*.* Section 14.3 describes procedures for Technical Corrective Actions. Formal corrective action procedures must be followed for non-conforming work that could reoccur (beyond expected random QC failures) or where there is doubt about the laboratory's compliance to its own policies and procedures.

The investigation and associated corrective action of non-conforming work involving alleged violations of the company's Ethics and Data Integrity policies must follow the procedures outlined in Section 19 – "Data Integrity Investigations"*.*

The laboratory evaluates the significance of the non-conforming work, and takes corrective action immediately. The customer is notified if their data has been impacted and work recalled, where necessary. The laboratory allows the release of non-conforming data only with approval by the Director or Operations Manager, on a case-by-case basis. Non-conforming data is clearly identified in the final report (see Section 28 – "Reporting the Results").

The discovery of a nonconformance for results that have already been reported to the customer must be immediately evaluated for significance of the nonconformance, its acceptability to the customer, and determination of the appropriate corrective action.

As stated above, the management of non-conforming work is detailed in SOP 80_0009 (Incident/ Corrective Action), which is a Quality Assurance Dept. SOP and copies of which are available to all departments; SOP 80_0009 is applicable to situations where non-conforming work could reoccur or where there is doubt that the laboratory is in compliance with its own policies and procedures. Corrective action for routine, non- recurring exceedances can be documented on raw data worksheets, logbooks, e-mail or other documents (e.g. temperature logs).

12.3 Stop Work Procedures

Halting work, or subsequent resumption of work, is authorized by top management, the LIMS administrator, departmental supervisors or analysts in accordance with SOP 80_0009 (Incident/Corrective Action) or pertinent SOPs.

Personnel will notify top management of any nonconformance, per SOP 80_0009 or pertinent SOPs. Management will review the significance of the nonconformance and develop a course of action. If data are questionable, client(s) will be notified, preferably within the hour, but definitely by close of business that day.

Should an investigation of a nonconformance indicate that its cause requires that use of method be limited until any necessary modifications are implemented, management will immediately notify affected personnel of the decision. The laboratory will hold relevant reports to clients pending the outcome of the review. The Quality Assurance Dept. will verify that the issue is resolved before work is allowed to resume; personnel will be notified by management accordingly. Management will document the incident, root cause and resolution using the corrective action procedures described in Section 14 – "Corrective Action".

The reporting of nonconformances involving alleged violations of the laboratory's Ethics and Data Integrity policies must be reported to the Quality Manager. Procedures described in Section 19– "Data Integrity Investigations" are followed.

Section 13

IMPROVEMENT

(TNI V1:M2 – Section 4.10; ISO/IEC 17025/2005(E) - Clause 4.10)

It is the policy of the laboratory to improve the overall effectiveness of the laboratory's management system and this is accomplished by the implementation of the various aspects of the management system: Quality policy and objectives (Section 5 – "Management"); internal auditing practices (Section 17 – "Internal Audits"); the review and analysis of data (Section 27 – "Quality Assurance for Environmental Testing"); the corrective action (Section 14 – "Corrective Action") and preventive action (Section 15 – "Preventive Action") processes; and the annual management review of the quality management system (Section 18 – "Management Reviews") where the various aspects of the management/quality system are summarized and evaluated, and plans for improvement are developed. Employees are encouraged to start discussions for improvements by initiating "Improvement Items" through the Incident Reporting system.

Section 14

CORRECTIVE ACTION
(TNI V1:M2 – Section 4.11; ISO/IEC 17025/2005(E) - Clause 4.11)

Corrective action is the action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation, in order to prevent recurrence.

Deficiencies cited in incident reports, external assessments, internal quality audits, data reviews, customer feedback/complaints, control of nonconforming work or managerial reviews are documented and require corrective action. Corrective actions taken are commensurate with the magnitude of the problem and the degree of risk. All actions are documented.

14.1 General Procedure

The laboratory uses a database software program to document and track corrective actions (incident reports) in accordance with SOP 80_0009 (Incident/Corrective Action). This program is used to generate audit/code reports, which help management plan and assign priorities to corrective actions.

Employees are responsible for initiating incident reports, related corrective action (and also suggesting preventive action – see Section 15) on routine data reviews/activities where a nonconformance is found that could reoccur (beyond expected random QC failures) or where there is doubt about the compliance of the laboratory with its own policies and procedures, in accordance with SOP 80_0009. The Quality Assurance Dept. is responsible for monitoring and recording closure of the corrective action, per this SOP.

All deficiencies are investigated and a corrective action plan is developed and implemented if determined necessary. The implementation is monitored for effectiveness.

14.1.1 Cause Analysis

When failures due to systematic errors have been identified, the first step of the corrective action process starts with the initial investigation and determination of root cause(s) of the problem. A root cause investigation, which is a major tool for continuous process improvement, begins and ends with the question "Why did this deficiency occur". When a reason can no longer be identified then there is reasonable assurance that the cause has been isolated. Records are maintained in the database of nonconformances requiring corrective action to show that the root cause(s) was investigated, and include the results of the investigation.

Where there may be non-systematic errors and as such the initial cause is readily identifiable, or there are expected random failures (e.g. failed quality control), a formal root cause analysis is not performed and the process begins with selection and implementation of corrective action (also see Section 14.3 "Technical Corrective Actions").

14.1.2 Selection and Implementation of Corrective Actions

Where uncertainty arises regarding the best approach for analysis of the cause of a nonconformance that require corrective action, appropriate personnel will recommend corrective actions that are commensurate with the magnitude and risk of the problem and that will most likely eliminate the problem and prevent recurrence.

Management ensures that corrective actions are discharged by assigned personnel within the agreed upon time frame. The Quality Assurance Manager provides the necessary oversight by tracking progress.

14.1.3 Monitoring of Corrective Action

The Quality Assurance Manager will monitor implementation and documentation of the corrective action to assure that the corrective actions were effective. The Quality Assurance Manager will publish periodic status reports to top management, project managers and affected departmental managers, as well as Quality Assurance Dept. personnel, per SOP 80_0009. Normal expectation is to complete non-critical corrective action within thirty days. Critical corrective action is to be completed as soon as possible.

14.1.4 Improvement Items

The database software program is also used to compile employees' ideas for improvement. These ideas are ones that would increase quality and/or productivity in the laboratory or administrative procedures. There is no current limit to the type of improvement item that can be added to the database.

14.2 Additional Audits

Where the identification of nonconformances or departures from normal lab procedures cast doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with the TNI or other regulatory Standards, the laboratory ensures that the appropriate areas of activity are audited in accordance with Section 17 – "Internal Audits" as soon as possible.

In many cases, the additional audits are follow-ups after the corrective action has been implemented to ensure it is effective. These are especially done when a serious issue or risk to the laboratory, or a repetitive nonconformance, have been identified.

14.3 Technical Corrective Action

Sample data associated with a failed quality control result are evaluated for the need to be reanalyzed or qualified. Unacceptable quality control results are documented, and if the evaluation requires cause analysis, the cause and solution are recorded (also see Section 12 – "Control of Nonconforming Environmental Testing Work").

Analysts routinely implement corrective actions for data with unacceptable QC measures. First level correction may include re-analysis without further assessment. If the test method SOP addresses the specific actions to take, they are followed. Otherwise, corrective actions start with assessment of the cause of the problem. Corrective actions shall be to a degree commensurate with the magnitude and the risk of the problem.

Corrective action for non-systematic errors, or expected random failures not subject to formal incident reporting, are documented in the comments section of respective logbooks, per SOP 80_0040. Corrective actions for any nonconformance that may reoccur (beyond expected random QC failures) or where there is concern that the laboratory is not in compliance with its own policies and procedures require that an incident report be completed (see Section 14.1).

Technical managers review incident reports and suggest improvements, alternative approaches and procedures, where needed.

If the data reported are affected adversely by the nonconformance, the affected data is clearly identified in the report and the customer is notified. If necessary, data will be recalled and a revised report meeting regulatory and client needs issued.

Section 15

PREVENTIVE ACTION
(TNI V1:M2 – Section 4.12; ISO/IEC 17025/2005(E) - Clause 4.12)

Preventive action is a proactive process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints.

Preventive action includes, but is not limited to: review of nonconformance (incident report) database entries; review of QC (control chart) data to identify quality trends; regularly scheduled (daily) staff meetings to ensure client needs are being met; review of client feedback to look for improvement opportunities; review of proficiency testing data to look for borderline issues; annual managerial reviews; and review of scheduled instrument maintenance.

When improvement opportunities are identified or if preventive action is required, action plans are developed, implemented and monitored to reduce the likelihood of the occurrence of nonconformities.

Procedures for preventive actions include the initiation of such actions and subsequent monitoring to ensure that they are effective. The implementation and record maintenance of preventive action activities is outlined in SOPs 80_0009 (Incident/Corrective Action) and 80_0035 (Internal Assessment).

All personnel have the authority to offer suggestions for improvements and to recommend preventive actions, however management is responsible for implementing preventive action.

Section 16

CONTROL OF RECORDS

(TNI V1:M2 – Section 4.13; ISO/IEC 17025/2005(E) - Clause 4.13)

"Records" include all documents, such as this QA Manual and SOPs, data recordings that include annotations, such as daily refrigerator temperatures posted to a laboratory form, lists, spreadsheets, and analyst notes on a chromatogram. Records may be on any form of media, including electronic (a/k/a computer-resident) and hard copy. Records allow for the historical reconstruction of laboratory activities related to sample-handling and analysis. The terms "documents" and "records" are considered to be analogous.

The laboratory maintains a record system appropriate to its needs, records all laboratory activities, and complies with applicable standards or regulations as required. Records of original observations and derived data are retained to establish an audit trail. Records help establish factors affecting the uncertainty of the test and enable test repeatability under conditions as close as possible to the original.

16.1 Records Maintained

Records of all procedures to which a sample is subjected while in the possession of the laboratory are kept. The laboratory retains all original observations, calculations and derived data (with sufficient information to produce an audit trail), calibration records, personnel records and a copy of the test report, for a minimum of ten years from generation of the last entry in the records. At a minimum, the following records are maintained by the laboratory to provide the information needed for historical reconstruction:

i) All raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' worksheets and data output records (chromatograms, strip charts, and other instrument response readout records);

ii) A written description or reference to the specific method(s) used, which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value (all pertinent Standard Operating Procedures);

iii) Laboratory sample ID code;

iv) Date of analysis;

v) Time of analysis is always required if the regulatory holding time is stated in hours, or when time critical steps are included in the analysis (e.g., extractions and incubations);

vi) Instrumentation identification and instrument operating conditions/parameters (or reference to such data);

vii) All manual calculations (including manual integrations);

viii) Analyst's or operator's initials/signature or electronic identification;

ix) Sample preparation, including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

x) Test results (including a copy of the final report);

xi) Standard and reagent origin, receipt, preparation, and use;

xii) Calibration criteria, frequency and acceptance criteria;

xiii) Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;

xiv) Quality control protocols and assessment;

xv) Electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries;

xvi) Method performance criteria including expected quality control requirements;

xvii) Proficiency test results;

xviii) Records of demonstration of capability for each analyst;

xix) A record of names, initials, and signatures for all individuals who are responsible for signing or initialing any laboratory record;

xx) Correspondence relating to laboratory activities for a specific project;

xxi) Corrective action reports;

xxii) Preventive action records;

xxiii) Copies of internal and external audits including audit responses;

xxiv) Copies of all current and historical laboratory SOPs, policies and *Quality Manuals*;

xxv) Sample receiving records (including information on any interlaboratory transfers);

xxvi) Sample storage records;

xxvii) Data review and verification records;

xxviii) Personnel qualification, experience and training records;

xxviv) Archive records; and

xxviv) Management reviews.

16.2 Records Management and Storage

The laboratory maintains a record management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage, and reporting, per SOPs 80_0040 (Logbooks), 70_0004 (Work Order Management), 70_0007 (Data Entry & Data Reporting) and 70_0008 (Sample Login). Hard copy data is recorded immediately and legibly in permanent ink while data generated by automated data collections systems are recorded electronically per SOP 80_0040 and various test SOPs. Hard copy corrections are initialed and dated with the reason noted for corrections other than transcription errors. A single line strikeout is used to make corrections so that the original record is not obliterated. In the case of electronic records, software audit tracking features provide an audit trail and notes may be added to electronic document fields, as required by SOP 80_0040 and various test SOPs.

All laboratory data is saved to computer systems which are networked to a Windows 2012 R2 server, which is the destination of all files. Daily backups to disk are done at 3:45 AM. Full backups are performed on Saturday and differential backups Sunday through Friday. 14 disk backups are kept on disk. Full disk backups are copied to tape on Sundays. The weekly tapes are kept for 4 weeks, the monthly tapes for 4 months, the quarterly tapes for 4 quarters, and the yearly tapes for 10 years.

Records, including electronic records, are easy to retrieve, legible, and protected from deterioration, computer viruses or damage; held secure and in confidence; and are available to accrediting bodies for a minimum of ten years or as required by regulation or contract. Records that are stored only on electronic media are supported by the hardware and software necessary for their retrieval. Access to protected records is limited to employees on a need to know basis, as determined by the Laboratory Director, to prevent unauthorized access or amendment. Access is password protected. Individual user names and passwords are required for all LIMS users.

Additional information regarding control of data is included in Section 22.5 – "Control of Data".

Procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records are found in the SOPs listed above and also in SOPs 80_0012 (Document Control) and 80_0029 (Management of Procedure Documents). Quality records shall include reports from internal audits and management reviews as well as records of corrective and preventive actions. Electronic storage is the primary medium for long-term storage of vital records.

Archived information are protected against fire, theft, loss, environmental deterioration, vermin, and in the case of electronic records, electronic or magnetic sources. Archived records have limited access and are kept in a secured and locked area. Electronic and hard copy records are archived onsite.

In the event that the laboratory transfers ownership or goes out of business, records are maintained or transferred according to client instructions. Appropriate regulatory and state legal requirements concerning laboratory records shall be followed.

16.3 Legal Chain of Custody Records

Evidentiary sample data are used as legal evidence. Procedures for evidentiary samples can be found in SOPs 10_0001, 10_0017 and the Sample Acceptance Policy.

A sample is in someone's custody if;

1. It is in one's actual physical possession;
2. It is in one's view, after being in one's physical possession;
3. It is in one's physical possession and then locked up so that no one can tamper with it;
4. It is kept in a secured area, restricted to authorized personnel only.

Section 17

AUDITS
(TNI V1:M2 – Section 4.14; ISO/IEC 17025/2005(E) - Clause 4.14)

Audits measure laboratory performance and verify compliance with the TNI, ISO 17025 and other regulatory Standards, and accreditation/ certification and project requirements. Audits specifically provide management with an on-going assessment of the management system. They are also instrumental in identifying areas where improvement in the management/quality system will increase the reliability of data. Audits are of four main types: internal, external, performance, and system. Section 17.5 discusses the handling of audit findings.

17.1 Internal Audits

Annually, the laboratory prepares a schedule of internal audits to be performed during the year. These audits verify compliance with the requirements of the management/quality system, including analytical methods, SOPs, the *Quality Manual*, ethics policies, data integrity, other laboratory policies, and the TNI/ISO 17025 Standards. Annual internal audits are carried out per SOP 80_0035.

It is the responsibility of the Quality Manager to plan and organize audits as required by the schedule and requested by management. These audits are carried out by trained and qualified personnel who are independent of the activity to be audited. The Laboratory Director shall determine the training and qualification requirements for audit personnel, including quality managers, and shall establish procedures to ensure that audit personnel have the necessary education or experience required for their assigned positions. These requirements and procedures must be recorded. Personnel conducting independent assessments shall have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the results of such assessments to laboratory management.

In addition to the scheduled internal audits, it may sometimes be necessary to conduct special audits as a follow-up to corrective actions, PT results, complaints, regulatory audits or alleged data integrity issues. These audits address specific issues.

The area audited, the audit findings, and corrective actions are recorded. Audits are reviewed after completion to assure that corrective actions were implemented and effective. If findings are observed that cast doubt on the validity of results, top management shall be informed immediately, the incident documented and timely corrective action implemented per Sections 12, 14 and 17.5, which includes notification of clients, when data is impacted.

17.2 External Audits

It is the laboratory's policy to cooperate and assist with all external audits, whether performed by clients or an accrediting body. Management ensures that all areas of the laboratory are accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit.

17.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, on-site auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified or redacted. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information.

17.3 Performance Audits

Performance audits may be Proficiency Test Samples, internal single-blind samples, double-blind samples through a provider or client, or anything that tests the performance of the analyst and method.

Proficiency Test Samples are discussed in Section 27 – "Quality Assurance for Environmental Testing".

17.4 System Audits

The Laboratory's management system is audited through Quality Dept. annual systems audits and annual management reviews. Refer to Section 18 – "Management Reviews" for further discussion of management reviews.

17.5 Handling Audit Findings

Internal or external audit findings are responded to within the time frame agreed to at the time of the audit. The response may include action plans that could not be completed within the response time frame. A completion date is established by management for each action item and included in the response.

Development and implementation of corrective actions to findings is the responsibility of the Quality Assurance Manager. Corrective actions are documented through the corrective action process described in Section 14 – "Corrective Actions".

Audit findings that cast doubt on the effectiveness of the laboratory operation to produce data of known and documented quality or that question the correctness or validity of sample results must be investigated. Corrective action procedures described in Section 14 – "Corrective Action" must be followed. Clients must be notified in writing if the investigation shows the laboratory results have been negatively affected and the client's requirements have not been met. The client must be notified by close of business on the day the laboratory discovers the issue. Laboratory management will ensure that this notification is carried out within the specified time frame.

All investigations that result in findings of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. See Section 19 (Data Integrity Investigation) for additional procedures for handling inappropriate activity.

Section 18

MANAGEMENT REVIEWS

(TNI V1:M2 – Section 4.15; ISO/IEC 17025/2005(E) - Clause 4.15)

Top management reviews the management system on an annual basis and maintains records of review findings and actions.

18.1 Management Review Topics

The following are reviewed to ensure their suitability and effectiveness:

- The 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;
- The results of interlaboratory comparisons or proficiency tests;
- Changes in the volume and type of the work;
- Customer feedback;
- Complaints;
- Recommendations for improvement;
- Other relevant factors, such as quality control activities, resources, and staff training.

18.2 Procedure

The procedure for management review is included in SOP 80_0035 (Internal Assessment).

Findings and follow-up actions from management reviews are recorded. Management will determine appropriate completion dates for action items and ensures they are completed within the agreed upon time frame.

Section 19

DATA INTEGRITY POLICY & DATA INTEGRITY INVESTIGATIONS
(TNI V1:M2 – Section 4.16; ISO/IEC 17025/2005(E) - Clause 4.16)

ESS Laboratory is committed to ensuring the integrity of its data and providing valid data of known and documented quality to its clients. Top management endorses its support for data integrity by implementing the specific requirements of the laboratory's data integrity program. The elements in ESS Laboratory's Ethics and Data Integrity program include:

- Documented data integrity procedures, signed and dated by top management,
- Documented data integrity training,
- An Ethics and Data Integrity Training Agreement signed by all management and staff, at the time of hire and annually thereafter following annual data integrity training. This Ethics Agreement includes a requirement that all suspected violations of the policy be reported to senior management.
- Procedures for confidential reporting of alleged data integrity issues, handling data integrity investigations and client notifications,
- An audit program that addresses in-depth, periodic monitoring of data integrity (see Section 17 – "Audits"). The Quality Assurance Manager has the responsibility of overseeing the Ethics and Data Integrity program.

19.1 Ethics and Data Integrity Procedures

The Ethics and Data Integrity Policy provides an overview of the program. Written procedures that are considered part of the Ethics and Data Integrity program include:

- Manual integration procedures (SOP 110_0016)
- Corrective action procedures (Section 14 of this QA Manual)
- Procedures for Data Integrity Investigations are detailed below
- Data recall procedures (Section 14 of this QA Manual)
- Data Integrity training procedures are detailed below and in SOP 80_0049

Management reviews data integrity procedures yearly and updates these procedures as needed. These procedures and the associated implementation records are properly maintained and made available for assessor review.

19.2 Training

Data integrity training is provided as a formal part of new employee orientation and a refresher is given annually for all employees; in the latter case, such training may be asynchronous* (see below). Employees are required to understand that any infractions of the laboratory data integrity procedures shall result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment or civil/criminal prosecution. This is discussed in the Ethics and Data Integrity Policy that every employee is required to sign at the time of hire. Attendance for required training is monitored through a signature attendance sheet demonstrating all staff have participated and understand their obligations related to data integrity.

An agenda is provided to each trainee prior to the training session. The following topics and activities are covered:

- The organizational mission and its relationship to the need for honesty and full disclosure in all analytical reporting;
- An ethics policy must be read and signed by all personnel;
- How and when to report data integrity issues;
- Recordkeeping;
- Analysts must record an explanation and sign off on all manual changes to data; and
- Where available in the instrument software, all electronic tracking and audit functions must be enabled.
- Discussion regarding all data integrity procedures;
- Data integrity training documentation;
- In-depth data monitoring;
- Data integrity procedure documentation;
- Improper data manipulations (detailed in SOP 80_0049);
- Adjustments of instrument time clocks;
- Inappropriate changes in concentrations of standards;
- The importance of proper written narration on the part of the analyst with respect to those cases where analytical data may be useful, but are in one sense or another partially deficient;
- Written ethics agreements;
- Examples of improper practices (detailed in SOP 80_0049);
- Examples of improper chromatographic manipulations (detailed in SOPs 80_0049 and 110_0016);

- Requirements for external ethics program training;
- Any external resources available to employees; and
- Consequences for data integrity infractions.

*Asynchronous online training tools enable communication and collaboration over a period of time through a "different time-different place" mode. These tools allow people to connect together at each person's own convenience and own schedule. Asynchronous tools are useful for sustaining dialogue and collaboration over a period of time and providing people with resources and information that are instantly accessible, day or night.

When contracted technical or support personnel are used, top management is responsible for ensuring that they are trained to the laboratory's management system and data integrity procedures, competent to perform the assigned tasks, and appropriately supervised.

Topics covered are provided in writing and provided to all trainees.

19.3 Confidential Reporting of Ethics and Data Integrity Issues

Confidential reporting of data integrity issues is assured as follows: A data integrity officer/advisor/ombudsman shall be appointed by senior management to determine the need for a detailed investigation when data integrity is in question. This will normally be the Quality Assurance Manager. The data integrity officer shall insure confidentiality and a receptive environment in which to privately discuss personal ethical dilemmas with staff or observed unethical practices by others. Confidential records of such discussions shall be kept by the data integrity advisor, who will keep top management informed of the need for any further detailed investigation.

19.4 Investigations

All investigations resulting from data integrity issues are conducted confidentially. They are documented and notifications are made to clients who received any negatively affected data that did not meet the client's data quality requirements. Procedures for investigation are included in SOP 80_0049.

Section 20

PERSONNEL

(TNI V1:M2–Section 5.2; ISO/IEC 17025/2005(E)-Clause 5.2)

ESS Laboratory employs competent personnel based on education, training, experience and demonstrated skills, as required. The laboratory's organization chart can be found in Appendix B.

20.1 Overview

All personnel are responsible for complying with all quality and data integrity policies and procedures that are relevant to their area of responsibility.

All personnel who are involved in activities related to sample analysis, evaluation of results or who sign test reports, must demonstrate competence in their area of responsibility. Appropriate supervision is given to any personnel in training and the trainer is accountable for the quality of the trainee's work. Personnel are qualified to perform the tasks for which they are responsible based on education, training, experience and demonstrated skills as required for their area of responsibility.

The laboratory management provides goals with respect to education, training and skills of laboratory staff. These goals are outlined in the ESS Policy Manual (Job Descriptions) and SOP 80_0016 (Training). Training needs are identified at the time of employment and when personnel are moved to a new position, or new responsibilities are added to their job responsibilities; appropriate training is provided. Ongoing training, as needed, is also provided to personnel in their current jobs. The effectiveness of the training must be evaluated before the training is considered complete.

Contracted personnel, when used, must meet the same competency standards and follow the same policies and procedures that laboratory employees must meet.

20.2 Job Descriptions

Job descriptions are available for all positions that manage, perform, or verify work affecting data quality, and are located in the ESS Laboratory Policy Manual (Job Descriptions). An overview of top management's responsibilities is included in Section 5 – "Management".

Job descriptions include the specific tasks, minimum education and qualifications, skills, and experience required for each position.

20.3 Training

All personnel are appropriately trained and are competent in their assigned tasks before they contribute to functions that can affect data quality. It is management's responsibility to assure personnel are trained in accordance with SOP 80_0016 (Training). Training records are used to document management's approval of personnel competency. The date on which authorization and/or competence is confirmed is included.

Training records are maintained by the Quality Assurance Manager and include safety training certificates. The latter are also kept track of in an online database by the corporate safety manager.

20.3.1 Training for New Staff

New staff members are given the following training, per SOP 80_0016 (Training Process):

Orientation (General Policies, Ethics and Data Integrity Agreement, Good Documentation and SOP/QA Manual training plan checklist), Initial Demonstrations of Capability, specialized training and formal safety training.

All new staff members are given introductory training and orientation upon arrival. The training is documented on training forms that outline what was covered during the training. The new employee also receives Data Integrity training and must sign-off on the Ethics and Data Integrity Policy.

The initial training for a new task contains the following steps:

- All documentation involved with a new and unfamiliar task is read and understood by the trainee.
- Training is under the direct supervision of a qualified senior analyst. During the time the trainee is in training, he/she may sign laboratory notebooks, logbooks, worksheets, etc., but they must be co-signed by the trainer, who is responsible for the data generated.
- The trainee demonstrates competency in the new task before they can operate independently. The competency for a test method is accomplished by a demonstration of capability as defined in Section 22 – "Environmental Methods and Method Validation". Approval of competency is noted by the date and initials or signature of the Technical Manager and Quality Assurance Manager on a training form.
- Each step of the training process is documented.
- The documentation is maintained in the employees training record.

Part-time, temporary, contracted and administrative personnel are trained, at a minimum, in the basic quality assurance and health and safety programs.

20.3.2 Ongoing Training

Staff members are given the following ongoing training:

- Annual Data Integrity per SOP 80_0049
- Annual QA Manual - current revision
- Annual Continuing Demonstration of Capability per Appendix F.2 of this manual and SOP 80_0016
- Annual Safety (Corporate, online)
- Any pertinent specialized training

Section 21

ACCOMODATIONS AND ENVIRONMENTAL CONDITIONS
(TNI V1:M2 – Section 5.3)

21.1 Environmental

The laboratory facility is designed and organized to facilitate correct testing of environmental samples. Environmental conditions are monitored to ensure that conditions do not invalidate results or adversely affect the required quality of any measurement. Such environmental conditions include lighting, energy sources, humidity, voltage, temperature, atmospheric cross-contaminants (via storage blanks) and vibration levels which could affect balance operation.

If the laboratory environment is required to be controlled by a method or regulation, the adherence is recorded. An example would be the recording of temperature during TCLP extraction.

Environmental tests are stopped when the environmental conditions jeopardize the results.

When conducting external sampling procedures, any mobile equipment such as pH meters or ISCO samplers are only operated under the environmental conditions for which they were designed and in accordance with pertinent SOPs.

21.2 Work Areas

Work areas may include access and entryways to the laboratory, sample receipt area, sample storage area, sample process area, instrumental analysis area, chemicals, gas cylinders and waste storage area, and data handling and storage area.

Access to, and use of, areas affecting the quality of the environmental tests is controlled by restriction of areas to authorized personnel only. See Section 21.4 below.

The laboratory work spaces are adequate for their use, and appropriately clean to support environmental testing and ensure an unencumbered work area.

Laboratory space is arranged to minimize cross-contamination between incompatible areas of the laboratory. Prep labs are isolated from instrumental labs; samples suspected of containing high concentrations of volatile analytes shall be isolated from other samples. Refrigerator storage and trip blanks shall be used to determine if cross-contamination may have occurred.   Laboratory temperature/humidity/ ventilation are controlled via separate, dedicated HVAC units.

Testing occurs only within dedicated laboratory departments. Laboratory space is maintained and monitored to the specifications required for laboratory space and the testing performed. Electronic balances are located away from drafts and doorways and mounted on a marble slab in areas where their use is affected by vibrations. Neighboring test areas of incompatible activities are effectively separated. Specific work areas are defined and access is controlled. (Only authorized laboratory personnel and escorted signed-in visitors may enter the work area.)

Good housekeeping measures are employed to avoid the possibility of contamination. The laboratory procedure for good housekeeping includes such measures as:

- Janitorial service (internal) is in operation.
- Each employee is responsible for keeping their work area clean and tidy.
- A kitchen area, isolated from the testing labs, is the only place where eating/drinking is allowed.
- Smoking is prohibited in the laboratory. Employees are not allowed to wear cologne, perfumes or other personal care products that might contaminate the samples for volatile organics. Live plants and animals are prohibited in the laboratory area.

21.3 Building Security

The laboratory is a secure (locked) facility, accessible to authorized personnel only and is kept secure during off hours with an alarm system.

A visitor's logbook is maintained for every visitor to sign in and out. Visitors must be accompanied by laboratory personnel when in secure areas.

Signs are used to designate secure areas.

Security procedure is described in SOP 110_0015 (Lab Security).

Section 22

ENVIRONMENTAL METHODS AND METHOD VALIDATION
(TNI V1:M2 – Section 5.4; TNI V1:M4 - Sections 1.4, 1.5 and 1.6; and ISO/IEC 17025/2005(E)-Clause 5.4)

Methods and/or procedures are available and are used for all activities associated with the sampling, handling, transport, storage and analysis of the sample including preparation and testing. For purposes of this Section, "method" refers to both the sample preparation and determinative methods. A master list of analytical methods is located in Appendix C.

Before being put into use, a test method is confirmed by a demonstration of capability or method validation process.

All methods are published or documented. Deviations from the methods are allowed only if the deviation is documented, technically justified, authorized by management and accepted by the customer

22.1 Method Selection

A reference method is a method issued by an organization generally recognized as competent to do so (when ISO refers to a standard method, that term is equivalent to reference method). When a laboratory is required to analyze a parameter by a specified method due to a regulatory requirement, the parameter/method combination is recognized as a reference method.

The laboratory will use methods that meet the needs of the customer. Such methods will be based on the latest edition of the method unless it does not meet the needs of the customer.

The laboratory selects methods that are appropriate to the customer needs. When the regulatory authority mandates or promulgates methods for a specific purpose, only those methods will be used.

If a method proposed by a customer is considered to be inappropriate or out-of-date, the customer is informed and the issue resolved before proceeding with analysis of any samples (see Section 7 – Review of Requests, Tenders and Contracts).

If a method is not specified by the customer or is inappropriate, a method appropriate to the end use of the data will be selected using the process outlined below.

- If the data are to be submitted to a regulatory authority, the method(s) specified by the regulatory authority will be used.

- For drinking water compliance a method will be selected from those specified in 40 CFR Part 141, or the applicable state regulations.
- For NPDES permits, the method will be selected from those specified in 40 CFR Part 136.
- If the end use of the data is not regulatory or if the regulatory authority does not specify a method, the laboratory will determine the customer needs in terms of reporting level (e.g., LOD, LLOQ), bias (e.g., screening versus quantitative) and the laboratory capabilities and capacity. Based on these criteria, the laboratory will select an appropriate method based on the following hierarchy:
    - Resources published in regional, national or international standards;
    - Methods published by other technical organizations such as ASTM, Standard Methods, NIOSH or AOAC;
    - Methods develop by the instrument manufacturer; or
    - Laboratory–developed methods.

The customer will be informed of the selected method and must approve its use before being used to report data.

All communications between the laboratory and the customer are documented.

22.2 Non-Standard and Laboratory-Developed Methods

If the laboratory develops a method, the process of designing and validating the method is carefully planned and documented. All personnel involved in the method design, development and implementation will be in constant communication during all stages of development.

The procedure for methods development and validation is outlined below and in SOP 80_0024.

22.3 Method Validation

Validation is the confirmation, by examination and objective evidence, that the particular requirements for a specific intended use are fulfilled.

At a minimum, reference methods are validated by performing an initial demonstration of capability. Additional requirements are discussed for each technology.

All methods that are not reference methods are validated before use. The validation is designed so that the laboratory can demonstrate that the method is appropriate for its intended use. All records (e.g., planning, method procedure, raw data and data analysis) shall be retained while the method is in use. Based on the validation process, the laboratory will make a statement of the intended use requirements and whether or not the validated method meets the use requirements, in a specific Process Validation Protocol form per SOP 80_0024. The form will be filed in the QA Dept.

Method validation and Demonstration of Capability procedures can be found in:

- Appendix F.1 – Chemistry
- Appendix F.2 – Demonstration of Capability

22.4 Estimation of Analytical Uncertainty

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.

When requested, the laboratory will provide an estimate of the analytical uncertainty, using quality control measurement data, as determined by SOP 110_0014:

a) The exact nature of some test methods may preclude rigorous, statistically valid estimation of analytical uncertainty. In these cases the laboratory shall attempt to identify all components of analytical uncertainty and make a reasonable estimation, and shall ensure that the form of data reporting does not give a wrong impression of the uncertainty. A reasonable estimation shall be based on knowledge of method performance and previous experience. When estimating the analytical uncertainty, all uncertainty components which are of importance in the given situation shall be taken into account.

b) In those cases where a well-recognized test method specifies limits to the values of the major source of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory is considered to have satisfied the requirements on analytical uncertainty by following the test method and reporting instructions.

c) The laboratory is only responsible for estimating the portion of measurement uncertainty that is under its control. Test reports shall include a statement of the estimated analytical uncertainty only when required by the customer. If a project requires analytical uncertainty to be reported, the laboratory shall report the estimated uncertainty based on project-specific procedures or, if not available, any other scientifically valid procedures.

The estimated analytical uncertainty can be expressed as a range (±) around the reported analytical results at a specified confidence level. A laboratory may report the in-house, statistically-derived Laboratory Control Sample (LCS) control limits based on historical LCS recovery data as an estimate of the minimum laboratory contribution to analytical uncertainty at a 99% confidence level. For testing laboratories, the laboratory shall ensure that the equipment used can provide the analytical portion of measurement uncertainty needed by the customer.

22.5 Control of Data

To ensure that data are protected from inadvertent changes or unintentional destruction, the laboratory establishes and uses procedures to check calculations and data transfers (both manual and automated).

22.5.1 Computer and Electronic Data Requirements

The laboratory assures that computers, user-developed computer software, automated equipment, or microprocessors used for the acquisition, processing, recording, reporting, storage, or retrieval of environmental test data are:

- Documented in sufficient detail and validated as being adequate for use;
- Protected for integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;
- Maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of environmental test data; and
- Held secure including the prevention of unauthorized access to, and the unauthorized amendment of, computer records. Data archive security is addressed in Section 16 – "Control of Records" and building security is addressed in Section 21- "Accommodations and Environmental Conditions".

The Laboratory Director controls access to all programs that are used to acquire, process, record or report data. All programs have limited access and capabilities. All programs are password-protected or are protected by electronic ID. Each employee is granted access only to those programs that he or she uses, depending on his/her responsibilities and job description. Each employee is provided with an ID with electronic information unique to that individual. The ID must be read by the card reader before any employee can input bar-coding data. Passwords are unique to the individual, and cannot be shared. A programmer is given access to change the underlying code, but may not access or modify any data entry. A reviewer may review the data input, and may change entries only when a second reviewer concurs with the modification. Analysts input data, and have an opportunity to check data entries before permanently saving them. After the data has been saved, modifications may be made only with the authorization of the supervisor. Validators may only review data and assign any validation codes necessary to help interpret the data. Once the data have been reviewed, the technical manager authorizes the data for release to the client. The technical manager may not change data, but may alert the applicable supervisor and analyst of any errors.

The laboratory uses spreadsheets to calculate final results from the raw data, per the test methods. Before reporting any results derived from these programs, the laboratory validates the underlying calculations per SOP 80_0047 (Computer Review & Validation).

After the spreadsheet is validated, the calculations are protected from inadvertent manipulations by access limitation, as described above. If any changes are made to the spreadsheet program, the laboratory revalidates the entire system before reporting results.

Data from all electronic media are backed up and backed up copies are stored as described in Section 16, to ensure that data are not lost.

22.5.2 <u>Data Reduction</u>

The analyst calculates final results from raw data, or appropriate computer programs provide the results in a reportable format. The test methods provide required concentration units, calculation formulas and any other information required to obtain final analytical results. As a part of the management system, the laboratory ensures that all manual calculations are checked by another individual (when possible) at a rate of one per project of all calculations. In addition all data transfers (data entry, transcribing raw or calculated data, etc.) will be similarly spot-checked for checked for accuracy. If checked values are found to be incorrect, the laboratory will recheck all entries. In addition, if the errors are attributed to one individual, 100% of the work done by the individual will be checked until the work is error-free.

The laboratory has a manual integration procedure, SOP 110_0016 (Manual Integration Policy & Procedure) that must be followed when integrating peaks during data reduction. This SOP is available to analysts in all departments where manual integration may be necessary.

The laboratory will report numerical data to three significant figures unless required to do otherwise by regulations.

All raw data must be retained electronically and it is maintained as described in Section 16 – "Control of Records".

22.5.3 <u>Data Review Procedures</u>

Data review procedures are located in Section 27.4 – "Data Review".

Section 23

CALIBRATION REQUIREMENTS
(TNI V1:M2 – Section 5.5; TNI V1:M4 - Section 1.7; ISO/IEC 17025/2005(E) - Clause 5.5)

23.1 General Equipment Requirements

The laboratory provides all the necessary equipment required for the correct performance of the scope of environmental testing performed by the laboratory.

All equipment and software used for testing and sampling are capable of achieving the accuracy required for complying with the specifications of the environmental test methods as specified in the laboratory SOPs.

Equipment is operated only by authorized and trained personnel (see Section 20 – "Personnel").

The laboratory has procedures for the use, maintenance, handling, transportation and storage of equipment and they are readily available to laboratory personnel. Manuals provided by the manufacturer of the equipment provide information on use, maintenance, handling and storage of the equipment. The laboratory maintains an inventory of equipment that includes additional information on storage location. Table 23-5 (below) summarizes planned equipment maintenance. These procedures ensure proper functioning of the equipment and prevent contamination or deterioration.

All equipment is calibrated or verified before being placed in use to ensure that laboratory specifications and relevant standard specifications are met, per SOP 110_0018 (Balance Calibration), 110_0005 (Volumetric Ware Calibration) and 110_0010 (Thermometer Calibration). Completed forms and related raw data are kept in the laboratory department electronic files, except for SOP 110_0010 which is maintained in the QA Department files.

Test equipment, including hardware and software, are safeguarded from adjustments that would invalidate the test result measurements by limiting access to the equipment (see Section 21-3 – "Building Security") and using password protection where possible (see Section 22-5 – "Control of Data").

Equipment that has been subject to overloading, mishandling, that has given suspect results, or shown to be defective or outside specifications is taken out of service. The equipment is isolated to prevent its use or clearly labeled as being out of service until it has been shown to function properly. If it is shown that previous tests are affected, then procedures for nonconforming work are followed and results are documented (see Section 12 – "Control of Nonconforming Environmental Testing Work" and Section 14 – "Corrective Action").

Should equipment be needed for a test that is outside of permanent control of the laboratory, the lab ensures the equipment meets the requirements of this manual by inspecting or otherwise testing prior to use.

When using external calibration services, traceability of measurement shall be assured by the use of calibration services from laboratories that can demonstrate competence, measurement capability and traceability. The calibration certificates issued by these laboratories shall contain:

1. The measurement results, including the conditions (e.g. Environmental) under which the calibrations were made that have an influence on the measurement results;

2. The measurement uncertainty and/or a statement of compliance with an identified metrological specification (when a statement of compliance with a specification is made omitting the measurement results and associated uncertainties, the laboratory shall record those results and maintain them for possible future reference);

3. When an instrument for calibration has been adjusted or repaired, the calibration results before and after adjustment or repair, if available, shall be reported;

4. A calibration certificate (or calibration label) shall not contain any recommendation on the calibration interval except where this has been agreed with the customer;

5. The calibration certificate shall relate only to quantities and the results of functional tests. If a statement of compliance with a specification is made, this shall identify which clauses of the specification are met or not met; this requirement may be superseded by legal regulations;

6. When opinions and interpretations are included, the laboratory shall document the basis upon which the opinions and interpretations have been made. Opinions and interpretations shall be clearly marked as such in a test report;

7. When a calibration has been subcontracted, the laboratory performing the work shall issue the calibration certificate to the contracting laboratory.

Each item of equipment and software used for testing and significant to the results is uniquely identified. Records of equipment and software are maintained in the ESS Inventory (a limited access computer database), equipment validation records, and maintenance records as well as various testing SOPs. This information includes the following:

a) identity of the equipment and its software;

b) manufacturer’s name, type identification, serial number or other unique identifier;

c) checks that equipment complies with specifications of applicable tests;

d) current location;

e) methods performed on the specific instrument;

f) manufacturer’s instructions, if available, or a reference to their location;

g) dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration;

h) maintenance plan where appropriate, and maintenance carried out to date; documentation on all routine and non-routine maintenance activities and reference material verifications;

i) any damage, malfunction, modification or repair to the equipment;

j) date received and placed into service

k) condition when received (new, used, reconditioned)

l) operational status

23.2 Support Equipment

Support Equipment includes, but is not limited to: balances, weights, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, volumetric/non-volumetric dispensing devices, water purification system, radiation monitors and thermal/pressure sample preparation devices.

All support equipment is maintained in proper working order. Electronic or hard copy records are kept for all repair and maintenance activities, including service calls, per SOP 40_0040 (Logbook Use and Control).

All raw data records are retained to document equipment performance. These records include logbooks, data sheets, or equipment computer files.

Regular maintenance of support equipment, such as balances and fume hoods is conducted at least annually. Fume hood air flow is checked at least monthly.

Maintenance on other support equipment, such as ovens, refrigerators, and thermometers is conducted on an "as needed" basis.

Records of maintenance to support equipment are documented in Instrument Maintenance Logs. Each piece of support equipment does not necessarily have its *own* logbook but is documented. Maintenance logbooks may be shared with equipment that is housed in the same laboratory area. See also Tables 23-2 below.

Table 23-2 Summary of Support Equipment Calibration And Maintenance

Instrument	Activity	Frequency	Documentation
Balance	1. Clean (check before use) 2. Check alignment 3. Service Contract	1. After use 2. Before use 3. Annually	Worksheet/log book Post annual service date on balance
ASTM Class 1 Weights	1. Only use for the intended purpose 2. Use plastic forceps to handle 3. Keep in case	Re-calibrate every 5 years	Certificate of Calibration from ISO/IEC 17025 accredited calibration laboratory

Table 23-2 Summary of Support Equipment Calibration And Maintenance

Instrument	Activity	Frequency	Documentation
	4. Re-calibrate		
NIST Traceable Thermometer	Accuracy determined by established calibration laboratory using NIST traceable equipment and procedures	At purchase and then annually	Certificate of Calibration
Thermometers: 1. Glass and electronic 2. Dial thermometers 3. IR thermometer	Check at the temperature used, against a reference NIST certified thermometer	1. Annually for glass 2. Quarterly for electronic and IR thermometers	ID, Calibration factor and date of calibration on worksheet/log book Thermometer stickered with initials/ date of calibration
pH electrometers	Calibration: 1. pH buffer aliquots are used only once 2. Buffers used for calibration will bracket the pH of the media, reagent, or sample tested	Before use	Log book
pH probe	Maintenance: Per manufacturer's recommendations	As needed	Log book
Photometer	1. Keep cells clean 2. Service contract, Check wavelength settings with color standards	Annually	Certificate of Calibration Post service date on instrument
Automatic or digital type pipettes	Calibrate for accuracy and precision per SOP 110_0005	Weekly (or daily, if convenient)	Log book
Refrigerators, Freezers, and BOD incubator.	1. Thermometers are immersed in liquid. 2. The thermometers are graduated in increments of 1°C or less	Temperatures are recorded twice each day in use Digital Min/Max temp record for weekend/holidays	Worksheet/log book Refrigerators: 0°C to 6°C Freezers: ≤-10°C
DO electrometer	Calibrate as specified in SOP	Before use	Log book
DO probe	Maintenance as specified by manufacturer	As needed	Log book
Conductivity Meter	Maintenance as specified by manufacturer	When more than 5% drift	Log book

The water purification system and radiation monitoring devices are checked daily prior to use, per SOPs 110_0003 (Water System Testing) and 10_0010 (Radiation Monitor Operation).

23.2.2 Support Equipment Calibration

All support equipment (except for weights) is calibrated or verified at least annually over the entire range of use using NIST traceable references where available. The results obtained from the calibration of support equipment needs to meet requirements found in Tables 23-3, or (1) the equipment is removed from service until repaired, or (2) records are maintained of correction factors to correct all measurements. If correction factors are used this information is clearly marked on or near the equipment.

Support equipment such as balances, ovens, refrigerators, freezers, and water baths are verified with a NIST traceable reference, if available, each day prior to use, to ensure operation is within the expected range for the application for which the equipment is to be used.

Volumetric dispensing devices are checked for accuracy per SOP 110_0005 (Volumetric Ware Calibration) to meet TNI & ISO 17025 Standards criteria. See also Table 23-3 below.

Table 23-3 Calibration Verification Acceptance Criteria for Support Equipment

Equipment	Type of Calibration/ Number of Standards	Frequency	Acceptance Limits	Corrective Action
Balances	Accuracy determined using A2LA-accredited NIST weights, which are verified every 5 years. Minimum of 2 weights bracketing the range of interest. Inspected and adjusted annually by a qualified service person.	Daily accuracy verification, prior to use Annual service	± 0.2% (TNI) Top-loading balance: ±2% or ±0.02g, whichever is greater Analytical balance: ±0.1% or ±0.5 mg, whichever is greater.	Clean, check level, insure lack of drafts, and that unit is warmed up, recheck. If fails, call service
Thermometer	Against NIST-traceable thermometer [Using a thermometer traceable to the SI through an NMI] [Performed at two temperatures that bracket the target temperatures when the spread exceeds 10°. Assume linearity between the two bracketing temperatures] [If only a single temperature is used, perform at the temperature of use]	Liquid in glass: Before first use and annually	± 1.2°C	Apply correction factors or replace thermometer
Minimum-Maximum Thermometers	Against NIST-traceable thermometer [if only a single temperature is used, at the temperature of use]	Electronic: Before first use and quarterly	± 2.0°C	Apply correction factors or replace thermometer
Infrared Temperature Guns	Against NIST-traceable thermometer [if only a single temperature is used, at the temperature of use]	Quarterly at appropriate temperature range for intended use	± 1.5°C	Repair/replace

Table 23-3 Calibration Verification Acceptance Criteria for Support Equipment

Equipment	Type of Calibration/ Number of Standards	Frequency	Acceptance Limits	Corrective Action
Volumetric Dispensing Devices (Eppendorf ® pipette, automatic dilutor or dispensing devices)	One delivery by weight. Using DI water, dispense into tared vessel. Record weight with device ID number.	Weekly (or daily, if needed for convenience)	± 1% Per SOP 110_0005	Adjust/ Replace
Volumetric labware	Per SOP 110_0005	Class B: By lot before first use. Class A and B: Upon evidence of deterioration	Bias: Mean within ± 2% of nominal volume Precision: RSD ≤1% of nominal volume (based on 10 replicate measurements)	Replace
Non-volumetric labware [Applicable only when used for measuring initial sample volume and final extract/ digestates volume]	Per SOP 110_0005	By lot before first use or upon evidence of deterioration	Bias: Mean within ±3% of nominal volume Precision: RSD ≤3% of nominal volume (based on 10 replicate measurements)	Replace
Glass microliter syringe	Per SOP 110_0005	Upon receipt and upon evidence of deterioration	General Certificate of Bias & Precision upon receipt	Replace if deterioration is evident
Drying oven temperature check		Daily prior to and after use	Within ±5% of set temperature	Adjust

23.3 Analytical Equipment

23.3.1 Maintenance for Analytical Equipment

All equipment is properly maintained, inspected, and cleaned.

Maintenance of analytical instruments and other equipment may include regularly scheduled preventive maintenance or maintenance on an as-needed basis. See

Table 23-5 below. Instrument malfunction is documented in Maintenance logs, which become part of the laboratory's permanent records. A description of what was done to repair the malfunction and proof of return to control are also documented in the log. If repair was done by an outside source, invoice record is filed and reference to it made in the maintenance log; indicate proof of return to control by recording that a QC sample met criteria. Instruments and related maintenance procedures (which may be routine) are documented per the test SOPs.

Table 23-5 Analytical Equipment Maintenance

Instrument	Procedure	Frequency
AA (Graphite Furnace)	Clean lens and furnace head Replace windows Clean atomizer cell/furnace hood Nebulizer cleaned/dried Clean filters Change graphite tube/platform Empty waste container Check sample introduction probe	Daily As required Daily Weekly or as required Weekly As required Daily Daily
Mercury Analyzer	Check tubing for wear Fill rinse tank with 3% HCl Fill reductant bottle with Stannous Chloride	Daily Daily Daily
ICP	Check pump tubing Check liquid argon supply Check fluid level in waste container Check filters Clean or replace filters Check torch Check sample spray chamber for debris Clean and align nebulizer Replace pump tubing	Daily Daily Daily Weekly As required Daily As required As required Daily
ICPMS1	Replace tubing TUNE Clean cones	Daily Daily As required
ICPMS2	Replace tubing Check torch alignment TUNE Clean cones	Daily Daily Daily As required
UV-Vis Spectrophotometer	Clean ambient flow cell Precision check/alignment of flow cell Wavelength verification check	As required As required Annually (daily auto-check)
Auto Analyzers	Clean sampler Check all tubing Oil rollers/chains/side rails Clean optics and cells	As required As required As required As required

Table 23-5 Analytical Equipment Maintenance

Instrument	Procedure	Frequency
Hewlett Packard GC/MS	Pump oil-level check Pump oil changing Analyzer bake-out Analyzer cleaning Resolution adjustment	Monthly Annually or as required As required As required As required
Gas Chromatograph	Compare standard response to previous day or since last initial calibration Check carrier gas flow rate in column Check temp. of detector, inlet, column oven Septum replacement Glass wool replacement Check system for gas leaks with SNOOP Check for loose/fray wires and insulation Bake injector/column Change/remove sections of guard column Replace connectors/liners Change/replace column(s)	Daily Daily via use of known compound retention Daily As required As required Each cylinder change as req'd Monthly As required As required As required As required
Electron Capture Detector (ECD)	Detector wipe test (Ni-63) Detector cleaning	Semi-annually As required
Flame Ionization Detector (FID)	Detector cleaning	As required
Hall 700A Detector Hall 1000 Detector	Electrolyte change Reactor tube/teflon connecting tube change Clean detector cell	As required by noise As required As required
Photoionization Detector (PID)	Change O-rings Clean lamp window	As required As required
HPLC	Change guard columns Change lamps Change pump seals Replace tubing Change fuses in power supply Filter all samples and eluents (auto-filtered) Change autosampler rotor/stator	As required As required As required As required As required Daily As required
Computers/Printers	Keyboard cleaning (air) Printer nozzle/head cleaning Platen cleaning	As required As required As required
Balances	Class "1" or "3" traceable weight check Clean pan and check if level External service	Daily, when used Daily Annually
Conductivity Meter	0.01 M KCl calibration Conductivity cell cleaning	As required As required
Turbidimeter	Check light bulb	Daily, when used

Table 23-5 Analytical Equipment Maintenance		
Instrument	**Procedure**	**Frequency**
	Service by qualified technician	Annual
Deionized/Distilled Water	Check conductivity System cleaning Replace cartridge & large mixed bed resins	Daily As required As required
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerator/Freezer	Temperature monitoring Temperature adjustment Defrosting/cleaning	Daily As required As required
Vacuum Pumps/ Air Compressor	Drained Belts checked Lubricated	Weekly Monthly Semi-annually
pH/Specific Ion Meter	Calibration/check slope Clean electrode	Daily As required
BOD Incubator	Temperature monitoring	Daily
Centrifuge	Check brushes and bearings	Every 6 months or as needed
Water Baths	Temperature monitoring Water replaced	Daily when used As needed
Other	Per SOP	Per SOP

23.3.2 Instrument Calibration

Information on instrument calibration can be found in Appendix F (Chemistry)

Initial instrument calibration and continuing instrument calibration verification are an important part of ensuring data of known and documented quality. If more stringent calibration requirements are included in a mandated method or by regulation, those calibration requirements override any requirements outlined here or in laboratory SOPs (although SOPs should reflect method stipulations). Generally, procedures and criteria regarding instrument calibrations are provided in test methods.

Section 24

MEASUREMENT TRACEABILITY
(TNI V1:M2 – Section 5.6; ISO/IEC 17025/2005(E) - Clause 5.6)

Measurement quality assurance comes in part from traceability of standards to certified materials.

All equipment used affecting the quality of test results is calibrated prior to being put into service and on a continuing basis. These calibrations are traceable to national standards of measurement where available. When using external calibration services, traceability of measurement shall be assured by the use of calibration services from organizations that can demonstrate competence, measurement capability and traceability to the International System of Units (see Section 23 – "Calibration Requirements").

If traceability of measurements to SI units is not possible or not relevant, evidence for correlation of results through interlaboratory comparisons, proficiency testing, or independent analysis is provided.

24.1 Reference Standards

Reference standards are standards of the highest quality available at a given location, from which measurements are derived. Reference standards shall be calibrated before and after any adjustment.

The laboratory uses ASTM Class 1 or 3 weights for daily checks and the lab sends out their ASTM Class 1 weights for a calibration check every five years. It has been established historically (no change between indicated periodic calibrations) that their performance as reference standards has not been invalidated by daily use.

Reference standards, such as ASTM Class 1 or 3 weights, are calibrated by an entity that can provide traceability to national or international standards. The following reference standards are sent out to be calibrated to a national standard as indicated in Section 23 – "Calibration Requirements"

- Class 1 weights
- Class 3 weights
- NIST traceable reference thermometers

24.2 Reference Materials

Reference materials are substances that have concentrations that are sufficiently well established to be used for calibration or as a frame of reference.

Reference materials, where commercially available, are traceable to SI/ national standards of measurement, or to Certified Reference Materials, usually by a Certificate of Analysis.

Purchased reference materials require a Certificate of Analysis meeting ISO Guide 34 requirements, where available. If a reference material cannot be purchased with a valid Certificate of Analysis, it is verified by analysis and comparison to a certified reference material and/or demonstration of capability for characterization. Records for standards, reagents, and reference materials shall include lot numbers. Documentation for reagents and solvents shall be checked to ensure that the stated purity will meet the intended use, and the supporting records of the checks shall be filed electronically.

Internal reference materials, such as working standards or intermediate stock solutions, are checked as far as is technically and economically practical, in accordance with SOPs 20_0001 (Standards Tracking – VOA Dept.), 30_0003 (Standards Tracking – Metals Dept.), 40_0039 (Reagent & Standards Tracking – Wet Chem. Dept.), 50_0006 (Reagent & Standards Tracking – Org. Prep. Dept.), 60_0001 (Reagent & Standards Tracking – SVOA Dept.), 80_0013 (Reagent Review and Tracking) and 110_0003 (Deionized Water System Testing)

Additional working standards such as internal thermometers, etc. are checked using the frequency summarized in Table 23-3 in Section 23 – "Calibration Requirements" or in the test SOPs.

24.3 Transport and Storage of Reference Standards and Materials

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials.

Reference standards and materials are stored according to manufacturer's recommendations, method SOP requirements and separately from samples, extracts and digestates, per SOPs listed above.

24.4 Labeling of Reference Standards, Reagents, and Reference Materials

The laboratory has procedures for purchase, receipt and storage of standards, reagents and reference materials. Purchase procedures are described in Section 9 – "Purchasing Services and Supplies".

Reagent quality is verified per SOPs listed above. The quality of water sources is monitored and documented per SOP 110_0003 and shall meet method specified requirements.

24.4.1 Stock Standards, Reagents, Reference Materials and Media

Records for all standards, reagents, reference materials, and media include:

- the manufacturer/vendor name (or traceability to purchased stocks or neat compounds)

- the manufacturer's Certificate of Analysis or purity (if supplied)
- the date of receipt
- recommended storage conditions

If the original container does not have an expiration date provided by the manufacturer or vendor it is not required to be labeled with an expiration date. If an expiration date is provided, it must be labeled with the expiration date.

In methods where the purity of reagents is not specified, analytical reagent grade is used. If the purity is specified, that is the minimum acceptable grade. Purity is verified and documented according to Section 9 – "Purchasing Services and Supplies".

24.4.2 Prepared Standards, Reagents, Reference Materials and Media

Records for standards, reagents, reference materials, and media preparation include:

- traceability to purchased stock or neat compounds
- reference to the method of preparation
- date of preparation
- an expiration date after which the material shall not be used
- preparer's initials (if prepared)

Refer to SOPs listed above.

All containers of prepared standards, reagents, or materials are labeled with a unique ID and an expiration date per SOPs listed above. The expiration date of the prepared standard shall not exceed the expiration date of the primary standard.

Prepared reagents are verified to meet the requirements of the test method per SOPs listed above. Verification can usually be achieved through the use of laboratory control standards.

Section 25

COLLECTION OF SAMPLES

(TNI V1:M2 – Section 5.7; ISO/IEC 17025/2005(E) - Clause 5.7)

When ESS Laboratory is not required to provide sampling services, the laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms and packing materials required to properly preserve, pack, and ship samples to the laboratory.

When ESS Laboratory provides sampling and courier services, these procedures are described in the following SOPs:

10_0006	PCB Wipe Field Sampling Procedure
10_0007	Industrial Wastewater Sampling
10_0011	ISCO Maintenance
10_0012	Field Soil Sampling
10_0013	Groundwater Well Sampling
10_0016	Field pH Testing
10_0017	Sample Courier Service
10_0021	Drinking Water Sample Collection
10_0022	General Field Wipe Sampling Procedure

These SOPs include procedures for recording relevant data and operations relating to sampling that form part of the testing that is undertaken. These records include the sampling procedure used, the identification of the sampler, environmental conditions (if relevant) and diagrams or other equivalent means to identify the sampling location as necessary and, if appropriate, the statistics upon which the sampling procedures are based. These SOPs are available for use by the sampler at the location where sampling is undertaken.

Where the customer requires deviations, additions or exclusions from the documented sampling procedure, these shall be recorded in detail with the appropriate sampling data and shall be included in all documents containing test results, and shall be communicated to the appropriate personnel.

25.1 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers, which may or may not contain preservative, are frequently purchased as such. Lots of pre-cleaned containers are only obtained from vendors who can supply certificates of compliance to USEPA OSWER directive #9240.0-05A (Specs/Guidance for Contaminant-free Sample Containers). In the event that ESS has to purchase containers without certificates of compliance, these containers are lot-checked for contamination and the check results are tracked per SOP 80_0013 (Supplies Tracking).

25.1.1 Preparing Container Orders

Containers (containing any required preservatives) are provided to the client upon request per SOP 10_0017 (Courier Service). Bottle orders are made by telephone, e-mail or via the ESS Lab website; in all cases a bottle order request form is completed per SOP 10_0017.

25.1.2 Sampling Containers, Preservation Requirements, Holding Times

Sampling container, preservation and holding time requirements can be found in SOP 10_0001, Attachment A, which is also available to clients on the ESS website as a pdf document.

If preservation or holding time requirements are not met, the procedures in Section 12 – "Control of Nonconforming Environmental Testing Work" are followed.

25.2 Sampling Plan

The laboratory uses sampling plans provided by clients or prepared in consultation with the client. The plan must include any factors that must be controlled to ensure the validity of the test. Sampling plans and written sampling procedures are used for sampling substances, materials or products for testing. The plan and procedures are made available at the sampling location.

The laboratory's procedures for dealing with nonconformances are used when the client requests any deviations from the sampling plan or sampling procedures. The requests are documented and included in the final test report.

25.3 Sampling Records

The following relevant sampling data are recorded: sampling procedure used, the date and time of sampling, the identification of the sampler, environmental conditions (if relevant), the sampling location, and any other pertinent information which may be necessary to protect the integrity of the test or calibration item, and to protect the interests of the laboratory and the customer.

Section 26

HANDLING SAMPLES AND TEST ITEMS
(TNI V1:M2 – Section 5.8 and Section 1.7 of Technical Modules TNI V1:M4; ISO/IEC 17025/2005(E)-Clause 5.8)

26.1 Sample Receipt

When samples are received at the laboratory, chain-of-custody is reviewed, condition is documented, samples (and bottles/vials) are given unique identifiers, and they are logged into the sample tracking system, in accordance with SOPs 10_0001 (Sample Receiving), 70_0006 (Bar Coding) and 70_0008 (Sample Login).

26.1.1 <u>Chain of Custody</u>

The chain of custody or sample submission sheets from the field are reviewed. This documentation is completed in the field and provides a written record of the handling of the samples from the time of collection until they are received at the laboratory. Section 25 – “Collection of Samples” outlines what information is needed on this record. The chain of custody form also provides information on what type of testing is being requested and can act as an order for laboratory services in the absence of a formal contract. A typical chain of custody form can be found in Figure 26-1 below and in SOP 10_0001. Chain of custody and any additional records (which may include special instructions, reporting limit requirements etc.) received at the time of sample submission are maintained by the laboratory. These are scanned by the sample receiver, filed as PDFs in an appropriate network directory and are available for use by analysts should testing need to begin before work has been formally logged into the LIMS. These scanned chains are also available for use in subcontracted record keeping.

26.1.1.1 Legal Chain of Custody

The laboratory has procedures (see above) for legal chain of custody services. If samples are noted as being used for legal/evidentiary purposes, the chain of custody followed by the laboratory ensures that pertinent regulatory requirements are met.

The legal COC protocol records shall establish an intact, continuous record of the physical possession, storage and disposal of used sample containers, collected samples, sample aliquots, and sample extracts or digestates, collectively referred to below as “samples”. The COC records shall account for all time periods associated with the samples. For ease of discussion, the above-mentioned items shall be referred to as samples:

a) A sample is in someone’s custody if:

   i) It is in one’s actual physical possession;
   ii) It is in one’s view, after being in one’s physical possession;

iii) It has been in one's physical possession and then locked or sealed so that no one can tamper with it; and/or
iv) It is kept in a secure area, restricted to authorized personnel only.

b) The COC records shall identify all individuals who physically handled individual samples. Proof of custody is accomplished via the laboratory's bar-coding and LIMS.

c) Should it become necessary to subcontract any testing to an off-site facility (refer to Section 8), custody must continue to be maintained.

d) Normal practice is for a laboratory courier to deliver sampling containers in accordance with SOP 10_0017 (Sample Courier Service).

26.2 Sample Acceptance

Procedures for opening shipping containers and examining samples are provided in SOP 10_0001 (Sample Receiving).

When samples are received outside of normal business hours, the second shift sample receiver takes care of all samples that still need to be received; bar coding samples, scanning the COCs as PDFs, logging COCs into the LIMS (except where projects need to be set up) and placing the bar coded samples onto carts (in order) to be 2nd level reviewed by the end of the second shift. If necessary, the carts with non-volatile samples are stored in a "Walk-in" refrigerator and samples for volatiles analysis are stored in their appropriate fridges/freezers.

The laboratory has a sample acceptance policy that is followed by sample collection personnel and is posted in the sample receiving area and on the company website. It emphasizes the need for use of water-resistant ink, providing proper documentation (to include sample ID, location, date and time of collection, collector's name, preservation type, sample type and any special remarks about the sample), labeling of sample containers to include a unique sample ID, use of appropriate containers, adherence to holding times, and sample volume requirements. ESS has strict policies in effect that limit the acceptance of hazardous chemical samples without an accompanying Safety Data Sheet (SDS). No radioactive samples are accepted. In addition the laboratory has nonconformance/corrective action procedures to handle samples that don't meet the requirements above or show signs of damage, contamination or inadequate preservation. Data will be appropriately narrated where samples are reported that do not meet sample acceptance requirements.

The laboratory checks samples for the conditions above per SOP 10_0001, where appropriate, to evaluate sample acceptance. Criteria regarding preservation, holding time and sample volume requirements can be found in SOP 10_0001, Attachment A. If these conditions are not met, the client is contacted by the project manager prior to any further processing, then 1) the sample is rejected as agreed with the client, 2) the decision to proceed is documented and agreed upon with the client, 3) the condition is noted on the Chain of Custody form and/or lab receipt documents, and 4) the data are qualified in the report.

26.2.1 <u>Preservation Checks</u>

The following preservation checks are performed and documented upon receipt:

26.2.1.1 *Thermal preservation:*

a) For temperature preservation of samples at 4°C, the acceptable range is from just above freezing to ≤6°C. Samples which need to be kept frozen are stored at ≤-10°C.
b) Samples that are delivered to the lab the same day as they are collected are likely not to have reached a fully chilled temperature. This is acceptable if the samples are received on ice and the chilling process has begun.
c) Record on the receipt form if ice is present and the temperature.

26.2.1.2 *Chlorine checks:*

d) Laboratories that receive samples from potable water supplies (including source water) that have a demonstrated history of acceptable preservation may check a sample from each client at a frequency of once per month if:

   i) the laboratory can show that the received sample containers are from their laboratory;
   ii) sufficient sodium thiosulfate was in each container before sample collection to neutralize at minimum 5 mg/l of chlorine for drinking water and 15 mg/l of chlorine for wastewater samples;
   iii) one container from each batch of laboratory prepared containers or lot of purchased ready-to-use containers is checked to ensure efficacy of the sodium thiosulfate to 5 mg/l chlorine or 15 mg/l chlorine as appropriate and the check is documented;

   iv) chlorine residual is checked in the field and actual concentration is documented with sample submission.

26.2.1.3 *Chemical Preservation:*

e) Chemical preservation should be checked at the time of sample receipt unless it is not technically acceptable to do so (e.g., VOC analyses; samples received after hours when sample receiver might be working alone) and this requirement will normally be followed. When other programs (e.g. TNI, MCP, RCP) permit, then procedures for checking sample preservation using readily available techniques (such as pH or chlorine) at the time of sample preparation or analysis, shall be implemented. Chemical preservation of samples for volatile organic compound analysis may be checked after analysis. The sample receiving procedure is detailed in SOP 10_0001.

If any of the following conditions exist, chemical preservation must be rechecked in the laboratory:

i) Continued preservation of the sample is in question (e.g., the sample may not be compatible with the preservation); or

ii) Deterioration of the preservation is suspected.

26.2.2 Rush/Short Hold Time Samples

The laboratory ensures that the appropriate laboratory personnel are notified when samples are received with a quick turn-around time request, short hold times, or a short amount of hold time is remaining, per SOPs 10_0001 and 10_0002.

26.2.3 Radioactive Samples

The laboratory does not accept radioactive samples. The laboratory routinely tests samples for radioactivity per SOP 10_0001. Samples found to be radioactive samples will be isolated and arrangements made to return them to sender.

26.2.4 Non-routine Samples

Samples that require non-routine or additional sample preparation steps are accepted by pre-arrangement with the client.

26.2.5 On-Hold Samples

Samples may be stored in the Sample Receiving area refrigerator, pending client's instructions on when and how to proceed with testing.

26.3 Sample Identification

Samples, including subsamples, extracts and digestates, are uniquely identified in a permanent chronological record in the LIMS, per the aforementioned SOPs, to prevent mix-up and to document receipt of all sample containers.

Samples are assigned sequential numbers that reference more detailed information kept in the Project Number Login, per SOP 10_0001.

The following information is included in this log:

- Client or project name
- Container type
- Unique laboratory identification number
- Signature or initials of person making the entries
- Subcontracting information
- Turn Around Time

In addition, the following information is maintained and linked to the log-in record:

- Date and time of sampling linked to the date and time of laboratory receipt.
- Unique field identification number linked to the laboratory sample ID.
- Analyses requested (including applicable approved method numbers) linked to the laboratory sample ID, per COC.
- Cooler receipt information.
- Comments regarding rejection (if any).

All documentation received regarding the sample, such as memos or chain of custody, are scanned into an electronic project folder for permanent retention.

26.4 Sample Aliquots / Subsampling

In order for analysis results to be representative of the sample collected in the field, the laboratory has subsampling procedures. See SOP 10_0001 Attachment G.

26.5 Sample Storage

Storage conditions are monitored for any required criteria, verified, and the verification recorded in logbooks.

Samples that require thermal preservation are stored under refrigeration that is ±2°C of the specified preservation temperature unless regulatory or method specific criteria require something different. For samples with a specified storage temperature of 4°C, storage at a temperature above the freezing point of water to ≤6°C is acceptable.

Samples are held secure, as required. Samples are accessible only to laboratory personnel.

Samples are stored apart from standards, reagents, food or potentially contaminating sources and such, so that cross-contamination is minimized/eliminated. All portions of samples, including extracts, digestates, leachates, or any product of the sample is maintained according to the required conditions.

Samples with potentially high levels of volatile organics, cyanide or restricted (foreign) soil are stored in refrigerators/freezers designated for these purposes.

Refrigerator blanks are stored with samples in volatile sample refrigerators, and are analyzed weekly to check for possible cross-contamination.

26.6 Sample Disposal

Samples are retained a minimum of 30 days after completion of testing unless other arrangements have been made with the client; samples are then disposed of appropriately or returned to client (if requested).

Samples are disposed of according to Federal, State and local regulations. Procedures are described in SOP 10_0002 (Sample Storage) and 90_0002 (Hazardous Waste Contingency), for the disposal of samples, digestates, leachates, and extracts.

26.7 Sample Transport

Samples that are transported under the responsibility of the laboratory, where necessary, are done so safely and according to storage conditions. This includes moving bottles within the laboratory. Specific safety operations are addressed outside of this document.

Sample shipping procedures are described in SOP 10_0017 (Courier Service).

Figure 26-1 Example Chain of Custody

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab #

Turn Time	5-Day	**Rush**
Regulatory State		

Is this project for any of the following?:
○CT RCP ○MA MCP ○RGP

Reporting Limits

Electonic Deliverables ☐Limit Checker ☐Standard Excel ☐Other (Please Specify →)

Company Name	**Project #**	**Project Name**

Contact Person	**Address**

City	**State**	**Zip Code**	**PO #**

Telephone Number	**FAX Number**	**Email Address**

Analysis

ESS Lab ID	**Collection Date**	**Collection Time**	**Sample Type**	**Sample Matrix**	**Sample ID**

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G - Glass O-Other P-Poly S-Sterile V-Vial

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*

Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*

Number of Containers per Sample:

Laboratory Use Only

Cooler Present: ________

Seals Intact: ________

Cooler Temperature: °C

Sampled by :

Comments: **Please specify "Other" preservative and containers types in this space**

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

Figure 26-2 Sample Acceptance Policy

ESS Laboratory Sample Acceptance Policy

The following criteria are used by ESS Laboratory to define its sample acceptance policy for regulatory samples:

ESS Laboratory is an environmental analytical laboratory and as such is prepared to handle environmental samples. These include soils, sediments, ground waters, surface waters, and drinking waters. All other samples require notification prior to sending to the laboratory. ESS Laboratory will make provisions to accept caulk, oil, tissue, concrete and other types of matrices. ESS Laboratory will not receive radioactive samples, untreated sewage, samples containing body fluids, or acutely hazardous materials. If client is sending any type of chemical, it must be accompanied by a material safety data sheet.

Samples should be received in coolers on ice and clearly labeled. Tissue samples must be shipped and stored frozen at less than -10°C.

Samples must be received with paperwork (Chain of Custody – available in .pdf or .xls formats) detailing name of sample, date collected, time collected, number of bottles, and analyses required. Chain of Custody (COC) should also include client contact information and any special handling requirements. All samples must be relinquished to the laboratory and received by the laboratory and this information must be documented clearly and legibly on the COC in indelible ink.

Samples should be taken in appropriate containers with appropriate preservation. Refer to the ESS Guide to Sample Handling and Preparation table. Bottles will be furnished upon request.

Upon arrival at the laboratory, ESS will take the temperature of the cooler and record it on the COC and the cooler receipt form. The sample receiver will ensure that the samples are not radioactive and are in good condition (no leaks, air bubbles, broken caps, etc). Samples will be lined up and compared to chain of custody. The COC is signed, formally indicating receipt.

Samples will be assigned a unique barcode ID. A cooler receipt form will be generated and reviewed by the Customer Services Department. All deviations such as temperature, inadequate preservation, insufficient volumes and hold time issues will be recorded. The client will be notified and required to address all deviations before work is initiated on the samples. If the laboratory is required to preserve unpreserved samples, a notation will be made on the cooler receipt form. If the preservation is outside of regulations, the report will contain a statement recording this issue. All deviations outside of regulatory controls will be qualified in the report narrative.

Section 27

QUALITY ASSURANCE FOR ENVIRONMENTAL TESTING *(TNI V1:M1, V1:M2 - Section 5.9, V1:M4 - Section 1.7; ISO/IEC 17025/ 2005(E)-Clause 5.9)*

ESS Laboratory has procedures for monitoring the validity of the testing it performs. The qualities of test results are recorded in such a way that trends are detectable, and where practicable, are statistically evaluated. To evaluate the quality of test results, the laboratory uses certified reference materials, control charting, replicate or confirmational analyses, retesting of retained sample(s) (which may be at a dilution) and correlation of results for different characteristics of a sample.

In addition to procedures for calibration (Section 23 & Appendix F), the laboratory monitors quality control measurements such as blanks, laboratory control samples or blank spikes (LCS/BS), matrix spikes (MS), duplicates, surrogates and internal standards to assess precision and accuracy. Proficiency Testing samples are also analyzed to assess laboratory performance.

Quality control data are analyzed and, when found to be outside pre-defined criteria, action is taken to correct the problem and to prevent incorrect results from being reported. Data associated with quality control data outside of criteria and still deemed reportable will be qualified so the end user of the data may make a determination of the usability of the data - see Section 28 – "Reporting of Results".

27.1 Essential Quality Control Procedures

The quality control procedures specified in test methods are followed by laboratory personnel. The most stringent of control procedures is used in cases where multiple controls are offered. If it is not clear which are the most stringent, those mandated by test method or regulation are followed.

Acceptance criteria are commonly defined in the QC sections of the test method SOPs. For test methods that do not provide acceptance criteria for an essential quality control element or where no regulatory criteria exist, acceptance criteria are developed per SOP 110_0014 (Control Charts). In some instances, the client may set criteria. In any event, acceptance criteria are entered in the Element LIMS under the pertinent test code.

Written procedures to monitor routine quality controls including acceptance criteria are located in the test method SOPs, except where noted, and include such procedures as:

- Use of laboratory control samples and blanks to serve as positive and negative controls for chemistry methods.
- Use of laboratory control samples to monitor test variability of laboratory results;

- Use of calibrations, continuing calibrations, certified reference materials and/or PT samples to monitor accuracy of the test method;
- Measures to monitor test method capability, such as limit of detection, limit of quantitation, and/or range of test applicability, such as linearity;
- Use of regression analysis, internal/external standards, or statistical analysis to reduce raw data to final results;
- Use of reagents and standards of appropriate quality and use of second source materials as appropriate;
- Procedures to ensure the selectivity of the test method for its intended use; &
- Measures to assure constant and consistent test conditions, such as temperature, humidity, rotation speed, etc., when required by test method.

27.2 Internal Quality Control Practices

Analytical data generated with QC samples that fall within all prescribed acceptance limits indicate the test method is deemed to be in control.

QC samples that fall outside QC limits indicate the test method are deemed to be out of control (nonconforming) and that corrective action is required and/or that the data are qualified (see Section 12 – “Control of Nonconforming Environmental Testing Work” and Section 14 - “Corrective Actions”).

Detailed QC procedures and QC limits are included in test method standard operating procedures (SOPs), or where unspecified in the SOPs, are detailed in e-mail directives pending formal addition to SOPs.

All QC measures are assessed and evaluated on an on-going basis, so that trends are detected and prompt corrective action may be scheduled, if needed.

27.2.1 <u>General Controls</u>

The following general controls are used:

27.2.1.1 Positive and Negative Controls such as:

a) Blanks (negative)
b) Laboratory control sample (positive)

27.2.1.2 Selectivity is assured through:

a) Absolute and relative retention times in chromatographic analyses (referenced in sops);
b) GC/MS (full scan or SIM) or two-column (dissimilar stationary phases) confirmation if composition of samples is not well characterized, as is the case when using non-specific detectors;

c) Use of acceptance criteria for mass-spectral tuning (found in test method SOPs); and

d) Use of the correct method according to its scope, assessed during method validation.

27.2.1.3 Consistency, Variability, Repeatability, and Accuracy are assured through:

a) Proper installation and operation of instruments according to manufacturer's recommendations or according to the processes used during method validation;

b) Monitoring and controlling environmental conditions (temperature, access, proximity to potential contaminants);

c) Selection and use of reagents and standards of appropriate quality (referenced in SOPs); and

d) Cleaning glassware appropriate to the level required by the analysis as demonstrated with method blanks, per glassware cleaning SOPs 30_0001 (metals) and 50_0001 (organic prep).

e) following sops and documenting any deviation, assessing for impact, and treating data appropriately;

f) Testing to define the variability and/or repeatability of the laboratory results, such as via replicates;

g) Use of measures to assure the accuracy of the test method, including calibration and/or continuing calibrations (detailed in Appendix F), use of certified reference materials, proficiency test samples, or other measures.

27.2.1.4 Test Method Capability (also see Section 22 – "Environmental Methods and Method Validation") is assured through:

a) Establishment of the limit of detection, where appropriate;

b) Establishment of the limit of quantitation or reporting level; and/or

c) Establishment of the range of applicability such as linearity.

27.2.1.5 Data reduction is assured to be accurate by:

a) Selection of appropriate formulae to reduce raw data to final results such as regression;

b) Following specific procedures for data reduction such as manual integration procedures; and

c) Periodic review of data reduction processes to assure applicability;

27.2.1.6 Sample Specific controls are used to evaluate the effect of sample matrix on the performance of the selected analytical method (not a measure of laboratory performance):

Examples:

- Matrix Spike and Matrix Spike Duplicate (MS/MSD)
- Surrogate Spikes
- Sample Duplicates

27.2.1.7 Tables summarizing the required elements of a quality control system (data quality objectives) by various regulatory bodies may be found in the pertinent test SOPs.

27.2.2 Specific Controls

27.2.2.1 Method Blanks

Method blanks are processed along with and under the same conditions as the associated samples to include all steps in the method. A method blank must be analyzed at a minimum of one per preparation batch. When no separate preparation method is used the batch is defined as the environmental samples that are analyzed with the same method and personnel, using the same lots of reagents, not to exceed the analysis of twenty environmental samples, not including method blanks, LCS, BS, matrix spikes and matrix duplicates. The matrix of the method blank must be similar to the associated samples and be free from any analytes of interest. Method blanks are not required for some analyses such as pH, conductivity, flashpoint, temperature.

Contaminated blanks are identified according to the acceptance limits in the test method SOPs or laboratory documentation.

The laboratory identifies a blank as contaminated when analyte results are greater than the reporting limit and greater than 1/10th the amount measured in any associated sample, or 1/10th the regulatory limit, whichever is greater; or where the contaminant affects the sample results, per test method requirements or client data quality objectives.

When a blank is determined to be contaminated, the cause must be investigated and measures taken to minimize or eliminate the problem.

Data that are unaffected by the blank contamination (non-detects or other analytes) are reported unqualified.

Sample data that are suspect due to the presence of a contaminated blank are reanalyzed, qualified, or voided.

27.2.2.2 Laboratory Control Samples (Blank Spikes)

Laboratory Control Samples (LCS; BS) are prepared from analyte free water or other clean matrix, and spiked with verified and known amounts of analytes for the purpose of establishing precision or bias measurements.

The matrix spike (Section 27.2.2.3 below) may be used in place of this control as long as the acceptance criteria are as stringent as for the LCS.

Alternatively, the LCS may consist of a media containing known and verified concentrations of analytes or as Certified Reference Material (CRM). All analyte concentrations shall be within the calibration range of the methods. The following shall be used in choosing components for the spike mixtures:

The components to be spiked shall be as specified by the mandated method or regulation or as requested by the client. In the absence of specified spiking components, the laboratory shall spike per the following:

a) for those components that interfere with an accurate assessment, such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike shall be chosen that represents the chemistries and elution patterns of the components to be reported; and

b) for those methods that have extremely long lists of analytes, a representative number may be chosen. The analytes selected shall be representative of all analytes reported.

The following criteria shall be used for determining the minimum number of analytes to be spiked. However, the laboratory shall insure that all targeted components are included in the spike mixture over a two (2) year period:

Laboratory control samples are analyzed at a frequency mandated by method, regulation, or client request, whichever is more stringent. The standard frequency of LCS preparation and analysis is at least one per analytical batch or as otherwise stated in a laboratory SOP. Exceptions would be for those analytes where no spiking solution is available, such as pH, color, odor, temperature. When no separate preparation method is used, the batch is defined as the environmental samples that are analyzed with the same method and personnel, using the same lots of reagents, not to exceed the analysis of twenty environmental samples, not including method blanks, LCS, matrix spikes and matrix duplicates.

The analytes to be spiked in the LCS are specified in the test method SOP. In some cases a client may specify a list of analytes for spiking and the request is handled using the laboratory's nonconformance procedures.

The results of laboratory control samples (LCS) are calculated in percent recovery or other appropriate statistical technique that allows comparison to established acceptance criteria. The laboratory documents the calculation in the pertinent test method SOP.

The individual LCS is compared to the acceptance criteria as published in the mandated test method, or where there are no established criteria, the laboratory uses in-house established limits as described in SOP 110_0014.

The TNI Standard allows certain marginal exceedances for target analytes, as follows (these are also specified in the test SOPs):

Number of analytes in LCS	Number of allowed exceedances
> 90	5
71 – 90	4
51 – 70	3
31 – 50	2
11 – 30	1
< 11	0

When the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualification; or when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level, with data qualifying codes.

27.2.2.3 Matrix Spikes and Matrix Spike Duplicates

Matrix Spikes and Matrix Spike Duplicates (MS/MSD) are environmental samples fortified with a known amount of analyte to help assess the effect of the matrix on method performance.

The laboratory procedure for MS/MSD includes spiking appropriate analytes at appropriate concentrations, calculating percent recoveries and relative percent difference (RPD), and evaluating and reporting the results. The procedure can be found in the pertinent method SOP.

Where there are no established criteria, MS/MSD criteria are established in the same manner as that described above for LCS.

For MS/MSD results outside established criteria, corrective action is documented or the data are reported with appropriate data qualification; an inability to meet QC criteria may result from matrix interference and if this is the case, then it will be so narrated in the final report. Only data from the parent spiked sample is qualified.

27.2.2.4 Surrogate Spikes

Surrogate spikes are substances with chemical properties and behavior similar to the analytes of interest and are used to assess method performance in individual samples. Surrogates are added to all samples (in test methods where surrogate use is appropriate) prior to sample preparation or extraction.

Surrogate recovery results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory follows the procedures described above in Section 27.2.2.2 to derive surrogate control limits.

For surrogate results outside established criteria, data are evaluated to determine the impact. Corrective actions are detailed in the respective SOPs.

27.3 Proficiency Test (PT) Samples or Interlaboratory Comparisons

27.3.1 Compliance to Accreditation Requirements

The laboratory analyzes at least two TNI-compliant PT samples per calendar year for each of the Fields of Proficiency Testing (FoPT) for which the laboratory is NELAC accredited. An exception is made for analytes where there is no PT available from any PTPA approved PT provider at least twice per year. In these cases the lab will run the PTs in the minimum time frame the PTs are available and not at all if they are not available.

The successive PTs are analyzed at least five months apart and no more than 7 months apart unless the PT is being used for corrective action to maintain or reinstate accreditation, in which case the dates of successive PT samples for the same accreditation FoPT is at least fifteen days apart.

27.3.2 PT Sample Handling, Analysis and Reporting

The laboratory does not share PT samples with other laboratories, does not communicate with other laboratories regarding current PT sample results, and does not attempt to obtain the assigned value of any PT sample from the PT provider.

Proficiency Testing samples are treated as typical samples in the normal production process where possible, including the same analysts, preparation, calibration, quality control and acceptance criteria, sequence of analytical steps, number of replicates, and sample log-in. PT samples are not analyzed multiple times unless routine environmental samples are analyzed multiple times. Where PT samples present special problems in the analysis process, they will be treated as laboratory samples where clients have special requests.

The type, composition, concentration and frequency of quality control samples analyzed with the PT samples are the same as with typical samples.

Prior to the closing date of a study, laboratory personnel do not:

- Subcontract analysis of a PT sample to another laboratory being run for accreditation purposes.
- Knowingly receive and analyze a PT for another laboratory being run for accreditation purposes.

- Communicate with an individual from another laboratory concerning the analysis of the PT sample.
- Attempt to find out the assigned value of a PT from the PT Provider.

A result for any PT study parameter which is at a concentration above or equal to the LOQ (defined in Appendix F) shall be reported as the resultant value.

A result for any PT study parameter which is at a concentration less than the LOQ shall be reported as less than the value of the LOQ.

When a PT sample assigned value falls below the range of the routine method, a low level procedure needs to be used. The laboratory's procedures for testing low level samples (including PT samples) are outlined in the pertinent laboratory SOPs. The laboratory reports PT study results to the PT provider, in the provider's specified format, on or before the study closing date. The frequency at which PT study results are reported to a regulatory body is determined by the agency in question. On or before the closing date of a study the laboratory authorizes the PT Provider to release the laboratory's final evaluation report directly to pertinent regulatory bodies.

The laboratory institutes corrective action procedures for failed PT samples following the guidelines in Section 14 – "Corrective Action".

Retention of PT records, including data necessary to reconstruct results, is similar to that maintained for regular environmental samples, as specified in test SOPs. In addition the lab maintains a copy of the online data entry summary when the PT results are submitted online.

27.4 Data Review

The laboratory reviews all data generated in the laboratory for compliance with method, laboratory and, where appropriate, client requirements, in accordance with SOPs 70_0004 (Work Order Management), 70_0005 (Levels III and IV Data Review) and 70_0007 (Data Entry and Data Reporting in Element LIMS):

Electronic preparation bench sheets, instrumental analysis run logs and the Element LIMS are used to record the information required for traceability of the analysis. These records include quality control measurements and acceptance criteria. Data are recorded on the bench sheets/run logs promptly at the time of analysis, per SOP 80_0040 (Logbooks). The reportable values are highlighted in a new XLS workbook by the first reviewer and the preparation bench sheet is added to it to produce a combined document.

Analysts (Level I review) review sample data and QC information at the time of the analysis and indicate necessary information by marking the run log. The analyst signs the run log (dating/time is done automatically by the software program) to indicate that they have performed the steps listed and that the analysis meets acceptance criteria or has exceptions that are noted in the comments column of the run log.

When the analyst has finished the primary analysis review, the combined record is then used by the appropriate personnel to enter the data into the LIMS.

Another person, either in the QA Dept. or in the originating laboratory dept. (Level II review), checks the combined record for the following items:

a) All required information has been recorded in the combined record.
b) QC acceptance criteria or exceptions are documented in the comments column of the run log.
c) Manual calculations are checked for accuracy.

When these checks have been completed, the second reviewer signs the combined record to show that the review has been performed.

When reporting data for methods requiring two column confirmation, project-specific reporting requirements are followed. If not available, method reporting requirements are followed. If these are not specified, report primary column results unless there is a scientifically valid and documented reason for not doing so, as specified in the test SOP and client agrees. These shall also be qualified in the test report and explained in the case narrative. Analyte presence is only indicated when confirmation is positive or cannot be discerned from interference.

The report is printed as a pdf and submitted to the approved signatories, who will normally be a QA Dept. data validator for final technical review (Level III review) and Admin. Dept. personnel for final administrative review (Level IV review). The final technical review includes verifying that the data entered on the worksheet has been appropriately transferred to the LIMS and that the data is coherent, that the QC results are acceptable, QC exceptions are appropriately reflected on the final report and that the results are in line with historical values, if known. Correlation of results for different characteristics of an item may also be considered.

The Level IV review is a final check of the work order to ensure that the three prior levels have been completed, any deviations have been noted in the project narrative, all sample analyses have been performed based on comparison with the COC, the final report was delivered to the client electronically or otherwise, and electronic data deliverables have been generated and submitted to the client as requested.

In addition, the Quality Manager or QA Officer shall review a minimum of 10% of all data packages for technical completeness and accuracy. This review (Level V review) is considered a part of overall data review and does not need to be completed before the data package is issued to the customer.

If electronic audit trail functions are available, they must be in use at all times, and associated data must be accessible. If the instrument does not have an audit trail, the laboratory must have procedures to record the integrity of the data. Refer to SOP 80_0040.

Section 28

REPORTING THE RESULTS
(TNI V1:M2 – Section 5.10; ISO/IEC 17025/2005(E) - Clause 5.10)

The result of each test performed is reported accurately, clearly, unambiguously, and objectively and complies with all specific instructions contained in the test method.

Laboratory results are reported in a test report that includes all the information requested by the client and necessary for the interpretation of the test results and all information required by the method used. Any information listed below in Section 28.1 which is not reported to the customer shall be readily available in the laboratory department/LIMS, which carried out the tests and/or calibrations.

Data are reported without qualification if they are greater than the lowest calibration standard, lower than the highest calibration standard, and without compromised sample or method integrity.

Test reports meeting the TNI/ISO 17025 standards are issued by electronic data transfer in PDF or, if requested, in spreadsheet format.

28.1 Test Reports

The report format has been designed to accommodate each type of test performed and to minimize the potential for misunderstanding or misuse.

Each test report generated contains the following information, unless dictated otherwise by contractual agreement:

a) A title, such as Certificate of Analysis;

b) The name and address of the laboratory, the location of the laboratory if different from the address; phone/fax number and web address;

c) Unique identification of the test report, such as a serial number, on each page and a pagination system that ensures that each page is recognized as part of the test report and a clear identification of the end of the report, such as 3 of 10;

d) The name, address of the client;

e) The project identification and location (if available);

f) The identification of the method used to detect and quantify the analytes of interest. Sample preparation procedures, if not included in the referenced analytical procedures, must also be referenced or described;

g) A description of, the condition of, and unambiguous identification of the sample(s) tested, including the client identification code;

h) The date of sample receipt when it is critical to the validity and application of the results, date and time of sample collection, dates the tests were performed, the time of sample preparation and analysis if the required holding time for either activity is less than or equal to 72 hours;

i) Reference to the sampling plan and procedures used by the laboratory where these are relevant to the validity or application of the results;

j) The test results, units of measurement, an indication of when results are reported on any basis other than as received (e.g. dry weight), failures identified by narrative and/or use of qualifiers (see SOP 70_0002 – Data Flagging).

k) The name, function, and signature or an equivalent electronic identification of the person authorizing the test report, and the date of issue;

l) Where relevant, a statement to the effect that the results relate only to the samples;

m) Any non-accredited tests or parameters shall be clearly identified as such to the client when claims of accreditation to regulatory standards are made in the analytical report or in the supporting electronic or hardcopy deliverables;

n) A statement that the report shall not be copied except in full without approval of the laboratory;

o) An Adobe® custom dynamic stamp stating "REVIEWED by ESS Laboratory at '*Time*' '*Date*' ";

p) Table of Contents, which may be generated electronically by the Adobe® software;

q) Date of issuance;

r) The date of sample extraction, if applicable to the analytical method performed, and the date of sample analysis.

28.2 Supplemental Test Report Information

When necessary for interpretation of the results or when requested for regulatory compliance, or when requested by the client, test reports include the following additional information (case narrative):

a) Deviations from, additions to, or exclusions from the test method, information on specific test conditions, such as environmental conditions, and any non-standard conditions that may have affected the quality of the results, and any information on the use and definitions of data qualifiers;

b) A statement of compliance/non-compliance when requirements of the management system are not met, including identification of test results that did not meet the laboratory and regulatory sample acceptance requirements, such as holding time, preservation, etc.;

c) Where applicable and when requested by the client, a statement on the estimated uncertainty of the measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit.

d) Where appropriate and needed, opinions and interpretations. When opinions and interpretations are included, the basis upon which the opinions and interpretations are documented. Opinions and interpretations are clearly marked as such in the test report case narrative.

e) Additional information which may be required by specific methods, regulatory agency or client (such as dates of extraction for test methods including extraction prodedures); and

f) Qualification of results with values outside the calibration range, as appropriate.

In addition to the items above, for test reports that contain the results of sampling, the following is provided when necessary for the interpretation of the results:

a) The date of sampling;

b) Unambiguous identification of the material sampled;

c) The locations of the sampling, including diagrams, sketches, or photographs;

d) A reference to the sampling plan and procedures used;

e) Details of any environmental conditions during sampling that may affect the interpretations of the test results;

f) Any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

In addition to the requirements listed above, calibration certificates shall include the following, where necessary for the interpretation of calibration results:

28.3 Environmental Testing Obtained from Subcontractors

Test results obtained from tests performed by subcontractors are clearly identified on the test report by subcontractor name and/or accreditation number.

The subcontractors report their results in writing or electronically. A copy of the subcontractor's report, as received on their letterhead, is included in the test report.

28.4 Electronic Transmission of Results

All test results transmitted by telephone, fax, telex, e-mail, or other electronic means comply with the requirements of the TNI/ISO 17025 Standards and associated procedures protecting the confidentiality and proprietary rights of the client (see Section 22- "Environmental Methods and Method Validation").

28.4.1 Electronic Data Deliverables

The preparation and submission of electronic data deliverables in a prescribed format (e.g. SEDD, AECOM, CLP-Like) created using special software programs (Element LIMS, EDD Writer) is by contractual agreement and is designed to accommodate each type of test or calibration carried out and to minimize the possibility of misunderstanding or misuse.

28.5 Amendments to Test Reports

Material amendments (revisions) to a test report after it has been issued are made only in the form of another document or data transfer and must be approved by management. All supplemental reports meet all the requirements for the initial report and the requirements of this *Quality Manual*.

Amended test reports include the statement, “This report has been revised to……” in bold letters or an equivalent form of wording to assure they can be differentiated from other test reports.

When it is necessary to issue a complete new report, the new report is uniquely identified and contains a reference to the original that it replaces.

Appendix A

Master List of Controlled Documents

SOP#	Rev#	SOP METHOD TITLE
10_0000		**Sample Receiving Department**
10_0001	10	Sample Receiving
10_0002	3	Storage of Samples
10_0003	2	Refrigerator/Freezer Temperature Maintenance
10_0006	4	PCB Wipe Field Sampling Procedure
10_0007	1	Industrial Waste Water Sampling
10_0010	0	Operation of Radalert Radiation Monitor
10_0011	1	ISCO Maintenance
10_0012	1	Field Soil Sampling
10_0013	1	Groundwater Well Sampling
10_0016	2	Field pH testing
10_0017	2	Sample Courier Service
10_0020	3	Restricted Soil
10_0021	0	Drinking Water (SDWA) Sample Collection
10_0022	0	General Field Wipe Sampling Procedure
10_0023	0	Wood Chip Sample Size Reduction Procedure
20_0000		**VOA Department**
20_0001	2	Reagent and Standard Tracking VOC Lab_
20_0002A	4	Measurement of Purgeable Organic Compounds in Water By Capillary Column GC/MS (EPA Method 524.2)
20_0004	9	Gasoline Range Organics(GRO)
20_624_1	0	Volatile Organic Compounds by GC/MS: Capillary Column Technique (EPA Method 624.1)
20_1311	3	TCLP SW846 Method 1311 (VOA)
20_8260B	11	Volatile Organic Compounds by GC/MS: Capillary Column Technique (SW-846 Method 8260B)
20_8260C	1	Volatile Organic Compounds by GC/MS: Capillary Column Technique (SW-846 Method 8260C)

20_5035	10	Volatile Organic Compounds by GC/MS: Capillary Column Technique (SW-846 Method 5035/A)
20_VPH	5	Volatile Petroleum Hydrocarbons
30_0000		**Metals Department**
30_0003	7	Reagent and Standard Tracking Metals Lab
30_0004	1	Acid Volatile Sulfides & Simultaneously Extracted Metals in Sediment
30_1311	6	TCLP SW846 Method 1311
30_2009	9	Determination of Trace Elements by Stabilized Temperature Graphite Furnace Atomic Absorption (Method 200.9/7010)
30_2451	5	Mercury Analysis for Aqueous Samples (Methods 245.1/ SW846 7470A)
30_3005	8	Acid Digestion of Waters for Total Recoverable or Dissolved Metals for analysis by GFAA or ICP Spectroscopy (EPA 200.7 PREP/SW846 3005A)
30_3050B	7	Acid Digestion for Metals in Soil/Sediment Samples for ICP And GFAA (SW-846 Method 3050B)
30_3060	1	Hexavalent Chromium Alkaline Digestion Procedure
30_6010	15	ICP-AES (SW 846 Method 6010C/D, EPA Method 200.7)
30_6020	2	ICP-MS (SW 846 Method 6020A/B, EPA Method 200.8/MCP Method)
30_7196	4	Hexavalent Chromium Method (SM3500-Cr B/SW846 Method 3060A/7196A)
30_7471	4	Mercury Analysis for Soil Samples (SW846 Method 7471A/ B)
40_0000		**Wet Chemistry Department**
40_0001	3	Conductivity (SM2510; EPA 120.1; SW9050A)
40_0003	3	Alkalinity (SM2320B)
40_0005	6	BOD and CBOD (SM5210B)
40_0006	4	COD (EPA 410.4/SM5220D)
40_0007L	3	Chloride (Lachat) (SM4500-Cl-E and EPA 9250)
40_0008	3	Residual Chlorine (SM4500-Cl G)
40_0008Amp	3	Residual Chlorine (SM4500-Cl D)
40_0009	8	Total Cyanide by Distillation (All Methods)
40_0010L	5	Nitrogen, Nitrate (Lachat) (EPA 353.2)
40_0011	4	Nitrogen, Nitrite (Manual) (EPA 353.3; SM4500-NO2 B)
40_0011L	3	Nitrogen, Nitrite (Lachat) (EPA 353.2)
40_0014B	3	Phosphorus (all forms) (EPA 365.3)
40_0014L	6	Phosphorus (all forms) (Lachat) (EPA 365.1)

40_0015	2	Phenols, Total Recoverable (EPA 420.1; SW9065)
40_0016	3	pH (EPA 150.1; SW9040C; SM4500-H^+B)
40_0017	2	Sulfate (SW9038; SM4500-SO4-E)
40_0018	1	Sulfide (SM4500-S^{2-}D)
40_0019B	1	TKN (EPA 351.2)
40_0019-ISE	4	TKN (SM4500- NH_3 D)
40_0020A	5	Total Dissolved Solids(SM2540 C)
40_0021A	3	Total Suspended Solids(SM2540 D)
40_0022A	3	Total Solids (SM2540 B)
40_0023	3	Turbidity (EPA 180.1)
40_0024L	4	Ammonia by Lachat (EPA Method 350.1)
40_0024ISE	3	Ammonia by Ion Selective Electrode (SM4500-NH_3 D)
40_0025W	1	Anions by Ion Chromatography (Method EPA 300.0/SW846-9056A -Waters Instrumentation)
40_0026	1	Reactivity (SW846 Methods 7.3.3.2 & 7.3.4.2)
40_0029	1	Total Volatile Solids(EPA 160.4; SM2540 E)
40_0030	0	Settleable Solids(SM2540 F)
40_0033	0	Color (HACH Method)
40_0039	4	Reagent and Standard Tracking
40_0040	0	Silica, Dissolved (HACH Method; SM4500-SiO_2 D)
40_0041	2	Acidity (SM2310B)
40_0042	1	Salinity (SM2520B)
40_0044	1	Mc Laughlin Oil Testing Procedure
40_0045	0	Sulfite(SM4500-$S0_3$ B)
40_0046	0	ORP/Eh – Electrometric Measurement (SM2580)
40_0047	0	Determination of Formaldehyde by HPLC
40_0048	1	Iron, Ferrous by HACH Method 8146
40_0049	0	% Fasteners, % Plastics, % Non-Wood
40_9060-Aq	2	Total Organic Carbon (Methods 5310B and 9060A)
40_9060-LK	0	Total Organic Carbon (Lloyd-Kahn Method)
40_9041A	0	pH Paper Method (SW846 9041A)
40_9045	1	Soil and Waste pH (SW846 9045C)
40_9071	0	Oil and Grease in Sludge and Sediment (SW846 9071)
40_9095A	2	Paint Filter (SW846 9095A)
50_0000		**Organic Preparation Department**
50_EPH	6	EPH (State of Mass_)

50_NJ-EPH	1	Extractable Petroleum Hydrocarbons per NJDEP Method 10/08 Rev 3
50_0001	2	Glassware Cleaning Organic Prep
50_0006	4	Reagent and Standard Tracking Organic Prep
50_1664	4	Organic Prep for TPH and O&G by Hexane Extraction
50_1010	3	Flashpoint (Closed Cup) and Ignitability
50_3510	12	Sep_ Funnel Liquid-Liquid Extraction
50_3511-mod	0	MSE Aqueous Extraction
50_3520C	5	Continuous Liquid-Liquid Extraction
50_3535_diox	0	Solid Phase Extraction of 1,4-Dioxane
50_3540	4	Soxhlet Extraction
50_3546	1	Microwave Extraction
50_3570-mod	0	MSE Solids Extraction
50_3580A	3	Organic Prep_ Waste Dilution
50_3620B	1	Florisil Cleanup for Pest/PCBs
50_3660B	1	Sulfur Cleanup by Copper Powder
50_3665A	0	Sulfuric Acid/Permanganate Clean-up For PCBs
50_CarboPrep	1	Carbo-Prep Sep-Pak Cartridge Cleanup for Pesticides
60_0000		**Semi-VOA Department**
60_0001	3	Reagent and Standard Tracking SVOC Lab
60_0002	1	PCBs in Transformer Fluid and Waste Oils
60_5041	3	EDB, DBCP & 1,2,3-Trichloropropane (EPA Methods 504.1 and 8011)
60_5522	3	Haloacetic acids
60_8151A	3	Chlorinated Herbicides by GC/ECD (EPA Method 8151A)
60_8081	8	Pesticides by GC/ECD (Methods 608.3 and 8081B)
60_8082	7	PCB Aroclors by GC/ECD (Methods 608.3 and 8082A)
60_8082Cong	2	PCB Congeners by GC/ECD
60_8100-mod	5	TPH (Methods 8100-Mod and CT ETPH)
60_8270	11	Semivolatile Organics by GC/MS (8270D)
60_DRO	8	Diesel Range Organics (Methods 8015 B,C & D)
60_RSK-175	1	Methane, Ethane and Ethene by GC of Sample Headspace (RSK-175)
60_Glycols	2	Glycols by GC/FID
60_8100-MOD-FA	0	Alkane Hydrocarbons-FA
60_8270-MOD	3	MAH/PAH by GC/MS-FA
60_8270-BIO	0	Petroleum Biomarkers by GC-FA

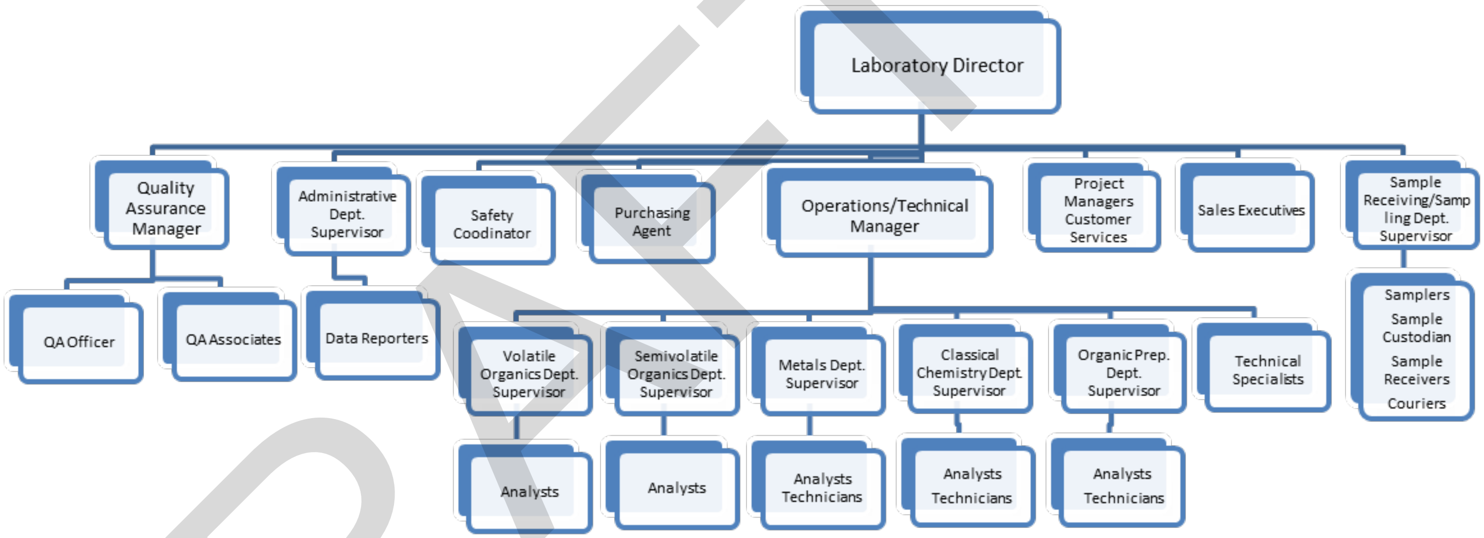
70_0000		**Administration Department**
70_0002	5	Data Flagging
70_0003	4	Purchasing
70_0004	5	Work Order Management Procedure
70_0005	4	Level III and IV Data Review
70_0006	1	Barcoding
70_0007	3	Data Entry and Data Reporting – Element LIMS
70_0008	2	Sample Login
70_0009	0	SDWA Reporting
80_0000		**Quality Assurance**
80_0004	5	QA Data Package Review
80_0009	4	Incident/Corrective Action
80_0012	3	Document Control
80_0013	4	Reagent Review and Tracking
80_0015	1	Review of QA
80_0016	3	Training
80_0018	0	Continuing Education Process
80_0020	0	Vendor Qualification
80_0024	2	Process Validation
80_0026	2	Proficiency Testing
80_0028	0	QC Procedure
80_0029	1	Management of Procedure Documents
80_0035	3	Internal Assessment
80_0040	2	Logbook Use, Review, and Control
80_0044	0	Laboratory Contingency Plan
80_0047	1	Computer Validation
80_0048	2	Sub-contract
80_0049	2	Data Integrity Plan
80_0051	0	Requests, Tenders and Contracts
LQAP	17	Laboratory Quality Assurance Plan
Policy Manual	0	Job Descriptions
GMP/GLP	3	Good Manufacturing Practices/Good Laboratory Practice Training
EQMT INV	2019	Equipment Inventory
SAP	2018	Sample Acceptance Policy
LOGLIST	2019	List of Log Books by Department

SOPMASLIST	2019	Current SOP Master List
INITIALS & SIGNATURES	2019	List of Employee Initials & Signatures
90_0000		**Safety**
90_0001	4	Laboratory Chemical Hygiene Plan
90_0002	4	Pollution Prevention and Haz Waste Cont and Emergency Response Plan
90_0003	3	Hazard Communication Program
90_0004	2	Safety and Hazardous Communication Program Training
90_0005	0	Respiratory Protection Policy
110_0000		**Quality Control**
110_0003	1	De-ionized Water System Testing
110_0005	4	Volumetric Ware Calibration
110_0010	1	In-House Thermometer Calibration and Tracking
110_0013	5	Method Detection Limit
110_0014	3	Control Charts
110_0015	1	Lab Security
110_0016	1	Manual Integration Policy and Procedure
110_0017	0	Tentatively Identified Compounds
110_0018	0	Balance Calibration and Verification
120_0000 (ESS Lab Internal Ref Nos_)	***Rev # or Date***	***ISO/ NELAC/State Documents and Checklists/Audits (ISO/ NELAC/State incorporated by reference)***
120_0007	2	ISO/IEC 17025:2005
120_0012	9/09	The NELAC Institute Standard EL-V1M2_V1M4 - 2009
120_0013		Commonwealth of Massachusetts DEP Regulations 310 CMR 22.0, 42.0 & 40.1600
120_0014		State of Rhode Island Drinking Water, Lab Certification & Remediation Regs
120_0016		Checklist: TNI Standard Module 4 - Quality Systems for Chemical Testing
120_0017		Checklist: TNI Standard Module 2 - Quality Systems for Chemical Testing
120_0018		Annual Systems Audit – TNI Module 2
120_0019		Annual Systems Audit – TNI Module 4
120_0020		Annual Systems Audit – TNI Module 1

Appendix B

Laboratory Organization Chart

(The most current chart can be obtained from the Quality Manager or Lab Director)



Appendix C

Analytical Methods

ANALYTE	POTABLE	NON-POTABLE	SOLIDS/WASTE
Metals			
Aluminum	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Antimony	200.5, 200.9, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Arsenic	200.5, 200.9, 200.8	200.7, SM3113B, 6010C/D, 7010, 7060A, 2008, 6020A/B	6010C/D, 7010, 6020A/B
Barium	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Beryllium	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D
Boron	200.7	200.7, 6010C/D	6010C/D, 6020A/B
Cadmium	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Chromium	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Chromium - Hexavalent	SM3500-Cr B	SM3500-Cr B, 7196A	7196A
Cobalt	200.7	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Copper	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Iron	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Lead	200.5, 200.9, 200.8	200.7, 6010C/D, 6020A/B	6010C/D, 6020A/B
Manganese	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Mercury	245.1	245.1/7470A	7471A
Molybdenum	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Nickel	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Selenium	200.5, 200.9, 200.8	200.7, SM3113B, 6010C, 7010, 7740, 200.8, 6020A	6010C/D, 7010, 6020A/B
Silver	200.7, 200.8	200.7, 6010C, 200.8	6010C/D
Strontium	X	200.7, 6010C/D	6010C/D
Thallium	200.9, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Tin	X	200.7, 6010C/D	6010C/D
Titanium	X	200.7, 6010C/D	6010C/D
Vanadium	200.7, 200.8	200.7, 6010C/D	6010C/D, 6020A/B
Zinc	200.7, 200.8	200.7, 6010C/D, 200.8, 6020A/B	6010C/D, 6020A/B
Minerals			
Calcium	200.7	200.7, 6010C/D	6010C/D
Hardness	200.7	SM2340 B	X
Magnesium	200.7	200.7, 6010C/D	6010C/D
Potassium	200.7	200.7, 6010C/D	6010C/D
Sodium	200.7	200.7, 6010C/D	6010C/D
Volatile Organic Compounds	524.2	624.1, 8260B/C	8260B/C
Haloacetic Acids	552.2	X	X

EDB/DBCP	504.1	8011	X
Methane, Ethane & Ethene, by head- space Analysis	X	RSK-175	X
Pesticides	X	608.3, 8081B	8081B
PCBs	X	608.3, 8082A	8082A
PCBs in Oil	X	8082A EPA 600/4-81-045	EPA 600/4-81-045 8082A
BNA Extractables	X	625.1, 8270D	8270D
Low Level PAHs	X	8270SIM	8270SIM
Oil and Grease (Hexane)	X	1664A/B	9071B
Total Petroleum Hydrocarbons	X	1664A/B/8100M/TPH/CtEPH	8100M/TPH/CtEPH
Volatile Petroleum Hydrocarbon	X	GRO (8015C/D), MADEP VPH	GRO (8015C/D), MADEP VPH
Extractable Petroleum Hydrocarbon, Mass , Maine & New Jersey	X	DRO(8015C/D), MADEP EPH, NJDEP EPH	DRO(8015C/D), MADEP EPH, NJDEP EPH
Herbicides	X	8151A	8151A
Inorganics			
Acidity	SM2310B	SM2310B	X
Alkalinity	SM2320B	SM2320B	SM2320B*
Ammonia	X	350.1, SM4500-NH3 D	350.1
BOD	X	SM5210B	X
COD	X	410.4, SM5220-D, HACH 8000	X
Chloride	300.0	300.0, SM4500-Cl-E, 9056A, 9250	9056A*, 9250*
Cyanide	4500-CN C,E	9014, SM4500-CN C,E	9014
Flashpoint	X	X	1010A
Fluoride	300.0	300.0, 9056A	X
Formaldehyde	X	8315A/1667 Rev. A Mod	X
Hardness	SM2340B	SM2340B, 6010C/D	6010C
Iron, Ferrous	X	HACH 8146	X
MBAS	5540C	5540C	5540C
Nitrate	353.2	353.2,	353.2*
Nitrite	353.2	300.0, 353.2, SM4500-NO2 B, 9056A	353.2*, 9056A*
Orthophosphate	365.1	365.1, 365.3	365.1*, 365.3*
Paint Filter	X	X	9095A
pH	150.1 SM4500-H$^+$ B	SM4500-H$^+$ B	9040, 9045C

Reactive Cyanide	X	X	7.3.3.2
Reactive Sulfide	X	X	7.3.4.1
Settleable Solids	X	SM2540F	X
Silica	X	SM4500-SiO_2 D	X
Specific Conductance	SM2510B	120.1, SM2510B	9050A*
Sulfate	300.0, 4500-SO_4-E	300.0, 9038, 9056A	9038*, 9056A*
Sulfide	HACH	HACH, SM4500-S^{2-}D	X
Sulfite	X	SM4500-SO_3^-B	X
Total Dissolved Solids	SM2540C	SM2540C	X
Total Suspended Solids	X	SM2540D	X
Total Kjehdahl Nitrogen	X	351.2, SM4500-NH3 D, SM4500 NORG B	X
Total Phenolics	X	420.1	9065
Total Phosphorous	X	365.1, 365.3	365.1, 365.3
Total Residual Chlorine	SM4500-Cl D, G	SM4500-Cl D, G	X
Total Solids	X	SM2540B	SM2540B
Turbidity	180.1	180.1	X
Volatile Solids	X	160.4, SM2540 E	X
Total Organic Carbon	SM5310B	SM5310B/9060A	9060A
TCLP	X	X	1311
SPLP	X	X	1312

* Water Leach

Appendix D

Laboratory Accreditation/Certification/Recognition

ESS Laboratory maintains the following certifications and accreditations with numerous state and national entities:

State/Federal Organization	Certificate Number
Connecticut DPH	PH-0750
Maine DEP	RI00002
Massachusetts DEP	M-RI002
New Hampshire DOH (NELAP Primary Accreditation Agency)	2424
New York State DOH	11313
Rhode Island DOH	LAI00179
New Jersey DEP	RI006
Pennsylvania DEP	68-01752
USDA (Foreign Soil Permit)	P330-18-00249

The certificates (with expiration dates) and parameter lists (which may differ) for each organization are filed in the QA Dept. files and may also be found in client reports, on the ESS Laboratory website and on the websites of the organizations identified above. Links to these organization websites are supplied in all clients' certificates of analysis. Certificates are on display in the ESS Laboratory conference room.

If accreditation is terminated or suspended, the laboratory will immediately cease to use the certificate number reference in any way and inform clients impacted by the change.

Appendix E

CONFLICT OF INTEREST AND UNDUE PRESSURE

It is the policy of ESS Laboratory to identify conflicts of interest involving the Laboratory and related parties, as well as to identify situations which may give rise to the appearance of a conflict of interest, and to address such conflicts and situations in a manner that will fully protect the integrity and reputation of the Laboratory, as well as related parties. All employees are expected to use good judgment, to adhere to high ethical standards, and to act in such a manner as to avoid any actual or potential conflict of interest. A conflict of interest occurs when the secondary personal, professional, or business interests of an employee conflict with the primary interests of the Laboratory.

When a secondary interest has inappropriate weight in a decision and distorts the pursuit of a primary interest, it is exerting undue influence.This policy is intended to supplement but not replace any applicable state and federal laws governing conflict of interest which are applicable to commercial organizations.

Such a policy works best when it is preventive and corrective rather than punitive. However, when a professional's judgment is actually distorted by the acceptance of a gift, the violation is no longer principally a conflict of interest but becomes a different kind of offense, one that may involve malpractice, scientific misconduct, or kickbacks.

Procedures:

- Upon or before hire or appointment and subsequently during annual performance review, each employee (manager, supervisor or analyst) shall disclose all direct or indirect financial interests that might benefit their private interest or may give the appearance of undue influence from outside parties thereby potentially resulting in a conflict of interest. This disclosure will be kept on file and will be updated as needed.

- Should there be any dispute as to whether a conflict of interest exists, the Director shall determine whether a conflict of interest exists for an employee, and shall determine the appropriate, fair and reasonable response.

- If the Director has reason to believe an individual has failed to disclose actual or potential conflicts of interest, the Director will inform the member and allow him/her to explain the alleged failure to disclose. If the Director still has reason to believe a conflict of interest exists after the alleged conflict is explained, the Director will take appropriate corrective action.

Principles for Identifying and Assessing Conflicts of Interest

The problem of conflict of interest is more complex than is often appreciated. As a result, both critics and defenders of conflict of interest policies sometimes misunderstand or misapply them.

A conflict of interest is not an actual occurrence of bias or a corrupt decision, but rather a set of circumstances that past experience and other evidence have shown poses a risk that primary interests may be compromised by secondary interests. Examples might be having financial interest in or working during off-hours for customer, competing or other companies, substance abuse etc. The existence of a conflict of interest does not imply that any individual is improperly motivated. To avoid these and similar misunderstandings and to provide guidance for formulating and applying such policies, a framework for assessing conflicts of interest is desirable.

Conflicts should be assessed by considering various factors that determine their likelihood and seriousness. Likelihood depends on the value of the secondary interest, the scope of the relationship between the professional and the secondary interest, and the extent of a professional's discretion. Seriousness depends on the value of the primary interest, the scope of the consequences that affect it, and the extent of accountability of the professionals. Conflict of interest policies should be evaluated by considering their effectiveness, transparency, accountability, and fairness.

Appendix F

Chemistry
(Sections 1.5 and 1.6 of Technical Module TNI V1:M4)

The lab is considered to have satisfied the requirements on analytical uncertainty by following recognized test methods and reporting instructions, in the absence of project specific instructions. Refer to Section 27.

F.1 Method Validation

Reference methods are validated by determining the LOD or LOQ, and precision and bias using the procedures outlined below.

Unless otherwise specified, the procedure for validating chemistry methods must include procedures for determining:

Establishment of SOPs

Limit of Detection (LOD) (must be in each quality system matrix to be used in the laboratory)

Limit of Quantitation/ Lower Limit of Quantitation (LOQ/LLOQ) - must be in each quality system matrix to be used in the laboratory

Evaluation of Precision and Accuracy (Bias)

Evaluation of Selectivity (see Section 27.2.1.2)

Demonstration of Capability

Calibration and calibration verification

Before any non-standard method is used in the laboratory, the laboratory determines the data quality indicators that must be used to ensure that the data are acceptable for the intended use. Based on the intended use, the laboratory establishes quality control acceptance criteria for precision, accuracy, selectivity (if applicable). Quality control procedures and acceptance criteria are consistent with those of similar standard methods or technologies, and must include the following:

i) Scope;

ii) Calibration and calibration verification;

iii) Interferences/Contamination, method/calibration blanks;

iv) Analyte identification;

v) Analyte quantitation;

vi) Selectivity;

vii) Sensitivity;

viii) Precision; and

ix) Bias.

Methods must be validated when modifications cause changes in stoichiometry, technology, mass tuning acceptance criteria, or quantitation ions to occur. Method modifications, as described in the Nov 20, 2007 USEPA Memorandum (incorporated here by reference) on method flexibility, are allowed.

a) <u>Limit of Detection (LOD) (also see SOP 110_0013)</u>

The Limit of Detection (LOD) is the laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility (also known as Method Detection Limit, MDL)

LODs are not required for any component for which spiking solutions or quality control samples are not available. These include tests such as pH, temperature, BOD and specific conductance. If the laboratory is not reporting a value below the Limit of Quantitation, a Limit of Detection study is not required for many methods. The Method Detection Limit study is required for Clean Water Act methods

The laboratory will select methods with LODs that are expected to meet the intended data use.

LODs are determined in samples that represent the quality system matrices to be evaluated. All sample processing/preparation steps and all determinative steps are used to validate the method for all targeted analytes. The representative quality system matrix will be free from the target analytes of interest or interfering analytes that impact the LOD.

When the method or applicable regulation specifies a LOD study, only the specified method will be used. The laboratory documents the process used to derive the LOD and retains all the supporting data.

A Detection Limit (DL) is established based upon historical data or 40CFR Part 136 Appendix B (if required). The DL is used to determine the LOD for each analyte and matrix as well as for all preparatory and cleanup methods routinely used on samples.

After each DL determination, the laboratory establishes the LOD by spiking a quality system matrix at a concentration of at least 2 times but no greater than four times the DL (this procedure is based on the DoD QSM Standard requirement). This spike concentration establishes the LOD and the concentration at which the LOD shall be verified. It is specific to each suite of analyte, matrix, and method (including sample preparation/cleanup).

The “Definition and Procedure for the Determination of Method Detection Limit” revision 2, in 40 CFR part 136, Appendix B is followed for methods that fall under the Clean Water Act, as detailed in SOP 110_0013, Appendix C. For all other methods, as appropriate, the following requirements apply to the initial LOD establishment and to the LOD verifications:

Once the LOD has been determined, the validity of the LOD is verified by detection of each target analyte in a quality control sample of a representative quality system matrix. The concentration of the analytes in the sample will be no more than 3 times the derived LOD unless the test contains multiple analytes. In the latter case, the concentration of the target analytes will be no greater than 4 times the LOD, per the TNI 2009 Standard. This verification will be performed on each instrument that is used for the test.

The LOD, if required, shall be verified for each quality system matrix, technology, and analyte. However, not all possible combinations of preparation and cleanup techniques are required to have LOD/LOQ verifications. If LOD/LOQ verifications are not performed on all combinations, the laboratory must base the LOD/LOQ verifications on the worst case basis (preparation method with all applicable cleanup steps).

i) The apparent signal to noise (S/N) ratio at the LOD must be greater than zero and should normally be at least three; the results must meet all method requirements for analyte identification (e.g., ion abundance, second column confirmation, or pattern recognition). For data systems that do not provide a measure of noise, the signal produced by the verification sample should produce a result that is at least three standard deviations greater than the mean method blank concentration. This is initially estimated based on a minimum of four method blank analyses and later established with a minimum of 20 method blank results.

ii) If the LOD verification fails, then the laboratory must perform and pass two consecutive LOD verifications at a higher spike concentration and set the LOD at the higher concentration.

iii) The laboratory shall maintain documentation for all DL determinations and LOD verifications.

The LOD shall be verified annually. In situations where methods are setup and used on an infrequent basis, the laboratory may choose to perform LOD (and LOQ) verifications on a one per batch basis. All verification data will be in compliance, reported, and available for review.

LODs are performed/repeated:

- before reporting the LOD for a given analyte,
- any time there is a change that affects how the method is performed,
- when there is a change in instrumentation that affects the sensitivity of the analysis.

b) Limit of Quantitation (a/k/a Lower Limit of Quantitation)

The Limit of Quantitation (LOQ, LLOQ) is the minimum amount of a substance that can be reported with a specified degree of confidence.

If an LOD study is not performed, concentration values less than the Limit of Quantitation are not reported.

LOQs are not required for components or properties for which spiking solutions or QC samples are not available. These include tests such as pH, temperature, BOD and specific conductance

An LOQ study includes all sample processing and analysis steps in the analytical method. The study is performed for each analyte in each quality system matrix for which the test will be performed. The procedure is documented and all supporting data are retained.

The laboratory will verify the LOQ by the analysis of a QC sample containing the analytes of concern at a concentration of 1 to 2 times the derived (claimed) LOQ. The LOQ is considered verified if recovery of each analyte is within the laboratory's acceptance limits, or the client's data quality objectives. The LOQ must be greater than the LOD.

The LOQ will be verified annually for each quality system matrix, technology and analyte. However, the annual LOQ verification is not required if the LOD was determined or verified annually on that instrument.

c) Precision and Bias

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms.

Bias is the systematic error that contributes to the difference between the mean of a significant number of test results and the accepted reference value.

Precision and bias of a reference method is determined by using the Demonstration of Capability procedure (Section F.2 below).

Precision and bias using non-reference, modified reference or laboratory-developed methods are established using the procedure outlined as follows, and compared to the criteria established by the client (when requested), the method, or the laboratory.

Precision and bias are determined by processing samples through all phases of the method (sample preparation, cleanup, analysis, etc.) and are evaluated across the analytical calibration range of the method. This study is performed for all quality system matrices for which the test is to be used and the typical procedure is as follows:

1. Analyze in triplicate QC samples containing the analytes of concern at or near the limit of quantitation, at the upper-range of the calibration (upper 20%) and at a mid-range concentration.
2. Process these samples on different days as 3 sets of samples through the entire measurement system for each analyte of interest.
3. Each day, one QC sample at each concentration is analyzed.
4. A separate method blank shall be subjected to the analytical method along with the QC samples on each of the three days. (Note that the three samples at the LOQ concentration can demonstrate sensitivity as well).
5. For each analyst, calculate the mean recovery for each day, for each level over each day, and for all nine samples.
6. Calculate the relative standard deviation for each of the separate means obtained.
7. Compare the standard deviations for the different days and the standard deviations for the different concentrations.
8. If the different standard deviations are all statistically insignificant (e.g. F-test), then compare the overall mean and standard deviation with the established criteria from above.

d) <u>Selectivity</u>

Selectivity is the capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances.

The laboratory evaluates selectivity using the procedures described in Section 27.2.1.2 of this QA Manual and is defined further in the test method SOPs.

F.2 Demonstration of Capability

Demonstration of Capability (DOC): A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Before reporting any data with a given method, a satisfactory initial DOC is performed in accordance with F.2.(a) below and SOP 80_0016 (Training) Thereafter, each analyst demonstrates continuing proficiency through the procedures outlined in Ongoing Demonstration of Capability below.

a) <u>Initial Demonstration of Capability (IDOC)</u>

An IDOC is performed:

- Before using any method
- Each time there is a change in instrument type, personnel or method (or any change that could potentially affect the precision and bias, sensitivity or selectivity of the output), and

- If the laboratory or analysts has not performed the method in a preceding twelve-month period.

The IDOC(s) for each analyst is documented in the analysts' training files kept by the QA Dept. The document identifies the analyst(s) involved in preparation and/or analysis; matrix; analyte(s), class of analyte(s), or measured parameter(s); the method(s) performed; the laboratory-specific SOP used for analysis (including revision number); the date(s) of analysis; and a summary of the results used to calculate the mean recovery and standard deviations.

All raw data, preparation records, and calculations for each IDOC are retained and are available for review.

When methods specify procedures to be followed only those procedures will be used. If no procedures are specified, the laboratory uses its own procedure (per SOP 80_0016 and below). SOP 80_0016 is documented in the QA Dept. master SOP files and also in the relevant departmental files.

Process for Initial DOC:

a) A quality control sample is obtained from an outside source. If not available, the QC is prepared using stock standards that are prepared independently from those used in instrument calibration.

b) The analyte(s) is diluted in a volume of clean quality system matrix sufficient to prepare four aliquots at the concentration specified, or if unspecified, to a concentration of 1-4 times the limit of quantitation.

c) At least four aliquots are prepared and analyzed according to the test method either concurrently or over a period of days.

d) Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations of the population sample (in the same units) for each parameter of interest. When it is not possible to determine mean and standard deviations, such as for presence/absence and logarithmic values, the performance is assessed against established and documented criteria.

e) Compare the information from (d) above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria (if mandatory criteria have not been established). If all parameters meet the acceptance criteria, the analysis of actual samples may begin. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter. The acceptance criteria must be defined prior to the analyst performing the method.

f) When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to 1) or 2) below.

    1. Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with c) above.

2. Beginning with c) above, repeat the test for all parameters that failed to meet criteria.

Repeated failure, however, confirms a general problem with the measurement system. If this occurs, the source of the problem is located and corrected and the test repeated for all compounds of interest beginning with c).

b) Ongoing Demonstration of Capability

After the demonstration of capability is completed, on-going proficiency is maintained and demonstrated at least annually. Each analyst is expected to consistently meet the QC requirements of the method, the laboratory SOP, client requirements and/or the TNI Standard. Ongoing DOCS are documented in the analysts' training files kept by the QA Dept. and all records related to the demonstration are retained.

The laboratory uses the following procedure described in SOP 80.0016 and below to demonstrate ongoing DOC:

Process for Ongoing (a/k/a Continuing) DOC:

a) Acceptable performance of a blind sample (single blind to the analyst). Successful analysis of a blind performance sample on a similar method using the same technology (e.g., GC/MS volatiles by purge and trap for Methods 524.2, 624 or 5030/8260) would only require documentation for one of the tests.;
b) Another initial DOC;
c) At least four (4) consecutive (as listed chronologically in the LIMS database) laboratory control samples with acceptable levels of precision and accuracy. The laboratory shall determine the acceptable limits for precision and accuracy prior to analysis. The laboratory shall tabulate or be able to readily retrieve four (4) consecutive passing laboratory control samples (LCS) for each method for each analyst each year;
d) A documented process of analyst review using quality control (QC) samples. QC samples can be reviewed to identify patterns for individuals or groups of analysts and determine if corrective action or retraining is necessary; or
e) If a) through d) are not technically feasible, then analysis of real-world samples with results within predefined acceptance criteria (as defined by the laboratory or method) shall be performed.

F.3 Calibration

Section 23.2.2 includes information on calibration of support equipment. This Section covers calibration of analytical equipment.

Initial instrument calibration and continuing instrument calibration verification are an important part of ensuring data to be of known and documented quality. If more stringent calibration requirements are included in a mandated method or by regulation, those calibration requirements override any requirements outlined here or in laboratory SOPs. Generally, procedures and criteria regarding instrument calibrations are provided in test SOPs.

F.3.1 Initial Instrument Calibration

- Records:

  Initial instrument calibration includes calculations, integrations, acceptance criteria, and associated statistics referenced in the test method SOP. Sufficient raw data records are collected and retained to allow reconstruction of the initial instrument calibration. These include, at a minimum, calibration date, test method, instrument, analysis date, analyte names, analysts signature or initials, concentration and response, calibration curve or response factor, or unique equation or coefficient used to reduce instrument responses to concentration. Calibration date and expiration date (when recalibration is due) is documented for equipment requiring calibration, where practicable (see Section 23.1).

- Number of Standards and Concentrations:

  If the reference or mandated method does not specify the number of calibration standards to use, the minimum number is three for inorganic analyses and five for organic analyses, not including blanks or a zero standard, except as noted below. All reported analytes and surrogates shall be included in the initial calibration. Reported results for all analytes and surrogates shall be quantified using a multipoint calibration curve, except as noted above. Exclusion of calibration points without a scientifically valid technical justification is not permitted.

  For instrumentation where single point calibration is recommended by manufacturer's instructions, such as with some ICP and ICP/MS technologies (with a zero and single point calibration), the following apply:

  a) For single point plus zero blank calibrations, the zero point and the single point standard are analyzed prior to the analysis of samples, and the linear range of the instrument established by analyzing a series of standards, one of which is at the lowest quantitation level.
  b) Zero blank and single point calibration standards are analyzed with each analytical batch for methods where they are specified.
  c) A standard corresponding to the limit of quantitation is analyzed with each analytical batch and must meet established acceptance criteria when using single point plus zero blank calibrations.
  d) The linearity of single point plus zero blank calibrations is verified at a frequency established by the method or the manufacturer.

The lowest calibration standard is the lowest concentration for which quantitative results can be reported without qualification. The lowest calibration standard is at or below the Limit of Quantitation (LOQ) and is greater than the Limit of Detection. Results that are less than the LOQ are considered to have increased uncertainty, and are either reported with a qualifier code or explained in the case narrative.

The highest calibration standard is the highest concentration for which quantitative results can be reported. Data reported exceeding the highest calibration standard without dilutions (which must be done if sufficient sample volume and holding time permit) is considered to have increased uncertainty and are reported with a qualifier code or reanalyzed and explained in the case narrative. However, for metals analysis with a single point calibration, the laboratory may report a sample result above the quantitation range if the laboratory analyzes and passes a CCV that exceeds the sample concentration but is within the linear dynamic range.

- Evaluation, Verification and Corrective Action

All initial instrument calibrations are verified with a standard obtained from a second source traceable to a national standard when commercially available. If a second source is not available, a standard prepared from a different lot (independently prepare from different source materials) may be used. Concentration of the second source shall be at or near the midpoint of the calibration range.

Criteria for the acceptance of an initial instrument calibration is established (e.g., correlation coefficient or relative percent difference) and defined in the test SOP. The criteria used are appropriate to the calibration technique and must be at least as stringent as those for the continuing calibration verification (CCV).

Where appropriate, the laboratory has manual integration procedures (SOP 110_0016 (Manual Integration Policy and Procedure) that are adhered to when evaluating calibration data.

Any samples that are analyzed after an unacceptable initial calibration are re-analyzed or the data are reported with qualifiers, appropriate to the scope of the unacceptable condition (see Section 12 – "Control of Nonconforming Environmental Testing").

Quantitation is always determined from the initial calibration unless the test method or applicable regulations require quantitation from the continuing instrument calibration verification.

Corrective actions are performed when the initial calibration results are outside acceptance criteria. Calibration points are not dropped from the middle of the curve unless the cause is determined and documented. If the cause cannot be determined, the calibration curve is re-prepared. If the low or high calibration point is dropped from the curve, the working curve is adjusted and sample results outside the curve are qualified.

F.3.2 Continuing Instrument Calibration

- Records

  The calculations and associated statistics for continuing instrument calibration are included or referenced in the test method SOPs. The concentration of the CCV standard is greater than the low calibration standard and less than or equal to the midpoint of the calibration range. All CCVs must be analyzed and reported. If a CCV fails, reanalysis or corrective action must be taken.

  Sufficient raw data records are retained to allow reconstruction of the continuing instrument calibration verification. Continuing instrument calibration verification records connect the continuing verification date to the initial instrument calibration.

  Where appropriate, the laboratory has manual integration procedures, detailed in SOP 110_0016 that are adhered to when evaluating calibration data.

- Frequency

  Calibration shall be verified for each compound, element, or other discrete chemical species, except for multi-component analytes such as Aroclors, Chlordane, Total Petroleum Hydrocarbons, or Toxaphene, where a representative chemical, related substance or mixture can be used.

  Calibration verifications are performed:

  - At the beginning and end of each analytical batch. For methods employing internal standards, a single verification is performed at the beginning of the analytical batch, per the TNI Standard. Some methods have more frequent CCV requirements (see specific SOPs). Many inorganic methods require the CCV to be analyzed after every 10 samples.
  - Whenever it is expected that the analytical system may be out of calibration or might not meet verification acceptance criteria.
  - When the time period for calibration or the most recent calibration verification has expired.
  - For all analytical systems that have a calibration verification requirement. Requirements can be found in the method SOPs.
  - Before sample analysis, after every 10 field samples, and at the end of the analysis sequence, with the exception of CCVs for Pesticides multi-component analytes (i.e. Aroclors, Toxaphene, Chlordane, total petroleum hydrocarbons), where a representative chemical, related substance or mixture can be used.

- Evaluation, Verification and Corrective Actions

  The validity of the initial calibration is verified prior to sample analysis by use of a continuing instrument calibration verification (CCV) standard. CCV acceptance criteria are included in the test method SOPs.

Corrective action is initiated for CCV results that are outside of acceptance criteria (see Section 12 – "Control of Nonconforming Environmental Testing" and below).

F.3.3 Unacceptable Continuing Instrument Calibration Verifications

If routine corrective action for continuing instrument calibration verification fails to produce a second consecutive (immediate-must start within one hour; no samples can be run between the failed CCV and the two additional CCVs) calibration verification within acceptance criteria, then a new calibration is performed or acceptable performance is demonstrated after corrective action with two consecutive calibration verifications.

For any samples analyzed on a system with an unacceptable calibration, some results may be useable if qualified and under the following conditions:

a) If the acceptance criteria are exceeded high (high bias) and the associated samples are below detection, then those sample results that are non-detects may be reported as non-detects.

b) If the acceptance criteria are exceeded low (low bias) and there are samples that exceed the maximum regulatory limit, then those exceeding the regulatory limit may be reported.

Saturated Hydrocarbons and Alkylated MAH and PAH:

ESS Laboratory performs the forensic GCFID and GCMS analysis using the following procedures:

Soil Extraction: Samples are extracted by Microscale Solvent Extraction- MSE (EPA Method 3570 Modified):

Initial volume: 5g

Final volume 2 mL

Water Extractions: Samples are extracted by MSE (EPA Method 3511 Modified):

Initial volume: 35mL

Final Volume: 2mL

Saturated Hydrocarbons, Isoprenoids and Aliphatic Ranges (DRO and TPH): GC/FID analysis

Alkylated MAH and PAH: GC/MS analysis (Analytes evaluated from SIM with full scan also collected)

QC Criteria: Surrogates 50-120%, Blank Spike 60-140%

GC-FID CCV +/-20%D w/ 15% <25%D

GC-MS CCV +/- 25%D w/ Average <15%D

Soil samples are dried with sodium sulfate in glass vials, spiked with surrogate and extracted for 4 hours using method 3570-Mod. Once complete samples are filtered through sodium sulfate and concentrated to a final volume of 2mL. If high levels of contamination are present the final volume may be adjusted. The extract is spiked with internal standard and aliquots removed for GC-FID and GC-MS analysis.

Water samples have sodium chloride, surrogate and 2mLs of DCM added and are extracted for 4 hours using method 3511-Mod. Once complete a portion of the DCM is removed, spiked with internal standard and aliquots removed for GC-FID and GC-MS analysis.

For saturated hydrocarbons the extracts are analyzed by wide-range GC-FID using method 8015-Mod. This method provides gas chromatographic conditions for the detection of some volatile and all semi-volatile petroleum fractions including gasoline, kerosene, diesel fuel or No. 2 fuel oil (home heating oil), lubricating oil, No. 6 oils, and crude oil. In addition, the method can be used to identify pyrogenic materials such as coal tar, creosote, and pitch. Extracted samples are injected into a capillary column that is temperature programmed to facilitate separation of organic compounds. Detection and quantitation are based on FID detection response compared to calibration standards using the internal standard technique.

For alkylated MAH and PAH the extracts are analyzed by GCMS/SIM using method 8270-Mod. The GC column is temperature programmed to separate the analytes, which are then detected with a mass spectrometer (MS), connected to the gas chromatograph. Analytes eluted from the capillary column are introduced into the mass spectrometer by a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using an initial calibration curve. In addition, a full scan run is collected simultaneously and can be provided for TIC identification.

Petroleum Hydrocarbon Analysis / Fingerprinting

Compound	Aqeous (ug/L - ppb)	Soil (mg/Kg - ppm)	NAPL (mg/Kg - ppm)
C-8	57.1	0.400	200
C-9	57.1	0.400	200
C-10	57.1	0.400	200
C-11	57.1	0.400	200
C-12	57.1	0.400	200
C-13	57.1	0.400	200
2,6,10-trimethyldodecane (1380)	57.1	0.400	200
C-14	57.1	0.400	200
2,6,10-trimethyltridecane (1470)	57.1	0.400	200
C-15	57.1	0.400	200
C-16	57.1	0.400	200
2,6,10-trimethylpentadecane (1650)	57.1	0.400	200
C-17	57.1	0.400	200
Pristane	57.1	0.400	200
C-18	57.1	0.400	200
Phytane	57.1	0.400	200
C-19	57.1	0.400	200
C-20	57.1	0.400	200
C-21	57.1	0.400	200
C-22	57.1	0.400	200
C-23	57.1	0.400	200
C-24	57.1	0.400	200
C-25	57.1	0.400	200
C-26	57.1	0.400	200
C-27	57.1	0.400	200
C-28	57.1	0.400	200
C-29	57.1	0.400	200
C-30	57.1	0.400	200
C-31	57.1	0.400	200
C-32	57.1	0.400	200
C-33	57.1	0.400	200
C-34	57.1	0.400	200
C-35	57.1	0.400	200
C-36	57.1	0.400	200
C-37	57.1	0.400	200
C-38	57.1	0.400	200
C-39	57.1	0.400	200
C-40	57.1	0.400	200
TPH (C8-C40)	57.1	0.400	200

MAH_PAH Analyte List

Compound	Aqeous (ug/L - ppb)	Soil (ug/Kg - ppb)	NAPL (mg/Kg - ppm)
Benzene	0.571	4.00	2.00
C1-Benzene	0.571	4.00	2.00
C2-Benzenes	0.571	4.00	2.00
C3-Benzenes	0.571	4.00	2.00
C4-Benzenes	0.571	4.00	2.00
C5-Benzenes	0.571	4.00	2.00
Methylcyclohexane	0.571	4.00	2.00
Toluene	0.571	4.00	2.00
Ethylbenzene	0.571	4.00	2.00
m,p-Xylene	0.571	4.00	2.00
Styrene	0.571	4.00	2.00
o-Xylene	0.571	4.00	2.00
Isopropylbenzene	0.571	4.00	2.00
n-Propylbenzene	0.571	4.00	2.00
1,3,5-Trimethylbenzene	0.571	4.00	2.00
1,2,3-Trimethylbenzene	0.571	4.00	2.00
1,2,4-Trimethylbenzene	0.571	4.00	2.00
t-Butylbenzene	0.571	4.00	2.00
sec-Butylbenzene	0.571	4.00	2.00
p-Isopropyltoluene	0.571	4.00	2.00
n-Butylbenzene	0.571	4.00	2.00
trans-Decalin	0.571	4.00	2.00
cis-Decalin	0.571	4.00	2.00
C1-Decalins	0.571	4.00	2.00
C2-Decalins	0.571	4.00	2.00
C3-Decalins	0.571	4.00	2.00
C4-Decalins	0.571	4.00	2.00
Benzo(b)thiophene	0.571	4.00	2.00
C1-Benzo(b)thiophenes	0.571	4.00	2.00
C2-Benzo(b)thiophenes	0.571	4.00	2.00
C3-Benzo(b)thiophenes	0.571	4.00	2.00
C4-Benzo(b)thiophenes	0.571	4.00	2.00
Naphthalene	0.571	4.00	2.00
2-Methylnaphthalene	0.571	4.00	2.00
1-Methylnaphthalene	0.571	4.00	2.00
C1-Naphthalenes	0.571	4.00	2.00
C2-Naphthalenes	0.571	4.00	2.00
C3-Naphthalenes	0.571	4.00	2.00
C4-Naphthalenes	0.571	4.00	2.00
Biphenyl	0.571	4.00	2.00
Acenaphthylene	0.571	4.00	2.00
Acenaphthene	0.571	4.00	2.00
Dibenzofuran	0.571	4.00	2.00
Fluorene	0.571	4.00	2.00
C1-Fluorenes	0.571	4.00	2.00
C2-Fluorenes	0.571	4.00	2.00
C3-Fluorenes	0.571	4.00	2.00

Dibenzothiophene	0.571	4.00	2.00
C1-Dibenzothiophenes	0.571	4.00	2.00
C2-Dibenzothiophenes	0.571	4.00	2.00
C3-Dibenzothiophenes	0.571	4.00	2.00
C4-Dibenzothiophenes	0.571	4.00	2.00
Phenanthrene	0.571	4.00	2.00
Anthracene	0.571	4.00	2.00
C1-Phenanthrenes/Anthracenes	0.571	4.00	2.00
C2-Phenanthrenes/Anthracenes	0.571	4.00	2.00
C3-Phenanthrenes/Anthracenes	0.571	4.00	2.00
C4-Phenanthrenes/Anthracenes	0.571	4.00	2.00
Retene	0.571	4.00	2.00
Benzo(b)naphtho(2,1-d)thiophene	0.571	4.00	2.00
C1-Benzonaphthothiophenes	0.571	4.00	2.00
C2-Benzonaphthothiophenes	0.571	4.00	2.00
C3-Benzonaphthothiophenes	0.571	4.00	2.00
C4-Benzonaphthothiophenes	0.571	4.00	2.00
Fluoranthene	0.571	4.00	2.00
Pyrene	0.571	4.00	2.00
C1-Fluoranthenes/Pyrenes	0.571	4.00	2.00
C2-Fluoranthenes/Pyrenes	0.571	4.00	2.00
C3-Fluoranthenes/Pyrenes	0.571	4.00	2.00
Benzo(b)fluorene	0.571	4.00	2.00
Benzo(c)fluorene	0.571	4.00	2.00
2-Methylpyrene	0.571	4.00	2.00
4-Methylpyrene	0.571	4.00	2.00
1-Methylpyrene	0.571	4.00	2.00
Benzo(a)anthracene	0.571	4.00	2.00
Chrysene/Triphenylene	0.571	4.00	2.00
C1-Benzo(a)anthracenes/Chrysenes	0.571	4.00	2.00
C2-Benzo(a)anthracenes/Chrysenes	0.571	4.00	2.00
C3-Benzo(a)anthracenes/Chrysenes	0.571	4.00	2.00
C4-Benzo(a)anthracenes/Chrysenes	0.571	4.00	2.00
Benzo(b)fluoranthene	0.571	4.00	2.00
Benzo(k)fluoranthene	0.571	4.00	2.00
Benzo(e)pyrene	0.571	4.00	2.00
Benzo(a)pyrene	0.571	4.00	2.00
Perylene	0.571	4.00	2.00
Indeno(1,2,3-cd)pyrene	0.571	4.00	2.00
Dibenzo(a,h)anthracene	0.571	4.00	2.00
Benzo(g,h,i)perylene	0.571	4.00	2.00
Coronene	0.571	4.00	2.00
2,6,10-trimethyldodecane (1380)	0.571	4.00	2.00
2,6,10-trimethyltridecane (1470)	0.571	4.00	2.00
2,6,10-trimethylpentadecane (1650)	0.571	4.00	2.00
C-17	0.571	4.00	2.00
Pristane	0.571	4.00	2.00

C-18	0.571	4.00	2.00
Phytane	0.571	4.00	2.00

MAH_PAH Additional Compounds

Compound	Aqeous (ug/L - ppb)	Soil (ug/Kg - ppb)	NAPL (mg/Kg - ppm)
2,6-Dimethylnaphthalene	0.571	4.00	2.00
2,3,5-Trimethylnaphthalene	0.571	4.00	2.00
4-Methyldibenzothiophene	0.571	4.00	2.00
2/3-Methyldibenzothiophene	0.571	4.00	2.00
1-Methyldibenzothiophene	0.571	4.00	2.00
3-Methylphenanthrene	0.571	4.00	2.00
2-Methylphenanthrene	0.571	4.00	2.00
2-Methylanthracene	0.571	4.00	2.00
9/4-Methylphenanthrene	0.571	4.00	2.00
1-Methylphenanthrene	0.571	4.00	2.00
Carbazole	0.571	4.00	2.00
C0-Naphthobenzothiophenes	0.571	4.00	2.00

The following are summaries of ESS Laboratory procedures with standard operating values. Volumes used and detection limits can change with difficult sample matrices and high moisture content.

MADEP EPH with PAHs:

ESS Laboratory performs the MADEP EPH analysis with the following parameters:

Soil Extractions: Sample are extracted by Microwave method 3546.

Initial volume: 25g

Final volume: 1ml

Water Extractions: Samples are extracted by Separatory Funnel method 3510.

Initial Volume: 1L

Final Volume: 1ml

Fractionation: 5 gram silica cartridges

Aliphatic range analysis: GC/FID analysis

Aromatic range and PAHs: GC/MS analysis following modified 8270 criteria per MADEP EPH method, using EPH surrogates and internal standards.

PAHs can be analyzed by GCMS-SIMs when lower detection limits are required.

Total Petroleum Hydrocarbon analysis from the EPH extract:

The sample is extracted by the MADEP EPH method. The extract is split into two sub-extracts. One sub-extract is analyzed by GC/FID for DRO C10-C28 and TPH in the C9-C36 range. (This range can be expanded to C40 or C44.) The remaining sub-extract is fractionated though a silica cartridge according to the MADEP EPH method and analyzed for Aliphatic and Aromatic hydrocarbons.

VOC Analysis, including MtBE:

Soils: Soils are prepared by method 5035 and analyzed by method 8260C. Method 5035 provides two procedures to prepare soil samples, a Low Level VOC analysis and a Mid to High Level VOC analysis using Methanol.

Low Level VOC analysis: The Low Level VOC analysis can produce low detection limits and is not suitable for samples with high concentrations of VOCs or difficult matrices that adsorb VOCs. Vials must be analyzed immediately or frozen with 48 hours of sampling for a 14 day hold time.

Methanol Analysis: For those samples with high concentrations of VOCs and difficult matrices, the methanol procedure is recommended. Vials must be stored <6C with a 14 day hold time.

ESS laboratory typically provides vials for both the Low Level VOC and Methanol analysis. It is recommended that only Methanol vials be submitted when detection limits from the Methanol vials are low enough to meet data quality objectives. The methanol can sometimes produce a better extraction, especially for difficult matrices. Low Level vials should be submitted when low detection limits are needed. Low Level vials should always be submitted in duplicate accompanied by one methanol vial. Any analyte outside of the low level calibration range will need to be analyzed from the methanol vial.

Required containers:

Low Level VOC: 2 x 40 ml pre-weighed VOA vials with 5 ml if DI water and a stir bar.

Methanol: 1 x 40 ml pre-weighed VOA vial with 15ml of methanol.

% Solids: An additional jar should accompany the VOA vials for % solids analysis.

Waters are prepared according to method 5030 and analyzed according to method 8260C. ESS requests 3 x 40ml 1:1HCl preserved vials with zero headspace for each sample. Vials must be stored <6C with a 14 day hold time.

TAL Metals plus Tin

Metals in soil are digested by method 3050 and analyzed by methods 6000 and 7000. Mercury in soil is digested and analyzed by method 7471.

Metals in water are digested by method 3005. Mercury in water is digested and analyzed by method 7470.

Samples (waters and soils) are initially run by ICP method 6010.   The lab may opt to analyze some elements by ICPMS or GFAA either to achieve lower detection limits or due to suspect matrix interferences.

Soil: (Elements not including Hg) – increasing weight for wet samples

Initial Volume: 2.5- 5 grams

Final Volume: 100ml

Soil Hg: – increasing weight for wet samples

Initial Volume: 0.6 to 2g

Final Volume: 40ml

Water (Elements not including Hg) : (or 100 to 10 for lower DLs)

Initial Volume: 50 ml

Final Volume: 25 ml

Water Hg:

Initial Volume: 20 ml

Final Volume: 40 ml

Semivolatile 8270D:

ESS Laboratory performs the 8270D analysis with the following parameters:

Soil Extractions: Sample are extracted by Microwave method 3546.

Initial volume: 15g

Final volume: 0.5ml

Water Extractions: Samples are extracted by Liquid/Liquid Extraction method 3520.

Initial Volume: 1L

Final Volume: 1ml

PCB 8082A:

ESS Laboratory performs the 8082A analysis with the following parameters:

Soil Extractions: Sample are extracted by Soxhlet method 3540.

Initial volume: 20g

Final volume: 10ml

Water Extractions: Samples are extracted by Separatory Funnel method 3510.

Initial Volume: 1L

Final Volume: 1ml

Cleanups: All sample extracts are acid washed. Extracts are copper cleaned when sulfur interferes with chromatography.

Pesticide 8081A:

ESS Laboratory performs the 8081A analysis with the following parameters:

Soil Extractions: Sample are extracted by Microwave method 3546.

Initial volume: 20g

Final volume: 5ml

Water Extractions: Samples are extracted by Separatory Funnel method 3510.

Initial Volume: 1L

Final Volume: 5ml

Cleanup: All sample extracts are Carbopreped.

Herbicide 8151A:

ESS Laboratory performs the 8151A analysis with the following parameters:

Soil Extractions: Sample are extracted by Microwave method 3546.

Initial volume: 10g

Final volume: 4ml

Water Extractions: Samples are extracted by Separatory Funnel.

Initial Volume: 500ml

Final Volume: 4ml

Micro-extractions (When low reporting limits not needed)

Initial Volume: 40ml

Final Volume: 4ml

Cyanide, Free method 9014

Soils: Colorimetric analysis of a water leach

Waters: Colorimetric Analysis of water.

Total Cyanide method 9014

Soil Extractions: Midi-distillation followed by manual colorimetric analysis

Initial volume: 1ml

Final volume: 5ml

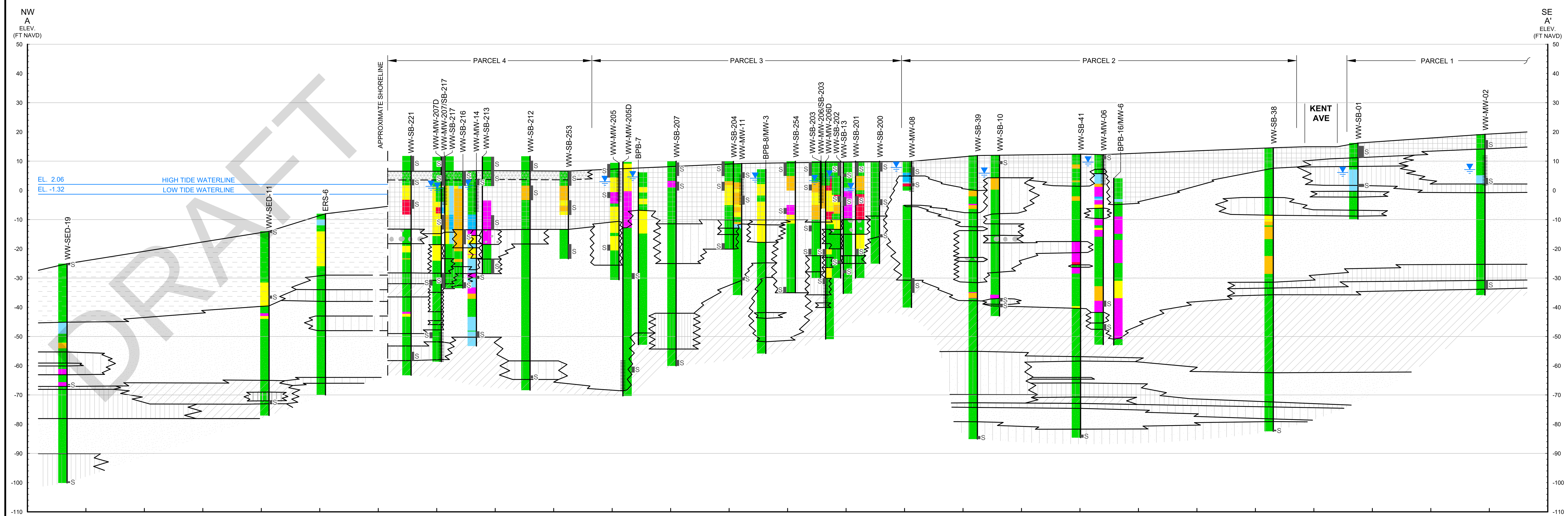
Water Extractions: Midi-distillation followed by manual colorimetric analysis

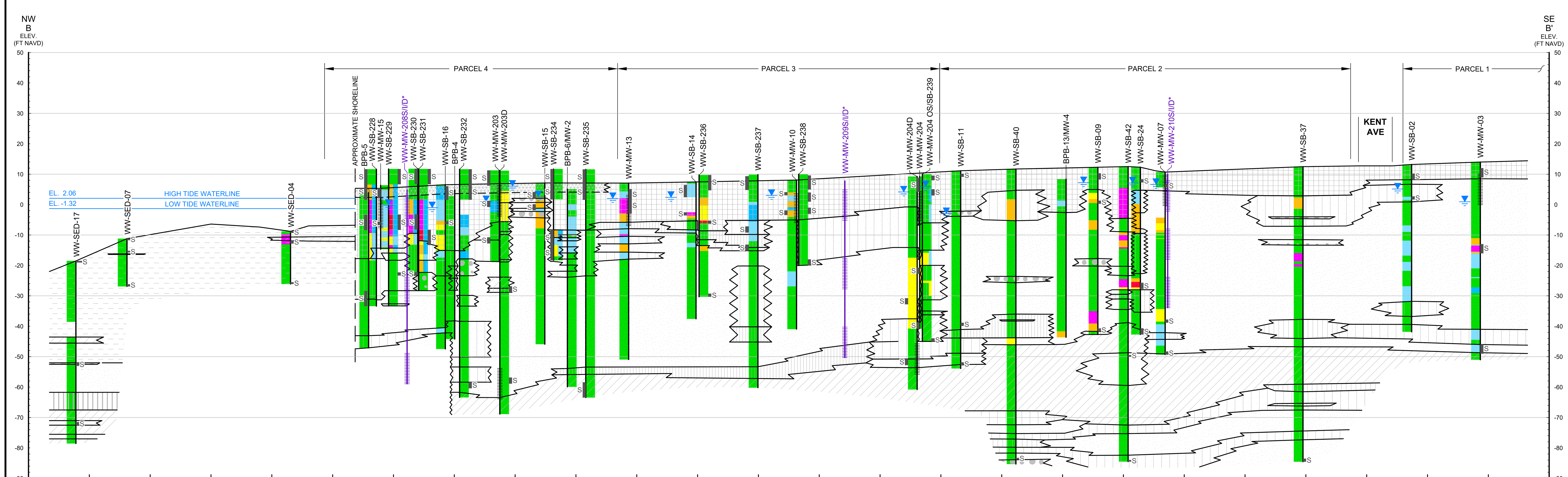
Initial Volume: 50ml

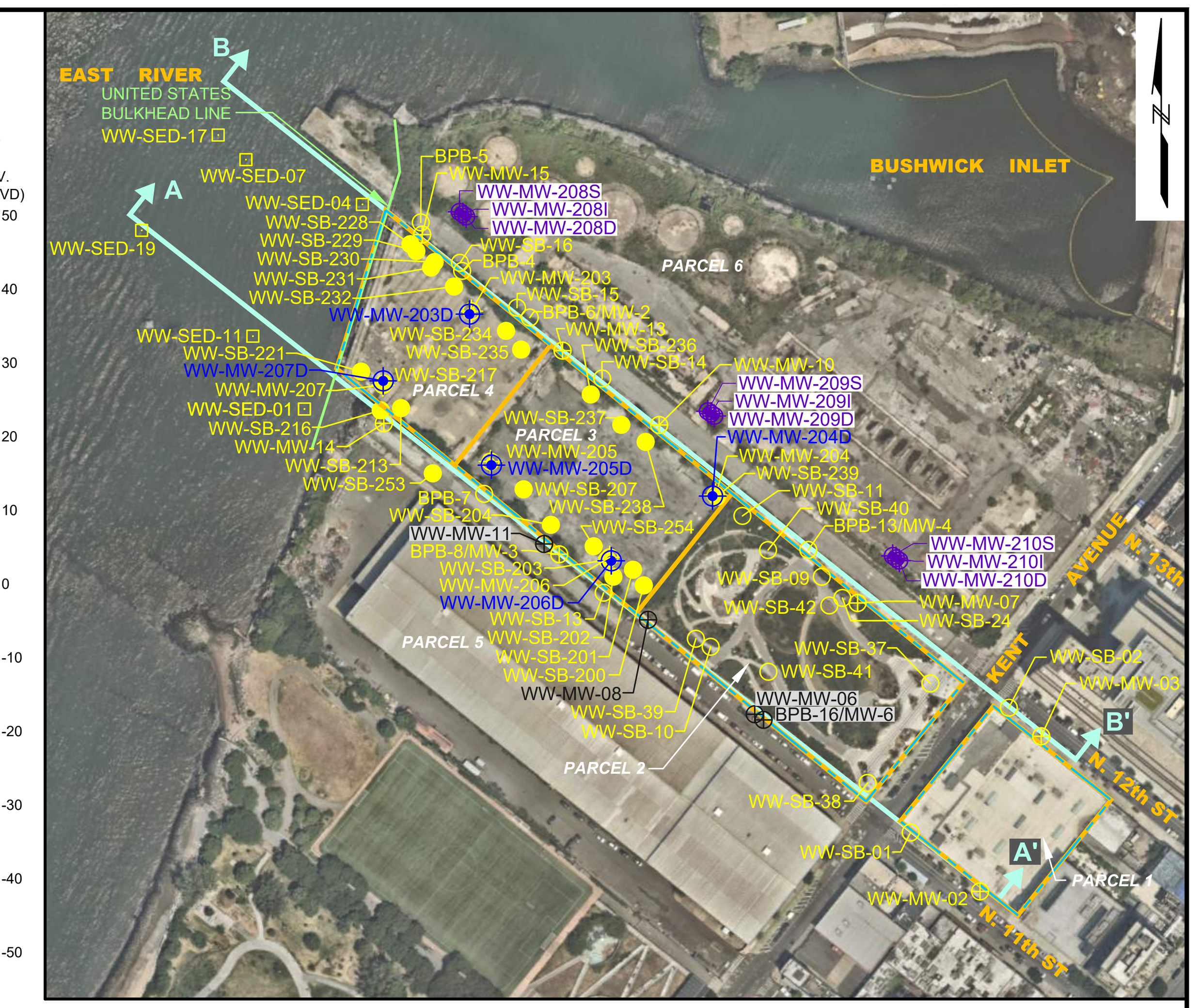
Final Volume: 50ml

Appendix E

Remedial Investigation Figures







CROSS-SECTION LOCATION

0 200' 400'

SCALE: 1" = 200'

CROSS SECTION LOCATION LEGEND

- A A' GEOLOGIC CROSS-SECTION LOCATION

PROPOSED 2024 SUPPLEMENTAL REMEDIAL INVESTIGATION - PARCEL 6 SAMPLE LOCATIONS

- MONITORING WELL LOCATION

2024 REMEDIAL INVESTIGATION SAMPLE LOCATIONS

- SOIL BORING AND MONITORING WELL

2022 REMEDIAL INVESTIGATION SAMPLE LOCATIONS

- SOIL BORING
- SOIL BORING AND MONITORING WELL

PREVIOUS INVESTIGATION SAMPLE LOCATIONS

- MONITORING WELL LOCATION
- ABANDONED/DESTROYED MONITORING WELL LOCATION
- SOIL BORING LOCATION
- SEDIMENT CORE LOCATION

CROSS SECTION LEGEND

GEOLOGIC UNIT

- POST-MGP FILL / FILL WEDGE
- FILL
- IRM EXCAVATION

ALLUVIAL DEPOSITS

- ORGANIC SOIL
- PEAT
- SILT (SHALLOW)
- CLAY (SHALLOW)

GLACIAL DEPOSITS

- SAND
- SILTY SAND
- SILT (DEEP)
- ELASTIC SILT
- GRAVEL
- SILTY GRAVEL
- CLAYEY SAND
- CLAY (DEEP)

PHYSICAL OBSERVATIONS

- NAPL IMPACTS SATURATED
- NAPL IMPACTS COATED MATERIAL, LENSES
- NAPL IMPACTS BLEBS, GLOBS, SHEEN
- NAPL IMPACTS STAINING
- PETROLEUM IMPACTS SATURATION & SHEEN
- PETROLEUM IMPACTS STAINING
- NO IMPACT OBSERVED
- OBSERVED APPARENT GROUNDWATER TABLE
- CONTACT
- BOUNDARY IS APPROXIMATED
- WW-MW-14 SOIL BORING, MONITORING WELL OR SEDIMENT CORING IDENTIFICATION
- S SAMPLE LOCATION
- WELL SCREEN INTERVAL
- WW-MW-208S/I/D PROPOSED MONITORING WELL IDENTIFICATION
- PROPOSED WELL SCREEN INTERVAL

NOTES:

1. HIGH AND LOW TIDE WATERLINE MEASUREMENTS ARE FROM THE 12/19/12 GROUNDWATER GAUGING EVENT.
2. IMPACTS SHOWN ON PARCEL 2, N.11TH STREET, AND N. 12TH STREET ARE BASED ON IMPACTS OBSERVED DURING INSTALLATION OF THE SOIL BORING, NOT FOLLOWING THE NAPL RECOVERY IRM.
3. *PROPOSED MONITORING WELLS ARE PROJECTED ONTO CROSS SECTION B-B' BY THE FOLLOWING DISTANCES:
   - WW-MW-208S/I/D - 61 FEET
   - WW-MW-209S/I/D - 59 FEET
   - WW-ME-210S/I/D - 62 FEET

SOURCES:

1. AERIAL PHOTOGRAPH NEARMAP ©2024 IMAGERY DATE: 06/18/2024.
2. SANBORN FIRE INSURANCE MAPS (1887 THROUGH 1996).
3. HISTORIC MAP OF BROOKLYN UNION GAS, DATED JULY 27, 1921.
4. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM http://www.oasisnyc.net, ACCESSED JANUARY 2008.
5. SURVEY OF WILLIAMSBURG WORKS BOUNDARIES, EXISTING CONDITIONS, AND SAMPLE LOCATIONS CONDUCTED BY GEI CONSULTANTS, INC. SURVEYED BY NEW YORK STATE-LICENSED LAND SURVEYOR No. 050146.
6. SITE INVESTIGATION REPORT PROPERTY WEST OF KENT AVENUE BETWEEN AND INCLUDING NORTH 10TH AND NORTH 12TH STREETS, PREPARED BY: METCALF AND EDDY OF NEW YORK, INC., NOVEMBER 2006.

HORIZONTAL SCALE: 1" = 60'

0 60' 120'

0 20' 40'

VERTICAL SCALE: 1" = 20'

NOTE: 3x VERTICAL EXAGGERATION

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Remedial Investigation Report
Williamsburg Works Former MGP Site
Borough Of Brooklyn, New York

nationalgrid

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GEOLOGIC CROSS SECTIONS
A-A' AND B-B'

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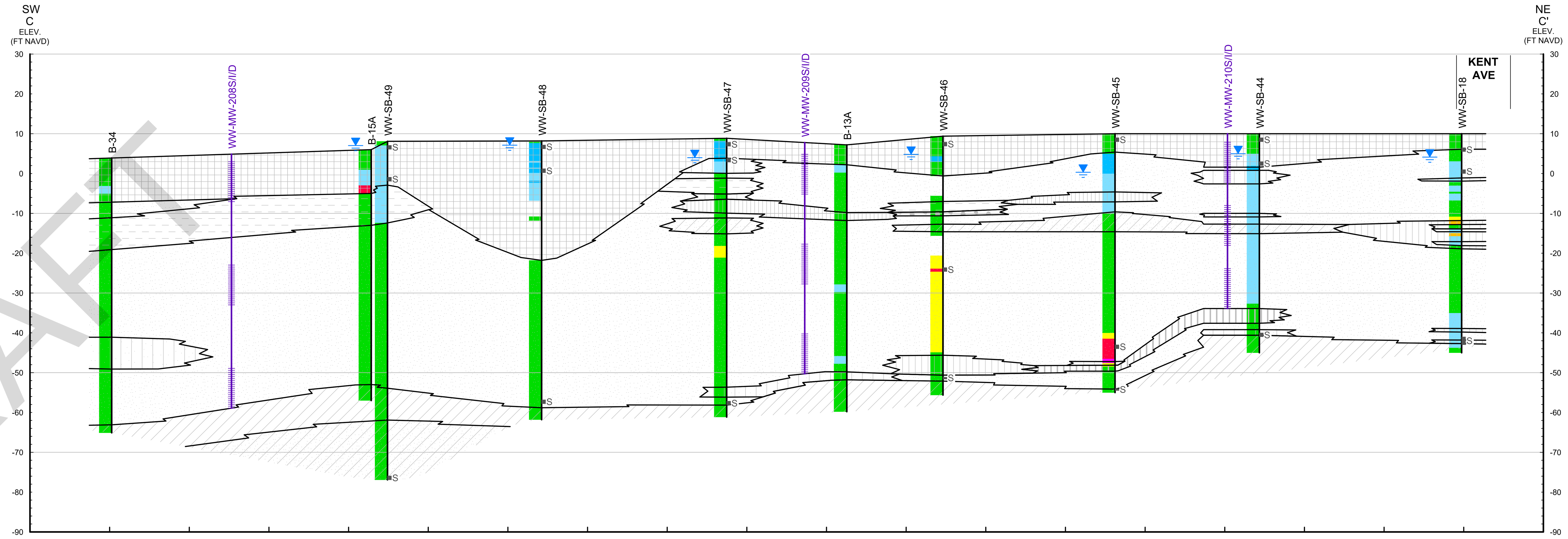
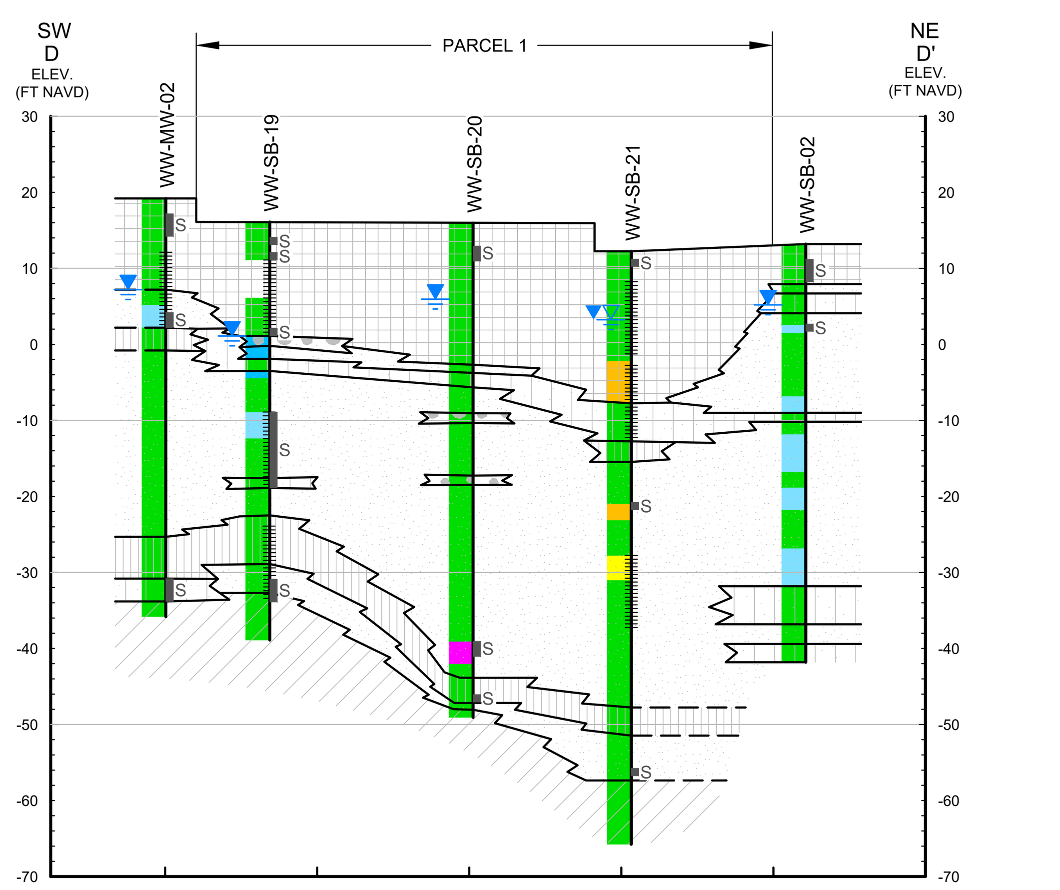
---- B:\Working\NATIONAL GRID\093060 - WILLIAMSBURG\00_CAD\Figures\RIR_2024\P3-6_093060_RIR_XSCS.dwg - 2/7/2025



CROSS-SECTION LOCATION

0 200' 400'
SCALE: 1" = 200'



CROSS SECTION LEGEND

GEOLOGIC UNIT	GLACIAL DEPOSITS	PHYSICAL OBSERVATIONS	
POST-MGP FILL / FILL WEDGE	SAND	NAPL IMPACTS SATURATED	OBSERVED APPARENT GROUNDWATER TABLE
FILL	SILTY SAND	NAPL IMPACTS COATED MATERIAL, LENSES	CONTACT
IRM EXCAVATION	SILT (DEEP)	NAPL IMPACTS BLEBS, GLOBS, SHEEN	BOUNDARY IS APPROXIMATED
ALLUVIAL DEPOSITS	ELASTIC SILT	NAPL IMPACTS STAINING	WW-MW-14 SOIL BORING, MONITORING WELL OR SEDIMENT CORING IDENTIFICATION
ORGANIC SOIL	GRAVEL	PETROLEUM IMPACTS SATURATION & SHEEN	S SAMPLE LOCATION
PEAT	SILTY GRAVEL	PETROLEUM IMPACTS STAINING	WELL SCREEN INTERVAL
SILT (SHALLOW)	CLAYEY SAND	NO IMPACT OBSERVED	WW-MW-208S/I/D PROPOSED MONITORING WELL IDENTIFICATION
CLAY (SHALLOW)	CLAY (DEEP)		PROPOSED WELL SCREEN INTERVAL

CROSS SECTION LOCATION LEGEND

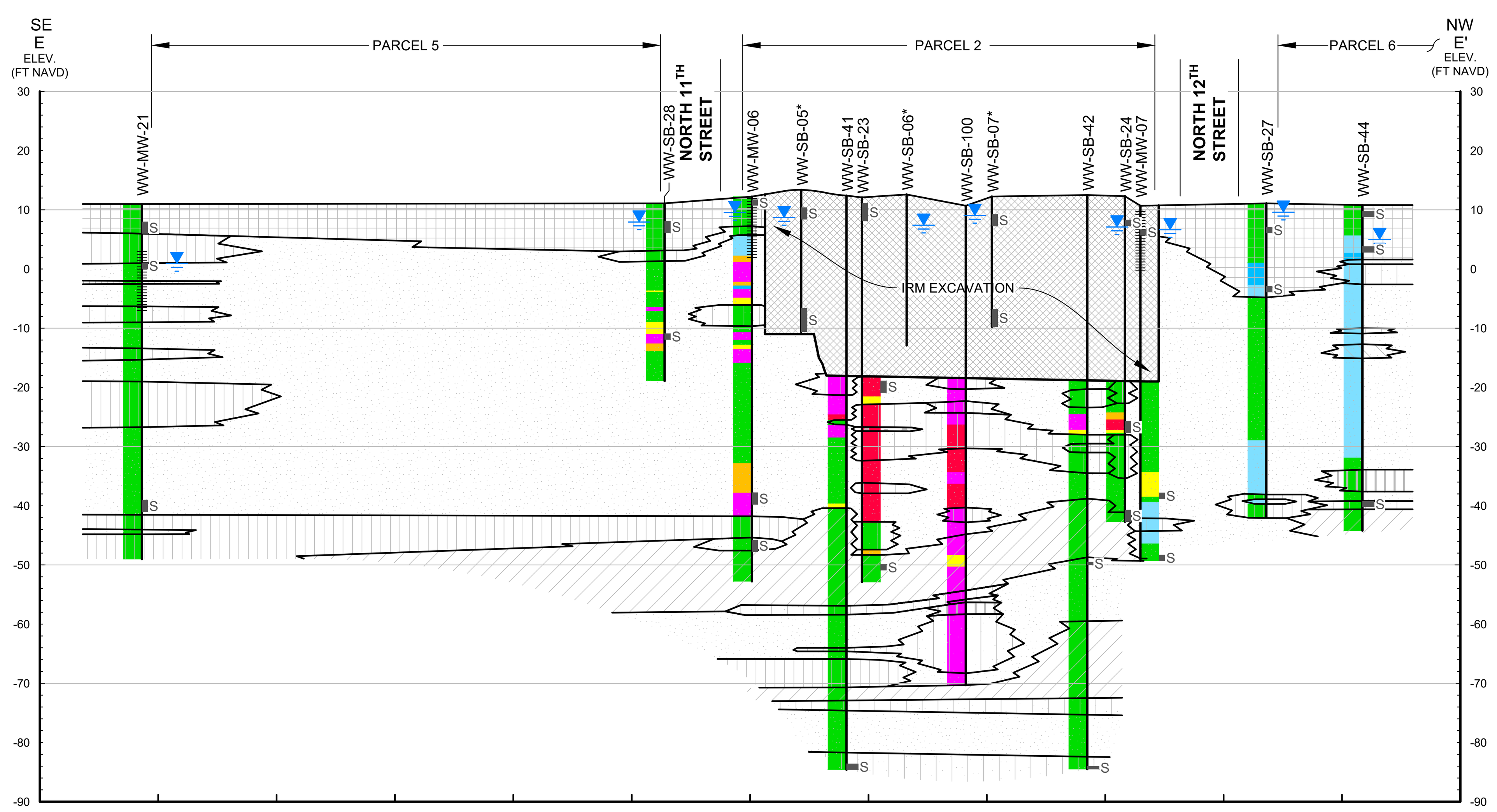
C C' GEOLOGIC CROSS-SECTION LOCATION

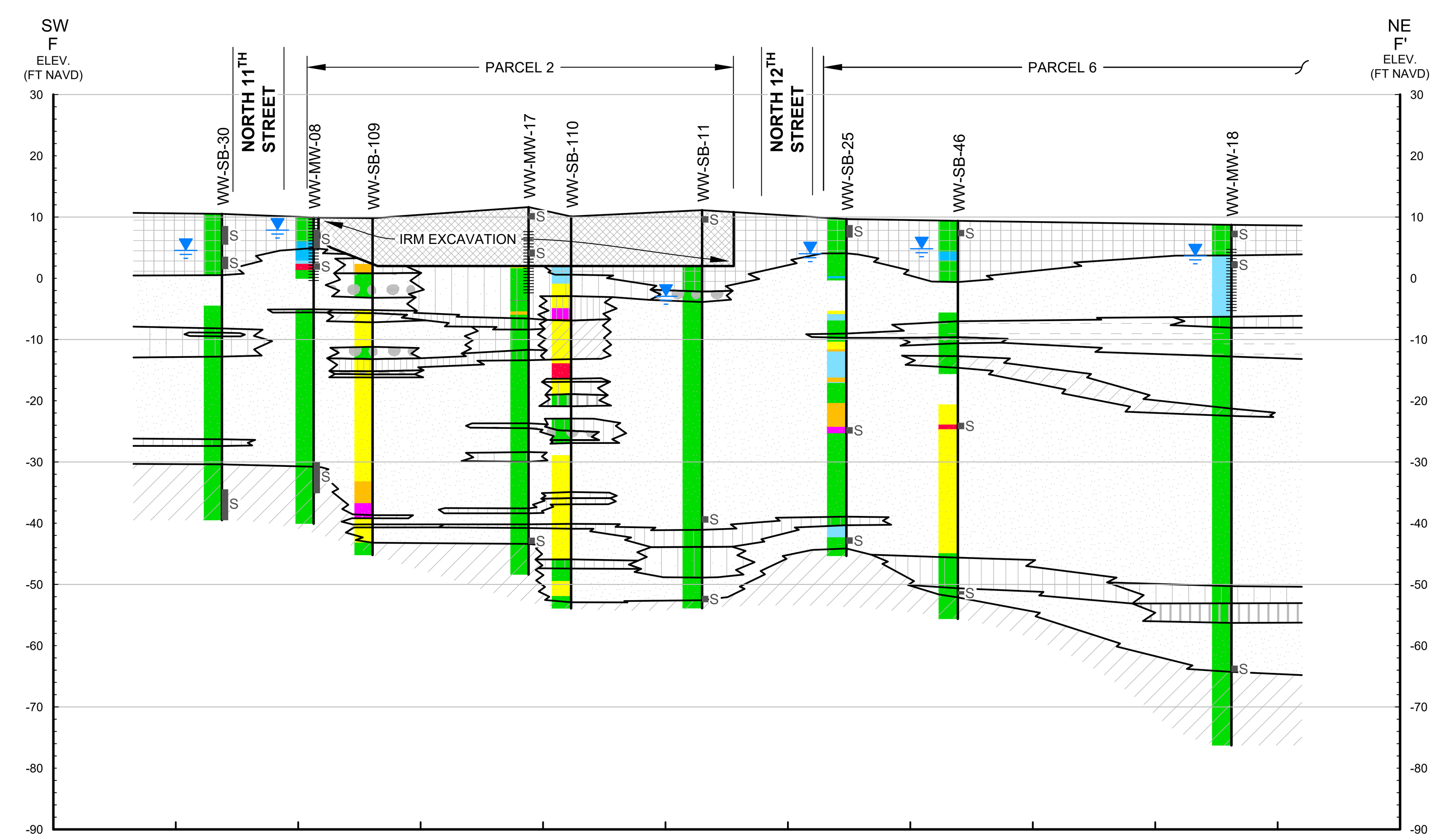
PROPOSED 2024 SUPPLEMENTAL REMEDIAL INVESTIGATION - PARCEL 6 SAMPLE LOCATIONS

- MONITORING WELL LOCATION

PREVIOUS INVESTIGATION SAMPLE LOCATIONS

- MONITORING WELL LOCATION
- ABANDONED/DESTROYED MONITORING WELL LOCATION
- SOIL BORING LOCATION
- SEDIMENT CORE LOCATION





HORIZONTAL SCALE: 1" = 60'
0 60' 120'
0 20' 40'
VERTICAL SCALE: 1" = 20'
NOTE: 3x VERTICAL EXAGGERATION

NOTES:

1. HIGH AND LOW TIDE WATERLINE MEASUREMENTS ARE FROM THE 12/19/12 GROUNDWATER GAUGING EVENT.
2. IMPACTS SHOWN ON PARCEL 2, N.11TH STREET, AND N. 12TH STREET ARE BASED ON IMPACTS OBSERVED DURING INSTALLATION OF THE SOIL BORING, NOT FOLLOWING THE NAPL RECOVERY IRM.
3. RI BORING WW-MW-11 WAS USED IN CROSS SECTION F-F' RATHER THAN PREVIOUS BORING BPP-8/MW-3 WHICH IS LOCATED CLOSER TO THE CROSS SECTION LINE.

SOURCES:

1. AERIAL PHOTOGRAPH NEARMAP ©2024 IMAGERY DATE: 06/18/2024.
2. SANBORN FIRE INSURANCE MAPS (1887 THROUGH 1996).
3. HISTORIC MAP OF BROOKLYN UNION GAS, DATED JULY 27, 1921.
4. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM http://www.oasisnyc.net, ACCESSED JANUARY 2008.
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6. SITE INVESTIGATION REPORT PROPERTY WEST OF KENT AVENUE BETWEEN AND INCLUDING NORTH 10TH AND NORTH 12TH STREETS, PREPARED BY: METCALF AND EDDY OF NEW YORK, INC., NOVEMBER 2006.
7. URS CORPORATION IRM DESIGN INVESTIGATION BORING LOGS AND LOCATION MAP PROVIDED TO GEI CONSULTANTS, INC. VIA EMAIL ON FEBRUARY 12, 2013

DRAFT

Remedial Investigation Report Williamsburg Works Former MGP Site Borough Of Brooklyn, New York	GEI Consultants	GEOLOGIC CROSS SECTIONS C-C', D-D', E-E', AND F-F'
nationalgrid	Project 093060	February 2025 Plate 4

LEGEND:

APPROXIMATE CURRENT PARCEL BOUNDARY
APPROXIMATE BOUNDARY OF FORMER MGP PROPERTY / SITE BOUNDARY
HISTORIC MGP STRUCTURES

PROPOSED 2024 SUPPLEMENTAL REMEDIAL INVESTIGATION - PARCEL 6 SAMPLE LOCATIONS

WW-MW-208S PROPOSED MONITORING WELL

PREVIOUS REMEDIAL INVESTIGATION SAMPLES

WW-MW-02 MONITORING WELL
WW-MW-07 ABANDONED/DESTROYED MONITORING WELL
WW-SB-21 SOIL BORING WITH TEMPORARY GROUNDWATER POINT
TBM TIDAL BENCHMARK
5.0 GROUNDWATER CONTOUR (FEET NAVD88)
GROUNDWATER FLOW DIRECTION
3.52 GROUNDWATER ELEVATION (FEET NAVD88) MEASURED 9/11/2024

ANALYTICAL BOXES

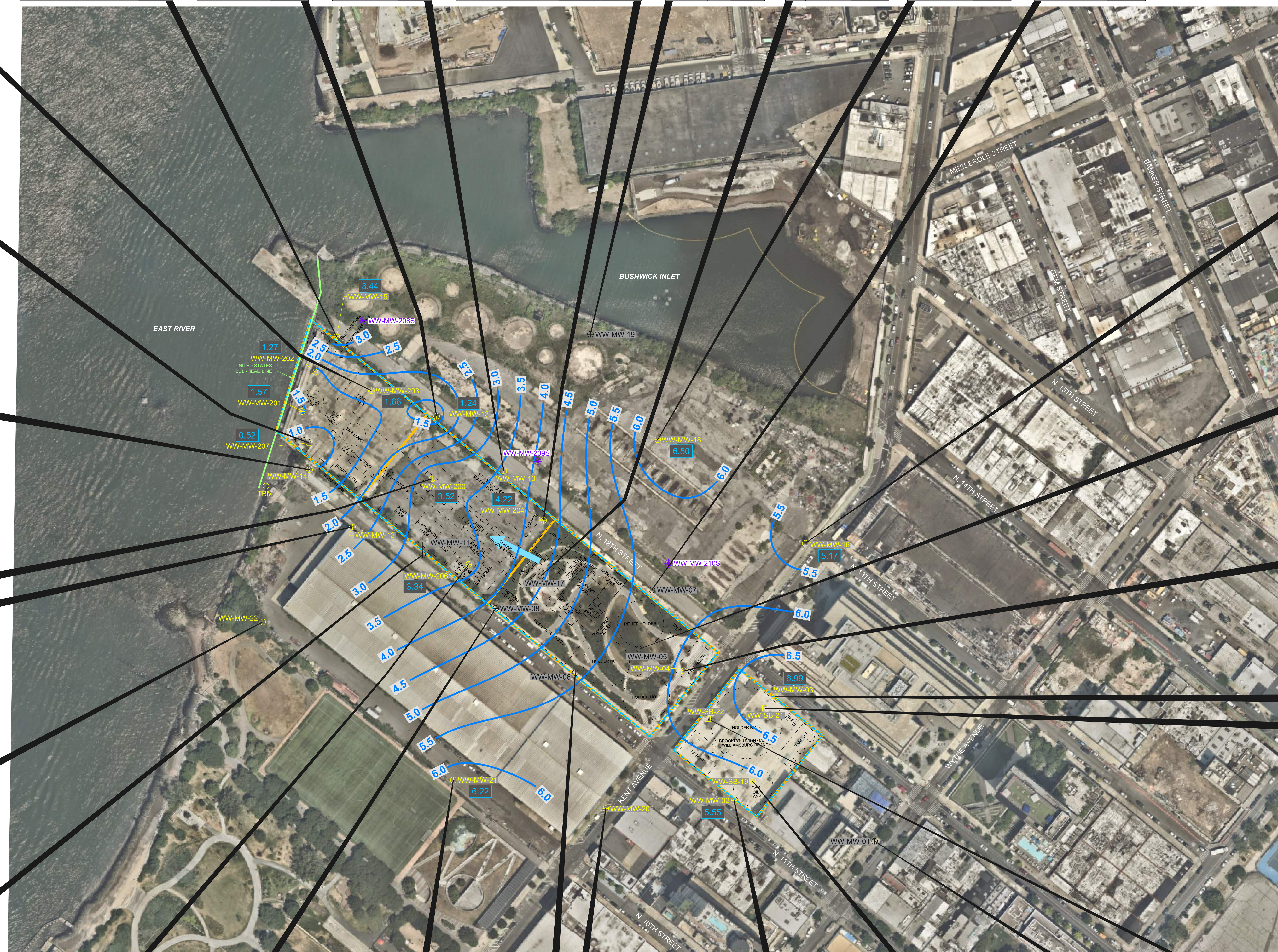
NYS AWQS	NEW YORK STATE AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES FOR GA GROUNDWATER
ND	NOT DETECTED
NE	NOT ESTABLISHED NYS AWQS
J	ESTIMATED VALUE
JN	ANALYTE IS PRESUMPTIVELY PRESENT AT AN APPROXIMATED QUANTITY
*	THE VALUE IS A GUIDANCE VALUE AND NOT A STANDARD
µg/L	MICROGRAMS PER LITER OR PARTS PER BILLION (ppb)
BTEX	BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES
PAHs	POLYCYCLIC AROMATIC HYDROCARBONS
SVOCs	SEMI-VOLATILE ORGANIC COMPOUNDS
VOCs	VOLATILE ORGANIC COMPOUNDS
BOLD	DETECTED CONCENTRATION
BOLD (shaded)	THE DETECTED RESULT VALUE EXCEEDS NYS AWQS

NOTES:

1. CONTOURS MADE BY LINEAR INTERPOLATION WITH MANUAL SMOOTHING TO ADJUST ARTIFACTS OF INTERPOLATION BETWEEN RELATIVELY DISTANT WELLS.
2. GROUNDWATER CONTOURS AND ELEVATIONS ARE IN FEET ABOVE NORTH AMERICAN VERTICAL DATUM (NAVD88)
3. WW-MW-01 AND WW-MW-04 WERE UNABLE TO BE LOCATED AND WERE NOT INCLUDED IN THE GROUNDWATER CALCULATIONS..
4. GROUNDWATER CONTOURS WERE GENERATED USING DATA FROM HIGH TIDE GAUGING ON SEPTEMBER 11, 2024
5. PERMANENT WELLS WERE INSTALLED SPANNING THE GROUNDWATER SURFACE. TEMPORARY GROUNDWATER POINTS WERE INSTALLED AT VARIOUS DEPTHS SHOWN ON THE ANALYTICAL SAMPLE TABLES.

SOURCES:

1. AERIAL PHOTOGRAPH NEARMAP ©2024 IMAGERY DATE: 06/18/2024.
2. SANBORN FIRE INSURANCE MAPS (1887 THROUGH 1996).
3. HISTORIC MAP OF BROOKLYN UNION GAS, DATED JULY 29, 1921.
4. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM *HTTP://WWW.OASISNYC.NET* ACCESSED JANUARY 2008.
5. SURVEY OF WILLIAMSBURG WORKS BOUNDARIES, EXISTING CONDITIONS, AND SAMPLE LOCATIONS CONDUCTED BY GEI CONSULTANTS, INC. SURVEYED BY NEW YORK STATE-LICENSED LAND SURVEYOR No. 050146.



Sample Name: / Sample Date:	NYS AWQS	WW-MW-203 9/12/2022
BTEX (ug/L)		
Total BTEX	NE	ND
Other VOCs (ug/L)		
Acetone	50*	**66.8 J**
Chloromethane	5	**6.6 J**
Naphthalene	10*	**11.6**
Total VOCs	NE	**85.9**
PAHs (ug/L)		
Total PAHs	NE	**22.4**
Other SVOCs (ug/L)		
Total SVOCs	NE	**34.4**
PFAS (ng/L)		
Perfluorooctanesulfonic acid (PFOS)	2.7*	**19**
Perfluorooctanoic Acid (PFOA)	6.7*	**24**
Total Metals (ug/L)		
Iron	300	**6490**
Magnesium	35000*	**39900**
Manganese	300	**498**
Sodium	20000	**536000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-15 11/6/2009
BTEX (ug/L)		
Benzene	1	**1.7 J**
Total BTEX	NE	**1.7**
Other VOCs (ug/L)		
Total VOCs	NE	**1.7**
PAHs (ug/L)		
Total PAHs	NE	**17.28**
Other SVOCs (ug/L)		
Total SVOCs	NE	**19.28**
Pesticides (ug/L)		
alpha-BHC (Hexachlorocyclohexane)	0.01	**0.02 J**
Total Metals (ug/L)		
Arsenic	25	**42.8 J**
Iron	300	**310 J**
Magnesium	35000*	**688000**
Sodium	20000	**5980000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-13 11/6/2009
BTEX (ug/L)		
Benzene	1	**540**
Toluene	5	**7 J**
Ethylbenzene	5	**190**
Total Xylene	5	**100**
Total BTEX	NE	**837**
Other VOCs (ug/L)		
Total VOCs	NE	**837**
PAHs (ug/L)		
Acenaphthene	20*	**100**
Naphthalene	10*	**370**
Total PAHs	NE	**556.2**
Other SVOCs (ug/L)		
Phenol	1	**3.2 J**
Total SVOCs	NE	**570.4**
Total Metals (ug/L)		
Iron	300	**2390**
Magnesium	35000*	**130000**
Sodium	20000	**982000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-10 11/5/2009
BTEX (ug/L)		
Benzene	1	**29**
Toluene	5	**3.1 J**
Ethylbenzene	5	**330**
Total Xylene	5	**200**
Total BTEX	NE	**562.1**
Other VOCs (ug/L)		
Total VOCs	NE	**578.1**
PAHs (ug/L)		
Acenaphthene	20*	**28 J**
Naphthalene	10*	**580**
Total PAHs	NE	**749.6**
Other SVOCs (ug/L)		
Total SVOCs	NE	**749.6**
Total Metals (ug/L)		
Iron	300	**5000**
Manganese	300	**489**
Sodium	20000	**343000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-204 9/12/2022	Duplicate of WW-MW-204 9/12/2022
BTEX (ug/L)			
Total BTEX	NE	ND	ND
Other VOCs (ug/L)			
Acetone	50*	10 U	**76.4 J**
Chloromethane	5	**5.4 J**	**8.2 J**
Total VOCs	NE	**8**	**87.1**
PAHs (ug/L)			
Total PAHs	NE	**3.1**	**2.5**
Other SVOCs (ug/L)			
Total SVOCs	NE	**8.6**	**8.9**
PFAS (ng/L)			
Perfluorooctanesulfonic acid (PFOS)	2.7*	**35**	**35**
Perfluorooctanoic Acid (PFOA)	6.7*	**20 J**	**23**
Total Metals (ug/L)			
Iron	300	**1850**	**1870**
Manganese	300	**415**	**409**
Sodium	20000	**35600**	**35800**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-19 12/20/2012
BTEX (ug/L)		
Total BTEX	NE	ND
Other VOCs (ug/L)		
Total VOCs	NE	**1.82**
PAHs (ug/L)		
Total PAHs	NE	**2.4**
Other SVOCs (ug/L)		
Total SVOCs	NE	**2.4**
Total Metals (ug/L)		
Iron	300	**41000 J**
Magnesium	35000*	**100000**
Manganese	300	**1200**
Selenium	10	**12**
Sodium	20000	**870000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-17 11/5/2009
BTEX (ug/L)		
Total BTEX	NE	ND
Other VOCs (ug/L)		
Total VOCs	NE	ND
PAHs (ug/L)		
Total PAHs	NE	**8.47**
Other SVOCs (ug/L)		
Total SVOCs	NE	**8.47**
Total Metals (ug/L)		
Iron	300	**629**
Sodium	20000	**316000**
Cyanides (ug/L)		
Total Cyanide	200	**281**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-18 12/20/2012
BTEX (ug/L)		
Total BTEX	NE	**0.15**
Other VOCs (ug/L)		
Total VOCs	NE	**10.33**
PAHs (ug/L)		
Total PAHs	NE	**1.2**
Total Metals (ug/L)		
Iron	300	**5900 J**
Magnesium	35000*	**39000**
Sodium	20000	**170000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-07 11/5/2009
BTEX (ug/L)		
Benzene	1	**23**
Toluene	5	**9**
Ethylbenzene	5	**8.4**
Total Xylene	5	**60**
Total BTEX	NE	**100.4**
Other VOCs (ug/L)		
Styrene	5	**22**
Total VOCs	NE	**122.4**
PAHs (ug/L)		
Naphthalene	10*	**120**
Total PAHs	NE	**163.71**
Other SVOCs (ug/L)		
Total SVOCs	NE	**163.71**
Total Metals (ug/L)		
Lead	25	**25.9**
Manganese	300	**542**
Sodium	20000	**187000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-207 10/27/2022
BTEX (ug/L)		
Benzene	1	**17.1**
Ethylbenzene	5	**8.4**
Total BTEX	NE	**29.2**
Other VOCs (ug/L)		
Total VOCs	NE	**46.1**
PAHs (ug/L)		
Benzo(a)anthracene	0.002*	**1.9 J**
Benzo(k)fluoranthene	0.002*	**1.3 J**
Benzo(a)pyrene	ND	**1.9 J**
Chrysene	0.002*	**1.8 J**
Total PAHs	NE	**35.5**
Other SVOCs (ug/L)		
Total SVOCs	NE	**37.7**
Total Metals (ug/L)		
Iron	300	**1590 J**
Lead	25	**26.1**
Magnesium	35000*	**461000 J**
Sodium	20000	**3990000 J**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-14 11/6/2009	WW-MW-14 3/20/2019	Duplicate of WW-MW-14 3/20/2019
BTEX (ug/L)				
Total BTEX	NE	ND	NA	NA
Other VOCs (ug/L)				
Total VOCs	NE	ND	NA	NA
PAHs (ug/L)				
Total PAHs	NE	ND	NA	NA
Other SVOCs (ug/L)				
Total SVOCs	NE	ND	NA	NA
PFAS (ng/L)				
Perfluorooctanesulfonic acid (PFOS)	2.7*	NA	**19.5 J**	**20.6 J**
Perfluorooctanoic Acid (PFOA)	6.7*	NA	**9.71**	**9.89**
Total Metals (ug/L)				
Arsenic	25	**32 J**	NA	NA
Chromium	50	**74.2**	NA	NA
Iron	300	**334 J**	NA	NA
Magnesium	35000*	**697000**	NA	NA
Nickel	100	**159 J**	NA	NA
Sodium	20000	**5990000**	NA	NA

Sample Name: / Sample Date:	NYS AWQS	WW-MW-200 10/27/2022
BTEX (ug/L)		
Total BTEX	NE	**0.5**
Other VOCs (ug/L)		
Total VOCs	NE	**2.4**
PAHs (ug/L)		
Benzo(a)anthracene	0.002*	**1.6 J**
Benzo(a)pyrene	ND	**1.5 J**
Chrysene	0.002*	**1.5 J**
Other SVOCs (ug/L)		
Total SVOCs	NE	**47.3**
PFAS (ng/L)		
Perfluorooctanesulfonic acid (PFOS)	2.7*	**100**
Perfluorooctanoic Acid (PFOA)	6.7*	**16 J**
Total Metals (ug/L)		
Iron	300	**2350 J**
Manganese	300	**558**
Sodium	20000	**36700 J**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-12 11/5/2009	WW-MW-12 3/20/2019
BTEX (ug/L)			
Benzene	1	**180**	NA
Total BTEX	NE	**187.79**	NA
Other VOCs (ug/L)			
Total VOCs	NE	**187.79**	NA
PAHs (ug/L)			
Total PAHs	NE	**1.59**	NA
Other SVOCs (ug/L)			
Total SVOCs	NE	**1.59**	NA
PFAS (ng/L)			
Perfluorooctanesulfonic acid (PFOS)	2.7*	NA	**100 J**
Perfluorooctanoic Acid (PFOA)	6.7*	NA	**57.5**
Total Metals (ug/L)			
Iron	300	**1940**	NA
Magnesium	35000*	**79400**	NA
Manganese	300	**613**	NA
Sodium	20000	**1080000**	NA

Sample Name: / Sample Date:	NYS AWQS	WW-MW-22 12/20/2012
BTEX (ug/L)		
Total BTEX	NE	**0.69**
Other VOCs (ug/L)		
Total VOCs	NE	**1.42**
PAHs (ug/L)		
Total PAHs	NE	**9.99**
Other SVOCs (ug/L)		
Total SVOCs	NE	**9.99**
Total Metals (ug/L)		
Iron	300	**2200 J**
Magnesium	35000*	**430000**
Selenium	10	**34**
Sodium	20000	**3100000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-11 11/5/2009
BTEX (ug/L)		
Benzene	1	**320**
Toluene	5	**38 J**
Ethylbenzene	5	**1600**
Total Xylene	5	**280**
Total BTEX	NE	**2238**
Other VOCs (ug/L)		
Total VOCs	NE	**2238**
PAHs (ug/L)		
Acenaphthene	20*	**140 J**
Naphthalene	10*	**6300**
Total PAHs	NE	**7060**
Other SVOCs (ug/L)		
Total SVOCs	NE	**7060**
Pesticides (ug/L)		
delta-BHC (delta-Hexachlorocyclohexane)	0.04	**0.041 J**
Total Metals (ug/L)		
Iron	300	**1740**
Manganese	300	**559**
Sodium	20000	**362000**
Cyanides (ug/L)		
Total Cyanide	200	**211**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-206 10/27/2022
BTEX (ug/L)		
Benzene	1	**97**
Ethylbenzene	5	**180**
o-Xylene	5	**25.4**
m/p-Xylene	5	**57.3**
Total BTEX	NE	**362**
Other VOCs (ug/L)		
Isopropylbenzene	5	**24.4**
Naphthalene	10*	**698**
Total VOCs	NE	**1088**
PAHs (ug/L)		
Acenaphthene	20*	**188**
Naphthalene	10*	**484**
Total PAHs	NE	**761.7**
Other SVOCs (ug/L)		
Total SVOCs	NE	**775.6**
Total Metals (ug/L)		
Iron	300	**596 J**
Manganese	300	**638**
Sodium	20000	**55600 J**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-08 11/5/2009
BTEX (ug/L)		
Benzene	1	**570**
Toluene	5	**64 J**
Ethylbenzene	5	**2800**
Total Xylene	5	**3100**
Total BTEX	NE	**6534**
Other VOCs (ug/L)		
Total VOCs	NE	**6534**
PAHs (ug/L)		
Acenaphthene	20*	**140 J**
Naphthalene	10*	**4000**
Total PAHs	NE	**4680**
Other SVOCs (ug/L)		
Total SVOCs	NE	**4680**
Total Metals (ug/L)		
Iron	300	**4690**
Sodium	20000	**525000**
Cyanides (ug/L)		
Total Cyanide	200	**323**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-21 12/20/2012	Duplicate of WW-MW-21 12/20/2012
BTEX (ug/L)			
Total BTEX	NE	**0.39**	**0.38**
Other VOCs (ug/L)			
Total VOCs	NE	**4.94**	**4.55**
PAHs (ug/L)			
Total PAHs	NE	ND	**0.23**
Other SVOCs (ug/L)			
Total SVOCs	NE	ND	**0.23**
Total Metals (ug/L)			
Iron	300	**3900 J**	**3900 J**
Manganese	300	**1200**	**1200**
Sodium	20000	**110000**	**110000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-06 11/4/2009
BTEX (ug/L)		
Benzene	1	**270**
Toluene	5	**13 J**
Ethylbenzene	5	**940**
Total Xylene	5	**690**
Total BTEX	NE	**1913**
Other VOCs (ug/L)		
Total VOCs	NE	**1913**
PAHs (ug/L)		
Acenaphthene	20*	**60 J**
Naphthalene	10*	**2500**
Total PAHs	NE	**2724**
Other SVOCs (ug/L)		
Total SVOCs	NE	**2724**
Total Metals (ug/L)		
Iron	300	**11400**
Manganese	300	**790**
Sodium	20000	**873000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-20 12/20/2012
BTEX (ug/L)		
Benzene	1	**1.5**
Total BTEX	NE	**1.5**
Other VOCs (ug/L)		
Total VOCs	NE	**4.07**
PAHs (ug/L)		
Total PAHs	NE	ND
Other SVOCs (ug/L)		
Total SVOCs	NE	ND
Pesticides (ug/L)		
beta-BHC (beta-Hexachlorocyclohexane)	0.04	**0.063**
Total Metals (ug/L)		
Iron	300	**7800 J**
Manganese	300	**960**
Sodium	20000	**210000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-02 11/4/2009
BTEX (ug/L)		
Total BTEX	NE	ND
Other VOCs (ug/L)		
cis-1,2-Dichloroethene	5	**14**
Total VOCs	NE	**14**
PAHs (ug/L)		
Total PAHs	NE	**0.87**
Other SVOCs (ug/L)		
Total SVOCs	NE	**0.87**
Total Metals (ug/L)		
Iron	300	**9480**
Magnesium	35000*	**37300**
Manganese	300	**3480**
Sodium	20000	**496000**

Sample Name: / Sample Date:	NYS AWQS	WW-SB-19 (5-15) 7/28/2009
BTEX (ug/L)		
Benzene	1	**79**
Toluene	5	**170**
Ethylbenzene	5	**35**
Total Xylene	5	**190**
Total BTEX	NE	**474**
Other VOCs (ug/L)		
Chloroform (Trichloromethane)	7	**7.9**
cis-1,2-Dichloroethene	5	**1.1 J**
trans-1,2-Dichloroethene	5	5 U
Trichloroethene (TCE)	5	5 U
Total VOCs	NE	**483**
PAHs (ug/L)		
Benzo(a)anthracene	0.002*	**0.8 J**
Chrysene	0.002*	**0.92 J**
Naphthalene	10*	**6.8**
Total PAHs	NE	**54.72**
Other SVOCs (ug/L)		
Total SVOCs	NE	**60.52**
Total Metals (ug/L)		
Iron	300	**34900**
Magnesium	35000*	**13200**
Manganese	300	**581**
Sodium	20000	**43400 J**
Cyanides (ug/L)		
Total Cyanide	200	**29.2**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-01 11/4/2009
BTEX (ug/L)		
Total BTEX	NE	ND
Other VOCs (ug/L)		
Total VOCs	NE	ND
PAHs (ug/L)		
Total PAHs	NE	**0.53**
Other SVOCs (ug/L)		
Total SVOCs	NE	**0.53**
Total Metals (ug/L)		
Iron	300	**25500**
Magnesium	35000*	**36600**
Manganese	300	**2080**
Sodium	20000	**294000**

Sample Name: / Sample Date:	NYS AWQS	WW-SB-22 7/8/2009
BTEX (ug/L)		
Benzene	1	**43**
Toluene	5	5 U
Ethylbenzene	5	**1 J**
Total Xylene	5	5 U
Total BTEX	NE	**44**
Other VOCs (ug/L)		
Acetone	50*	10 U
cis-1,2-Dichloroethene	5	5 U
Styrene	5	5 U
Vinyl chloride	2	5 U
Total VOCs	NE	**44**
PAHs (ug/L)		
Acenaphthene	20*	**3.1 J**
Indeno(1,2,3-cd)pyrene	0.002*	**5.3**
Naphthalene	10*	4 U
Total PAHs	NE	**18.82**
Other SVOCs (ug/L)		
Total SVOCs	NE	**26.08**
Pesticides (ug/L)		
Aldrin	ND	0.05 U
Total Metals (ug/L)		
Iron	300	**3390**
Magnesium	35000*	**34100**
Manganese	300	**1820**
Sodium	20000	**93500 J**
Other (ug/L)		
Ammonia	2000	**960**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-16 11/4/2009
BTEX (ug/L)		
Total BTEX	NE	ND
Other VOCs (ug/L)		
Total VOCs	NE	ND
PAHs (ug/L)		
Total PAHs	NE	ND
Other SVOCs (ug/L)		
Total SVOCs	NE	**0.64**
Total Metals (ug/L)		
Iron	300	**13400**
Manganese	300	**899**
Sodium	20000	**210000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-05 11/5/2009
BTEX (ug/L)		
Benzene	1	**9200**
Toluene	5	**13000**
Ethylbenzene	5	**2700**
Total Xylene	5	**6200**
Total BTEX	NE	**31100**
Other VOCs (ug/L)		
Styrene	5	**2600**
Total VOCs	NE	**33700**
PAHs (ug/L)		
Naphthalene	10*	**6600**
Total PAHs	NE	**7627**
Other SVOCs (ug/L)		
2-Methylphenol (o-Cresol)	1	**34 J**
4-Methylphenol (p-Cresol)	1	**34 J**
Total SVOCs	NE	**7695**
Pesticides (ug/L)		
beta-BHC (beta-Hexachlorocyclohexane)	0.04	**0.14 J**
delta-BHC (delta-Hexachlorocyclohexane)	0.04	**0.057 JN**
Total Metals (ug/L)		
Iron	300	**2840**
Manganese	300	**566**
Sodium	20000	**779000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-04 11/4/2009	Duplicate of WW-MW-04 11/5/2009
BTEX (ug/L)			
Benzene	1	**8.7**	**9.2**
Toluene	5	**5.2**	**5.4**
Ethylbenzene	5	**16**	**17**
Total Xylene	5	**21**	**23**
Total BTEX	NE	**50.9**	**54.6**
Other VOCs (ug/L)			
Total VOCs	NE	**61.91**	**66.9**
PAHs (ug/L)			
Naphthalene	10*	**43**	**56**
Total PAHs	NE	**124.4**	**150.2**
Other SVOCs (ug/L)			
Total SVOCs	NE	**126.6**	**153.1**
Total Metals (ug/L)			
Iron	300	**2330**	**2350**
Sodium	20000	**363000**	**356000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-03 11/4/2009	WW-MW-03 3/20/2019
BTEX (ug/L)			
Total BTEX	NE	ND	NA
Other VOCs (ug/L)			
Total VOCs	NE	ND	NA
PAHs (ug/L)			
Total PAHs	NE	**0.33**	NA
Other SVOCs (ug/L)			
Total SVOCs	NE	**0.33**	NA
PFAS (ng/L)			
Perfluorooctanoic Acid (PFOA)	6.7*	NA	**24.8**
Total Metals (ug/L)			
Iron	300	**29100**	NA
Manganese	300	**1130**	NA
Sodium	20000	**735000**	NA

Sample Name: / Sample Date:	NYS AWQS	WW-SB-21 7/8/2009	Duplicate of WW-MW-21 7/8/2009
BTEX (ug/L)			
Benzene	1	**330**	**370**
Toluene	5	**3.7 J**	**4.5 J**
Ethylbenzene	5	**46**	**50**
Total Xylene	5	**58**	**65**
Total BTEX	NE	**437.7**	**489.5**
Other VOCs (ug/L)			
cis-1,2-Dichloroethene	5	20 U	20 U
trans-1,2-Dichloroethene	5	20 U	20 U
Styrene	5	20 U	20 U
Total VOCs	NE	**440.6**	**489.5**
PAHs (ug/L)			
Acenaphthene	20*	**42**	**58**
Naphthalene	10*	**440 J**	**180 J**
Total PAHs	NE	**543.4**	**308.5**
Other SVOCs (ug/L)			
Phenol	1	**22 J**	**9.9 J**
Total SVOCs	NE	**571.4**	**332**
Pesticides (ug/L)			
Aldrin	ND	**0.028 J**	**0.044 J**
Total Metals (ug/L)			
Iron	300	**2320**	**2390**
Magnesium	35000*	**256000**	**267000**
Manganese	300	**135**	**139**
Sodium	20000	**208000 J**	**217000 J**
Cyanides (ug/L)			
Total Cyanide	200	**3540**	**3900**
Other (ug/L)			
Ammonia	2000	**610**	**600**

0 80 160
SCALE, FEET

Remedial Investigation Report
Williamsburg Works Former MGP Site
Borough of Brooklyn, New York

nationalgrid

GEI Consultants

SEPTEMBER 11, 2024 HIGH TIDE SHALLOW CONTOURS AND GROUNDWATER ANALYTICAL SUMMARY

Project 093060 | February 2025 | Plate 7

Sample Name: Sample Date:	NYS AWQS	WW-MW-202I 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	**0.75**
Other VOCs (ug/L)		
Total VOCs	ND	**1.47**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Iron	300	**2030**
Magnesium	35000*	**156000**
Manganese	300	**456**
Sodium	20000	**2800000**

Sample Name: Sample Date:	NYS AWQS	WW-MW-203I 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	ND
Other VOCs (ug/L)		
Total VOCs	ND	**2.78**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Iron	300	**754**
Magnesium	35000*	**70500**
Manganese	300	**340**
Sodium	20000	**556000**

Sample Name: Sample Date:	NYS AWQS	WW-MW-200I 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	ND
Other VOCs (ug/L)		
Total VOCs	ND	**3.07**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Iron	300	**1980**
Magnesium	35000*	**239000**
Manganese	300	**1640**
Sodium	20000	**2000000**

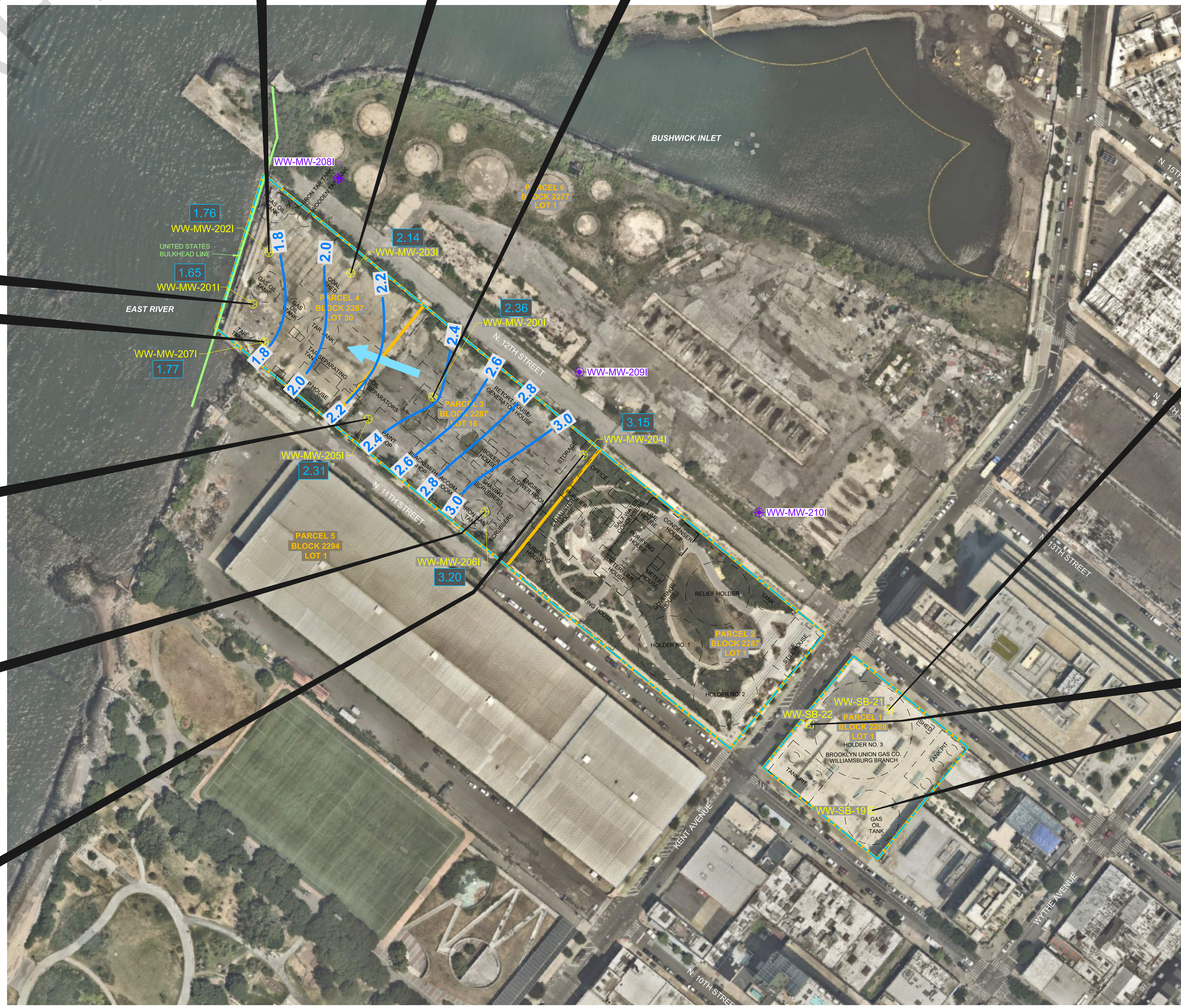
Sample Name: Sample Date:	NYS AWQS	WW-MW-201I 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	**6.06**
Other VOCs (ug/L)		
Total VOCs	ND	**6.92**
PAHs (ug/L)		
Total PAHs	ND	**3.6**
Other SVOCs (ug/L)		
Total SVOCs	ND	**3.6**
Total Metals (ug/L)		
Iron	300	**3440**
Magnesium	35000*	**400000**
Manganese	300	**1420**
Sodium	20000	**4130000**

Sample Name: Sample Date:	NYS AWQS	WW-MW-207I 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	ND
Other VOCs (ug/L)		
Total VOCs	ND	**0.51**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Iron	300	**1670**
Magnesium	35000*	**110000**
Nickel	100	**115**
Sodium	20000	**1860000**

Sample Name: Sample Date:	NYS AWQS	WW-MW-205I 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	**0.32**
Other VOCs (ug/L)		
Vinyl chloride	2	**3.3**
Total VOCs	ND	**13.09**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Iron	300	**555**
Magnesium	35000*	**38700**
Sodium	20000	**231000**

Sample Name: Sample Date:	NYS AWQS	WW-MW-206I 9/12/2024
BTEX (ug/L)		
Benzene	1	**18**
Ethylbenzene	5	**6.5**
Total BTEX	ND	**28.7**
Other VOCs (ug/L)		
Total VOCs	ND	**36.26**
PAHs (ug/L)		
Naphthalene	10*	**56**
Total PAHs	ND	**67.2**
Other SVOCs (ug/L)		
Total SVOCs	ND	**67.2**
Total Metals (ug/L)		
Iron	300	**8920**
Magnesium	35000*	**65200**
Sodium	20000	**297000**

Sample Name: Sample Date:	NYS AWQS	WW-MW-204I 9/12/2024
BTEX (ug/L)		
Benzene	1	**7800**
Toluene	5	**10 J**
Ethylbenzene	5	**730**
o-Xylene	5	**180**
m/p-Xylene	5	**160**
Total BTEX	ND	**8880**
Other VOCs (ug/L)		
Chloroform (Trichloromethane)	7	**31**
Isopropylbenzene	5	**42**
Total VOCs	ND	**8953**
PAHs (ug/L)		
Total PAHs	ND	**16.6**
Other SVOCs (ug/L)		
Phenol	1	**20**
Total SVOCs	ND	**43.59**
Total Metals (ug/L)		
Sodium	20000	**154000**



LEGEND:

APPROXIMATE CURRENT PARCEL BOUNDARY

APPROXIMATE BOUNDARY OF FORMER MGP PROPERTY / SITE BOUNDARY

HISTORIC MGP STRUCTURES

PROPOSED 2024 SUPPLEMENTAL REMEDIAL INVESTIGATION - PARCEL 6 SAMPLE LOCATIONS

WW-MW-208I PROPOSED MONITORING WELL

PREVIOUS REMEDIAL INVESTIGATION SAMPLES

WW-MW-200I MONITORING WELL

WW-SB-21 SOIL BORING WITH TEMPORARY GROUNDWATER POINT

5.0 GROUNDWATER CONTOUR (FEET NAVD88)

GROUNDWATER FLOW DIRECTION

2.36 GROUNDWATER ELEVATION (FEET NAVD88) MEASURED 9/11/2024

ANALYTICAL BOXES

NYS AWQS	NEW YORK STATE AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES FOR GA GROUNDWATER
ND	NOT DETECTED
NE	NOT ESTABLISHED NYS AWQS
J	ESTIMATED VALUE
JN	ANALYTE IS PRESUMPTIVELY PRESENT AT AN APPROXIMATED QUANTITY
*	THE VALUE IS A GUIDANCE VALUE AND NOT A STANDARD
µg/L	MICROGRAMS PER LITER OR PARTS PER BILLION (ppb)
BTEX	BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES
PAHs	POLYCYCLIC AROMATIC HYDROCARBONS
SVOCs	SEMI-VOLATILE ORGANIC COMPOUNDS
VOCs	VOLATILE ORGANIC COMPOUNDS
BOLD	DETECTED CONCENTRATION
BOLD (shaded)	THE DETECTED RESULT VALUE EXCEEDS NYS AWQS

Sample Name: Sample Date:	NYS AWQS	WW-SB-21 (15-25) 7/22/2009
BTEX (ug/L)		
Benzene	1	**4000**
Toluene	5	**2000**
Ethylbenzene	5	**850**
Total Xylene	5	**3200**
Total BTEX	NE	**10050**
Other VOCs (ug/L)		
cis-1,2-Dichloroethene	5	250 U
trans-1,2-Dichloroethene	5	250 U
Styrene	5	**400**
Total VOCs	NE	**10450**
PAHs (ug/L)		
Acenaphthene	20*	**29 J**
Naphthalene	10*	**3400**
Total PAHs	NE	**3651**
Other SVOCs (ug/L)		
Phenol	1	210 U
Total SVOCs	NE	**3651**
Pesticides (ug/L)		
Aldrin	ND	NA
Total Metals (ug/L)		
Iron	300	**8890**
Magnesium	35000*	**261000**
Manganese	300	**332**
Sodium	20000	**205000**
Cyanides (ug/L)		
Total Cyanide	200	**3140**
Other (ug/L)		
Ammonia	2000	**960**

Sample Name: Sample Date:	NYS AWQS	WW-SB-22 (35-45) 7/27/2009
BTEX (ug/L)		
Benzene	1	**1300**
Toluene	5	**360**
Ethylbenzene	5	**160**
Total Xylene	5	**290**
Total BTEX	NE	**2110**
Other VOCs (ug/L)		
Acetone	50*	**55 J**
cis-1,2-Dichloroethene	5	**97**
Styrene	5	**16 J**
Vinyl chloride	2	**14 J**
Total VOCs	NE	**2292**
PAHs (ug/L)		
Acenaphthene	20*	**40 J**
Indeno(1,2,3-cd)pyrene	0.002*	210 U
Naphthalene	10*	**2000**
Total PAHs	NE	**2284**
Other SVOCs (ug/L)		
Total SVOCs	NE	**2284**
Pesticides (ug/L)		
Aldrin	ND	NA
Total Metals (ug/L)		
Iron	300	**22400**
Magnesium	35000*	**62500**
Manganese	300	**6270**
Sodium	20000	**842000 J**
Other (ug/L)		
Ammonia	2000	**7600**

Sample Name: Sample Date:	NYS AWQS	WW-SB-19 (25-35) 7/29/2009	Duplicate of WWSB-19 (25-35) 7/29/2009
BTEX (ug/L)			
Benzene	1	**44**	**36**
Toluene	5	**91 J**	**59 J**
Ethylbenzene	5	**45**	**40**
Total Xylene	5	**95**	**75**
Total BTEX	NE	**275**	**210**
Other VOCs (ug/L)			
Chloroform (Trichloromethane)	7	**7.6**	**7.1**
cis-1,2-Dichloroethene	5	**21**	**19**
trans-1,2-Dichloroethene	5	**30 J**	**29 J**
Trichloroethene (TCE)	5	**42**	**38**
Total VOCs	NE	**378.4**	**305.9**
PAHs (ug/L)			
Benzo(a)anthracene	0.002*	4.2 U	4 UJ
Chrysene	0.002*	4.2 U	4 UJ
Naphthalene	10*	**28**	**21 J**
Total PAHs	NE	**37.16**	**27.44**
Other SVOCs (ug/L)			
Total SVOCs	NE	**38.8**	**29.52**
Total Metals (ug/L)			
Iron	300	**15800**	**16500**
Magnesium	35000*	**39700**	**41100**
Manganese	300	**2800**	**2900**
Sodium	20000	**118000 J**	**122000 J**
Cyanides (ug/L)			
Total Cyanide	200	**9.7 J**	**10**

NOTES:

1. CONTOURS MADE BY LINEAR INTERPOLATION WITH MANUAL SMOOTHING TO ADJUST ARTIFACTS OF INTERPOLATION BETWEEN RELATIVELY DISTANT WELLS.
2. GROUNDWATER CONTOURS AND ELEVATIONS ARE IN FEET ABOVE NORTH AMERICAN VERTICAL DATUM (NAVD88)
3. MONITORING WELLS WERE INSTALLED SPANNING THE GROUNDWATER SURFACE.
4. GROUNDWATER CONTOURS WERE GENERATED USING DATA FROM HIGH TIDE GAUGING ON SEPTEMBER 11, 2024.

SOURCES:

1. AERIAL PHOTOGRAPH NEARMAP ©2024 IMAGERY DATE: 06/18/2024.
2. SANBORN FIRE INSURANCE MAPS (1887 THROUGH 1996).
3. HISTORIC MAP OF BROOKLYN UNION GAS, DATED JULY 29, 1921.
4. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM *HTTP://WWW.OASISNYC.NET* ACCESSED JANUARY 2008.
5. SURVEY OF WILLIAMSBURG WORKS BOUNDARIES, EXISTING CONDITIONS, AND SAMPLE LOCATIONS CONDUCTED BY GEI CONSULTANTS, INC. SURVEYED BY NEW YORK STATE-LICENSED LAND SURVEYOR No. 050146.

0 80 160
SCALE, FEET

Remedial Investigation Report
Williamsburg Works Former MGP Site
Borough of Brooklyn, New York

nationalgrid

GEI Consultants

SEPTEMBER 11, 2024
HIGH TIDE INTERMEDIATE CONTOURS AND GROUNDWATER ANALYTICAL SUMMARY

Project 093060 | February 2025 | Plate 8

Sample Name: / Sample Date:	NYS AWQS	WW-MW-202D 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	ND
Other VOCs (ug/L)		
Total VOCs	ND	**4.86**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Iron	300	**1240**
Magnesium	35000*	**543000**
Manganese	300	**1110**
Sodium	20000	**4800000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-203D 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	ND
Other VOCs (ug/L)		
Chloroform (Trichloromethane)	7	**47**
Total VOCs	ND	**56.5**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Magnesium	35000*	**57100**
Sodium	20000	**586000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-200D 9/12/2024
BTEX (ug/L)		
Benzene	1	**3.1**
Total BTEX	ND	**4.64**
Other VOCs (ug/L)		
Chloroform (Trichloromethane)	7	**11**
Total VOCs	ND	**17.95**
PAHs (ug/L)		
Total PAHs	ND	**1**
Other SVOCs (ug/L)		
Total SVOCs	ND	**1**
Total Metals (ug/L)		
Iron	300	**14300**
Magnesium	35000*	**295000**
Manganese	300	**1770**
Sodium	20000	**2150000**

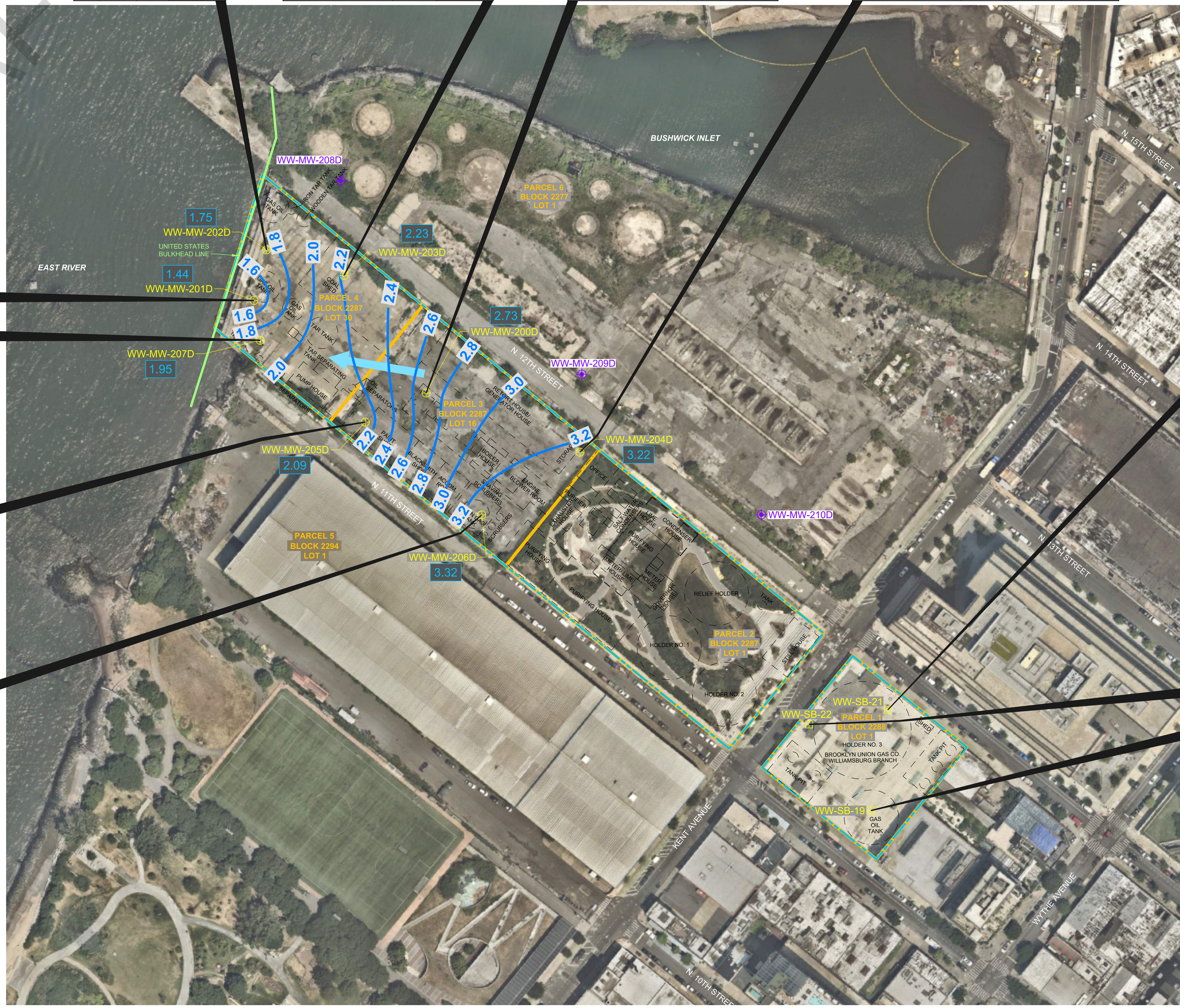
Sample Name: / Sample Date:	NYS AWQS	WW-MW-204D 9/12/2024	Duplicate of WW-MW-204D 9/12/2024
BTEX (ug/L)			
Benzene	1	**3**	**2.9**
Total BTEX	ND	**3.31**	**2.9**
Other VOCs (ug/L)			
Chloroform (Trichloromethane)	7	**15**	**15**
Total VOCs	ND	**23.51**	**23.8**
PAHs (ug/L)			
Total PAHs	ND	**1.1**	**1.1**
Other SVOCs (ug/L)			
Total SVOCs	ND	**1.1**	**1.1**
Total Metals (ug/L)			
Sodium	20000	**157000**	**158000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-201D 9/12/2024
BTEX (ug/L)		
Benzene	1	**1.5**
Total BTEX	ND	**6.18**
Other VOCs (ug/L)		
Total VOCs	ND	**9.46**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Iron	300	**12900**
Magnesium	35000*	**595000**
Manganese	300	**2070**
Sodium	20000	**5840000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-207D 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	ND
Other VOCs (ug/L)		
Total VOCs	ND	**7.78**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Magnesium	35000*	**280000**
Manganese	300	**986**
Sodium	20000	**3670000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-205D 9/12/2024
BTEX (ug/L)		
Total BTEX	ND	**3.08**
Other VOCs (ug/L)		
Chloroform (Trichloromethane)	7	**34**
Total VOCs	ND	**38.58**
PAHs (ug/L)		
Total PAHs	ND	ND
Other SVOCs (ug/L)		
Total SVOCs	ND	ND
Total Metals (ug/L)		
Magnesium	35000*	**243000**
Sodium	20000	**2050000**

Sample Name: / Sample Date:	NYS AWQS	WW-MW-206D 9/12/2024
BTEX (ug/L)		
Benzene	1	**4.5**
Total BTEX	ND	**8**
Other VOCs (ug/L)		
Chloroform (Trichloromethane)	7	**35**
Total VOCs	ND	**49.8**
PAHs (ug/L)		
Total PAHs	ND	**1.7**
Other SVOCs (ug/L)		
Total SVOCs	ND	**1.7**
Total Metals (ug/L)		
Sodium	20000	**108000**



Sample Name: / Sample Date:	NYS AWQS	WW-SB-21 (40-50) 7/23/2009
BTEX (ug/L)		
Benzene	1	**8300**
Toluene	5	**2700**
Ethylbenzene	5	**1600**
Total Xylene	5	**1800**
Total BTEX	NE	**14400**
Other VOCs (ug/L)		
cis-1,2-Dichloroethene	5	**130 J**
trans-1,2-Dichloroethene	5	**240 J**
Styrene	5	500 U
Total VOCs	NE	**14770**
PAHs (ug/L)		
Acenaphthene	20*	**42 J**
Naphthalene	10*	**2200**
Total PAHs	NE	**2617**
Other SVOCs (ug/L)		
Phenol	1	200 U
Total SVOCs	NE	**2617**
Pesticides (ug/L)		
Aldrin	ND	NA
Total Metals (ug/L)		
Iron	300	**2420**
Magnesium	35000*	**29100**
Manganese	300	**452**
Sodium	20000	**56500**
Cyanides (ug/L)		
Total Cyanide	200	**58.6**
Other (ug/L)		
Ammonia	2000	**3800**

Sample Name: / Sample Date:	NYS AWQS	WW-SB-22 (55-65) 7/27/2009
BTEX (ug/L)		
Benzene	1	**9600**
Toluene	5	**1100**
Ethylbenzene	5	**1400**
Total Xylene	5	**1500**
Total BTEX	NE	**13600**
Other VOCs (ug/L)		
Acetone	50*	1000 U
cis-1,2-Dichloroethene	5	500 U
Styrene	5	500 U
Vinyl chloride	2	500 U
Total VOCs	NE	**13600**
PAHs (ug/L)		
Acenaphthene	20*	**82 J**
Indeno(1,2,3-cd)pyrene	0.002*	200 U
Naphthalene	10*	**2600**
Total PAHs	NE	**2902**
Other SVOCs (ug/L)		
Total SVOCs	NE	**2902**
Pesticides (ug/L)		
Aldrin	ND	NA
Total Metals (ug/L)		
Iron	300	**21000**
Magnesium	35000*	**39300**
Manganese	300	**466**
Sodium	20000	**106000 J**
Other (ug/L)		
Ammonia	2000	**9200**

Sample Name: / Sample Date:	NYS AWQS	WW-SB-19 (40-50) 7/29/2009
BTEX (ug/L)		
Benzene	1	5 U
Toluene	5	**64**
Ethylbenzene	5	**11**
Total Xylene	5	**55**
Total BTEX	NE	**130**
Other VOCs (ug/L)		
Chloroform (Trichloromethane)	7	**3.1 J**
cis-1,2-Dichloroethene	5	**4.9 J**
trans-1,2-Dichloroethene	5	5 U
Trichloroethene (TCE)	5	5 U
Total VOCs	NE	**138**
PAHs (ug/L)		
Benzo(a)anthracene	0.002*	4.2 U
Chrysene	0.002*	4.2 U
Naphthalene	10*	4.2 U
Total PAHs	NE	ND
Other SVOCs (ug/L)		
Total SVOCs	NE	ND
Total Metals (ug/L)		
Iron	300	**40400**
Magnesium	35000*	**38800**
Manganese	300	**1080**
Sodium	20000	**41400 J**
Cyanides (ug/L)		
Total Cyanide	200	**297**

N

LEGEND:

APPROXIMATE CURRENT PARCEL BOUNDARY

APPROXIMATE BOUNDARY OF FORMER MGP PROPERTY / SITE BOUNDARY

HISTORIC MGP STRUCTURES

PROPOSED 2024 SUPPLEMENTAL REMEDIAL INVESTIGATION - PARCEL 6 SAMPLE LOCATIONS

WW-MW-208D PROPOSED MONITORING WELL

PREVIOUS REMEDIAL INVESTIGATION SAMPLES

WW-MW-200D MONITORING WELL

WW-SB-21 SOIL BORING WITH TEMPORARY GROUNDWATER POINT

5.0 GROUNDWATER CONTOUR (FEET NAVD88)

GROUNDWATER FLOW DIRECTION

2.73 GROUNDWATER ELEVATION (FEET NAVD88) MEASURED 9/11/2024

ANALYTICAL BOXES

NYS AWQS	NEW YORK STATE AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES FOR GA GROUNDWATER
ND	NOT DETECTED
NE	NOT ESTABLISHED NYS AWQS
J	ESTIMATED VALUE
JN	ANALYTE IS PRESUMPTIVELY PRESENT AT AN APPROXIMATED QUANTITY
*	THE VALUE IS A GUIDANCE VALUE AND NOT A STANDARD
µg/L	MICROGRAMS PER LITER OR PARTS PER BILLION (ppb)
BTEX	BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES
PAHs	POLYCYCLIC AROMATIC HYDROCARBONS
SVOCs	SEMI-VOLATILE ORGANIC COMPOUNDS
VOCs	VOLATILE ORGANIC COMPOUNDS
BOLD	DETECTED CONCENTRATION
BOLD	THE DETECTED RESULT VALUE EXCEEDS NYS AWQS

NOTES:

1. CONTOURS MADE BY LINEAR INTERPOLATION WITH MANUAL SMOOTHING TO ADJUST ARTIFACTS OF INTERPOLATION BETWEEN RELATIVELY DISTANT WELLS.
2. GROUNDWATER CONTOURS AND ELEVATIONS ARE IN FEET ABOVE NORTH AMERICAN VERTICAL DATUM (NAVD88)
3. MONITORING WELLS WERE INSTALLED SPANNING THE GROUNDWATER SURFACE.
4. GROUNDWATER CONTOURS WERE GENERATED USING DATA FROM HIGH TIDE GAUGING ON SEPTEMBER 11, 2024.

SOURCES:

1. AERIAL PHOTOGRAPH NEARMAP ©2024 IMAGERY DATE: 06/18/2024.
2. SANBORN FIRE INSURANCE MAPS (1887 THROUGH 1996).
3. HISTORIC MAP OF BROOKLYN UNION GAS, DATED JULY 29, 1921.
4. NEW YORK CITY OPEN ACCESSIBLE SPACE INFORMATION SYSTEM *HTTP://WWW.OASISNYC.NET* ACCESSED JANUARY 2008.
5. SURVEY OF WILLIAMSBURG WORKS BOUNDARIES, EXISTING CONDITIONS, AND SAMPLE LOCATIONS CONDUCTED BY GEI CONSULTANTS, INC. SURVEYED BY NEW YORK STATE-LICENSED LAND SURVEYOR No. 050146.

DRAFT

0 80 160
SCALE, FEET

Remedial Investigation Report
Williamsburg Works Former MGP Site
Borough of Brooklyn, New York

nationalgrid

GEI Consultants

SEPTEMBER 11, 2024
HIGH TIDE DEEP CONTOURS
AND GROUNDWATER
ANALYTICAL SUMMARY

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